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RAMACO

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HYDROLOGY

Appendix D6

Prepared by:
WWC Engineering

December 2019

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D6 HYDROLOGY

Hydrologic sections for RAMACO's Brook Mine were prepared by WWC Engineering (WWC) of Sheridan, Wyoming.

D6.1 Surface Water

The following sections provide the information gathered to define the surface-water baseline for the Brook Mine permit area.

D6.1.1 Regional Description

The Brook Mine is located in the upper reaches of the Tongue River drainage basin (Hydrologic Unit Code (HUC) 10090102) near its confluence with Goose Creek. The Tongue River originates in the Bighorn Mountains in north central Wyoming, flows through southeastern Montana where it empties into the Yellowstone River at Miles City. The drainage area for the Tongue River encompasses approximately 5,397 square miles (United States Geological Survey, 2013). Exhibit D6.1-1 shows the Tongue River and Goose Creek drainage basins above the Brook Mine permit area. The main tributaries to Tongue River and Goose Creek on and near the permit area are Slater Creek and Hidden Water Creek. Exhibit D6.1-2 shows the major drainage basin divides in the general area of the Brook Mine permit area.

The Brook Mine is located in the semi-arid west where evaporation exceeds annual precipitation. Climatology for the site is discussed in Appendix D4.

D6.1.2 Drainage Basin Description

Brook Mine is located in the northeastward flowing Tongue River drainage basin as shown on Exhibit D6.1-1. Slater Creek and Hidden Water Creek flow from northwest to southeast and the majority of the runoff from areas within the Brook Mine permit boundary will flow into one of these streams with the remaining runoff flowing into either Tongue River or Goose Creek via a minor tributary as shown on Exhibit D6.1-2. Drainage basin geomorphology for the Brook Mine area is presented in Table D6.1-1.

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The permit area is typical of the Tongue River Basin with rugged terrain in steep-sided, irregular gullies and washes. These types of features continue in each direction from the permit area. The permit area contains portions of valleys for the drainages of Tongue River, Goose Creek, Slater Creek and Hidden Water Creek. These valleys range in width from 200 feet for Hidden Water Creek to 3,500 feet for Tongue River.

The Tongue River drainage system cuts into the Fort Union Formation. Structural and bedrock controls on stream channel orientation are reflected in the sub-dendritic drainage pattern. Tributaries are often oriented parallel to the northwest-to-southeast structural trends, and abrupt changes in channel direction may follow major joint or fault trends. Elevations in the Tongue River drainage basin range from approximately 11,800 feet msl in the headwaters area to approximately 3,600 feet msl at the confluence with Goose Creek. Hidden Water Creek, its minor contributing tributaries and Slater Creek's minor contributing streams are all ephemeral streams. Flows in ephemeral streams are in response to precipitation and snowmelt. These flows are dependent on precipitation frequency-duration relationships and on the characteristics of the contributing drainage areas. Slater Creek is identified as an intermittent stream. Intermittent streams are streams that are below the local water table for some part of the year, but are not perennial streams. In addition to direct runoff due to precipitation, Slater Creek may also have some discharge that comes from infiltration of precipitation into high perched scoria burn above the channel areas that seep into the colluvial/alluvial areas as described in Appendix D11. The water is then stored and slowly released into the surface flow downstream. Based on upstream and downstream flows presented in Addendum D6-4, Slater Creek is likely a losing stream through the permit area. This loss of flow is likely due to the infiltration of flow into the colluvial alluvial material that comprise the channel bottom. Basin characteristics, which control precipitation-runoff characteristics are: area, relief, soil type, vegetative cover and stream length. These parameters are critical in determining the hydrologic and geomorphic characteristics of the drainage basin.

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D6.1.3 Surface Runoff Estimates

D6.1.3.1 Regional USGS

There are no long-term streamflow records available for the streams inside of the permit boundary. However, two United States Geological Survey (USGS) gaging stations are located on Tongue River, two USGS gaging stations are located on Goose Creek, and one on Slater Creek near Monarch, WY. One Tongue River gaging station is approximately 2.9 miles upstream from the Goose Creek confluence. The second Tongue River gaging station is approximately 27.9 miles below the Goose Creek confluence. One Goose Creek gaging station is approximately 11.5 miles above the Tongue River confluence and the other Goose Creek gaging station is approximately 3.3 miles above the Tongue River confluence. The Slater Creek gaging station is approximately 0.2 miles above its confluence with Tongue River. Although the gaging stations are not located on the permit area, the data collected by the gaging stations is useful for observing and verifying trends that cannot be obtained with the limited records from the Brook Mine gaging stations alone. Locations of the USGS gaging stations are shown on Exhibit D6.1-1. Information for these gaging stations is presented in Table D6.1-2.

Figure D6.1-1 displays the mean monthly discharge rate at four of the USGS gaging stations. The discharge is typically lowest from August to April and highest from May to June. Table D6.1-3 presents the observed peak annual flows at the USGS gaging stations. During the period of record for the Tongue River gaging station at Monarch WY the peak flow was in June 2007 at 3,910 cfs. The peak flow for the Tongue River gaging station at State Line near Decker MT was in May 1978 at 17,500 cfs. The peak flow for the Goose Creek gaging station below Sheridan WY was in June 1963 at 5,450 cfs. The peak flow for the Goose Creek gaging station near Acme WY was in June 2007 at 3,430 cfs. The peak flow for the Slater Creek gaging station was in June 1967 at 1,700 cfs. The timing of these peak flows indicates that snow melt and spring run-off typically result in the highest flows.

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D6.1.3.2 Flood Studies

Due to the relatively small drainage areas within the Brook Mine Permit, no USGS stream gages are located on any of the channels within the permit area. Therefore, flood studies were conducted to calculate the peak flow and runoff volumes for the drainage within the permit.

The rainfall-runoff computer program, HEC-HMS (U.S. Army Corps of Engineers, 2009) was used to predict peak discharge and runoff volumes for various recurrence intervals within the permit area. The program was selected due to the range of sizes of the drainage areas, the watershed routing functions available in the program, and the universal acceptance of the program within the hydrologic sciences community. The HEC-HMS model uses a form of the NRCS (formerly SCS) Triangular Hydrograph Method, and is a parametric method of estimating flood peaks and runoff volumes from site-specific data, in addition to providing watershed routing parameters. The NRCS method was utilized for the evaluation of individual watershed hydrology, while the Muskingum-Cunge method was used for routing procedures. Existing impoundments (such as stock reservoirs) were not considered in routing of the precipitation events. Impoundments would attenuate peak flows during runoff events. By not considering attenuation of flows through impoundments, the peak flow estimates from HEC-HMS should be conservatively high.

Procedures followed in applying these methods may be found in the HEC-HMS Users Manual (U.S. Army Corps of Engineers, August 2009), HEC-HMS Technical Reference Manual (U.S. Army Corps of Engineers, 2000) and the Design of Small Dams (U.S. Bureau of Reclamation, 1987).

The precipitation values used for surface runoff estimates were determined from the NOAA Atlas No. 2 for Wyoming (National Oceanic and Atmospheric Adminstration, 1973) and are presented in Table D6.1-4. Soil types, land condition and vegetation cover were used to develop a runoff curve number (CN) for each drainage basin. Soil types were obtained from the NRCS Web Soil Survey Program (NRCS Web Soil Survey, 2013). The hydrologic soil groups were used in

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conjunction with rangeland in fair condition to determine the curve number for each soil type. The curve number for each drainage was determined by area weighting the values for each soil type. Curve numbers utilized are presented in Table D6.1-1.

The HEC-HMS analyses input parameters and results are presented in Addendum D6-1. The surface runoff estimates for the 6-hour and 24-hour storm events are summarized in Table D6.1-5 and Table D6.1-6, respectively.

Runoff calculations for Hidden Water Creek and Slater Creek were also performed using regression equations developed by Miller's equations which were developed through the use of refined analytical techniques to interpret data from 364 selected continuous and partial-records streamflow gaging stations that were minimally affected by anthropogenic activities and had at least ten years of annual peak data (Miller, 2003). Instantaneous peak flow data through the year 2000 were also utilized in the analysis. The data were used to provide a correlation between flow characteristics and basin characteristics. The resulting information was transformed into regression equations that provide an analytical tool for estimating peak flow events where no gaging data is available. The regression calculations are provided in Addendum D6-2. A comparison of the runoff estimates using the Miller (2003) and HEC-HMS methods is shown in Table D6.1-7. The HEC-HMS runoff estimates are higher than the estimates using Miller's method due in part to existing reservoirs. The Miller method is based on empirical measurements of Wyoming streams, most of which are affected by existing reservoirs. Aforementioned, the HEC-HMS model did not consider attenuation by existing reservoirs. A report released by the U.S.G.S. examined the floods of May 1978 in southeastern Montana and northeastern Wyoming. This report stated that during the May 1978 flood event, peak flows in the Tongue River basin were measured at approximately the 1-percent-chance (100-year) flood estimates. The flow reported for Slater Creek during this event was approximately 1,100 cfs (United States Geological Survey, 1984). For the 100-year flood, this is more comparable to the Miller method as shown in Table D6.1-7. However, channel hydraulics were calculated using the higher runoff estimates from the

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HEC-HMS method because of its broad acceptance in the hydrologic community; the flowrates provide for conservative design; and comparable results to the postmining hydrology can be obtained through using HEC-HMS. HEC-HMS will calculate the same storm in the same area repeatedly, as opposed to measurements that only represent a specific period in time under specific drainage basin conditions. The ability to change drainage basin parameters is useful in comparing the change in the postmining hydrologic environment. Channel hydraulics based on the HEC-HMS results are provided in Addendum D6-3.

D6.1.3.3 Channel Geometry

Premining longitudinal profiles of the streams were determined from flight topography. The topography was generated from LiDAR data collected by Fugro EarthData, Inc. on October 16, 2013. The LiDAR data accuracy meets the National Map Accuracy Standards (U.S. Bureau of the Budget, 1947) for 1"=100' scale, 2' contour interval mapping. The profiles are shown on Exhibit D6.1-3. Some of the minor tributaries exhibit more deeply incised channels and show evidence of localized headcutting. Numerous stock ponds are located along the lengths of some of these tributaries, and they may factor in the presence of headcutting along the tributaries by reducing instream sediment loads.

Hydraulic properties of the Slater Creek and Hidden Water Creek channels were determined using the U.S. Army Corps of Engineer's HEC-RAS© River Analysis System. The primary input parameters for the steady flow analysis were as follows: peak discharge for the 2-year, 24-hour and 100-year, 24-hour precipitation events (as determined by HEC-HMS watershed model); Manning's roughness value "n" for the channel and overbank areas (inferred based on site conditions including vegetation type, vegetation height and soil conditions); and station/elevation data for stream cross sections within the study area. Based on experience with other HEC-RAS modeling analyses in the Powder River Basin and to adequately represent the entire stream length, the cross section interval utilized in the model was selected at 500 feet. Cross sections were developed using cross

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section routines in the Carlson® software packages using the 2' contour interval flight topography described earlier in this section. Cross sections were evaluated and removed/revised individually prior to modeling to adequately capture channel geometry and prevent overlapping. Each cross section was reviewed individually and adjusted as necessary to determinate the channel thalweg and overbanks. Channel hydraulic values for flow depth, water surface width, flow area, manning's "n", hydraulic radius and mean channel velocity can be found in Table D6.1-8. Results of HEC-RAS modeling can be found in Addendum D6-3.

Discussion of channel vegetation, soils and sediment deposits may be found in Appendices D7, D8 and D11; respectively. Table D6.1-1 provides channel geometry information such as sinuosity and channel slope.

D6.1.4 Surface Water Use

A surface water rights search was completed within the permit area and adjacent to the permit area using the Wyoming State Engineer's Office database. The search of the database found 45 reservoir surface water rights and 47 diversion ditch water rights exist within the search area. A summary of the surface water features is included in Tables D6.1-9 (Stockponds and Impoundments) and D6.1-10 (Diversions) and are shown on Exhibit D6.1-2. In addition to the permitted surface water rights, 14 additional unpermitted reservoirs were identified. Unpermitted reservoirs have been included in the table and are denoted as such. Refer to Adjudication for a complete list of water rights within and adjacent to the permit area.

Surface water use within the permit area and surrounding area are primarily for livestock watering, with lesser amounts of irrigation, fishing, wetlands and industrial uses. The diversions within the permit area and surrounding area are primarily used for irrigation, with lesser amounts used for domestic, municipal and temporary uses. The number and age of surface water rights provide insight into the historical water and land use in the area. Stock reservoirs account for about 75% of the total reservoir water rights in the search area, but if stock reservoirs not listed in the Wyoming State Engineer's Office

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database are included, the proportion climbs to about 80% of the total reservoir water rights. Most of the stock reservoirs were constructed before 1970 with the majority still in use today. Irrigation water rights account for approximately 70% of the diversion surface water rights. Approximately 80% of the irrigation rights were permitted between 50 and 100 years ago with recent permits primarily being for diversion enlargements or domestic use.

D6.1.5 Surface Water Monitoring

D6.1.5.1 Monitoring Stations

The Brook Mine established four surface water monitoring stations in September 2013, two sites on Slater Creek and two sites on Hidden Water Creek. The locations of the monitoring sites are shown on Exhibit D6.1-2. Details on the monitoring stations are summarized in Table D6.1-11. The sites were identified during a preliminary field investigation and discussions with the Wyoming Department of Environmental Quality Land Quality Division. Criteria for each station location included: 1) a straight reach of the channel, 2) the channel should be close to an elevated bank that has a fairly steep grade to ensure the instruments will not be flooded, 3) the distance from the center of the channel to the instruments is less than 50 feet (length of sensor cable), and 4) avoid being located in submerged channel reaches (pools).

In September 2013, continuous stage recorders were installed at all four of the sites and an integrated pump sampler at the lower Slater Creek site (SM578418-SW-1). The stage recorders are designed to continuously measure flow. During installation of each station, the cross section and profile of the stream channel at each station was surveyed. The survey data were then used to develop a rating curve, which was programmed into the continuous stage recorder to calculate flow. The pump sampler installed on lower Slater Creek was used to collect water quality samples during runoff events. The pump sampler was initiated by a specific flow stage for flows greater than one foot based on stream geomorphology. The water sample will automatically be collected in a single container located in the instrument. Following the runoff event the water was

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manually transferred from the container to sample bottles and submitted to the laboratory for analysis.

Surface water monitoring sites were monitored monthly during baseline sampling for structural, mechanical, and electrical integrity of equipment; during site visits by field personnel. These inspections are denoted on the field sheets included in Addendum D6-6. During these site investigations personnel also checked for signs of erosion or debris preventing the proper function of any equipment. If problems were discovered during the site visit they were corrected and denoted in the field sheets. Site visits were also conducted after 2-year, 24-hour or greater storm events. The surface water monitoring stations were removed from the site during the winter to prevent damage to the equipment. The timeframes that the monitoring stations were onsite are as follows: the monitoring stations were installed on September 17 & 30, 2013 and removed for the winter on October 31, 2013; the monitoring stations were reinstalled on April 22 & 24, 2014 and remained for the summer of 2014.

In addition to the surface water monitoring stations, RAMACO established two grab sample sites on the Tongue River (578420-TR-1 and 578524-TR-1), one grab sample site on an irrigation ditch adjacent to the Tongue River (578513-IRR-DITCH), and one grab sample site on Goose Creek (578434-GC-1). The sites were established to collect baseline data and details on the monitoring stations are summarized in Table D6.1-11. Sampling at the grab sample site on Goose Creek commenced in 2015, while sampling on all the other sites commenced in 2018.

Wyoming Department of Environmental Quality classifies the Tongue River and Goose Creek as 2AB streams and Earley Creek, Slater Creek, and Hidden Water Creek as 3B. Waters classified as 2AB are suitable for use as drinking water, game fish, non-game fish, fish consumption, other aquatic life, recreation, wildlife, agriculture, industry and scenic value. Waters classified 3B streams are suitable for use of other aquatic life, recreation, wildlife, agriculture, industry, and scenic value.

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In addition to the monitoring performed by RAMACO, monitoring of the Tongue River watershed has been conducted by the Sheridan County Conservation District (SCCD), the Big Horn Mine, USGS, and WDEQ/WQD. The SCCD prepared a report outlining water quality of the Tongue River watershed from the confluence with Goose Creek to the Bighorn National Forest boundary (Sheridan County Conservation District, 2017, which is included as Addendum D6-11). Data for this report was collected from 1996 through 2016 and included the parameters: water temperature, pH, conductivity, dissolved oxygen, discharge, turbidity and E.Coli. The water quality data obtained for the report was generally within expected ranges for several parameters including pH, dissolved oxygen and specific conductivity. Several of the sites experienced an increase in E.Coli bacteria compared to samples collected in 2006. However, the increase may be attributed to higher run-off and streamflows experienced during May-June 2016. Generally, turbidity values for the 2016 report were normal; however, during the spring and early summer runoff period values were occasionally high.

The Tongue River watershed report from the SCCD contains water flow and quality data collected from monitoring station TR03. This site is located on the Tongue River, approximately 20 meters downstream of Hwy 339 bridge crossing, as shown on Exhibit D6.1-1. Water flow data from the site can be found in Table D6.1-14.

The Big Horn Mine operated monitoring station TR2B80 and HWC1-79 as part of their monitoring program. TR2B80 is located downstream of the mining at Big Horn Mine on the Tongue River and HWC1-79 is located on Hidden Water Creek. The monitoring station locations are presented on Exhibit D6.1-2. Mean daily flow at TR2B80 for 2016 and 2017 can be found in Table D6.1-15. When rating curve data at TR2B80 appeared to be inaccurate at the measured stages, the flow data in Table D6.1-15 were estimated by adding reported flows from the Goose Creek (GC00) and upper Tongue River (Tr01) (or corresponding USGS) stations. Table D6.1-16 provides a summary of flow days for the HWC1-79 monitoring site from 1982 to 1998. As shown by the table, Hidden Water Creek

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flows in response to snow melt or precipitation events. Water quality samples were collected from Tongue River water stations TR03, TR2B80, and HWC1-79 in 2016, 2016-2018, and 1979-1989, respectively. A summary of the water quality data can be found in Table D6.1-17. Conductivity and discharge levels at the monitoring station TR03 for 2013 and 2016 are displayed in Figures D6.1-2 and D6.1-3, respectively. Figure D6.1-4 presents conductivity and discharge levels for monitoring station TR2B80.Sections of the Tongue River near the proposed mine are currently on the Wyoming Department of Environmental Quality's 303(d) list due to impaired water quality. Also, Goose Creek has been on the 303(d) list in the past and a Total Maximum Daily Load (TDML) has been set. The 303(d) list is a list compiled by a state that includes impaired and threatened waters for which the effluent limits are not effective in attaining designated uses.

D6.1.5.2 Surface Water Quantity

The general area surrounding the Brook Mine is characterized by mostly ephemeral streams. The drainage basins convert little precipitation to runoff because of generally dry soil conditions, high evapotranspiration rates, high initial abstractions, stock ponds, and reservoirs. These factors, in addition to low-frequency, low-magnitude precipitation events result in low average annual volume of runoff. A summary of discharge data for the USGS gaging stations on the Tongue River is contained in Section D6.1.3.1.

Hydrographs generated from the data collected from the monitoring stations located on Hidden Water Creek (SM578415-SW-1 and SM578409-SW-1) within the permit area are shown in Addendum D6-4. As shown on these hydrographs, no measurable flows were detected on Hidden Water Creek. Minimum measurable flow rates are listed on the rating curves included in Addendum D6-5 as less than 0.15 cfs for monitoring station SM578415-SW-1 and less than 0.22 cfs for monitoring station SM578409-SW-1. Flow on Hidden Water Creek is influenced by: the existing mine pits in the upper portions of the Hidden Water Creek drainage, several reservoirs existing in the drainage as shown on Exhibit D6.1-2, and the lack of a significant precipitation event during the monitoring period. The

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collected data indicates that Hidden Water Creek is an ephemeral stream with flow responses primarily due to large storm events. Flow data from former Big Horn Mine surface monitoring station HWC1-79 supports Hidden Water Creek being a primarily ephemeral stream with the majority of the flows occurring in late winter and early spring. The summarized flow data is in Table D6.1-16 depicted by the number of flow days at HWC1-79. The approximate location for surface monitoring station HWC1-79 appears on Exhibit D6.1-2.

Hydrographs generated from the data collected from the monitoring stations located on Slater Creek (SM578418-SW-1 and SM578512-SW-1) within the permit area are also shown in Addendum D6-4. As shown on these hydrographs, no measurable flows were collected in during baseline monitoring. Minimum measurable flow rates are listed on the rating curves included in Addendum D6-5 as less than 0.29 cfs for monitoring station SM578418-SW-1 and less than 0.09 cfs for monitoring station SM578512-SW-1. The Slater Creek gages were removed for winter conditions from October 31, 2013 through April 22, 2014. The gages were reinstalled on April 22 and had measurable flows every day through late June as shown in Addendum D6-4. The collected flow rates show typical event durations of three to six days. Slater Creek is above the upper zone of saturation of the adjacent unconfined overburden, which is dry and incapable of producing greater than 0.5 gpm of water. This data indicates that Slater Creek is an intermittent stream with flow responses due to snowmelt, rainfall/runoff events and discharge from infiltration of precipitation from high perched scoria burn areas seeping into colluvial and alluvial areas. The data also shows that the recorded peak runoff events for the baseline monitoring occurred on May 8 (SM578418-SW-1) and May 10 (SM578512-SW-1). The peak runoff dates correlate with the typical peak runoff events for Goose Creek and Tongue River as shown in Table D6.1-3.

D6.1.5.3 Surface Water Quality

Water quality data for the general area are available from the USGS gaging stations on Tongue River and Goose Creek. These data are available online from

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the USGS National Water Information System Web Interface (USGS, 2013). Field samples from USGS station 06299980 Tongue River at Monarch, WY near the permit area were analyzed for multiple parameters. Average water quality from the USGS station indicates a water type of calcium-bicarbonate. Water quality data for the general area can also be found in the aforementioned SCCD report for the Tongue River (Sheridan County Conservation District, 2017).

Water quality samples were collected from two surface water monitoring stations located on Slater Creek. Samples were collected during flow events via an ISCO automatic sampler. In addition, grab samples were also collected at monitoring stations on a quarterly basis if flow was occurring during the quarterly site visit. Samples were obtained in accordance with criteria established in WDEQ/LQD Guideline 8. Due to the low flow nature of the Slater and Hidden Water Creeks only five grab samples from Slater Creek were obtained for the baseline water quality. Hidden Water Creek sites were checked but were found dry. A total of five quarterly grab samples (2nd quarter 2015 through 2nd quarter 2016) were obtained from the site on Goose Creek. Quarterly sampling on the Tongue River sites and irrigation ditch adjacent to the Tongue River commenced in the 2nd quarter 2018. All samples were analyzed for the constituents listed in Table D6.1-12. Table D6.1-12 also includes the analytical method used for the samples. The samples from Slater and Hidden Water Creeks indicate a water type of magnesium-calcium sulfate, with moderately high total dissolved solid (TDS) concentrations. The five samples from Slater Creek indicate no exceedances of Class 3B criteria. All other parameters exhibited low to non-detect values. The samples from Goose Creek indicate a water type of magnesium-calcium bicarbonate, with low TDS. The Tongue River and the irrigation ditch results indicate a calcium bicarbonate water type with low TDS. The samples from Goose Creek indicate no exceedances of Class 2AB criteria. At least one sample from the Tongue River sites and the irrigation ditch site exceeded the Class 2AB temperature criterion of 20°C. All other parameters exhibited low to non-detect values. Summary of the water quality sampling results are listed in Table D6.1-13.

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Addendum D6-6 provides the laboratory results and field sheets for the surface water stations. In addition, nine samples were collected from the former Big Horn Mine surface water station, HWC1-79, on Hidden Water Creek. The samples indicate a water type of magnesium sulfate. Some concentrations of aluminum and copper exceed WDEQ standards for aquatic life. A summary of HWC1-79 can be found in Table D6.1-17 and the location can be found on Exhibit D6.1-2.

Field parameters were measured during grab sample events and from events activating the automatic sampler including; pH, electrical conductivity (EC), temperature, turbidity, dissolved oxygen, oxygen reduction potential (ORP), and discharge or water level where appropriate. The results of the field measurements are shown in Table D6.1-13. Field observations have been recorded on the water quality sampling field forms (Addendum D6-6).

The laboratory analysis of collected grab and flow event water samples was conducted by a contracted laboratory. A quality assurance and quality control program was adhered to which included comparison of field EC to laboratory EC, comparison of field turbidity to laboratory turbidity, comparison of measured TDS to calculated TDS, ion balance analysis and holding time/preservation evaluations. The laboratory reports, field sheets, and chain of custodies (COCs) for the surface water monitoring are also included in Addendum D6-6.

D6.1.5.4 Sediment Transport

A water quality sample was taken for the downstream Slater Creek gaging station (SM578418-SW-1). This station reported a total suspended solids (TSS) of 9 mg/L in 2014. Two additional water quality samples in 2015 from this station reported a TSS of 10 mg/L and 4800 mg/L. The 4800 mg/L TSS value is thought to be from high flow conditions occurring at the time of sampling. A summary of the collected TSS data is shown in Table D6.1-13 and included in Addendum D6-6. No discharges occurred for Hidden Water Creek during the baseline monitoring period. Only a single downstream water quality sample was collected during the baseline monitoring program.

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D6.2 Groundwater

The following is a brief description of the geologic setting at the Brook Mine as it relates to groundwater hydrology. Appendix D5 contains a more detailed description of the geologic setting.

D6.2.1 Regional Hydrogeology

The Brook Mine permit area is located in the Tongue River Member of the Fort Union Formation and is underlain by the Lebo Shale Member of the Fort Union Formation as discussed in Appendix D5. The Ground-Water Resources of Sheridan County, Wyoming (USGS, 1966) identified the Fort Union formation as continental deposits of light-colored sandstone, dark-colored shale, and coal. Coal is the only regional shallow (less than 1000') aquifer that has sufficient quantities of water for domestic and stock use, and which is continuous enough to be considered a regional aquifer. The Tongue River Member and the Lebo Shale Member are interbedded sandstones and claystones and not continuous enough to be considered a regional aquifer.

The structure of the basin and local topography are the main factors controlling groundwater movement within the Powder River Basin. On a regional basis, flow moves from peripheral recharge areas (Clinker outcrops) toward the center of the basin. Locally, shallow groundwater movement is affected by topography. Infiltrating water falling on topographically high areas generally moves downward and laterally in the overburden. Depending on the local geology, this results in water in the overburden system recharging the coal or discharging to nearby valleys. The water reaching the coal through the overburden system also generally moves downward and laterally to discharge areas in nearby valleys.

D6.2.1.1 Local Hydrogeology

There are three potential hydrogeologic units at the Brook Mine: the Carney seam, the Masters seam; and the underburden. Of these three units, only the Carney seam and the Masters seam appear to be significant units. The overburden is comprised of sand lenses, clinker and alluvial that has the potential of being

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water bearing bodies. The topography in this area the valley cut and faulting through these deposits provide enough discontinuity to preclude holding large quantities of water. Addendum D5-2 contains electric logs with resistivity data that demonstrates the overburden is dry. In review of those lithologic logs it is noted that the overburden is mostly dry except for a few boreholes where the alluvium/colluvium and burn materials indicated the presence of water. These areas of saturation are generally shallow, less than 30 feet below the ground surface, and generally occur near streams within the permit area. The alluvial system is discussed in D11. Detailed cross sections of the permit area geology are shown in Appendix D5. These sections show the geologic units, geologic features and existing surface. Exhibit D6.2-1 shows the monitor well sites while Exhibits D6.2-2 and D6.2-3 show potentiometric surfaces, recharge/discharge areas and approximate coal outcrop and edge of saturation boundaries for the Masters and Carney coal seams. Appendix D11 contains an exhibit showing the potentiometric surface and recharge/discharge areas of the alluvial materials. Supporting data used in developing the geologic cross sections including geophysical logs and/or lithologic logs can be found in Appendix D5.

The Big Horn Coal (BHC) Mine operated under Permit 213. Brook Mine is including portions of Permit 213 groundwater material as Addendum D6-12 and the Ground Water Restoration Demonstration as Addendum D6-13. These materials are being provided to supplement the data that Brook Mine has collected and compiled. These materials are being included to respond to issues brought forth by the Environmental Quality Council. The findings from the council implied that Brook Mine did not sufficiently describe the groundwater hydrology for the region. These materials will increase the baseline data information for the Brook Mine and also demonstrate that the findings in the BHC permit documents are not dissimilar to the conclusions that were made by the Brook Mine. It is important to keep in mind that portions of the Big Horn Mine were mined prior to the requirement of collecting baseline information. Surface coal mining operation at the Big Horn Mine started in approximately 1965. The Surface Mine and Reclamation Act (SMACRA)was not passed until 1977. As discussed in Brook Mine

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Appendix D2, underground mining has occurred throughout this area dating back to the early 1900's. Several decades of mining occurred in the vicinity of the Big Horn Mine before SMACRA was enforced, during which, portions of the Tongue River and Goose Creek were relocated to their current configurations. Figure D6.2-1 shows the approximate location of the different mine pits for the Big Horn Mine. The areas closest to Brook Mine are Pit 1, Pit 4, and Pit 5. The following provides a brief summary of the groundwater baseline for Big Horn Coal.

The BHC permit identifies six potential aquifers:

1. Consolidated sediments overlying and underlying the coal seams,
2. Dietz 2 coal,
3. Dietz 3 coal,
4. Monarch coal,
5. Carney coal, and
6. Reclaimed mine spoils.

The BHC permit states "Due to the fine-grained nature of the consolidated sediments of the Fort Union Formation, they characteristically serve as aquicludes or confining beds between the more permeable coal aquifers." This is consistent to the findings from the drilling and testing that was conducted by Brook Mine. The Brook mine described these sediments as the overburden or inter-burden. The BHC Permit 213 and Brook Mine determined that these fine-grained sediments yield very little to no quantities of water, therefore by definition are not aquifers. This is reiterated in the Ground Water Restoration Demonstration for BHC. As stated in the Groundwater Restoration Demonstration "Very little, if any, groundwater resaturation was predicted at Pits 4 and 5 because the coals mined in these areas naturally existed as remnants isolated from recharge sources of the Tongue River and Goose valley floors. No groundwater aquifers were identified before or during mining in Pits 4 and 5 and none has been projected to develop after mining in either area."

The BHC permit indicates that two perennial channels, the Tongue River and Goose Creek, flow through the mine area. The BHC permit indicates that where the coal subcrops in the alluvium, the alluvium is a direct recharge for the coal. Permit 213 further indicates that the testing that they conducted indicates

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permeabilities sufficient to allow for recharge to the coal. However, it appears that in the area where the coal subcroped in the alluvium is the location where coal was removed and the Tongue River relocated. The findings by the Brook Mine are similar in that the Tongue River alluvium has sufficient permeability to be considered an aquifer, but in the areas adjacent to the Brook Mine the only area where it appears there is an area where the coal subcrops in the alluvium is at the western portion of the permit where Early Creek confluences with the Tongue River. It should be noted that unlike the Big Horn Mine, Brook Mine will not be mining in the Tongue River alluvium.

The BHC permit discusses the importance of the connection of the Tongue River and Goose Creek to the coal and spoils for recharge to the aquifer systems. BHC permit indicates that the coal seams (Dietz 2, Dietz 3, Monarch, and Carney), cannot be classified as aquifers where they lie stratigraphically higher in elevation than that of the Tongue River. The BHC permit indicates that for coals that are above the Tongue River have either been burned or do not have significant quantities of water to be considered an aquifer. The permit text goes on to further clarify this statement in that there are areas where the coal does have sufficient water to be considered and aquifer. Similar to the discussions in the Brook Mine, depending on the locations in relation to topography, the coal may or may not have sufficient quantities of water to be considered an aquifer. The coal that Brook Mine is targeting is typically higher in elevation than the Tongue River. The Groundwater Restoration Demonstration discusses the importance of the alluvial system on the recharge of the coals and spoils after mining.

Specific aquifer properties for the different aquifers discussed in the Big Horn Permit are presented in Table D6.2-2A. Testing data for the parameters are included as Addendum D6-14.

D6.2.1.2 Tongue River Alluvium

The Tongue River alluvium yields enough water that it classifies as an aquifer. The Tongue River and its major tributary, Goose Creek, are large perennial streams having broad, actively degrading channels and well-defined

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terraces. As the Groundwater Restoration Demonstration states, the most significant source of groundwater recharge within the vicinity of the Big Horn Coal Mine is the Tongue River. Permeable strata such as coal seams that subcrop beneath saturated Tongue River alluvium are subject to recharge. Hydrostatic pressure in the coal seams rapidly increases downdip from their subcrops, which is indicative of direct recharge at the point of intersection between coals and alluvium (Big Horn Coal Company 2002). However, extensive exploratory drilling has shown that where coal seams are stratigraphically higher in elevation than the Tongue River alluvium, that they cannot classify as aquifers. Much of the Brook Mine activities are north of the Tongue River, which is updip of the alluvial subcrops. Near the eastern portion of the Brook Mine permit area, the Carney seam potentiometric surface is 100 to 150 feet below the Tongue River alluvium. This indicates that the strata between the Tongue River alluvium and the Carney coal seam serve as an aquiclude that prevent communication between the two aquifers in this area.

The approximate gradient of the premine Tongue River alluvium potentiometric surface is depicted on Exhibit D6.2-9. The potentiometric surface of the Tongue River alluvium closely resembles the elevation of water in the Tongue River. Being that the Tongue River is a perennial stream, it is the primary recharge source of the Tongue River alluvium. Exhibit D6.2-3 depicts the potentiometric surface of the Carney coal seam. As these Exhibits show, in Section 20 of Township 57 North, Range 84 West and Section 24 of Township 57 North, Range 85 West, the potentiometric surfaces of the Carney seam and Tongue River alluvium are very similar. This indicates that these are locations where the Carney seam subcrops in the Tongue River alluvium. However, these locations are limited and much of the Carney seam's potentiometry within the Brook Mine permit area is 50 to 150 feet higher than the Tongue River. These are areas where the Carney seam is updip of the alluvial subcrops. Baseline groundwater quality is discussed in Section D6.2.3. In comparing the water quality of Tongue River alluvium to the Carney coal seam, they are of different water quality type, as demonstrated by Figure D6.2-3.

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As the Groundwater Restoration Demonstration states, alluvial aquifer tests conducted in Tongue River alluvium have shown that alluvial materials are sufficiently permeable to allow unimpeded recharge. Big Horn Coal monitored the water quality of Tongue River alluvium downgradient of the mine in a single well. The water quality consistently met limits for livestock use over twenty years of monitoring.

D6.2.1.3 Big Horn Coal Spoils

Discussed in Section D6.2.1.1, reclaimed mine spoils are a potential aquifer according to the studies performed by Big Horn Coal. This is not inclusive of all spoils. The areas of Big Horn Coal Pits 1, 2, and 3 are in direct hydraulic connection with Tongue River and Goose Creek alluvium. Big Horn Coal Pits 1 and 2 lie within the Brook Mine permit area south of the Tongue River. Big Horn Coal Pit 3 lies north of the Tongue River but is mostly outside of the Brook Mine permit area. Evidence from the Big Horn Coal Groundwater Restoration Demonstration (Big Horn Coal Company 2002) demonstrates the direct hydraulic connection of spoils to the Tongue River alluvium with both groundwater flow characteristics and groundwater quality. As stated on page 13 of the Groundwater Restoration Demonstration:

> "In Pit 2 and between Pits 2 and 3, the Tongue River has a profound effect on the water table configuration. This is particularly evident with the 3580-foot water table contour traversing nearly parallel to the river between Pits 2 and 3, indicating flow directly into the spoils and thence into Pit 3 Reservoir. The 3580-foot contour in the spoils of Pits 1 and 3 join the same water table contour in Tongue River alluvium south of South French Drain. Overall, the salient feature of Exhibit 1 is that the spoils of Pits 1, 2 and 3 are in direct hydraulic continuity with the alluvium of Goose Creek and Tongue River." (Big Horn Coal Company 2002)

The groundwater gradients of the spoils adjacent to the Tongue River in Pits 1, 2, and 3 are closely related to the groundwater gradients of Goose Creek and Tongue River alluvium. Goose Creek recharges the Pit 1 and Pit 2 spoils

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upgradient. Pit 1 and Pit 2 spoils discharge into Tongue River alluvium. Tongue River alluvium recharges Pit 3 spoils and the Pit 3 reservoir. Pit 3 discharges into Tongue River alluvium downgradient. This is supported by Big Horn Coal's mapped potentiometric contours and the groundwater quality comparison between the spoils wells and alluvial water quality. As stated by the Groundwater Restoration Demonstration when analyzing the water quality of Pit 1 and Pit 2 spoils, "The water quality at wells 656-81 and 819-84 reflects the major influence to the backfill materials from the high quality waters of Goose Creek and its alluvium" (Big Horn Coal Company 2002). The water quality of Pit 3 spoils was not as good as the quality of Pit 1 and Pit 2 spoils. A few exceedances of livestock quality water were detected, but water quality continued to improve as installation of the Pit 3 reservoir influenced groundwater. In summary, the water quantity and quality of groundwater in Pit 1, 2, and 3 spoils is suitable for livestock use.

The Big Horn Coal Pits 4 and 5 spoils are representative of the spoils that will be impacted by Brook Mine activities. Brook will mine through Pit 4. Pit 5 is also near Brook Mine activities, though out of the permit area. Refer to the Mine Plan for discussions regarding Brook Mine activities. As discussed in the Groundwater Restoration Demonstration, there is insufficient water in the Pit 4 and Pit 5 spoils to develop for livestock use. Big Horn Coal could only sample wells in the Pit 4 and Pit 5 spoils by bailing very slowly. The Pit 4 and Pit 5 spoils have relatively limited infiltration and wells are slow to recharge. Therefore, Pit 4 and Pit 5 spoils cannot serve as viable aquifers. As shown in the Groundwater Restoration Demonstration, Big Horn Coal Company could not develop potentiometric surfaces for the Pit 4 and Pit 5 spoils. Subsequently, there are not groundwater gradients or groundwater velocities available for the Pit 4 and Pit 5 spoils. The Pit 4 and Pit 5 spoils are above and disconnected from the Tongue River alluvium.

Because saturated spoils have a large range in hydraulics, it is difficult to calculate recharge and recharge rates (Big Horn Coal Company 2002). The wells in Big Horn Coal's Pits 1, 2, and 3 spoils showed relatively rapid recovery (or recharge) due to the direct continuity with Tongue River and Goose Creek

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alluvium. In contrast, Big Horn Coal's Pits 4 and 5 spoils demonstrated very slow recharge rates contributing to the fact that the Pits 4 and 5 spoils do not and will not constitute as an aquifer. Spoil monitor wells are very difficult to install because of the highly variable characteristics of spoils. Brook discovered this during the installation of two spoil monitor wells during 2018, and this fact is supported by Big Horn Coal's Groundwater Restoration Demonstration. During drilling of spoils monitor wells, the spoils tend to cave into the borehole at a rate that makes installation of casing very difficult. The problem is exacerbated when boreholes produce large groundwater flows. Brook encountered this problem when installing monitoring wells in Big Horn Coal's Pit 1 and Pit 2 area.

Brook Mine activities will not occur in the spoils that are a potential aquifer (Pits 1, 2, and 3). These are the areas where if activities impacted spoils, Tongue River alluvium could subsequently be impacted. However, Big Horn Coal mining only mined to the Monarch coal seam. Brook Mine activities will focus on the Carney coal seam. As shown by Cross Section K-K' in Appendix D5, The Big Horn Coal spoils are separated from the Carney coal seam by approximately 100 feet. Many of the strata between the Monarch coal seam and the Carney coal seam are low permeability claystone and siltstone. This has been supported by permeability testing. Results of permeability testing are provided in Addendum D6-16. This is also supported by Big Horn Coal's Groundwater Restoration Demonstration. As stated in the Groundwater Restoration Demonstration, the Carney coal seam was not physically or hydraulically affected by Big Horn Coal Company mining since it lies approximately 100 feet below the Monarch coal (Big Horn Coal Company 2002). The hydrograph for the Carney well 465-79 clearly shows no effect from mining. Just as mining to the Monarch coal seam where current spoils are present had no impact on the Carney seam, mining of the Carney seam will have no impact on the Big Horn Coal Pits 1, 2, and 3 spoils due to approximately 100 feet of separation with low permeability claystone and siltstone serving as aquicludes.

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D6.2.2 Baseline Monitoring Plan

Groundwater monitoring began in October of 2013 and was conducted on a quarterly basis. The baseline groundwater quality samples and static water levels were obtained for four consecutive quarters and the monthly water level data was obtained from alluvial monitor wells for a duration of one year. The locations of the monitor wells used to characterize baseline are shown on Exhibit D6.2-1. Monitor well completion information is submitted in Addendum D6-7.

In June 2018, it was determined that the Masters seam would no longer be targeted for mining, making the Carney seam the lowest targeted coal seam. Based on this, the stratum between the Carney and Masters seams is now the underburden and the Masters seam will be the underlying aquifer monitored during mining. Underburden is defined as the strata underlying the lowest mined coal seam (the Carney seam). Underburden in the permit area is generally made up of shale with low hydraulic conductivity. Underburden is not a water-bearing interval that can be defined as an aquifer. The Masters seam is predominantly the existing underlying aquifer throughout the proposed permit area. An underlying aquifer is defined as a water-bearing interval located beneath the lowest mined coal or strata of interest. The areas where the Masters seam has been eroded or moved due to faulting are minor in size and do not occur in ears where surface or highwall mining is planned since the majority of these areas have no coal. As such, these minor areas have not been evaluated.

D6.2.2.1 Monitor Well Construction, Completion and Development

Construction of the baseline groundwater monitoring network began in the third quarter of 2013 and was completed early in the fourth quarter 2013. In accordance with SEO Policy memo dated March 12, 2013 "Permitting Requirements for Groundwater Monitoring Well" (SEO, 2013) the monitor wells were not permitted with the State Engineer's Office. The groundwater monitoring network consists of 9 Carney coal wells, 10 Masters coal wells, 8 alluvium wells, 1 underburden well and 1 well perforated in both the Masters and Carney coal seams. No monitoring wells were completed in the overburden or interburden as

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no water was found in these units during drilling operations. Addendum D5-2 contains drilling logs and resistivity logs that demonstrate the overburden and interburden are dry, the locations of the drill holes can be found on Addendum D5-3 Exhibit 1. Also, one well 578409-MST-UB showed the presence of water in the underburden. An aquifer for this application is defined as a drilled hole capable of producing 0.5 gpm or greater. Locations and depths of monitoring well/piezometer installations are provided in Table D6.2-1 and the locations are depicted on Exhibit D6.2-1.

The Groundwater monitor wells/piezometers were completed using air rotary methods in accordance with WDEQ/LQD guidelines. Construction of the monitoring wells consisted of the following. A pilot hole was drilled and logged as it progresses through each stratigraphic layer. When the geologic formation was determined to be an aquifer a monitor well/piezometer was completed in that aquifer as follows: the pilot hole was reamed to the appropriate diameter, and casing and factory slotted screen was installed. Coal wells did not require filter pack, and were constructed with a cement basket at the top of the screened interval to hold the annular sealant, which consisted of hydrated bentonite chips. Centralizers were installed at the top and approximately every 20 feet within screened intervals.

In a July 15, 2013 meeting between RAMACO and WDEQ/LQD to discuss acquisition of baseline at RAMACO's Brook Mine property, it was the consensus of the group, based on recent and historical drilling, that areas of the RAMACO Brook Mine Property contain limited groundwater resources and could be dry. The group agreed that installation of 2-inch diameter piezometers in core holes following core retrieval could be used to demonstrate the absence or presence of groundwater in the various coal seams and overlying intervals. This was performed on wells 578417-MST, 578417-CRN, 578408-MST and 578408-CRN. See Table D6.2-1 for an explanation of which cores holes were utilized for this. The procedure for this was as follows.

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Coring operations consisted of a pilot hole that was drilled, geophysically logged, and plugged with bentonite chips. Core intervals were selected from geophysical logs, and a core hole was drilled approximately 20 feet from the pilot hole. Following coring, the core hole was plugged with bentonite chips except when a coring location was selected for piezometer installation. The piezometer screened interval was selected from the geophysical log. The core hole was completed and, depending upon the interval to be screened, the lower portion of the hole was plugged. As an example, if the core hole extended to the base of the Masters coal bed, and the piezometer was to be completed in the overlying Carney coal bed, the interval from the base of the Master coal to the base of the Carney was plugged with bentonite chips to hydraulically isolate the two coal beds. During plugging operations, the volume of the hole to be plugged was measured against the volume of bentonite chips placed to ensure that the bentonite chip seal was intact and bridging had not occurred. A weighted measuring line was also used to tag the top of the bentonite plug to verify proper placement. Following plugging, two-inch diameter threaded, flush casing and screen was installed. The screened interval contained one centralizer every 20 feet, and in smaller intervals, at least one centralizer was used. The screen was placed opposite the entire target interval with a screen slot size of 0.020-inch. Filter pack consisted of 8-12 silica sand across and slightly above the screened interval. The remaining portion of the piezometer was sealed with bentonite chips, hydrated in 5-foot lifts. The piezometer was completed with a lockable metal protective casing set in cement.

The monitor well inspection and maintenance program was conducted throughout baseline monitoring. Site visits were conducted quarterly and if problems were discovered during site visits they were immediately fixed and denoted on the field sheets. The monitoring program consisted of the following inspection items 1) measurement of total depth compared with original completion depth to determine whether the well has silted up or the casing has failed, 2) checking surface seal and casing integrity which includes shaking the well to check for seal integrity, inspecting the seal for cracks and animal burrows, and checking ventilation/drain holes for plugging, 3) listening for trickling, bubbling

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or gas venting sounds, 4) checking historic data for abnormal water level trends, and 5) conducting well efficiency tests on wells suspected of blocked perforations or screens.

During the summer of 2018, seven additional monitor wells were installed. Two monitor wells were installed in the Big Horn Mine spoils (578415-SPL-1 and 578415-SPL-2), one well was installed in the overburden material (578513-OVB-1), two wells were installed in the Tongue River alluvium (578420-AL-1 and 578524-AL-1), and two wells were installed in the Carney Coal adjacent to the wells installed into the Tongue River alluvium (578420-CRN-PUMP and 578524-CRN-PUMP). The completion data for these wells is included in Addendum D6-7 and hydrographs for the wells are included in Addendum D6-9. All the wells installed in 2018 were in responses to issues raised by the EQC. The spoil wells were installed to address the geohydrologic concerns raised by not having data in this area. The logs indicate that the spoils are a mixed rubble. The hydrographs show that water is present in the spoils. The overburden well was installed to demonstrate that for the most part the overburden in the vicinity of the Brook Mine is dry. Well 578513-OVB-1 consisted of claystone and found that it produced no water. The other four wells were installed in the Tongue River alluvium or in the Carney Coal adjacent to the alluvial wells. These wells were used to demonstrate that there is no connectivity between the Tongue River alluvium and the Carney Coal. They will be discussed further in Section D6.2.2.2 Aquifer Tests.

In the summer of 2019, Brook Mine installed a third alluvial well (578415-AL-1) down gradient of 578524-AL-1 and 578420-AL-1. The first and second quarters of data have been collected in July of 2019 and December 2019 respectively, and Brook Mine commits to collecting the two remaining consecutive quarters of baseline data to characterize the Tongue River alluvial water quantity and quality. Brook Mine will provide the CARF data for the additional quarters to DEQ as soon as possible following sample collection and lab analysis. It is expected this data will be submitted at the latest in July of 2020. Water quality from two nearby Big Horn Coal alluvial wells (BH 371 and BH 508) were compared

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to the water quality in wells 578424-AL-1, 578420-AL-1, and 578415-AL-1. The piper diagram in Figure D6.2-9 shows that well BH508 had similar water quality to the Brook alluvial wells 578424-AL-1 and 578420-AL-1 (calcium-magnesium bicarbonate water type), while well 578415-AL-1 was more magnesium-sulfate type water and BH371 was more of magnesium-sodium-sulfate water type.

Groundwater level data was not collected in 2018-2019 for four wells. The four wells are: 578510-CRN, 578510-MST, 578512-CRN, and 578415-CRN-MST. Wells 578510-CRN and 578510-MST were not accessible to be sampled because of lack of land owner permission. Well 578512-CRN was found to be dry during the 2018 slug tests. Well 578515-CRN-MST was not able to be sampled because of gas coming out of the well. Groundwater levels for the 578409 wells were collected both in the 2013-2014 and 2018-2019 time period and showed no significant differences in the ground water levels.

D6.2.2.2 Aquifer Tests

Two types of aquifer tests have been conducted to collect baseline data for the permit, constant rate discharge aquifer pumping tests with one or more wells monitored for the duration of the test and single well slug tests. To complete a slug test a substantial volume of water is removed from the well rapidly and the speed of the water level recovery in the well is monitored. Slug tests are a scientifically accepted method for characterizing the hydraulic conductivity. Multiple sources including the ones listed below indicate that slug tests are adequate to characterize the hydraulic conductivity of aquifers, which would include coal seams, overburden, spoils, and alluvium that are saturated with water. Freeze and Cherry (1979) state that "it is possible to determine in situ hydraulic conductivity by means of tests carried out in a single piezometer." They further note in detail the methods of analyzing slug tests. Fitts (2002) states that slug tests yield estimates of the average in situ horizontal hydraulic conductivity of the region near the well. Cunningham and Schalk (2011) in association with the USGS in Groundwater Technical Procedures Documents (GWPD) 17 state that

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from the data collected with a slug test an estimate of hydraulic conductivity can be calculated.

Aquifer pumping tests were conducted on the section 9 cluster wells located in the SESE quarter of section 9, Township 57 north, Range 84 west. Selection of this cluster of wells was primarily in response to discussion with WDEQ and analysis of historic well data surrounding the permit area. Historic data characterized the coals seam within the western portion of the permit area as being dry; therefore, an eastern cluster of wells were selected for the tests. The section 9 cluster wells consist of two wells in the Carney seam, two wells in the Masters seam and one well in the underburden. As previously discussed, no wells were completed in the overburden or interburden since water was not encountered in these strata during drilling operations. Three alluvial wells were completed in Slater Creek and water levels were monitored quarterly. The slug tests that were conducted in the same wells as the pumping tests show comparable results to the aquifer test results.

During the aquifer tests, water levels in the alluvial aquifer were not observed. This was due to no alluvial material being present in the vicinity of the aquifer tests. The nearest potentially alluvial material to the tested well cluster was Hidden Water Creek to the east; however, as noted in Appendix D11, the fill material in the Hidden Water Creek channel is more colluvial than alluvial. As displayed by the absence of alluvial pump test in the Big Horn Coal Permit No. 213, alluvial pump tests were only conducted on the Tongue River and Goose Creek. Additional reasoning for not monitoring the alluvial wells is the presence of multiple claystone intervals between the Carney coal and the surface. The top of the Carney coal is approximately 90 feet below ground surface, which makes it approximately 50 feet below the level of any colluvial/alluvial deposits in Hidden Water Creek. Similarly, the potentiometric head in the Carney coal is approximately 50 feet below the level of colluvial/alluvial deposits in Hidden Water Creek and if there were a direct hydraulic connection, there would be no water in the Hidden Water Creek colluvium/alluvium. Given the confining intervals and the significant difference in potentiometric head between the Carney coal in the

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Hidden Water Creek colluvium/alluvium, additional shallow monitoring above the Carney coal was not necessary. Due to the confining intervals and the difference in potentiometric heads, aquifer tests were not conducted in the alluvial wells. The confining claystone intervals provide a barrier from mining activities impacting the alluvial aquifer; therefore, the presence of the confining intervals preclude the need for aquifer tests in the alluvial aquifer.

Two aquifer pumping tests were conducted in June 2018 to evaluate the potential communication between the Tongue River alluvium and the Carney Coal. No impacts from pumping in 578420-CRN was shown because of the low transmissivity of the Carney coal in the vicinity and the short duration of the aquifer test. The hydrograph from 578420—AL-1 confirms that the alluvial water level was not affected during the test. Memos of the test procedures and detailed results are provided in Addendum D6-15. The aquifer test data confirmed that the confining claystone intervals are a hydrologic barrier between the coal seam and the Tongue River alluvium. In addition to the aquifer tests and Tongue River alluvium being located outside and down dip of the permit boundary, the confining claystone intervals provide a barrier that prevents mining activities impacting the alluvial aquifer.

In addition to the aquifer test that was conducted by Brook Mine, the Big Horn Coal Mine also conducted aquifer testing. The Big Horn Coal data is included as Addendum D6-14, and the test results are provided in Table D6.2-2A. The Big Horn Coal Appendix D6 states that the "pumping test results indicate that the Tongue River and Goose Creek alluvium is a very significant aquifer with transmissivity values ranging from about 9,000 to 60,000 gpd/ft. Storage coefficients are in the order of 10^{-1} to 10^{-2} indicative of an unconfined to "semi" confined aquifer." The Big Horn Coal aquifer tests conducted in the alluvium resulted in higher hydraulic conductivities than the Brook Mine alluvial aquifer tests and the Big Horn Coal aquifer tests in other formations. Section D6.2.1.1 contains more discussion of the Big Horn Coal alluvial aquifer tests. DEQ also provided a summary of all the aquifer tests conducted in Wyoming. This list termed "Wyoming coal mines" includes observations from the coal mines located

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on the eastern side of the Powder River basin. A comparative analysis of the hydraulic conductivity values obtained from the aquifer tests conducted by Brook Mine, Big Horn Coal Mine, and Wyoming coal mines was completed. The results are shown in Table D6.2-22, and Figures D6.2-4 through D6.2-8. A comparative analysis of the aquifer tests to the slug tests was also completed and the results are in Table D6.2-28. Brook mine conducted slug tests at the Big Horn Coal Spoils, both tests failed due to the high hydraulic conductivities encounter. Representative hydraulic conductivities can be found in Addendum D6-13 that were completed by Big Horn Coal.

Based on a review of the statistics presented in Table D6.2-22 and Figures D6.2-4 through D6.2-8 the hydraulic conductivity values measured at Brooke mine generally compare well with those of the other mines. The one notable exception was that the average alluvial well hydraulic conductivity observations at Big Horn Coal are an order of magnitude larger than the observations at Brook Mine and the Wyoming coal mines. The higher values observed at Big Horn Coal are attributed to the fact they are from alluvial wells completed in the Tongue River alluvium and most of the observations from Brook Mine and the Wyoming coal mines are generally from smaller drainages. Due to its location at the foot of the mountain, the Tongue River has a lot of course sand and gravel deposits within the vicinity which can result in high hydraulic conductivities. Given the fact that the Brook Mine hydraulic conductivities mainly originated from Slater Creek and Goose Creek alluvium and only one sample came from the Tongue River, it is reasonable to expect that the hydraulic conductivities measured by Brooke Mine would be lower simply because the drainages in which the hydraulic conductivities were measured in were smaller with less potential for course sand and gravel deposits. Note that the alluvial well tested by Brook Mine along the Tongue River was located along a bend in the Tongue River. The well is located on the side of the river where the water is eroding into the bank with a high hill immediately adjacent. As such, the alluvial material is expected to be thinner and smaller in areal extent than on the other side of the River where more deposition

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of sorted sands and gravels are occurring. Therefore, a lower hydraulic conductivity is not surprising in this well.

The coal hydraulic conductivities as presented in Table D6.2-22 for the Wyoming mines are similar to the hydraulic conductivities in Brooke Mine and Big Horn Coal. However, it is important to disclose that the entire dataset provided by DEQ was not used in the statistical analysis. The vast majority of observations (87%) had a hydraulic conductivity less than 10 feet per day and were used for the analysis. The rest of the observations had very high hydraulic conductivities, up to 55,000 ft/day. The small number of very high hydraulic conductivities, several orders of magnitude larger than the bulk of the observations, significantly skewed the statistics. It is likely that these high hydraulic conductivity values were measured in a highly fractured coal, and while they skew the statistics, they are not typical of values measured in the Powder River Basin coals. The 87 percent of the observations used for the analysis are considered to be more representative of typical coal conditions in the Powder River basin.

As noted in Addendum MP-3, coal bed natural gas (CBNG) dewatering efforts have resulted in decreased water levels in the coals. However, all CBNG dewatering efforts have occurred approximately 2 miles away from the wells utilized for aquifer testing. Given the relatively low transmissivity of the coal it is unlikely that the CBNG dewatering efforts have significantly affected water levels in the wells utilized for the aquifer tests. The water levels measured in the Carney coal during the aquifer test demonstrate that the Carney coal is confined (see Addendum D6-8). If the drawdowns from CBNG dewatering were significant it is unlikely that the coal aquifer would still be confined.

Only one underburden well was evaluated during the testing since the other wells drilled into the underburden were dry during drilling. Separate multi-well pumping tests were conducted in the wells completed in the Masters and Carney seams. A report of these tests can be found in Addendum D6-8 and a summary tabulation of the aquifer test results is included in Table D6.2-2.

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The results as stated in Table D6.2-1 are comparable with measured coal aquifer properties at other mines in the vicinity. Big Horn Coal Company reported transmissivities ranging from 0.13-100 ft^2/day and a storage coefficient of $1.4x10^{-4}$ for the Monarch coal in their DEQ permit (no. 213). Similarly, in the Dietz 3 seam Big Horn Coal Company reported transmissivities ranging from 0.26-93 ft^2/day and a storage coefficient of $1.4x10^{-4}$. The aquifer test results from the Youngs Creek Mine DEQ permit (no. 406) in Sheridan County indicate average transmissivity (with an outlier thrown out) of about 24 gpd/ft.

Core from three drill holes within the permit area was submitted to analytical laboratories for measurement of permeability. Results are provided in Addendum D6-16. The results from the testing indicate that the materials above and below the coal (confining intervals) is comprised of clay and have low permeabilities. A summary of statistical data is presented in Addendum D6-16. The hydraulic conductivities of these intervals are much lower than those found in the coal seams and would suggest that vertical movement of groundwater in these layers would be extremely low and is typical for unweathered marine clay. Hydraulic conductivity is the ratio of velocity to hydraulic gradient. Due to the nature of the confining layers and the available head (hydraulic gradient) it is difficult to estimate the time it would take water to travel vertically through these layers but estimates lower than 0.5 feet/year would not be unreasonable.

D6.2.2.3 Water Levels

Potentiometric surfaces may be found on Exhibits D6.2-2 and D6.2-3. Water level measurements made quarterly during baseline monitoring may also be found in Addendum D6-9. As is shown by the data the Masters and Carney coal seams have varying water levels (typically 20'-60' difference). This difference suggests that the claystone interburden between the coal seams can be assumed to be a confining interval.

The Tongue River Alluvial aquifer is recharged by water from the Tongue River and infiltration of precipitation and snowmelt. During the months of May and June, the Tongue River is typically a losing stream in which stream water

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moves into the alluvial aquifer, recharging the local groundwater systems. This is indicated by the elevation of the river being above the alluvial ground water table. When water levels rise in the late spring and early summer due to snowmelt in the Bighorn mountains, water levels in the alluvial aquifer will rise to match the level of the river. For much of the year, the Tongue River is a gaining stream and ground water from the alluvial aquifer moves toward and into the stream. Starting in the summer around July and continuing through April when water levels in the river are at their lowest, the water level in the alluvial aquifer will drop. This trend can be seen in the water elevation levels presented in Addendum D6-9, Figure D6.2-10 and Figure D6.2-11. Figure D6.2-10 shows the comparison of alluvial well 578420-AL-1 with the surface water elevations from the former USGS gaging station USGS 0629980 and Figure D6.2-11 depicts the water levels of the Tongue River alluvial wells 578420-AL-1, 578524-AL-1, and 578415-AL-1 compared on a quarterly cycle.

D6.2.2.4 Premining Potentiometric Surface

Premining potentiometric surface exhibits for the Masters Coal and Carney Coal seams are shown on Exhibit D6.2-2 and Exhibit D6.2-3, respectively. Premining potentiometric surface exhibits for Tongue River, Goose Creek and Slater Creek are shown on Exhibit D6.2-9. Water elevation differences of alluvial well 578415-AL-1 compared to the nearby alluvial wells could be attributed to the french drain system that diverts water from the Tongue River into the Big Horn Coal Pit 3 Reservoir. The approximate location of the french drain system and the Pit 3 Reservoir is depicted on Exhibit D6.2-9. These exhibits characterize computed average water levels prepared from water level measurements obtained during baseline monitoring (Fall 2013 though Fall 2014) and applicable data from nearby domestic and stock wells as provided by the Wyoming SEO website. Research was also conducted utilizing the Wyoming Oil and Gas Conservation Commission (WOGCC) database and other nearby coal mines; however, the additional information was difficult to utilize in development of the potentiometric surfaces due to distance, completion intervals, extraneous impacts such as CBNG development, etc. Aquifer properties for the non-coal portion of the minable sequence are generally very poor. Sandstone intervals within the permit area, as desirable for

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development of groundwater resources, are typically thin and discontinuous. Additionally, where these strata lie stratigraphically higher than the Tongue River or Slater Creek valley floors, they generally lack any significant water content. Therefore, potentiometric surfaces were not prepared for the overburden, interburden or underburden. Refer to Appendix D11 for the discussion of alluvial valley floors.

Groundwater movement in both the Carney and Masters coal seams is generally northwest to southeast with local movement in the permit area north to south resulting from faulting. The direction of flow within the coal seams generally follows the geologic dip. Measured values of transmissivity from the Brook Mine area can be found in the aquifer testing data included in Section D6.2.2.2. Zones of high permeability are reflected by wide spacing of potentiometric surface contours, while zones of low permeability are reflected by closely spaced potentiometric surface contours. The groundwater gradient within the Masters and Carney seams ranges from approximately 0.016 ft/ft to 0.008 ft/ft and 0.017 ft/ft to 0.07 ft/ft, respectively within the Brook Mine area. Using K values of 1.4 ft/day and 0.097 ft/day for the Masters and Carney coals respectively, and a porosity of 0.10 groundwater velocities are low ranging from approximately 40 to 80 ft/year in the Masters Coal and 6 to 25 feet per year in the Carney Coal. The groundwater velocities as calculated above represent the velocity that a particle would travel through the tortuous pathway presented by each individual particle in the coal matrix. Because the pathway that the water molecule follows is tortuous, the actual distance that a water molecule travels in the aquifer on a macro scale would be much less. For example, a particle that may travel 40 feet in a year through the soil matrix may only move 4 feet from its original starting point due to the fact that the particle travels through the interspatial pores in the aquifer matrix along a tortuous pathway rather than in a straight line. The Darcy flux velocity would be more representative of the macro scale velocity in the aquifer. The Darcy Flux velocities are calculated at 4 to 8 ft/year in the Masters Coal and 0.6 to 2.5 ft/year in the Carney Coal. The Masters seam is generally confined in the permit area, although some areas of the mine are unconfined near surface outcrops, in stratigraphic highs, and near recent CBNG development. The Carney seam; however, is generally unconfined in the permit area due to substantial outcropping, faulting, limited recharge sources, and CBNG

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development. Available information indicates both the Carney and Masters coal seams are in a semi-confined state and are not single continuous aquifers within the permit area.

CBNG production has affected the potentiometric surface prior to baseline monitoring on the eastern edge of the permit area. CBNG development and production largely occurred from 2000 thru 2012. Based on a comparison of pre- and post-CBNG water levels from Big Horn Coal monitor wells, the potentiometric surface in the eastern portion of the permit area has been lowered by approximately 40-80 feet since CBNG development began. Since it has been several years since Big Horn Coal has been active and the CBNG development has occurred since Big Horn Coal activities ceased, any water level drawdowns that may have been induced from mining operations have been superseded by CBNG drawdowns.

D6.2.2.5 Recharge and Discharge Areas

Premining potentiometric surface exhibits for the Masters Coal and Carney Coal seams are shown on Exhibit D6.2-2 and Exhibit D6.2-3, respectively. The approximate outcrop line for the Carney coal seam is shown on Exhibit D6.2-3. Water in the Brook Mine hydrologic system generally recharges in the northwest and then flows down the geologic dip to the southeast although interrupted frequently from a series of normal faults perpendicular to the direction of groundwater flow. From a regional hydrogeologic perspective the Carney and Master's coal seams deepen in to the Powder River basin to the east. The groundwater migrates down the coal seam deeper into the basin. Groundwater within the Powder River Basin eventually migrates north into Montana although the flow is very slow, and the water is thousands of years old near the center of the Powder River Basin. As is shown by the outcrop line in Exhibit D6.2-3, additional areas of recharge and discharge exist on the Carney coal seam on the western portion of the Brook Mine permit area. Generally, the Carney coal is dry or only has a minimal amount of water in it along the western portion of the Brook Mine permit area. Therefore, there is only a minimal amount of discharge from the

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Carney coal within the permit area. No other areas of discharge for either the Carney or the Masters coal exist within the permit area. Sources of recharge for the Carney seam include clinker, locally known as scoria, that is in communication with the coal seam; historic surface mine pits (where the Carney Seam was mined) north of the permit area; regions where the Carney seam subcrops into either Slater Creek or Tongue River alluvial material; and infiltration from precipitation on the Monarch burn stratigraphically higher than the Carney seam. Recharge within the permit area is described in more detail within Section 2.6.1 of Addendum MP-3. As shown on Exhibit D6.2-2 the Masters seam does not outcrop in the permit area; however, it may subcrop into Slater Creek alluvial/colluvial materials. Sources of recharge for the Masters seam can then be assumed to include infiltration from overlying strata, communication with river alluvium and seam outcrops west of the Permit area. Both the Masters and Carney coal seams trend downward in a generally southeast direction. Surface and groundwater interactions are discussed in the groundwater model in the mine plan.

While different soil types are expected to have variable infiltration rates, the only infiltration rate that is significant for the coal aquifers is the infiltration rate assigned to the strata near the outcrop of the coal seams. Throughout the permit area, the strata overlying the coal aquifer are generally dry. Therefore, the primary source of recharge occurs at the outcrops. Scoria, in particular, plays a significant role in recharge of the coal seams because it usually occurs near the coal outcrop. Because of its highly permeable characteristics, most of the precipitation that falls on the scoria infiltrates into the scoria where it either infiltrates into the coal or discharges along a seep line at the base of the scoria. Ash material between the base of the scoria and the coal seams sometimes limits how much of the water in the scoria actually comes into direct contact with the coal. Nevertheless, because a large percentage of precipitation falling on the scoria infiltrates into it, the scoria does provide a consistent water source for recharge into the coal outcrops. Within the permit area, there are several locations where the coal seams outcrop as well. Since the strata overlying the coal seams to be mined are generally dry, the

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recharge component from the overburden to the coal is very low away from the outcrop areas. Because of the limited hydrologic interaction between the recharge at the surface and the coal in areas away from the outcrop, site specific changes in the recharge rates based on soil type will not impact the coal aquifers. For this reason, additional analysis of the infiltration properties of the soils within the permit area represents a level of detail that is not necessary to describe the hydrologic impacts to the coal aquifers from the proposed mining operations. Detailed descriptions of soil properties within the permit area are provided in Appendix D7.

Seeps and springs have been observed on the property, specifically in T57N R85W section 12. The springs are primarily the result of water seeping out from the contact of discontinuous saturated clinker knobs and the vuggy low permeable clay below the clinker.

D6.2.2.6 Regional Vertical Leakage and Infiltration

As indicated from the pumping test in Addendum D6-8 and as discussed earlier, the overburden and interburden are largely dry and the underburden is predominantly dry in and near the permit area where it lies stratigraphically higher than the Tongue River. Based on this information, vertical leakage through the minable sequence in the permit area is minimal. Large regions of Monarch clinker likely provide substantial infiltration zones; however, due to their perched nature, the majority of the infiltration likely escapes into the surface water system and only a small percentage is assumed to provide recharge to underlying coals.

Hydrographs of wells completed in the Carney coal seam and Masters coal seam do not show any distinct seasonal recharge-discharge effects. No general recharge or discharge trends are noticeable and all data seem to support the conclusion that the Carney coal seam and Masters coal seam are of limited extent and little hydraulic connection. Collected groundwater elevations and hydrographs of the groundwater wells are found in Addendum D6-9.

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D6.2.2.7 Saturation Zones

Maps showing the saturated, partially saturated, and dry zones of the overburden, Carney seam, underburden (Masters seam), spoil, and Slater Creek alluvium are included as Exhibits D6.2-4 through D6.2-8, respectively. These maps were developed using Tables D6.2-23 through D6.2-27, the potentiometric surfaces, Strata drill hole data and completion data, piezometer data, and Wyoming SEO data. Areas are considered dry when there is no water present in the layer, partially saturated when the water level is higher than the bottom of the layer but lower than the top of the layer, and fully saturated when the water level is equal to or higher than the top of the layer. These maps were prepared to help demonstrate the areas where no water is present within the permit.

Exhibit D6.2-4 shows that for the most part, the overburden within the permit area is dry. There are small areas of partially saturated sand lenses that do have water. The other area where water is present in the reclaimed area of the Big Horn Mine. These mine spoils are connected to both the adjacent mined coal and the Tongue River alluvium.

Exhibit D6.2-5 shows the areas where water is present in the Carney seam. As shown by the drawing, the eastern portion of the permit tends to have more water present in this seam. The western portions are mostly dry.

Exhibit D6.2-6 shows the underburden and Masters seam areas with water. As shown on the map, there are several areas within the permit where no water is present.

Exhibit D6.2-7 depicts the Big Horn Mine spoils. Since the spoils go the ground surface, the spoils were determined to be partially saturated. The area north of the Tongue River, as stated in the Big Horn Mine Groundwater Restoration Demonstration, is not considered an aquifer, therefore, is shown dry on this map.

Exhibit D6.2-8 shows that the Slater Creek alluvium is partially saturated. The well completion indicates that the alluvial materials in Slater Creek are a mix

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of scoria (clinker) chips and clay. The hydrograph shows the water depth ranges from about 5 feet (578418-AL) to almost 20 feet (578512-AL).

D6.2.3 Baseline Groundwater Quality

Numerous groundwater samples have been collected from wells within and adjacent to the permit area and have been analyzed for the constituents and methods shown in Table D6.1-12. Groundwater samples were collected on a quarterly basis as shown in Addendum D6-10. The Brook Mine adhered to the following procedures and protocols for groundwater quality and quantity monitoring:

- A water level, total depth measurement and well head inspection was completed at each monitoring event for each well monitored.
- All wells were pumped at the rate required to evacuate the casing of stagnant water and draw in at least three casing volumes of formation water.
- In low yield wells (those that produce 0.5 gpm or less during well development), it was not practical to purge three casing volumes prior to sampling. In low yielding wells, low flow sampling methods were employed.
- Field observations were recorded on the water quality sampling field forms.
- Field parameters such as pH, EC, temperature, dissolved oxygen and turbidity were measured throughout purging to determine geochemical stability. Three values with less than 10% difference indicated that the water was a stable representation of the aquifer, and samples were collected.
- Field filtered and preserved samples were collected in clean, unused plastic and or glass containers provided by the contract laboratory.
- Samples were kept on ice until arrival at the laboratory (no more than two days following sample collection). The laboratory analytical procedures used and constituents analyzed by the lab are presented in Table D6.1-12. Lab COCs are included in Addendum D6-10.
- A quality assurance and quality control program was adhered to which included comparison of field EC to laboratory EC, comparison of field turbidity to laboratory turbidity, comparison of measured TDS to calculated TDS, ion balance analysis and holding time/preservation evaluations.

The groundwater quality analyses results are tabulated and presented in Tables D6.2-3 through D6.2-7 and Table D6.2-19. In general, groundwater quality

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varies with respect to each of the geologic units and the location within any given unit in the mine permit area. Groundwater quality data recorded during the baseline monitoring period indicate that all groundwater in the permit area is suitable only for livestock watering according to WDEQ/WQD Rules and Regulations Chapter 8 underground water class standards and also generally meets EPA Primary maximum contaminant levels (MCLs) but not EPA secondary MCLs. This is shown in Tables D6.2-8 through D6.2-17 and Tables D6.2-20 through D6.2-21. The constituents that most frequently exceed the standard concentration limitations are ammonia, total dissolved solids (TDS), sulfate, and manganese. Other constituents that exceed standards at one or more sites include sodium absorption ratio (SAR) and iron. A piper diagram of the groundwater wells with measured values is presented in Figure D6.2-2. As can be seen in the tabular results and the figure, the water quality in the coal aquifers is variable. This is attributed to the strike and dip of the coal, the presence of several faults, the location of coal recharge areas next to outcrops and the transitioning of the coal aquifers from confined to unconfined within the permit area.

The water quality data was also reviewed to determine if any surface water and groundwater interactions exist. During baseline monitoring, a single water quality sample was taken from surface water flows for the two gaging stations located along Slater Creek. No samples were taken for Hidden Water Creek due to a no-flow condition. Therefore, only the wells in the Slater Creek drainage may be used as comparison for surface water groundwater interaction. Also, as discussed previously the Masters coal seam underlies the Carney coal seam and the interburden is dry, which indicates that if surface water groundwater interaction were to occur it would only occur in the Carney coal seam. As shown by Tables D6.2-3 through D6.2-7 all Carney coal wells in the Slater Creek drainage were dry during baseline monitoring except well 578511-CRN. The water type of this well was sodium sulfate. Comparing the water quality data for this well and the surface water quality samples for Slater Creek (magnesium-calcium sulfate water type) indicates no discernible patterns. Based on this information, a significant surface water groundwater interaction in the Permit area does not exist.

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The water quality data was also used to review interactions and connectivity between the Tongue River alluvium and the Tongue River. The water quality from three wells completed in the Tongue River alluvium (578420-AL-1, 578524-AL-1, and 578415-AL-1) were compared to two surface water sites on the Tongue River (578420-TR-1 and 578524-TR-1). The general chemistry of the Tongue River alluvium and Tongue River were similar, although concentrations in the Tongue River alluvium were at least double those in the Tongue River. The water type of the Tongue River was calcium bicarbonate, while the Tongue River alluvium was dominated by bicarbonate and sulfate anions and the cations were incomplete (55-65% magnesium, 35-55% calcium, and 20% sodium) for 578420-AL-1 and 578524-AL-1 and dominated by magnesium for 578415-AL-1. Differences in water quality of 578415-AL-1 from the upgradient alluvial wells 578420-AL-1 and 578524-AL-1 could be attributed to completion material and/or the french drain installed near 578415-AL-1. Well 578415-AL-1 is located in a reclaimed area, previously mined by Big Horn Coal. The well construction logs of the three alluvium wells indicate that the 578524-AL-1 and 578420-AL-1 are installed in native alluvium, while 578415-AL-1 is installed in backfill. Based on these completions, it is expected that the TDS and major ion chemistry of the 578415-AL-1 well would be different than the 578524-AL-1 and 578420-AL-1. The difference in water quality of backfill wells is well documented in various cumulative hydrologic impact assessment (CHIAs). The 2014 Spring Creek CHIA states that spoil water quality is poorer than the aquifers removed from mining and marked by increases in TDS, bicarbonate, sodium, and sulfate. The 2014 Spring Creek CHIA also states that depending on the location and the rate of groundwater flow through the spoil, it will likely take decades after the completion of reclamation to restore water quality. In addition, the 578415-AL-1 well is located near a french drain installed by Big Horn Coal, as depicted on Exhibit D6.2-9. The french drain was installed to divert water from the Tongue River alluvium away from Pit 3. Currently, the french drain diverts water from the Tongue River into the Pit 3 Reservoir located less than half-mile west of monitor well. The proximity to the drain may also be contributing to increased TDS in the 578415-AL-1 well. Metals concentrations were generally non-detect in both the Tongue River alluvium and Tongue River, iron and manganese (dissolved and total) concentrations were higher in the Tongue River alluvium.

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A comparison of alluvial wells to Carney wells was conducted to demonstrate different water quality. The three alluvial wells (578420-AL-1, 578542-AL-1, and 578415-AL-1) at the Brook Mine and eight alluvial wells at Big Horn Coal exhibited calcium (30 to 55 percent) and magnesium (45 to 70 percent) cation dominance with anions dominated by bicarbonate (45 to 80 percent) and sulfate (20 to 50 percent). The two Carney pump wells (578420-CRN-PUMP and 578542-CRN-PUMP) at the Brook Mine and one Carney well at Big Horn Coal demonstrated a sodium-bicarbonate type water. A piper diagram is provided in Figure D6.2-3 that depicts the difference in water quality between the Tongue River alluvium and Carney coal seam.

D6.2.4 Groundwater Rights

Adjacent and on-site groundwater rights are listed in Appendix B in the Adjudication Volume in detail. Table D6.2-18 provides a summary of the number of groundwater wells within the permit boundary and the adjacent three-mile buffer. The table shows the total number of wells and splits the wells into categories according to usage. Additionally, Table D6.2-18 provides the groundwater well use by percentage. As shown in the table, the water uses of groundwater wells in the vicinity include irrigation, coal bed methane, stock watering, domestic, industrial and miscellaneous uses. The predominant water use (24%) is for domestic use. Monitoring wells were excluded from the table due to their lack of consumptive use. In addition, not all wells included in the list are actively used. Wells identified as potentially located in the target coal seams and that could be possibly impacted by mining activities are discussed further in the Mine Plan Addendum MP-3.

D6.2.5 Groundwater Models

A groundwater model was conducted in 2014 by WWC. The purpose of the model was to predict drawdown in the coal aquifer due to mining the Brook Mine Area. Due to concerns made by the EQC, WWC conducted updates to the groundwater model in 2018. The 2018 model is constructed significantly different, and therefore the 2018 model supersedes the 2014 groundwater model. The 2018 model predicts drawdown due to mining. The 2018 model is included in the Mine Plan.

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D6.3 References

Big Horn Coal Company, 1983. Annual Report 2016-2017, Big Horn Coal Mine. Sheridan County, Wyoming. July 2017.

Big Horn Coal Company, 1983. Annual Report 2017-2018, Big Horn Coal Mine. Sheridan County, Wyoming. July 2018.

Big Horn Coal Company, 1983. Appendix D6 Permit 213, Big Horn Coal Mine. Sheridan County, Wyoming. January 1983.

Cunningham, W.L., and Schalk, C.W., comps., 2011, Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1, 151 p. (available only online at https://pubs.usgs.gov/tm/1a1/)

Fitts, C. R. (2002) Groundwater Science. San Diego, CA: Academic Press.

Freeze, R. A. & Cherry, J. A. (1979) Groundwater. Englewood Cliffs, NJ.: Prentice-Hall

Montana Department of Environmental Quality (MDEQ)/Water Quality Division (WQD), 2014, Decker Area Cumulative Hydrologic Impact Assessment (CHIA) Spring Creek Mine, East and West Decker Mines Bighorn County, Montana (includes groundwater and surface-water discussions). Electronic copy only. Available on request from OSMRE.

Miller, K. A. (2003). Peak-Flow Characteristics of Wyoming Streams: Water-Resources Investigations Report 03-4107. Cheyenne, Wyoming: U.S. Department of the Interior, U.S. Geological Survey

National Oceanic and Atmospheric Administration. (1973). Precipitation Frequency Atlas of the Western United States (Wyoming ed., Vol. II). U.S. Department of Commerce.

NRCS Web Soil Survey. (2013). Custom Soil Resource Report for Area of Interest. Retrieved from http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Sheridan County Conservation District. (2016). Tongue River Watershed Interim Monitoring Project. December 2017. Sheridan, WY.

State Engineer's Office (2013). Policy Memo: Permitting Requirements for Groundwater Monitoring Wells Retrieved from http://seo.wyo.gov/regulations-instructions

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U.S. Army Corps of Engineers. (2000). Hydrologic Modeling System: HEC-HMS Technical Reference Manual. Retrieved October 2014, from Hydrologic Engineering Center: http://www.hec.usace.army.mil/software/hec-hms/documentation/HEC-HMS_Technical%20Reference%20Manual_%28CPD-74B%29.pdf

U.S. Army Corps of Engineers. (2009). Hydrologic Modeling System (HEC-HMS).(Version 3.4) [Computer Program]

U.S. Army Corps of Engineers. (August 2009). Hydrologic Modeling System: HEC-HMS User's Manual (Version 3.4). Retrieved October 2014, from Hydrologic Engineering Center: http://www.hec.usace.army.mil/software/hec-hms/documentation/HEC-HMS_Users_Manual_3.4.pdf

U.S. Army Corps of Engineers. (2010). Hydrologic Engineering Center River Analysis System (HEC-RAS).(Version 4.1) [Computer Program]

U.S. Bureau of Reclamation. (1987). Design of Small Dams Third Edition, 1987. Washington D.C.

U.S. Bureau of the Budget. (1947). United States National Map Accuracy Standards. Retrieved from http://nationalmap.gov/standards/pdf/NMAS647.PDF

United States Geological Survey (1966). *Ground-Water Resources of Sheridan County, Wyoming* Retrieved http://pubs.er.usgs.gov/publication/wsp1807

United States Geological Survey (1984). *Floods of May 1978 in Southeastern Montana and Northeastern Wyoming.* Retrieved from http://pubs.usgs.gov/pp/1244/report.pdf

United States Geological Survey (2013). *National Water Information System: Web Interface* Retrieved from http://waterdata.usgs.gov/nwis

Water Quality Division Surface Water Standards (2001). *Wyoming Surface Water Classification List* Retrieved from http://deq.state.wy.us/wqd/watershed/surfacestandards/

Wyoming Department of Environmental Quality/Land Quality Division (WDEQ/LQD). (2014, January). *Guideline Number 8: Hydrology.* Retrieved 2014, from http://deq.state.wy.us/lqd/downloads/Guidelines/Guideline_8_(1_2014).pdf

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Table D6.1-1. Drainage Basin Characteristics

Drainage Basin Designation[2]	Watershed Area (ac)	Basin Length (mi)	Valley Length (mi)	Channel Length (mi)	Basin Relief (ft)	Valley Relief (ft)	Channel Relief (ft)	Total Stream Length (mi)	Basin Relief Ratio (ft/ft)	Valley Slope (ft/mi)	Channel Slope (ft/mi)	Channel Sinuosity	Drainage Density (mi/mi^2)	Curve No.
TR1	154.6	0.76	0.71	0.73	300	160	160	0.73	0.07	226	221	1.02	3.00	74
TR2	334.5	1.41	1.48	1.59	460	270	270	1.59	0.06	183	169	1.08	3.05	72
TRD1	25.1	0.38	0.31	0.31	260	210	210	0.31	0.13	675	672	1.01	7.97	72
TRD2	328.2	1.50	1.34	1.44	435	275	275	1.44	0.05	206	191	1.08	2.81	73
TRD3	378.6	1.61	1.65	1.77	445	375	375	2.27	0.05	227	212	1.07	3.84	71
TRD4	172.8	0.91	0.46	0.50	230	80	80	0.50	0.05	173	160	1.08	1.85	83
TRD5	593.1	1.73	1.56	1.64	300	200	200	2.86	0.03	128	122	1.05	3.08	84
SLATER CREEK	10532.6	10.60	10.63	14.20	1600	1100	1100	54.72	0.03	103	77	1.34	3.30	79
SCSUB1	270.6	1.20	1.20	1.23	375	265	265	1.74	0.06	222	215	1.03	4.11	77
SCSUB2	259.2	0.95	0.83	0.86	405	185	185	1.35	0.08	223	215	1.04	3.34	75
SCSUB3	198.8	0.98	0.91	0.95	300	230	230	0.95	0.06	252	242	1.04	3.06	76
SCSUB4	219.5	0.85	0.86	0.92	205	115	115	1.60	0.05	134	125	1.07	4.65	84
SCSUB5	81.3	0.62	0.62	0.62	290	180	180	0.62	0.09	289	289	1.00	4.91	75
EFEC	1178.1	3.63	3.40	3.82	520	310	310	4.81	0.03	91	81	1.12	2.61	87
HIDDEN WATER CREEK	5113.2	6.27	7.04	7.82	885	805	805	25.05	0.03	114	103	1.11	3.14	76
HWCSUB1	120.6	0.68	0.51	0.52	220	130	130	0.52	0.06	257	251	1.02	2.75	76
HWCSUB2	91	0.58	0.31	0.33	190	115	115	0.33	0.06	368	352	1.04	2.30	77
HWCSUB3	46.4	0.71	0.54	0.56	260	200	200	0.56	0.07	373	360	1.03	7.66	76
HWCSUB4	112	0.95	0.71	0.72	380	250	250	0.72	0.08	353	345	1.02	4.14	75
HWCSUB5	76.2	0.62	0.59	0.60	340	230	230	0.60	0.10	391	382	1.02	5.06	76
GC1	219.3	1.17	0.83	1.07	220	120	120	1.07	0.04	144	112	1.28	3.12	81

Notes: [1]Drainage basin characteristics are based on USGS Quads except for drainage GC1. Drainage GC1 is based on flight topography.
[2]Refer to Exhibit D6.1-2 for drainage basin designation.

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Table D6.1-2. USGS Gaging Station Data

Parameter	USGS Gaging Station			
	06299980	06306300	06305500	06305700
	Tongue River at Monarch WY	Tongue River at State Line nr Decker MT	Goose Creek Below Sheridan, WY	Goose Creek Near Acme, WY
Drainage Area (mi^2)	478	1,453	392	413
Mean Annual Discharge (cfs)	249	441	184	171
Mean Annual Flow (ac-ft)	180,300	319,300	133,200	123,800
Period of Record	2004-2013	1960-2013	1941-1984	1984-2017
Latitude	44.90028	45.00914	44.82250	44.88639
Longitude	107.02028	106.83594	106.96194	106.98833

Source: USGS National Water Information System: Web Interface

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Table D6.1-3. Annual Peak Streamflow for the Tongue River and Goose Creek

Water Year	Tongue River at Monarch WY		Tongue River at State Line near Decker MT		Goose Creek below Sheridan, WY		Goose Creek near Acme, WY	
	Date	Streamflow (cfs)	Date	Streamflow (cfs)	Date	Streamflow (cfs)	Date	Streamflow (cfs)
1942	ND	ND	ND	ND	27-May-42	1,650	ND	ND
1943	ND	ND	ND	ND	13-Jun-43	1,380	ND	ND
1944	ND	ND	ND	ND	4-Jun-44	4,040	ND	ND
1945	ND	ND	ND	ND	24-Jun-45	2,270	ND	ND
1946	ND	ND	ND	ND	25-Jun-46	2,780	ND	ND
1947	ND	ND	ND	ND	22-Jun-47	1,440	ND	ND
1948	ND	ND	ND	ND	23-Jun-48	2,340	ND	ND
1949	ND	ND	ND	ND	8-Jun-49	1,680	ND	ND
1950	ND	ND	ND	ND	15-Jun-50	1,120	ND	ND
1951	ND	ND	ND	ND	11-Jun-51	1,120	ND	ND
1952	ND	ND	ND	ND	7-Jun-52	1,690	ND	ND
1953	ND	ND	ND	ND	15-Jun-53	2,370	ND	ND
1954	ND	ND	ND	ND	23-May-54	591	ND	ND
1955	ND	ND	ND	ND	26-Jun-55	1,300	ND	ND
1956	ND	ND	ND	ND	29-May-56	3,360	ND	ND
1957	ND	ND	ND	ND	17-Jun-57	1,830	ND	ND
1958	ND	ND	ND	ND	24-May-58	1,080	ND	ND
1959	ND	ND	ND	ND	8-Jun-59	1,130	ND	ND
1960	ND	ND	ND	ND	19-Mar-60	600[e]	ND	ND
1961	ND	ND	30-May-61	1,720	30-May-61	939	ND	ND
1962	ND	ND	17-Jun-62	4,560	16-Jun-62	2,960	ND	ND
1963	ND	ND	16-Jun-63	6,080	16-Jun-63	5,450	ND	ND
1964	ND	ND	10-Jun-64	5,990	9-Jun-64	3,630[ud]	ND	ND
1965	ND	ND	14-Jun-65	3,510	14-Jun-65	1,450[ud]	ND	ND
1966	ND	ND	8-May-66	1,920	8-May-66	436[ud]	ND	ND
1967	ND	ND	15-Jun-67	7,480	14-Jun-67	4,050[ud]	ND	ND
1968	ND	ND	10-Jun-68	5,710	9-Jun-68	2,300[d]	ND	ND
1969	ND	ND	19-Mar-69	4,500[e]	27-May-69	886[d]	ND	ND
1970	ND	ND	14-Jun-70	4,190	15-Jun-70	1,670[d]	ND	ND
1971	ND	ND	31-May-71	3,110	14-Jun-71	1,460[d]	ND	ND
1972	ND	ND	22-May-72	2,590	10-Jun-72	1,070[d]	ND	ND
1973	ND	ND	21-May-73	3,810	10-Jun-73	2,180[d]	ND	ND
1974	ND	ND	29-May-74	2,900	17-Jun-74	1,330[d]	ND	ND
1975	ND	ND	22-Jun-75	5,350	21-Jun-75	2,560[d]	ND	ND
1976	ND	ND	6-Jun-76	2,140	7-Jun-76	986[d]	ND	ND
1977	ND	ND	11-May-77	3,230	5-Jun-77	806[d]	ND	ND
1978	ND	ND	19-May-78	17,500	18-May-78	5,430[d]	ND	ND

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Table D6.1-3. Annual Peak Streamflow for the Tongue River and Goose Creek (Continued)

Water Year	Tongue River at Monarch WY		Tongue River at State Line nr Decker MT		Goose Creek Below Sheridan, WY		Goose Creek near Acme, WY	
	Date	Streamflow (cfs)	Date	Streamflow (cfs)	Date	Streamflow (cfs)	Date	Streamflow (cfs)
1979	ND	ND	29-May-79	2,050	30-May-79	880[d]	ND	ND
1980	ND	ND	25-May-80	2,290	25-May-80	1,280[d]	ND	ND
1981	ND	ND	23-May-81	4,400	22-May-81	2,390[d]	ND	ND
1982	ND	ND	18-Jun-82	2,570	23-Jun-82	1,090[d]	ND	ND
1983	ND	ND	13-Jun-83	3,880	25-Jun-83	1,510[d]	ND	ND
1984	ND	ND	16-Jun-84	4,460	17-Jun-84	1,880[d]	17-Jun-84	2,150[d]
1985	ND	ND	4-May-85	932	ND	ND	26-May-85	282[d]
1986	ND	ND	5-Jun-86	3,670	ND	ND	25-Feb-86	1,770[d]
1987	ND	ND	28-Apr-87	1,190	ND	ND	10-Jun-87	664[d]
1988	ND	ND	18-May-88	3,130	ND	ND	18-May-88	1,070[d]
1989	ND	ND	11-May-89	714	ND	ND	10-Mar-89	356[d]
1990	ND	ND	11-Jun-90	2,710	ND	ND	11-Jun-90	1,220[d]
1991	ND	ND	22-May-91	3,930	ND	ND	22-May-91	1,900[d]
1992	ND	ND	16-Jun-92	3,160	ND	ND	16-Jun-92	1,470[d]
1993	ND	ND	8-Jun-93	3,210	ND	ND	8-Jun-93	1,320[d]
1994	ND	ND	13-May-94	2,340	ND	ND	5-Mar-94	1,490[d][e]
1995	ND	ND	18-Jun-95	5,470	ND	ND	17-Jun-95	3,330[d]
1996	ND	ND	11-Jun-96	2,720	ND	ND	16-Jun-96	1,330[d]
1997	ND	ND	16-Jun-97	3,910	ND	ND	16-Jun-97	1,920[d]
1998	ND	ND	15-Jun-98	1,360	ND	ND	23-Jun-98	722[d]
1999	ND	ND	7-Jun-99	3,350	ND	ND	9-Jun-99	1,770[d]
2000	ND	ND	18-May-00	3,890	ND	ND	18-May-00	2,060[d]
2001	ND	ND	15-May-01	645	ND	ND	16-May-01	151[d]
2002	ND	ND	2-Jun-02	1,050	ND	ND	1-Jun-02	545[d]
2003	ND	ND	31-May-03	2,820	ND	ND	30-May-03	1,390[d]
2004	7-May-04	293	6-Jun-04	326	ND	ND	5-Jul-04	210[d]
2005	11-May-05	3,350	12-May-05	5,440	ND	ND	11-May-05	2,930[d]
2006	24-May-06	1,170	24-May-06	1,840	ND	ND	24-May-06	744[d]
2007	7-Jun-07	3,910	8-Jun-07	6,450	ND	ND	8-Jun-07	3,430[d]
2008	23-May-08	2,460	25-May-08	4,310	ND	ND	ND	ND
2009	31-May-09	1,280	8-Jun-09	2,200	ND	ND	ND	ND
2010	29-May-10	1,930	12-Jun-10	3,550	ND	ND	ND	ND
2011	22-May-11	3,880	22-May-11	6,220	ND	ND	ND	ND
2012	6-Jun-12	886	6-Jun-12	1,890	ND	ND	ND	ND
2013	20-May-13	1,320[d]	12-Jun-13	1,940	ND	ND	ND	ND
2014	30-May-14	3,180[d]	31-May-14	4,710	ND	ND	ND	ND
2015	4-Jun-15	2,810[d]	26-May-15	4,730	ND	ND	18-Jun-15	1,030[d]
2016	24-Sep-16	722[d]	12-Jun-16	1,200	ND	ND	11-Jun-16	816[d]
2017	14-May-17	1,990[d]	19-May-17	3,860	ND	ND	7-Jun-17	1,920[d]

Source: USGS National Water Information System: Web Interface

[d] Discharge affected by Regulation or Diversion

[e] Discharge is an estimate

[ud] Discharge affected to unknown degree by Regulation or Diversion

ND No Data

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Table D6.1-4. Precipitation-Frequency Values

DURATION		RETURN PERIOD						
		2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR
HOURS	MIN.	PRECIPITATION IN INCHES						
0.08	5	0.19	0.28	0.34	0.41	0.47	0.53	0.67
0.17	10	0.30	0.43	0.52	0.64	0.74	0.83	1.05
0.25	15	0.37	0.55	0.66	0.81	0.93	1.05	1.33
0.5	30	0.52	0.76	0.91	1.13	1.29	1.46	1.84
1	60	0.66	0.96	1.16	1.43	1.64	1.84	2.33
2	120	0.75	1.06	1.27	1.56	1.78	2.00	2.51
3	180	0.83	1.16	1.37	1.67	1.91	2.14	2.67
6	360	1.03	1.38	1.62	1.95	2.21	2.47	3.06
12	720	1.26	1.69	1.98	2.39	2.71	3.02	3.74
24	1440	1.50	2.00	2.35	2.83	3.20	3.57	4.42

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Table D6.1-5. HEC-HMS Peak Flow and Runoff Volume for the 6-Hour Precipitation Event

Stream Designation[2]	Storm Event Recurrence Interval (yr)[1]											
	2		5		10		25		50		100	
	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)
GC1	21.1	4.6	39.2	8.7	52.9	11.8	71.1	16.0	85.4	19.4	100.1	22.9
Hidden Water Creek (HWC Out)	229.5	85.2	442.3	165.0	606.2	227.7	830.3	313.8	1010.2	383.6	1197.9	457.1
HWCSUB1	15.1	2.0	28.9	4.0	40.2	5.5	54.8	7.5	66.5	9.2	78.6	11.0
HWCSUB2	13.4	1.6	25.4	3.0	34.9	4.2	47.4	5.7	57.4	7.0	67.8	8.3
HWCSUB3	5.7	0.8	11.0	1.5	15.0	2.0	20.4	2.8	24.8	3.4	29.3	4.0
HWCSUB4	11.8	1.9	22.6	3.6	31.0	5.0	42.4	6.9	51.6	8.5	61.1	10.1
HWCSUB5	11.5	1.3	21.9	2.5	30.0	3.5	40.8	4.8	49.5	5.8	58.6	6.9
TR1	31.5	5.1	60.7	10.0	83.4	13.9	114.4	19.3	139.3	23.6	165.4	28.2
TR2	8.7	2.2	17.0	4.3	23.5	6.0	32.4	8.3	39.6	10.2	47.2	12.3
Slater Creek (SC Out)	497.6	197.7	947.4	378.5	1296.4	521.8	1761.4	713.8	2131.6	868.1	2516.3	1029.7
SCSUB1	23.8	4.5	45.6	8.8	65.8	12.5	89.5	17.2	108.5	21.0	128.1	25.0
SCSUB2	29.0	4.2	55.6	8.2	75.9	11.4	103.9	15.7	126.3	19.2	149.6	23.0
SCSUB3	19.3	3.3	36.9	6.5	50.5	8.9	68.8	12.3	83.5	15.0	98.8	17.9
SCSUB4	29.7	5.3	54.2	9.8	72.2	13.3	95.8	17.9	114.2	21.5	132.9	25.3
SCSUB5	10.4	1.4	20.0	2.8	25.5	3.6	34.9	5.0	42.4	6.1	50.3	7.3
EFEC	95.7	33.3	171.0	60.7	225.6	80.9	296.5	107.6	351.3	128.6	407.1	150.1
TRD1	2.8	0.3	5.4	0.5	10.1	1.0	13.9	1.4	17.0	1.7	20.2	2.0
TRD2	20.3	5.0	39.2	9.8	51.6	13.2	71.0	18.3	86.7	22.4	103.2	26.8
TRD3	19.9	5.2	38.9	10.2	54.2	14.2	75.0	19.8	91.8	24.4	109.6	29.2
TRD4	24.5	4.0	45.1	7.5	60.3	10.1	80.4	13.7	96.0	16.5	112.1	19.4
TRD5	58.8	13.7	108.0	25.7	153.3	36.2	203.5	48.8	242.7	58.7	282.8	68.9

Note: [1] Storm events are SCS Type II, 6-hr General Storms.

[2] See Exhibit D6.1-2 for Drainage Basin Locations.

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Table D6.1-6. HEC-HMS Peak Flow and Runoff Volume for the 24-Hour Precipitation Event

Stream Designation[2]	Storm Event Recurrence Interval (yr)[1]											
	2		5		10		25		50		100	
	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)
GC1	48	11	77	17	99	21	131	28	157	34	184	39
Hidden Water Creek (HWC Out)	474	206	772	331	1005	427	1351	570	1635	686	1930	807
HWCSUB1	37	5	60	8	78	10	105	14	127	16	151	19
HWCSUB2	33	4	53	6	69	8	93	10	112	12	132	15
HWCSUB3	14	2	23	3	29	4	39	5	48	6	56	7
HWCSUB4	28	5	46	7	60	9	80	13	98	15	115	18
HWCSUB5	28	3	46	5	60	6	80	9	97	10	115	12
TR1	75	12	123	20	161	26	217	35	264	42	312	50
TR2	20	5	33	9	43	11	58	15	71	19	84	22
Slater Creek (SC Out)	1022	473	1638	751	2115	965	2813	1277	3382	1530	3970	1791
SCSUB1	60	11	96	18	125	23	168	31	203	37	239	44
SCSUB2	69	10	113	16	148	21	199	28	241	34	285	40
SCSUB3	46	8	74	13	97	17	130	22	157	27	186	31
SCSUB4	69	12	108	19	138	24	181	31	215	36	250	42
SCSUB5	23	3	38	5	50	7	67	9	81	11	96	13
EFEC	194	74	298	112	376	141	486	182	574	214	663	247
TRD1	10	1	16	1	21	2	28	3	34	3	40	4
TRD2	44	12	72	19	94	25	128	33	155	40	184	48
TRD3	46	13	75	21	99	27	134	36	163	44	194	52
TRD4	58	9	91	14	116	18	152	24	182	28	212	33
TRD5	143	33	224	51	286	64	374	84	445	100	517	116

Note: [1] Storm events are SCS Type II, 24-hr General Storms.

[2] See Exhibit D6.1-2 for Drainage Basin Locations.

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Table D6.1-7. Peak Flow Estimates Comparison

Basin	Method	Parameter (unit)	Recurrence Interval (yr)					
			2	5	10	25	50	100
Hidden Water Creek	HEC-HMS	Peak Flow (cfs)	474	772	1005	1351	1635	1930
	Miller (2003)	Peak Flow (cfs)	80	208	339	560	766	1014
Slater Creek	HEC-HMS	Peak Flow (cfs)	1022	1638	2115	2813	3382	3970
	Miller (2003)	Peak Flow (cfs)	113	289	469	769	1049	1384

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Table D6.1-8. HEC-RAS Modeling Results

Channel	Storm Event	Average Channel Hydraulic Properties					
		Flow Depth (ft)	Channel Top Width (ft)	Flow Area (ft^2)	Manning's "n"	Hydraulic Radius (ft)	Channel Velocity (ft/s)
Hidden Water Creek	2-Year, 24-Hour	2.19	191.6	206.4	0.027	1.21	5.44
	100-Year, 24-Hour	3.83	297.6	562.2	0.026	2.13	8.04
Slater Creek	2-Year, 24-Hour	2.19	191.6	206.4	0.027	1.21	5.44
	100-Year, 24-Hour	3.83	297.6	562.2	0.026	2.13	8.04

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Table D6.1-9. Surface Features within 1 Mile of Project Area (Stockponds and Impoundments)

Facility Name	Stream Source	Permit #	Location (Tns-Rng-Sec-¼ ¼)	Priority Date	Applicant	Size of Reservoir (acre-ft)	Uses
Baldwin Reservoir	North Fork Hidden Water Creek	P3397.0R	NENE- Sec. 01- T57- R85	8/8/1916	Mooty Baldwin	21.15	IRR_SW
DeLapp No. 3 Stock Reservoir	Smokey Draw	P6960.0s	NESW- Sec. 03- T57- R84	4/22/1971	Chevron USA, Inc.	2.47	STO
Hart Bros Reservoir	Slater Creek	P60.0R	NENW- Sec. 03- T57- R85	06/18/1896	MALCOLM G. SWAN	26.1	IRR_SW
DAN SCOTT NO. 3 STOCK RESERVOIR	East Fork Earley Creek	P5504.0S	NESW- Sec. 04- T57- R85	12/10/1965	PADLOCK RANCH CO	3.99	STO
Perre Reservoir	Fork of Hidden Water creek	P2671.0R	NESE- Sec. 06- T57- R84	5/29/1914	CARMALLA PERRE	15	DOM_SW; FIS; IRR_SW; STO
MOCK-SMITH #1 STOCK RESERVOIR	Hidden Water Creek	P3695.0S	SWNE- Sec. 08- T57- R84	03/13/1961	GLENN MOCK	5.41	STO
Soltis State No. 1 Stock Reservoir	East Fork Earley Creek	P7404.0S	SENE- Sec. 09- T57- R85	11/2/1972	Rudolph Soltis	2.71	STO
TSCHIRGI #2 STOCK RESERVOIR	East Fork Earley Creek	P2350.0S	NENE- Sec. 09- T57- R85	08/11/1958	WY STATE LANDS & INVESTMENTS	10.84	STO
SCOTT NO 1 STOCK RESERVOIR	Dan Draw	P1392.0S	NWNE- Sec. 10- T57- R85	3/5/1956	PADLOCK RANCH CO	1.1	STO
Upper 10 Stock Reservoir	Riverside Mine Draw	P8206.0S	NWSE- Sec. 10- T57- R85	09/03/1976	WILLIAM F. WELCH	16.85	STO
Hall Reservoir	Spring Draw	P363.0R	NWSE- Sec. 11- T57- R85	11/28/1902	John R. Bocek	42	STO
Legerski Bros #1 Stock Reservoir	White Shale Draw	P7439.0S	SENE- Sec. 12- T57- R85	2/16/1973	John and Nina Mae Legerski	1.35	STO
Enl of the PIT 3 Reservoir	Tongue River	P11595.0R	NENW- Sec. 14- T57- R84	2/26/2001	BIG HORN COAL CO. C/O DECKER COAL CO.	3297.12	CMU; FIS; STO;WET; WL
LEGERSKI #1 STOCK RESERVOIR	Roman Draw	P2290.0S	SENE- Sec. 14- T57- R85	5/15/1958	TAYLOR INVESTMENTS LLC	3.8	STO
Welch #4 Stock Reservoir	Riverside Mine Draw	P8133.0S	NWNW- Sec. 14- T57- R85	07/06/1976	WILLIAM WELCH	9.52	STO
Black Mountain No. 1 Stock Reservoir	Riverside Mine Draw	P10306.0S	SENW- Sec. 14- T57- R85	09/16/1987	WYOMING FUEL COMPANY	6.15	STO
BIG HORN NO 14 RESERVOIR	Tongue River	P9257.0R	SESE- Sec. 15- T57- R84	3/18/1987	BIG HORN COAL CO.	17.77	IND_SW

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Table D6.1-9. Surface Features within 1 Mile of Project Area (Stockponds and Impoundments) (Continued)

Facility Name	Stream Source	Permit #	Location (Tns-Rng-Sec-¼ ¼)	Priority Date	Applicant	Size of Reservoir (acre-ft)	Uses
BIG HORN NO 2 RESERVOIR	Tongue River	P7949.0R	SESE- Sec. 15- T57- R84	6/21/1978	BIG HORN COAL CO.	0.17	IND_SW
FIRST ENL OF BIG HORN NO 14 RESERVOIR	Tongue River	P10952.0R	SESE- Sec. 15- T57- R84	12/20/1999	BIG HORN COAL CO.	19.3	STO
SANITARY TRATMENT FACILITIES NO. 1	Tongue River	P8477.0R	NESE- Sec. 15- T57- R84	7/6/1982	BIG HORN COAL CO.	0.97	IND_SW
PERMANENT IMPOUNDMENT NO 1 RESERVOIR	Slater Creek	P12986.0R	NWSW- Sec. 18- T57- R84	7/6/2007	TAYLOR INVESTMENTS LLC	0.32	IND_SW
Monarch Slough Reservoir	Tongue River	P6321.0R	SWNE- Sec. 19- T57- R84	4/17/1956	WILLIAM AND OLGA LONG	15.45	IRR_SW
LONG'S STOCK RESERVOIR	Monarch Slough	P1350.0S	NESE- Sec. 19- T57- R84	1/4/1956	WILLIAM AND OLGA LONG	0.29	STO
BIG HORN NO 8 RESERVOIR	Big Goose Creek	P8158.0R	NENE- Sec. 21- T57- R84	10/1/1979	BIG HORN COAL CO.	0	IND_SW
BIG HORN NO. 9 1 RESERVOIR	Tongue River	P8676.0R	NENW- Sec. 21- T57- R84	10/27/1983	BIG HORN COAL CO.	0	IND_SW
BIG HORN SCALE HOUSE RESERVOIR	Tongue River	P8677.0R	NWNW- Sec. 21- T57- R84	10/27/1983	BIG HORN COAL CO.	0	IND_SW
Sediment Stock Reservoir	Sediment Draw	P7236.0S	SENW- Sec. 22- T57- R85	05/15/1972	WILLIAM F. WELCH	1.04	STO
13-2374 (POND #10) RESERVOIR	BH 12 Draw	P13317.0R	NWSW- Sec. 23- T57- R84	10/9/2008	FIDELITY EXPLORATION & PRODUCTION COMPANY	0	CNG_SW; IND_SW; STO; WL
14-2374 (POND #11) STOCK RESERVOIR	Heart Draw	P19138.0S	SWSW- Sec. 23- T57- R84	10/9/2008	FIDELITY EXPLORATION & PRODUCTION COMPANY	0	STO
KOOI POND RESERVOIR	Tongue River	P13791.0R	NENW- Sec. 23- T57- R85	6/4/2010	HUGH WEAVER	2	Fis; STO; WL
DeLapp No. 2 Stock Reservoir	Dry Draw (23-57-84)	P6851.0S	SENE- Sec. 23- T57- R84	11/4/1970	NEIL DELAPP	4.98	STO
DELAPP NO. 4	West Fork Dry Draw	P7536.0S	NWSE- Sec. 23- T57- R84	3/12/1973	NEIL DELAPP	6.72	STO
SEAN CARROL NO. 2 STOCK RESERVOIR	Sean Creek	P12856.0S	NWSE- Sec. 24- T57- R85	3/19/1997	Sean Carroll	3.6	STO

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Table D6.1-9. Surface Features within 1 Mile of Project Area (Stockponds and Impoundments) (Continued)

Facility Name	Stream Source	Permit #	Location (Tns-Rng-Sec-¼ ¼)	Priority Date	Applicant	Size of Reservoir (acre-ft)	Uses
Sean Carrol No. 3 Stock Reservoir	Sean Creek	P12857.0S	NENW- Sec. 25- T57- R85	3/19/1997	Sean Carroll	5.5	STO
Sean Carrol No. 1 Stock Reservoir	Sean Creek	P12855.0S	SWSE- Sec. 24- T57- R85	3/20/1997	Sean Carroll	4.4	STO
ENLARGEMENT OF DELAPP NO. 1 STOCK RESERVOIR	Neil's Draw	P18796.0S	SWNW- Sec. 26- T57- R84	1/3/2008	FIDELITY EXPLORATION & PRODUCTION COMPANY	6.92	STO
DeLapp No. 1 Stock Reservoir	Neil's Draw	P6850.0S	SWNW- Sec. 26- T57- R84	11/4/1970	NEIL DELAPP	3.85	STO
14-2674 STOCK RESERVOIR	Contact Draw	P18569.0S	SWSW- Sec. 26- T57- R84	8/28/2007	NORTH SHERIDAN LAND CO LLC	8.55	STO
23-2674 STOCK RESERVOIR	Neil's Draw	P18566.0S	NESW- Sec. 26- T57- R84	8/28/2007	NORTH SHERIDAN LAND CO LLC	14.13	STO
34-2674 STOCK RESERVOIR	Neil's Draw	P18567.0S	SWSE- Sec. 26- T57- R84	8/28/2007	NORTH SHERIDAN LAND CO LLC	5.67	STO
44-2674 STOCK RESERVOIR	Deep Draw	P19072.0S	SESE- Sec. 26- T57- R84	12/24/2008	LAWRENCE G GILL III REVOCABLE TRUST	4.4	STO
Last Prospect Reservoir	Big Goose Creek	P684.0R	SESW- Sec. 27- T57- R84	5/15/1905	IDA HECHT	4.67	IRR_SW
Strip Mine Stock Reservoir	Kuzara Gulch	P7838.0S	SWSE- Sec. 28- T57- R84	9/16/1974	Flying V Cattle Co	3.96	STO
Jensik #2 Stock Reservoir	Jensik Dry Draw	P7371.0S	SWNW- Sec. 28- T57- R84	9/15/1972	Gene Lee	0.37	STO
JOHN JENSIK #1 STOCK RESERVOIR	Jensik Dry Draw	P2322.0S	SENW- Sec. 28- T57- R84	7/18/1958	John Jensik	7.6	STO
57-84-19-SWSW	Trib to Tongue River	Unpermitted	SWSW - Sec. 19 - T57 - R84	N/A	N/A	N/A	N/A
57-85-22-NWSW	Trib to North Dry Creek	Unpermitted	NWSW - Sec. 22 - T57 - R85	N/A	N/A	N/A	N/A
57-85-23-NWSW	Trib to Tongue River	Unpermitted	NWSW - Sec. 23 - T57 - R85	N/A	N/A	N/A	N/A

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Table D6.1-9. Surface Features within 1 Mile of Project Area (Stockponds and Impoundments) (Continued)

Facility Name	Stream Source	Permit #	Location (Tns-Rng-Sec-¼ ¼)	Priority Date	Applicant	Size of Reservoir (acre-ft)	Uses
57-84-20-SWSW	Trib to Tongue River	Unpermitted	SWSW - Sec. 20 - T57 - R84	N/A	N/A	N/A	N/A
57-84-28-NESW	Trib to Goose Creek	Unpermitted	NESW - Sec. 28 - T57 - R84	N/A	N/A	N/A	N/A
57-84-22-SESW	Trib to Goose Creek	Unpermitted	SESW - Sec. 28 - T57 - R84	N/A	N/A	N/A	N/A
57-85-14-NESE	Sediment Draw	Unpermitted	NESE - Sec. 14 - T57 - R85	N/A	N/A	N/A	N/A
57-85-15-NWNE	Trib to East Fork Early Creek	Unpermitted	NWNE - Sec. 15 - T57 - R85	N/A	N/A	N/A	N/A
57-85-2-SWSW	Trib to Slater Creek	Unpermitted	SWSW - Sec. 2 - T57 - R85	N/A	N/A	N/A	N/A
57-85-11-NWNE	Trib to Slater Creek	Unpermitted	NWNE - Sec. 11 - T57 - R85	N/A	N/A	N/A	N/A
57-85-1-SESE	Hidden Water Creek	Unpermitted	SESE - Sec. 1 - T57 - R85	N/A	N/A	N/A	N/A
57-84-7-NWNW	Hidden Water Creek	Unpermitted	NWNW - Sec. 7 - T57 - R84	N/A	N/A	N/A	N/A
57-84-7-NENE	Hidden Water Creek	Unpermitted	NENE - Sec. 7 - T57 - R84	N/A	N/A	N/A	N/A
57-84-5-SWNE	Trib to Hidden Water Creek	Unpermitted	SWNE - Sec. 5 - T57 - R84	N/A	N/A	N/A	N/A

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Table D6.1-10. Surface Water Rights within 1 Mile of Project Area Diversions

Facility Name	Stream Source	Permit #	Location (Tns-Rng-Sec-¼ ¼)	Priority Date	Applicant	Appropriation (cfs)	Uses
Baldwin Ditch	North Fork Hidden Water Creek	P14570.0D	NENE - Sec. 1 - T57 - R85	08/08/1916	Mooty Baldwin	0.64	IRR_SW
East Side Ditch No. 2	Slater Creek	P4077.0D	NENW - Sec. 3 - T57 - R85	07/31/1902	ELIAS A. HART	0.1	IRR_SW
Hart Brothers Ditches (CHANGEDIN PART TO WILLIAMS	Slater Creek	P1317.0D	NWNE - Sec. 3 - T57 - R85	06/15/1896	HART BROTHERS	1.87	IRR_SW
Perre Ditch	Fork of Hidden Water Creek	P12438.0D	NESE - Sec. 6 - T57 - R84	05/29/1914	CARMALLA PERRE		DOM_SW; IRR_SW; STO
Earley Creek Ditch No. 1	East Fork Earley Creek	P3456.0D	NWSW - Sec. 10 - T57 - R85	10/07/1901	LUELLA MORROW	1.2	IRR_SW
Badger Ditch	Badger Draw	P5864.0D	SWNW - Sec. 11 - T57 - R84	03/02/1904	ANNA SCHRIEBEIS	0.23	IRR_SW
Hall Ditch	Draw	P5195.0D	NWSE - Sec. 11 - T57 - R85	11/28/1902	John R. Bocek		IRR_SW
Landen Ditch	Slater Creek	P11695.0D	NENW - Sec. 11 - T57 - R85	01/29/1913	JAMES LANDEN	0.57	IRR_SW
Power Ditch	Tongue River	P8321.0D	NESW - Sec. 11 - T57 - R84	04/20/1908	W.E. Wagner		POW
Wagner No. 3 Ditch	Tongue River	P7820.0D	NESW - Sec. 11 - T57 - R84	04/25/1907	W.E. Wagner	1	IRR_SW
Earley Cr. Ditch No. 2	East Fork Earley Creek	P3459.0D	NWSW - Sec. 15 - T57 - R85	09/27/1901	LUELLA MORROW	0.54	IRR_SW
Monroe & Williams	Tongue River	P1107.0D	NWSW - Sec. 15 - T57 - R84	12/26/1895	JAMES MONROE	2	IRR_SW
Padlock Sprinkler System #5-G	Big Goose Creek	P22447.0D	SWSW - Sec. 15 - T57 - R84	05/14/1962	Big Horn Coal Co.	0.11	IRR_SW
Padlock Sprinkler System #9-T	Tongue River	P22445.0D	NWSE - Sec. 15 - T57 - R84	05/11/1962	Big Horn Coal Co.	0.15	IRR_SW
Sheridan County Electric Company Tunnel	Tongue River	P11181.0D	NWSW - Sec. 15 - T57 - R84	03/23/1912	Lee A. Bartel	5	POW

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Table D6.1-10. Surface Water Rights within 1 Mile of Project Area Diversions (Continued)

Facility Name	Stream Source	Permit #	Location (Tns-Rng-Sec-¼ ¼)	Priority Date	Applicant	Appropriation (cfs)	Uses
Sheridan County Electric Tunnel,, 1st Enl.	Tongue River	P5059.0E	NWSW - Sec. 15 - T57 - R84	03/10/1937	Sheridan County Electric Co.		MAN
McKinley Ditch	Tongue River	P1335.0D	SWSE - Sec. 16 - T57 - R84	09/28/1896	MINNIE STONER	1.64	IRR_SW
Padlock Sprinkler System #6-T, #7-T and #8-T	Tongue River	P22443.0D	SESW - Sec. 16 - T57 - R84	10/17/1961	Big Horn Coal Co.	1.98	IRR_SW
Addleman Sprinkler	Tongue River	P30385.0D	SWNW - Sec. 19 - T57 - R84	08/24/1989	Larry E. & Anna Lee Pilch	0.24	IRR_SW
Buyok Irrigation System	Tongue River	P28382.0D	SENW - Sec. 19 - T57 - R84	06/11/1982	Buyok Ranch	0.34	IRR_SW
JANE BUYOK DOMESTIC PUMP	Tongue River	P34669.0D	SENW - Sec. 19 - T57 - R84	01/31/2011	JANE BUYOK	0.06	DOM_SW
Long's Ditch #1	Tongue River	P21719.0D	SWNE - Sec. 19 - T57 - R84	01/04/1956	WILLIAM & OLGA LONG	0.34	IRR_SW; STO
Long's Ditch #2	Monarch Slough	P21720.0D	SWNE - Sec. 19 - T57 - R84	01/04/1956	WILLIAM & OLGA LONG	0	IRR_SW; STO
Longs Ditch No. 1,, Enlargement	--	P5856.0E	SWNE - Sec. 19 - T57 - R84	04/17/1956	William Long	0	RES
VANESSA DOMESTIC PUMP	Tongue River	P34570.0D	SWNE - Sec. 19 - T57 - R84	03/14/2011	JOHN AND VANESSA BUYOK	0.06	DOM_SW
Birchby Ditch	Tongue River	P1585.0D	NESW - Sec. 20 - T57 - R84	09/21/1897	James Birchby	1.71	IRR_SW
Birchly Ditch {Enl. of}	Tongue River	P1073.0E	NWNE - Sec. 20 - T57 - R84	06/11/1903	James Birchly	0	DOM_SW; IRR_SW
DR41299 WATER HAUL	Tongue River	P34741.0D	NWSE - Sec. 20 - T57 - R84	07/18/2012	WYDOT	1	TEM
Monarch Pipe Line	Tongue River	P18765.0D	SWNW - Sec. 20 - T57 - R84	09/03/1935	SHERIDAN WY COAL CO.	0.26	IRR_SW
Padlock Sprinkler System #1-T and #2-T	Tongue River	P22444.0D	NWNW - Sec. 20 - T57 - R84	05/11/1962	Big Horn Coal Co.	0.21	IRR_SW
Wyoming Coal Mining Co.s Water Supply Ditch	Tongue River	P8297.0D	SWNW - Sec. 20 - T57 - R84	03/16/1908	Wyoming Coal Mining Co.	2.5	MIN; MUN_SW; POW

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Table D6.1-10. Surface Water Rights within 1 Mile of Project Area Diversions (Continued)

Facility Name	Stream Source	Permit #	Location (Tns-Rng-Sec-¼ ¼)	Priority Date	Applicant	Appropriation (cfs)	Uses
Howd Ditch	Big Goose Creek	P945.0D	SWSW - Sec. 22 - T57 - R84	02/11/1895	THOMAS T. HOWD	1.07	DOM_SW; IRR_SW
Padlock Sprinkler System #3-G and #4-G	Big Goose Creek	P22446.0D	SWSW - Sec. 22 - T57 - R84	05/14/1962	Big Horn Coal Co.	0.47	IRR_SW
York Ditch {Enl. of}	Tongue River	P1128.0E	SWNE - Sec. 22 - T57 - R85	11/09/1903	Rosa Masters	0.79	IRR_SW
BLEVINS DOMESTIC PUMP DIVERSION	Tongue River	P33816.0D	NENE - Sec. 23 - T57 - R85	08/17/2007	STEPHANIE BLEVINS AND CLINTON KRUMM	0.056	DSP
JOHNSON DOMESTIC PUMP	Tongue River	P33569.0D	NENE - Sec. 23 - T57 - R85	08/11/2006	JOHN AND GAYLENE JOHNSON	0.056	DOM_SW
Kooi Coal Mining Co.s Water Supply Ditch	Tongue River	P8298.0D	NWNE - Sec. 23 - T57 - R85	03/16/1908	KOOI COAL MINING CO.		MIN; MUN_SW
McPhillamey Ditch	Tongue River	P5016.0D	NWNW - Sec. 23 - T57 - R85	08/25/1902	SARAH E. MCPHILLAMEY	0.74	IRR_SW
McPhilloney (McPhillonay) Ditch {Enl. of}	Tongue River	P1133.0E	NWNW - Sec. 23 - T57 - R85	11/02/1903	Jesse McPhillamey		IRR_SW
Smith Domestic Pump	Tongue River	P33570.0D	NENE - Sec. 23 - T57 - R85	08/14/2006	Earl & Robin Smith		DOM_SW
Vannoy Pipeline	Riverside Mine Draw	P24730.0D	NENE - Sec. 23 - T57 - R85	03/31/1975	LANAINE VANNOY	0.08	IRR_SW
B134035 & B134036 CB WATER HAUL	Big Goose Creek	P34862.0D	NWSW - Sec. 27 - T57 - R84	01/04/2013	WYDOT	1	TEM
Kuzara Sprinkler System No. 5	Big Goose Creek	P25555.0D	SWSW - Sec. 27 - T57 - R84	10/29/1974	BETTY KUZARA	0.04	IRR_SW
Last Prospect Ditch	Big Goose Creek	P6746.0D	SWSW - Sec. 27 - T57 - R84	05/15/1905	IDA M. HECHT		IRR_SW
Kuzara Sprinkler System No. 3	Big Goose Creek	P25553.0D	SESE - Sec. 28 - T57 - R84	10/29/1974	BETTY KUZARA	0.34	IRR_SW
Kuzara Sprinkler System No. 4	Big Goose Creek	P25554.0D	SESE - Sec. 28 - T57 - R84	10/29/1974	BETTY KUZARA	0.05	IRR_SW
Padlock Sprinkler System #1-G and #2-G	Big Goose Creek	P22442.0D	NESE - Sec. 28 - T57 - R84	10/17/1961	Big Horn Coal Co.	0.31	IRR_SW

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Table D6.1-11. Surface Water Monitoring Locations

Site ID	Stream	Location						Date Established	Monitoring Device[1,2]	Type and Frequency of Measurement[3]
		Qtr-Qtr	SEC	T(N)	R(W)	Northing (WY83ECF)	Easting (WY83ECF)			
SM578512-SW-1	Slater Creek	SE-SW	12	57	85	1,940,409	1,381,960	9/30/2013	Flowmeter	Continuous Recorder
SM578418-SW-1	Slater Creek	SE-SW	18	57	84	1,935,703	1,386,326	9/30/2013	Flowmeter and Pump Sampler	Continuous Recorder, Pump sampler water quality sampler based on precipitation event, Monthly grab sample if water is present
SM578409-SW-1	Hidden Water Creek	SW-NW	9	57	84	1,942,831	1,395,621	9/30/2013	Flowmeter	Continuous Recorder
SM578415-SW-1	Hidden Water Creek	SE-NW	15	57	84	1,938,209	1,402,426	9/30/2013	Flowmeter	Continuous Recorder
578420-TR-1	Tongue River	NW-SE	20	57	84	1,931,780	1,393,144	6/20/2018	USGS Gaging Station 06299980	Continuous Recorder, Quarterly grab water quality sample site
578524-TR-1	Tongue River	NE-NW	24	57	85	1,933,896	1,381,493	6/6/2018	None	Quarterly grab water quality sample site
578513-IRR-DITCH	Tongue River	SE-SW	13	57	85	1,935,863	1,381,427	6/6/2018	None	Quarterly grab water quality sample site
578434-GC-1	Goose Creek	NE-SW	34	57	84	1,921,527	1,403,315	4/14/2015	None	Quarterly grab water quality sample site

Notes: [1]Flow meter is a Teledyne Isco Signature Flow Meter with integral bubbler level sensor (330 Bubbler Module).

[2]Pump sampler is a Teledyne Isco 6712 Full-Size Portable Sampler.

[3]Flow meters and pump samplers were inactive during the winter to avoid damage to the equipment.

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Table D6.1-12. Water Quality Constituents

Constituent	Source[1,2]	Holding Time	Analytical Method
pH	GW,SW	At time of Sample	SM 4500 H B
Electrical Conductivity	GW, SW	28 Days	SM 2510B
Total Dissolved Solids (180)	GW, SW	7 Days	SM 2540
Sodium Adsorption Ratio (SAR)	GW, SW	NA	Calculation
Alkalinity, Total (as $CACO_3$)	GW, SW	14 Days	SM 2320B
Alkalinity, carbonate (as CO_3)	GW, SW	14 Days	SM 2320B
Alkalinity, Hydroxide (as OH)	GW, SW	14 Days	SM 2320B
Ammonia Nitrogen (as N)	GW, SW	28 Days	EPA 350.1
Total Suspended Solids	SW	7 Days	SM 2540
Turbidity	SW	48 Hours	SM 2130
Nitrate+Nitrite as N	GW, SW	28 Days	EPA 353.2
Alkalinity, bicarbonate as HCO_3	GW, SW	14 Days	SM 2320B
Boron	GW, SW	180 Days	EPA 200.7
Barium	GW, SW	180 Days	EPA 200.8
Copper	GW, SW	180 Days	EPA 200.8
Fluoride	GW, SW	28 Days	SM 4500FC
Sulfate	GW, SW	28 Days	EPA 300.0
Aluminum	GW, SW	180 Days	EPA 200.7
Arsenic	GW, SW	180 Days	EPA 200.8
Cadmium	GW, SW	180 Days	EPA 200.8
Calcium	GW, SW	180 Days	EPA 200.7
Chloride	GW, SW	28 Days	EPA 300.0
Chromium	GW, SW	180 Days	EPA 200.7
Iron	GW, SW	180 Days	EPA 200.7
Total Iron	GW, SW	180 Days	EPA 200.7
Lead	GW, SW	180 Days	EPA 200.8
Magnesium	GW, SW	180 Days	EPA 200.7
Manganese	GW, SW	180 Days	EPA 200.7
Total Manganese	GW, SW	180 Days	EPA 200.7
Molybdenum	GW, SW	180 Days	EPA 200.8
Nickel	GW, SW	180 Days	EPA 200.7
Potassium	GW, SW	180 Days	EPA 200.7
Selenium	GW, SW	180 Days	EPA 200.8
Sodium	GW, SW	180 Days	EPA 200.7
Mercury	GW, SW	28 Days	EPA 245.1
Total Mercury	GW, SW	28 Days	EPA 245.1
Zinc	GW, SW	180 Days	EPA 200.7

Notes: [1]SW = Surface Water Monitoring, GW = Groundwater Monitoring

[2]Surface and groundwater monitoring was conducted in accordance with WDEQ/LQD Guideline 8

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Table D6.1-13. Surface Water Quality Monitoring Results

Parameter	Units	578409-SW									
		Sep-13	Oct-13	Apr-14	May-14	Jul-14	Sep-14	Apr-15	Jun-15	Sep-15	Oct-15
Sample Type		DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Field											
Field Conductivity	µmhos/cm										
Field pH	s.u.										
Field turbidity	NTUs										
Temperature	Deg C										
General											
Alkalinity (as CaCO3)	mg/L										
Ammonia	mg/L										
Fluoride	mg/L										
Hardness (as CaCO3)	mg/L										
Hydroxide	mg/L										
Laboratory conductivity	µmhos/cm										
Dissolved oxygen	mg/L										
Laboratory pH	s.u.										
Laboratory turbidity	NTUs										
Nitrate/Nitrite	mg/L										
Total Dissolved Solids	mg/L										
Total Suspended Solids	mg/L										
Sodium Adsorption Ratio (SAR)	unitless										
Major Ions											
Calcium	mg/L										
Magnesium	mg/L										
Potassium	mg/L										
Sodium	mg/L										
Bicarbonate	mg/L										
Carbonate	mg/L										
Chloride	mg/L										
Sulfate	mg/L										
Metals											
Aluminum, dissolved	mg/L										
Arsenic, dissolved	mg/L										
Barium, dissolved	mg/L										
Boron, dissolved	mg/L										
Cadmium, dissolved	mg/L										
Chromium, dissolved	mg/L										
Copper, dissolved	mg/L										
Iron, dissolved	mg/L										
Iron, total	mg/L										
Lead, dissolved	mg/L										
Manganese, dissolved	mg/L										
Manganese, total	mg/L										
Mercury, dissolved	mg/L										
Molybdenum, dissolved	mg/L										
Nickel, dissolved	mg/L										
Selenium, dissolved	mg/L										
Zinc, dissolved	mg/L										
QA/QC											
Anion Sum	meq/L										
Cation Sum	meq/L										
Total Anion/Cation Balance	%										
Total Dissolved Solids (calc)	mg/L										

Note: GS = Grab Sample Collected
LF = Low flow recorded by sampler. Flow level wasn't enough to sample.
NP = No landowner access permission
FD = Field duplicate sample.
OL = Over limit

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Table D6.1-13. Surface Water Quality Monitoring Results (Continued)

Parameter	Units	578415-SW							
		Sep-13	Oct-13	Apr-14	May-14	Jul-14	Sep-14	Apr-15	Sep-15
Sample Type		DRY	DRY	DRY	DRY	DRY	DRY	NP	NP
Field									
Field Conductivity	µmhos/cm								
Field pH	s.u.								
Field turbidity	NTUs								
Temperature	Deg C								
General									
Alkalinity (as CaCO3)	mg/L								
Ammonia	mg/L								
Fluoride	mg/L								
Hardness (as CaCO3)	mg/L								
Hydroxide	mg/L								
Laboratory conductivity	µmhos/cm								
Dissolved oxygen	mg/L								
Laboratory pH	s.u.								
Laboratory turbidity	NTUs								
Nitrate/Nitrite	mg/L								
Total Dissolved Solids	mg/L								
Total Suspended Solids	mg/L								
Sodium Adsorption Ratio (SAR)	unitless								
Major Ions									
Calcium	mg/L								
Magnesium	mg/L								
Potassium	mg/L								
Sodium	mg/L								
Bicarbonate	mg/L								
Carbonate	mg/L								
Chloride	mg/L								
Sulfate	mg/L								
Metals									
Aluminum, dissolved	mg/L								
Arsenic, dissolved	mg/L								
Barium, dissolved	mg/L								
Boron, dissolved	mg/L								
Cadmium, dissolved	mg/L								
Chromium, dissolved	mg/L								
Copper, dissolved	mg/L								
Iron, dissolved	mg/L								
Iron, total	mg/L								
Lead, dissolved	mg/L								
Manganese, dissolved	mg/L								
Manganese, total	mg/L								
Mercury, dissolved	mg/L								
Molybdenum, dissolved	mg/L								
Nickel, dissolved	mg/L								
Selenium, dissolved	mg/L								
Zinc, dissolved	mg/L								
QA/QC									
Anion Sum	meq/L								
Cation Sum	meq/L								
Total Anion/Cation Balance	%								
Total Dissolved Solids (calc)	mg/L								

Note: GS = Grab Sample Collected
LF = Low flow recorded by sampler. Flow level wasn't enough to sample.
NP = No landowner access permission
FD = Field duplicate sample.
OL = Over limit

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Table D6.1-13. Surface Water Quality Monitoring Results (Continued)

Parameter	Units	578418-SW									
		Sep-13	Oct-13	Apr-14	May-14	Jul-14	Sep-14	Apr-15	Jun-15	Sep-15	Oct-15
Sample Type		DRY	DRY	GS	DRY	LF	LF	GS	GS	LF	DRY
Field											
Field Conductivity	µmhos/cm			1851				4200	3310		
Field pH	s.u.			8.48				8.04	8.23		
Field turbidity	NTUs			16.92				9.14	OL		
Temperature	Deg C			12.1				13.9	24.2		
General											
Alkalinity (as CaCO3)	mg/L			340				558	412		
Ammonia	mg/L			<0.1				0.2	0.3		
Fluoride	mg/L			0.6				1	0.8		
Hardness (as CaCO3)	mg/L			816				1940	1490		
Hydroxide	mg/L			<5				<5	<5		
Laboratory conductivity	µmhos/cm			1890				4170	2860		
Dissolved oxygen	mg/L			10							
Laboratory pH	s.u.			8.4				8.3	8.5		
Laboratory turbidity	NTUs			13.9				4.9	3070		
Nitrate/Nitrite	mg/L			<0.1				<.1	0.2		
Total Dissolved Solids	mg/L			1560				3990	3160		
Total Suspended Solids	mg/L			9				10	4800		
Sodium Adsorption Ratio (SAR)	unitless			2.2				3.5	3.4		
Major Ions											
Calcium	mg/L			104				234	147		
Magnesium	mg/L			136				329	272		
Potassium	mg/L			16				30	26		
Sodium	mg/L			147				353	298		
Bicarbonate	mg/L			395				663	459		
Carbonate	mg/L			10				9	22		
Chloride	mg/L			8				23	13		
Sulfate	mg/L			732				2230	1790		
Metals											
Aluminum, dissolved	mg/L			0.6				<.1	<.1		
Arsenic, dissolved	mg/L			<0.005				<.005	<.005		
Barium, dissolved	mg/L			<0.1				<.1	<.1		
Boron, dissolved	mg/L			0.2				0.3	0.3		
Cadmium, dissolved	mg/L			<0.001				<.001	<.001		
Chromium, dissolved	mg/L			<0.01				<.01	<.01		
Copper, dissolved	mg/L			<0.01				<.01	<.01		
Iron, dissolved	mg/L			0.35				<.05	<.05		
Iron, total	mg/L			0.39				<.02	49.4		
Lead, dissolved	mg/L			<0.02				0.49	<.02		
Manganese, dissolved	mg/L			0.12				0.31	<.02		
Manganese, total	mg/L			0.13				0.33	3.32		
Mercury, dissolved	mg/L			<0.001				<.001	<.001		
Molybdenum, dissolved	mg/L			<0.02				<.02	<.02		
Nickel, dissolved	mg/L			<0.01				<.01	<.01		
Selenium, dissolved	mg/L			<0.005				<.005	<.005		
Zinc, dissolved	mg/L			<0.01				<.01	<.01		
QA/QC											
Anion Sum	meq/L			22.27				58.32	46		
Cation Sum	meq/L			23.11				54.87	43.36		
Total Anion/Cation Balance	%			1.84				3.02	2.95		
Total Dissolved Solids (calc)	mg/L			1350				3530	2800		

Note: GS = Grab Sample Collected
LF = Low flow recorded by sampler. Flow level wasn't enough to sample.
NP = No landowner access permission
FD = Field duplicate sample.
OL = Over limit

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Table D6.1-13. Surface Water Quality Monitoring Results (Continued)

Parameter	Units	578512-SW										
		Sep-13	Oct-13	Apr-14	May-14	Jul-14	Sep-14	Apr-15	Apr-15	Jun-15	Sep-15	Oct-15
Sample Type		DRY	DRY	GS	DRY	DRY	LF	GS	FD	LF	LF	DRY
Field												
Field Conductivity	µmhos/cm			1504				5070	5070			
Field pH	s.u.			8.58				8.04	8.04			
Field turbidity	NTUs			17.84				11.3	11.3			
Temperature	Deg C			13.8				12.9	12.9			
General												
Alkalinity (as CaCO3)	mg/L			303				658	641			
Ammonia	mg/L			<0.1				0.3	0.3			
Fluoride	mg/L			0.5				1	0.9			
Hardness (as CaCO3)	mg/L			653				2320	2360			
Hydroxide	mg/L			<5				<5	<5			
Laboratory conductivity	µmhos/cm			1540				5060	5090			
Dissolved oxygen	mg/L			10								
Laboratory pH	s.u.			8.4				8.3	8.3			
Laboratory turbidity	NTUs			13.4				8.3	8.2			
Nitrate/Nitrite	mg/L			<0.1				<.1	<.1			
Total Dissolved Solids	mg/L			1220				5200	5060			
Total Suspended Solids	mg/L			8				10	10			
Sodium Adsorption Ratio (SAR)	unitless			1.9				4.1	1			
Major Ions												
Calcium	mg/L			87				238	241			
Magnesium	mg/L			106				421	427			
Potassium	mg/L			11				22	20			
Sodium	mg/L			112				455	453			
Bicarbonate	mg/L			347				793	774			
Carbonate	mg/L			11				<5	<5			
Chloride	mg/L			5				29	28			
Sulfate	mg/L			550				2790	2790			
Metals												
Aluminum, dissolved	mg/L			<0.1				<.1	<.1			
Arsenic, dissolved	mg/L			<0.005				<.005	<.005			
Barium, dissolved	mg/L			<0.1				<.1	<.1			
Boron, dissolved	mg/L			0.1				0.5	0.4			
Cadmium, dissolved	mg/L			<0.001				<.001	<.001			
Chromium, dissolved	mg/L			<0.01				<.01	<.01			
Copper, dissolved	mg/L			<0.01				<.01	<.01			
Iron, dissolved	mg/L			<0.05				0.06	<.05			
Iron, total	mg/L			0.35				0.89	0.94			
Lead, dissolved	mg/L			<0.02				<.02	<.02			
Manganese, dissolved	mg/L			0.08				0.94	0.96			
Manganese, total	mg/L			0.09				1.2	1.31			
Mercury, dissolved	mg/L			<0.001				<.001	<.001			
Molybdenum, dissolved	mg/L			<0.02				<.02	<.02			
Nickel, dissolved	mg/L			<0.01				<.01	<.01			
Selenium, dissolved	mg/L			<0.005				<.005	<.005			
Zinc, dissolved	mg/L			<0.01				<.01	<.01			
QA/QC												
Anion Sum	meq/L			17.68				72.14	71.74			
Cation Sum	meq/L			18.23				66.84	67.39			
Total Anion/Cation Balance	%			1.53				3.81	3.12			
Total Dissolved Solids (calc)	mg/L			1050				4350	4340			

Note: GS = Grab Sample Collected
LF = Low flow recorded by sampler. Flow level wasn't enough to sample.
NP = No landowner access permission
FD = Field duplicate sample.
OL = Over limit

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Table D6.1-13. Surface Water Quality Monitoring Results (Continued)

Parameter	Units	578420-TR-1				578513-IRR-DITCH-1				578524-TR-1				
		Jun-18	Jul-18	Nov-18	Jan-19	Jun-18	Jul-18	Nov-18	Jan-19	Apr-18	Jun-18	Jul-18	Nov-18	Jan-19
Sample Type		GS	GS	GS	GS	GS	GS	DRY	FROZEN	GS	GS	GS	GS	GS
Field														
Field Conductivity	µmhos/cm	292	329	533	500	241	326			588	232	335	526	474
Field pH	s.u.	8.16	8.45	8.6	8.14	8.89	8.69			8.69	7.97	8.64	8.63	8.15
Field turbidity	NTUs	11.6	9.09	2.14	1.9	27.5	33.2			10.7	19.2	6.17	3.44	1.93
Temperature	Deg C	15.5	20.7	3.6	1.4	23.7	22.6			9.4	18.8	21.8	3.4	1.4
General														
Alkalinity (as CaCO3)	mg/L	128	157	207	196	107	148			204	109	156	203	190
Ammonia	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1
Fluoride	mg/L	0.1	0.1	0.1	0.1	0.1	0.1			0.2	<0.1	0.1	0.2	0.1
Hardness (as CaCO3)	mg/L	136	163	229	213	116	156			257	113	160	217	205
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5			<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	292	356	458	434	248	335			598	242	343	446	396
Dissolved oxygen	mg/L													
Laboratory pH	s.u.	8.4	8.6	8.5	8.3	8.8	8.6			8.6	8.4	8.6	8.4	8.4
Laboratory turbidity	NTUs	9.9	7.7	1.7	1.2	22.8	24.1			8.8	15.1	6.9	1.7	1.2
Nitrate/Nitrite	mg/L	<0.1	<0.1	<0.1	0.2	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	0.2
Total Dissolved Solids	mg/L	170	210	290	280	150	210			380	140	190	280	270
Total Suspended Solids	mg/L	18	13	<5	<5	38	103			12	29	8	<5	<5
Sodium Adsorption Ratio (SAR)	unitless	0.25	0.31	0.46	0.35	0.26	0.28			0.76	0.2	0.28	0.45	0.33
Major Ions														
Calcium	mg/L	34	40	55	52	29	38			58	30	39	52	50
Magnesium	mg/L	12	16	23	20	10	15			28	10	15	22	19
Potassium	mg/L	1	1	2	1	1	1			3	2	1	2	1
Sodium	mg/L	7	9	16	12	7	8			28	5	8	16	11
Bicarbonate	mg/L	152	179	241	237	118	171			232	130	179	236	227
Carbonate	mg/L	<5	6	5	<5	6	<5			8	<5	6	6	<5
Chloride	mg/L	1	1	3	2	1	1			4	<1	1	3	2
Sulfate	mg/L	26	28	58	51	22	27			115	15	24	54	47
Metals														
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			<0.005	<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1
Boron, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			<0.05	<0.05	<0.05	<0.05	<0.05
Iron, total	mg/L	0.35	0.25	0.08	0.05	0.7	0.7			0.22	0.64	0.2	0.09	0.07
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02			<0.02	<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02			0.03	<0.02	<0.02	<0.02	<0.02
Manganese, total	mg/L	0.02	<0.02	<0.02	<0.02	0.03	0.03			0.04	0.03	<0.02	<0.02	<0.02
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02			<0.02	<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005			<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01
QA/QC														
Anion Sum	meq/L	3.13	3.76	5.43	5.04	2.63	3.55			6.59	2.5	3.66	5.26	4.84
Cation Sum	meq/L	3.03	3.7	5.33	4.8	2.63	3.5			6.43	2.52	3.59	5.06	4.61
Total Anion/Cation Balance	%	1.48	0.76	0.92	2.43	0.04	0.73			1.19	0.49	0.92	1.91	2.41
Total Dissolved Solids (calc)	mg/L	160	190	280	260	140	180			360	130	180	270	250

Note: GS = Grab Sample Collected
LF = Low flow recorded by sampler. Flow level wasn't enough to sample.
NP = No landowner access permission
FD = Field duplicate sample.
OL = Over limit

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Table D6.1-13. Surface Water Quality Monitoring Results (Continued)

Parameter	Units	Big Goose Creek				
		Apr-15	Sep-15	Dec-15	Mar-16	May-16
Sample Type		GS	GS	GS	GS	GS
Field						
Field Conductivity	µmhos/cm	502	712	662	665	336
Field pH	s.u.	8.97	8.45	8.67	8.89	8.73
Field turbidity	NTUs	5.83	3.93	4.07	6.57	28
Temperature	Deg C	14.1	15.1	2.2	7.1	17.9
General						
Alkalinity (as CaCO3)	mg/L	185	289	246	236	129
Ammonia	mg/L	<0.1	<0.1	<0.1	0.1	<0.1
Fluoride	mg/L	0.2	0.4	0.2	0.2	0.1
Hardness (as CaCO3)	mg/L	238	351	306	298	147
Hydroxide	mg/L	<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	517	759	628	628	349
Dissolved oxygen	mg/L					
Laboratory pH	s.u.	9	8.6	8.4	8.6	8.5
Laboratory turbidity	NTUs	3.4	2.9	2.2	1.6	14.3
Nitrate/Nitrite	mg/L	<0.1	0.5	0.5	0.4	<0.1
Total Dissolved Solids	mg/L	320	480	390	410	210
Total Suspended Solids	mg/L	11	<5	5	<5	30
Sodium Adsorption Ratio (SAR)	unitless	0.4	0.6	0.5	0.5	0.4
Major Ions						
Calcium	mg/L	46	64	60	57	31
Magnesium	mg/L	30	46	38	38	17
Potassium	mg/L	2	4	3	3	2
Sodium	mg/L	16	28	20	21	12
Bicarbonate	mg/L	183	314	294	260	150
Carbonate	mg/L	21	19	<5	14	<5
Chloride	mg/L	7	9	6	7	3
Sulfate	mg/L	83	117	95	98	43
Metals						
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Boron, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron, total	mg/L	0.27	0.15	0.18	0.14	0.67
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	0.02	0.02	0.02	0.04	<0.02
Manganese, total	mg/L	0.04	0.03	0.03	0.04	0.05
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
QA/QC						
Anion Sum	meq/L	5.61	8.51	7.11	6.99	3.55
Cation Sum	meq/L	5.5	8.33	7.04	6.94	3.48
Total Anion/Cation Balance	%	1.06	1.07	0.43	0.38	0.96
Total Dissolved Solids (calc)	mg/L	290	440	370	370	180

Note: GS = Grab Sample Collected
LF = Low flow recorded by sampler. Flow level wasn't enough to sample.
NP = No landowner access permission
FD = Field duplicate sample.
OL = Over limit

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Table D6.1-14. Tongue River Watershed Monitoring Station TR03 Flow Data[1]

Site	Date	Discharge (cfs)
TR03	5/1/2013	179.335
TR03	5/9/2013	194.97
TR03	5/15/2013	686.51
TR03	5/21/2013	ND[2]
TR03	5/29/2013	ND[2]
TR03	8/1/2013	67.67
TR03	8/6/2013	82.12
TR03	8/15/2013	78.78
TR03	8/21/2013	56.06
TR03	8/28/2013	50.69
TR03	5/18/2016	366.78
TR03	5/31/2016	508.88
TR03	6/13/2016	549.76
TR03	6/27/2016	172.6
TR03	7/13/2016	76.08
TR03	7/28/2016	36.01
TR03	8/10/2016	59.43
TR03	8/22/2016	106.32
TR03	9/7/2016	113.99
TR03	9/20/2016	98.69

Note: [1] Data from Sheridan County Conservation District 2016 Tongue River Watershed Interim Monitoring Report

[2] Data could not be collected because the gauge was submerged

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Table D6.1-15. Big Horn Mine Monitoring Station TR2B80 Flow Data

STATION TR2B80	Discharge in CFS, May 2016 Through April 2017, Mean Values																							
DAY	May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr	
1	360		674		192	E	71	E	61	E	234	E	*257*	E	104	E	141	E	*139*	E	203	E	1,164	
2	356		659		186	E	70	E	60	E	208	E	*232*	E	115	E	141	E	*137*	E	194	E	684	
3	368		669		171	E	63	E	61	E	209	E	*224*	E	120	E	137	E	*139*	E	186	E	595	
4	405		756		168	E	57	E	68	E	289	E	*215*	E	122	E	142	E	*127*	E	197	E	534	
5	466		825		175	E	53	E	109	E	280	E	*216*	E	124	E	150	E	*152*	E	91	E	488	
6	520		885		144	E	53	E	149	E	236	E	*211*	E	115	E	148	E	*173*	E	223	E	461	
7	566		930		119	E	51	E	126	E	232	E	*207*	E	110	E	153	E	*169*	E	186	E	453	
8	600		935		106	E	64	E	109	E	216	E	*202*	E	115	E	162	E	*163*	E	189	E	470	
9	669		975		95	E	70	E	103	E	206	E	*202*	E	131	E	167	E	*163*	E	213	E	543	
10	714		1,033		93	E	66	E	106	E	203	E	*197*	E	155	E	171	E	*190*	E	197	E	585	
11	614		1,068		103	E	59	E	105	E	210	E	*195*	E	166	E	174	E	*252*	E	196	E	614	
12	548		941		104	E	59	E	118	E	213	E	*192*	E	152	E	171	E	*328*	E	200	E	543	
13	600		874		*96*	E	64	E	139	E	205	E	*186*	E	145	E	164	E	*388*	E	211	E	524	
14	543		772		*81*	E	64	E	146	E	206	E	*195*	E	141	E	152	E	*439*	E	211	E	576	
15	524		639		*73*	E	63	E	142	E	203	E	*193*	E	145	E	147	E	*493*	E	223	E	590	
16	562		552		*74*	E	58	E	142	E	199	E	*191*	E	145	E	146	E	*579*	E	243	E	576	
17	529		492		*72*	E	55	E	136	E	202	E	*202*	E	129	E	141	E	*668*	E	261	E	617	E
18	538		435		*72*	E	67	E	122	E	215	E	*ICE*		138	E	134	E	*613*	E	240	E	658	E
19	557		435		*64*	E	130	E	*112*	E	203	E	*ICE*		150	E	131	E	*489*	E	251	E	668	E
20	610		414		*60*	E	167	E	*112*	E	196	E	*148*	E	148	E	130	E	*384*	E	273	E	610	
21	694		376		*62*	E	127	E	*106*	E	192	E	*150*	E	137	E	126	E	*337*	E	300	E	600	
22	782		352		*58*	E	100	E	*115*	E	198	E	*143*	E	135	E	122	E	*283*	E	285	E	644	
23	720		274	E	*55*	E	82	E	*146*	E	193	E	*133*	E	140	E	126	E	*247*	E	354	E	619	
24	644		241	E	*59*	E	72	E	*614*	E	192	E	*133*	E	149	E	127	E	*223*	E	493	E	624	
25	674		220	E	*62*	E	69	E	711	E	192	E	*136*	E	151	E	128	E	*214*	E	390	E	913	
26	704		198	E	*63*	E	73	E	341	E	192	E	*137*	E	139	E	125	E	*202*	E	498	E	1,116	
27	679		175	E	*57*	E	83	E	294	E	191	E	*133*	E	135	E	125	E	*191*	E	414	E	1,623	
28	649		160	E	*65*	E	79	E	265	E	193	E	*125*	E	130	E	124	E	*206*	E	424	E	2,156	
29	669		152	E	*69*	E	73	E	252	E	266	E	*114*	E	130	E	122	E			466	E	1,475	
30	709		146	E	*74*	E	71	E	246	E	315	E	*105*	E	130	E	128	E			396	E	1,449	
31	756				*77*		64	E			272	E			129	E	133	E			858	E		
																								WtrYr
Mean	591		575		95		74		177		218		178		135		142		289		292		772	295
Max	782		1,068		192		167		711		315		257		166		174		668		858		2,156	2,156
Min	356		146		55		51		60		191		105		104		122		127		91		453	51
Ac-ft	36,356		34,229		5,849		4,556		10,544		13,410		10,923		8,281		8,704		17,761		17,982		45,962	214,558

ICE = Measurement invalidated due to ice.

E - Estimated value derived from adding reported flows from Goose Creek (GC00) and upper Tongue River (Tr01) (or corresponding USGS) stations when rating curve appeared to be inaccurate at the measured stages.

Data from Big Horn Coal Mine Annual Reports.

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Table D6.1-15. Big Horn Mine Monitoring Station TR2B80 Flow Data (Continued)

STATION TR2B80		Discharge in CFS, May 2017 Through April 2018, Mean Values												
DAY	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
1	1,653	2,086	652	161	104	270	261	190	ICE	ICE	ICE	227	
2	1,384	2,292	618	146	110	254	256	209	ICE	ICE	ICE	289	
3	1,085	2,420	570	165	110	248	230	209	ICE	ICE	ICE	213	
4	1,048	2,620	505	168	106	240	236	200	ICE	ICE	ICE	223	
5	1,225	2,870	475	180	107	229	224	199	ICE	ICE	ICE	337	
6	1,467	3,110	451	176	117	231	193	216	ICE	ICE	ICE	322	
7	1,930	3,070	422	178	123	223	154	257	ICE	ICE	ICE	262	
8	2,410	3,030	415	150	116	220	154	216	ICE	ICE	ICE	279	
9	2,320	2,980	375	137	116	228	192	208	ICE	ICE	ICE	410	
10	2,270	2,750	396	141	116	216	203	216	ICE	ICE	ICE	449	
11	2,220	2,240	370	157	118	226	194	206	ICE	ICE	ICE	408	
12	2,340	2,090	344	160	116	226	173	213	ICE	ICE	ICE	433	
13	2,680	2,184	331	154	113	221	184	197	ICE	ICE	ICE	378	
14	3,070	1,839	301	173	124	212	207	180	ICE	ICE	ICE	294	
15	2,760	1,534	281	209	251	213	203	ICE	ICE	ICE	ICE	260	
16	2,700	1,421	286	244	361	208	195	ICE	ICE	ICE	ICE	257	
17	2,660	1,584	273	209	278	212	230	ICE	ICE	ICE	658	285	
18	3,490	1,573	241	189	249	208	212	ICE	ICE	ICE	491	290	
19	2,620	1,340	212	171	239	207	185	ICE	ICE	ICE	287	260	
20	2,160	1,275	201	159	266	206	196	ICE	ICE	ICE	317	241	
21	2,101	1,325	201	163	251	203	210	ICE	ICE	ICE	ICE	241	
22	1,963	1,271	191	143	266	196	205	ICE	ICE	ICE	ICE	271	
23	1,936	1,132	180	146	293	195	211	ICE	ICE	ICE	ICE	331	
24	1,862	1,012	161	137	320	197	224	ICE	ICE	ICE	383	330	
25	2,280	909	147	132	327	196	210	ICE	ICE	ICE	330	310	
26	2,147	789	173	125	336	209	199	ICE	ICE	ICE	290	299	
27	2,041	705	206	116	322	201	209	ICE	ICE	ICE	256	313	
28	1,897	739	221	113	316	202	206	ICE	ICE	ICE	257	384	
29	1,921	716	192	108	294	220	191	ICE	ICE		277	535	
30	1,914	724	211	102	288	211	188	ICE	ICE		263	619	
31	1,911		180	106		178		ICE	ICE		273		
													Wtr Yr
Mean	2,112	1,788	316	155	209	216	205	208	---	---	340	325	587
Max	3,490	3,110	652	244	361	270	261	257	---	---	658	619	3,490
Min	1,048	705	147	102	104	178	154	180	---	---	256	213	102
Ac-ft	129,850	106,375	19,403	9,551	12,407	13,302	12,577	12,812	---	---	20,916	19,339	356,531

ICE = Measurement invalidated due to ice.

E - Estimated value derived from adding reported flows from Goose Creek (GC00) and upper Tongue River (Tr01) (or corresponding USGS) stations when rating curve appeared to be inaccurate at the measured stages.

Data from Big Horn Coal Mine Annual Reports

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RECD 10-25-18

DEQ Ex. 3-079

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Table D6.1-16. Number of Flow Days at the Big Horn Mine Hidden Water Creek (HWC1-79) Gage

Year	HWC1-79											
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1982										0	0	0
1983	2 (5.88)	0	0	0	0	0	0	0	0	0	0	0
1984	0	0	0	0	0	0	0	0	0	0	0	0
1985	0	2 (0.56)	1 (0.01)	0	0	0	0	0	0	0	0	0
1986	0	2 (4.3)	0	0	1 (1.17)	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	4 (0.53)	0	0	0	0	0	0	0	0	0	0
1989	0	0	1(0.02)	0	0	0	0	0	0	0	0	0
1990	0	2 (0.67)	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	3 (2.48)	0	0	0	0	0	0	0	0	0
1994	0	0	3 (2.16)	0	0	0	0	0	0	0	0	0
1995	5 (0.51)	3 (3.17)	1 (1.5)	0	0	0	0	0	0	0	0	0
1996	0	0	0	3 (0.77)	0	0	0	0	0	0	0	0
1997	0	6 (1.79)	0	0	0	0	1(0.13)	0	0	0	0	0
1998	0	1(0.05)	0	0	0							

Notes: "( )" Maximum average daily flow (cfs) in given month.
Monitoring location depicted on Exhibit D6.1-2.
Data from Wyoming Department of Environmental Quality/Land Quality Division Database.

TFNS 2-025
RECD MAR 04, 2019

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Table D6.1-17. Big Horn Mine and Sheridan Consevation District Surface Water Quality Monitoring Results

Parameter	Units	HWC1-79[1,2]								
		3/22/79	4/9/79	4/16/79	3/11/80	2/24/86	2/25/86	6/5/86	3/2/88	3/13/89
Field										
Field Conductivity	µmhos/cm	4000	3500	3283	1390					
Field pH	s.u.	8.6	7.6		6.62					
Field turbidity	NTUs									
Temperature	Deg C	8.5	20	17.2	5					
General										
Alkalinity (as CaCO3)	mg/L	228	328	330	160	20	45	45	32.5	47.5
Ammonia	mg/L	<0.01	1.43	0.63	0.09	<0.01	0.01	<0.01	0.17	0.73
Fluoride	mg/L	0.85	0.63	0.61	0.28	0.11	0.13	0.14	<0.1	<0.1
Hardness (as CaCO3)	mg/L	1867	1950	1930	637	42	118	91.5	47	56
Hydroxide	mg/L									
Laboratory conductivity	µmhos/cm	3340	3400	3220	1290	57	217	126	123	136
Dissolved oxygen	mg/L									
Laboratory pH	s.u.	8.2	8.4	8.5	8.1	7.51	7.55	7.13	6.57	7.36
Laboratory turbidity	NTUs	2.3	2.9	3.2	50	180	88	1000	48	170
Nitrate/Nitrite	mg/L	0.15	0.01	<0.01	0.11	3.1	2.83	0.62	4.47	1.77
Total Dissolved Solids	mg/L	3190	3300	3220	1130	96	117	156	154	166
Total Suspended Solids	mg/L	5	11	9	72	488	234	3630	67	234
Sodium Adsorption Ratio (SAR)	unitless					0.12	0.6	0.15	0.11	0.12
Total Phosphorus	mg/L	0.02	0.03	0.02	0.35	0.19	0.3			0.64
Major Ions										
Calcium	mg/L	242	260	251	89	8.6	21.2	19.6	6.6	10.6
Magnesium	mg/L	307	316	317	101	2.7	13.7	6.7	3.8	4.1
Potassium	mg/L	2	26	25	16	7.2	9.6	2.1	15.2	14.8
Sodium	mg/L	186	191	188	70	1.6	14.5	3	1.4	1.8
Bicarbonate	mg/L	278	379	373	195	24.4	54.9	54.9	39.7	58
Carbonate	mg/L		10	15						
Chloride	mg/L	28	28	29	11	5	8	14	11	4
Sulfate	mg/L	1922	1970	1940	609	16.1	94	12.5	<1	12.5
Metals										
Aluminum, dissolved	mg/L	0.9	0.2	0.2	0.1	0.47	<0.1	2		
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.002	<0.002	<0.002		
Barium, dissolved	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		
Boron, dissolved	mg/L	0.6	0.4	0.5	0.1	0.03	0.72	0.26	1.63	0.17
Cadmium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.002	<0.002	<0.002		
Chromium, dissolved	mg/L	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02		
Copper, dissolved	mg/L	0.02	0.03	0.02	<0.01	<0.01	0.01	0.02		
Iron, dissolved	mg/L	0.13	0.06	<0.05	0.1	0.32	0.06	0.62		
Iron, total	mg/L	0.17	0.1	0.12	1.77	1.64	0.42	0.73		
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01		
Manganese, dissolved	mg/L	0.03	0.02	0.02	0.09	<0.01	<0.01	<0.01		
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
Molybdenum, dissolved	mg/L					<0.02	<0.02	<0.02		
Nickel, dissolved	mg/L	0.02	0.05	0.04	0.01	0.01	0.01	0.02		
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.002	<0.002	<0.002		
Zinc, dissolved	mg/L	0.03	0.05	0.05	0.01	0.01	0.01	<0.01		

Note: [1]Monitoring location depicted on Exhibit D6.1-2.

[2]Data from Big Horn Coal Mine Appendix D6 and Annual Reports

[3]Monitoring location depicted on Exhibit D6.1-1.

[4]Data from Sheridan County Conservation District 2016 Tongue River Watershed Interim Monitoring Report

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Table D6.1-17. Big Horn Mine and Sheridan Consevation District Surface Water Quality Monitoring Results (Continued)

Parameter	Units	TR2B80[1,2]							
		6/21/2016	9/19/2016	12/13/2016	3/16/2017	6/2/17	9/18/17	12/11/2017	3/27/2018
Field									
Field Conductivity	µmhos/cm	295	508	513	689	210	529	547	
Field pH	s.u.	8.2	8.3	8.4	8.6	7.9	8.4	8.7	
Field turbidity	NTUs								
Temperature	Deg C	22.1	18.7	1	9.6	14.1	14.6	3.1	
General									
Alkalinity (as CaCO3)	mg/L	121	203	197	225	86	208	217	225
Ammonia	mg/L	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Fluoride	mg/L	0.1	0.2	0.2	0.2	0.1	0.2	0.2	0.2
Hardness (as CaCO3)	mg/L	133	234	226	316	91	239	257	310
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	284	496	495	704	206	525	549	763
Dissolved oxygen	mg/L								
Laboratory pH	s.u.	8.5	8.7	8.6	8.7	8.2	8.5	8.6	8.5
Laboratory turbidity	NTUs	7.9	2.8	1.9	8.3	22.4	5.5	2	17.9
Nitrate/Nitrite	mg/L	<.05	<.05	0.29	<.05	<.05	0.1	0.24	0.38
Total Dissolved Solids	mg/L	170	300	300	450	120	330	350	500
Total Suspended Solids	mg/L	16	<5	<5	12	44	7	<5	19
Sodium Adsorption Ratio (SAR)	unitless	0.29	0.4	0.45	0.73	0.2	0.5	0.5	0.9
Total Phosphorus	mg/L	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Major Ions									
Calcium	mg/L	31	48	51	62	22	50	55	62
Magnesium	mg/L	14	28	24	39	9	28	29	38
Potassium	mg/L	1	2	2	3	<1	3	2	4
Sodium	mg/L	8	14	16	30	5	17	17	37
Bicarbonate	mg/L	140	223	221	243	104	236	244	258
Carbonate	mg/L	<5	12	10	15	<5	8	10	8
Chloride	mg/L	2	4	4	7	1	5	5	12
Sulfate	mg/L	29	65	60	143	19	72	74	158
Metals									
Aluminum, dissolved	mg/L	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Arsenic, dissolved	mg/L	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Barium, dissolved	mg/L	<.5	<.5	<.5	<.5	<.5	<.5	<.5	<.5
Boron, dissolved	mg/L	<.03	0.05	0.06	0.07	<.03	0.05	0.05	0.07
Cadmium, dissolved	mg/L	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002
Chromium, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Copper, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Iron, dissolved	mg/L	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Iron, total	mg/L	0.4	0.1	0.09	0.28	0.68	0.17	0.08	0.48
Lead, dissolved	mg/L	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
Manganese, dissolved	mg/L	0.02	<.02	<.02	0.03	<.02	<.02	<.02	0.06
Mercury, dissolved	mg/L	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Molybdenum, dissolved	mg/L	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
Nickel, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Selenium, dissolved	mg/L	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Zinc, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01

Note: [1]Monitoring location depicted on Exhibit D6.1-2.

[2]Data from Big Horn Coal Mine Appendix D6 and Annual Reports

[3]Monitoring location depicted on Exhibit D6.1-1.

[4]Data from Sheridan County Conservation District 2016 Tongue River Watershed Interim Monitoring Report

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Table D6.1-17. Big Horn Mine and Sheridan Consevation District Surface Water Quality Monitoring Results (Continued)

Parameter	Units	TR03[3,4]									
		5/18/2016	5/31/2016	6/13/2016	6/27/2016	7/13/16	7/28/16	8/10/2016	8/22/2016	9/7/2016	9/20/2016
Field											
Field Conductivity	µmhos/cm	308	248	188	378	441	503	607	538	519	493
Field pH	s.u.	8.6	8.18	8.15	8.45	8.51	8.37	8.41	8.55	8.5	8.61
Temperature	Deg C	12.2	11.3	17	20.8	20.4	23.6	23.3	19.7	17.6	16.4
Dissolved Oxygen	mg/L		9.3	8.45	9.31	9.07	7.32	8.13	8.51	9.25	9.26
Dissolved Oxygen	%		84.9	87.1	104.1	100.6	86.4	95.3	93.2	96.9	94.7
Turbidity	NTUs	7.8	16.2	14.5	2.3	2.2	4.5	4	7.1	3.8	2.6
E. Coli	cfu/100 mL	41	214	261	272	79	11	15	24	32	6

Note: [3] Monitoring location depicted on Exhibit D6.1-2.
[4] Data from Big Horn Coal Mine Appendix D6 and Annual Reports
[3] Monitoring location depicted on Exhibit D6.1-1.
Data from Sheridan County Conservation District 2016 Tongue River Watershed Interim Monitoring Report

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Table D6.2-1. Summary of Groundwater Monitoring Wells[1]

Well Number	Location					Ground Surface Elevation (ft)	Measuring Point Elevation (ft)	Height (ft)	Depths (ft)			Geologic Formation	Casing Diameter (in)	Drill Bit Diameter (in)	Date Completed
	SEC	T(N)	R(W)	Ground Coordinates					Total[2]	Casing	Perforation Interval				
				Northing	Easting										
578409-CRN	9	57	84	1,940,097	1,399,549	3,710.1	3,712.7	2.6	109	88	88-108	Carney Coal	5	9.875	1-Oct-13
578409-CRN-OB	9	57	84	1,940,108	1,399,538	3,710.3	3,713.0	2.7	110	89	89-109	Carney Coal Observ	5	9.875	1-Oct-13
578409-MST	9	57	84	1,940,088	1,399,559	3,709.8	3,712.4	2.6	122	115	115-120	Masters Coal	5	9.875	1-Oct-13
578409-MST-OB	9	57	84	1,940,085	1,399,547	3,710.3	3,713.3	3	122	116	116-121	Masters Coal Observ	5	9.875	2-Oct-13
578409-UBN	9	57	84	1,940,077	1,399,568	3,709.7	3,712.1	2.4	142	130	130-140	Masters Coal Underburden	5	9.875	1-Oct-13
578415-CRN-MST	15	57	84	1,936,078	1,404,292	3,611.4	3,614.3	2.9	182	121	121-141	Carney and Masters Coal	5	9.875	9-Oct-13
578418-AL	18	57	84	1,935,962	1,386,058	3,687.5	3,690.2	2.7	27	5	5-25	Alluvium	5	9.875	30-Sep-13
578418-CRN	18	57	84	1,936,928	1,387,102	3,882.4	3,884.5	2.1	153	132	132-152	Carney Coal	5	9.875	19-Sep-13
578418-MST	18	57	84	1,936,923	1,387,131	3,883.6	3,885.8	2.2	183	176	176-183	Masters Coal	5	9.875	16-Sep-13
578510-CRN	10	57	85	1,941,542	1,371,807	3,962.4	3,965.4	3	91	78	78-90	Carney Coal	5	9.875	24-Sep-13
578510-MST	10	57	85	1,941,558	1,371,823	3,962.4	3,964.4	2	146	141	141-146	Masters Coal	5	9.875	24-Sep-13
578511-CRN	11	57	85	1,940,246	1,377,926	3,893.8	3,896.1	2.3	128	119	119-127	Carney Coal	5	9.875	23-Sep-13
578511-MST	11	57	85	1,940,244	1,377,945	3,894.0	3,896.4	2.4	157	152	152-157	Masters Coal	5	9.875	23-Sep-13
578512-AL	12	57	85	1,940,880	1,381,530	3,758.0	3,760.5	2.5	22	5	5-20	Alluvium	5	9.875	25-Sep-13
578512-CRN	12	57	85	1,943,160	1,382,758	3,931.0	3,932.5	1.5	62	35	35-55	Carney Burn	5	9.875	20-Sep-13
578512-MST	12	57	85	1,943,172	1,382,743	3,930.9	3,932.7	1.8	115	109	109-114	Masters Coal	5	9.875	20-Sep-13
578513-AL	13	57	85	1,938,634	1,383,970	3,721.9	3,724.0	2.1	22	5	5-20	Alluvium	5	9.875	30-Sep-13
578513-CRN	13	57	85	1,938,329	1,381,665	3,847.7	3,850.0	2.3	116	107	107-115	Carney Coal	5	9.875	25-Sep-13
578513-MST	13	57	85	1,938,341	1,381,680	3,848.4	3,850.6	2.2	142	137	137-142	Masters Coal	5	9.875	25-Sep-13
578417-MST[4]	17	57	84	1,939,175	1,391,382	3,925.9	3,928.7	2.8	163	156	156-161	Masters Coal	2	5.125	21-Aug-13
578417-CRN[4]	17	57	84	1,939,152	1,391,364	3,926.4	3,929.1	2.7	141	118	118-140	Carney Coal	2	5.625	21-Aug-13
578408-MST[5]	8	57	84	1,941,802	1,394,423	3,887.9	3,890.5	2.6	118	113	113-118	Masters Coal	2	5.125	3-Sep-13
578408-CRN[5]	8	57	84	1,941,810	1,394,416	3,887.7	3,890.0	2.3	98	86	86-96	Carney Coal	2	5.125	3-Sep-13
578524-AL-1	24	57	85	1,934,069	1,381,927	3,671.6	3,673.9	2.3	40	20	20-40	Alluvium	5	8.75	8-Jan-18
578415-SPL-1	22	57	84	1,934,127	1,404,656	3,601.9	3,603.7	1.8	62	31	31-41	Spoil	2	5.125	24-May-18
578415-SPL-2	15	57	84	1,935,619	1,404,636	3,609.6	3,611.5	1.9	120	100	100-110	Spoil	2	5.125	25-May-18
578420-AL-1	20	57	84	1,931,385	1,392,945	3,632.7	3,634.4	1.7	20	5.6	5.6-15.6	Alluvium	2	5.5	18-Jun-18
578524-CRN-PUMP[6]	24	57	85	1,934,182	1,381,899	3,671.6	3,672.9	1.3	80	53	53-68	Carney Coal	5	8.75	5-Jun-18

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Table D6.2-1. Summary of Groundwater Monitoring Wells[1] (Continued)

Well Number	Location					Ground Surface Elevation (ft)	Measuring Point Elevation (ft)	Height (ft)	Depths (ft)			Geologic Formation	Casing Diameter (in)	Drill Bit Diameter (in)	Date Completed
	SEC	T(N)	R(W)	Ground Coordinates					Total[2]	Casing	Perforation Interval				
				Northing	Easting										
578420-CRN-PUMP	20	57	84	1,931,289	1,393,062	3,631.7	3,633.5	1.8	30	17.5	17.5-28.5	Carney Coal	5	8.75	19-Jun-18
578513-OVB-1	13	57	85	1,936,206	1,384,801	3,753.2	3,755.2	2.0	75	60	60-70	Overburden	2	5.5	6-Jun-18
578433-AL-1	33	57	84	1,922,703	1,402,206	3,643.0	3,645.0	2.0	16	6	6-16	Alluvium	2	3.5	14-Aug-15
578434-AL-1	34	57	84	1,921,551	1,403,229	3,648.0	3,650.0	2.0	13	3	3-13	Alluvium	2	3.5	14-Aug-15
578434-AL-2	34	57	84	1,919,747	1,404,529	3,652.5	3,654.5	2.0	16	6	6-16	Alluvium	2	3.5	14-Aug-15
578421-3-MAS	21	57	84	1,934,005	1,399,293	3,643.0	3,645.0	2.0	135	118	118-124	Masters Coal	5	8.75	5-Dec-14
578415-AL-1	15	57	84	1,404,303	1,936,458	3,573.1	3,576.0	2.9	34	24	24-34	Alluvium	2	4.25	19-Jul-19

Notes: [1]Exhibit D6.2-1 presents the location of the monitor wells.

[2]Reflects field measured depth from drilling log.

[3]Formation packer was not installed in any of the groundwater wells.

[4]2-inch diameter piezometers installed in core hole cluster R13-012.

[5]2-inch diameter piezometers installed in core hole cluster R13-018.

[6]Well has been abandoned following pump testing.

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Table D6.2-2. Summary of Aquifer Test Data

Test Well Number	Geologic Formation	Date of Test	Type of Test	Type of Analysis	Observation Well Number	Observation Well Distance (ft)	Length of Test (min)	Production Rate (gpm)	Aquifer Parameters				
									Spec. Cap. (gpm/ft)	Trans. (ft^2/day)	Aquif Thick (ft)	Hyd Cond (ft/day)	Storage Coefficient
578409 MST-1	Masters Coal	11/12/2013	Pump	Theis Drawdown, Cooper Jacob Straight Line Drawdown, Theis Recovery	578409 MST-OB	12.8	644	0.33	0.030	3.2	5	0.54	0.000249
578409 CRN-1	Carney Coal	11/14/2013	Pump	Theis Drawdown, Cooper Jacob Straight Line Drawdown, Theis Recovery	578409 CRN-OB	15.4	646	0.33	0.046	5.6	18	0.31	0.000364
578409 MST-1	Masters Coal	3/27/2019	Slug	Bouwer & Rice, 1976	None	NA	1066	NA	NA	2.55	5	0.51	NA
578409 CRN-1	Carney Coal	3/27/2019	Slug	Bouwer & Rice, 1976	None	NA	1335	NA	NA	5.63	18	0.31	NA
578408-CRN-1	Carney Coal	3/9/2018	Slug	Bouwer & Rice, 1976	None	NA	214	NA	NA	1.1	11	0.10	NA
578408-MST-1	Masters Coal	3/9/2018	Slug	Hvorslev, 1951	None	NA	254	NA	NA	7.1	5	1.42	NA
578417-CRN-1	Carney Coal	3/7/2018	Slug	Bouwer & Rice, 1976	None	NA	1338	NA	NA	0.3	16	0.02	NA
578417-MST-1	Masters Coal	3/8/2018	Slug	Bouwer & Rice, 1976	None	NA	1600	NA	NA	0.12	6	0.02	NA
578418-CRN-1	Carney Coal	3/9/2018	Slug	Bouwer & Rice, 1976	None	NA	1588	NA	NA	19.4	20	0.97	NA
578418-AL-1	Alluvium	3/14/2018	Slug	Bouwer & Rice, 1976	None	NA	1343	NA	NA	5.52	24	0.23	NA
578433-AL-1	Alluvium	3/15/2018	Slug	Bouwer & Rice, 1976	None	NA	96	NA	NA	80.6	12	6.72	NA

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Table D6.2-2. Summary of Aquifer Test Data (Continued)

Test Well Number	Geologic Formation	Date of Test	Type of Test	Type of Analysis	Observation Well Number	Observation Well Distance (ft)	Length of Test (min)	Production Rate (gpm)	Aquifer Parameters				
									Spec. Cap. (gpm/ft)	Trans. (ft^2/day)	Aquif Thick (ft)	Hyd Cond (ft/day)	Storage Coefficient
578434-AL-1	Alluvium	3/15/2018	Slug	Bouwer & Rice, 1976	None	NA	49	NA	NA	164.25	9	18.25	NA
578511-CRN-1	Carney Coal	3/14/2018	Slug	Bouwer & Rice, 1976	None	NA	1333	NA	NA	3	8	0.38	NA
578511-MST-1	Masters Coal	3/14/2018	Slug	Hvorslev, 1951	None	NA	1123	NA	NA	0.5	4	0.13	NA
578512-AL-1	Alluvium	3/12/2018	Slug	Bouwer & Rice, 1976	None	NA	139	NA	NA	426.2	18.5	23.04	NA
578512-MST-1	Masters Coal	3/12/2018	Slug	Bouwer & Rice, 1976	None	NA	281	NA	NA	6	5	1.20	NA
578513-AL-1	Alluvium	3/13/2018	Slug	Bouwer & Rice, 1976	None	NA	90	NA	NA	747.5	19	39.34	NA
578513-MST-1	Masters Coal	3/12/2018	Slug	Hvorslev, 1951	None	NA	38	NA	NA	278.4	5	55.68	NA
578421-3-MAS	Masters Coal	6/6/2018	Slug	Hvorslev, 1951	None	NA	1338	NA	NA	0.7	3	0.23	NA
578420-AL-1	Alluvium	7/3/2018	Slug	Bouwer & Rice, 1976	None	NA	14	NA	NA	189.8	10	18.98	NA
578420-CRN-PUMP-1	Carney Coal	6/21/2018	Pump	Theis Recovery (1935)	578420-AL-1	155	38	0.5	NA	0.07	5	0.01	NA
578524-CRN-PUMP-1	Carney Coal	6/7/2018	Pump	Theis Drawdown, Cooper Jacob Straight Line Drawdown, Theis Recovery	578524-AL-1	100	1440	4	NA	15.4	15	1.50	NA

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Table D6.2-2A. Summary of Big Horn Coal Mine Aquifer Test Data

Test Well Number	Township	Range	Section	Geologic Formation	Date of Test	Type of Analysis	Length of Test (hours)	Production Rate (gpm)	Aquifer Parameters							
									Spec. Cap. (gpm/ft)	Drawdown Trans. (ft^2/day)	Recovery Trans. (ft^2/day)	Perforation (ft)	Aquif Thick (ft)	Drawdown Hyd Cond (ft/day)	Recovery Hyd Cond (ft/day)	Storage Coefficient
Pit 4																
ww 390-79	57 N	84 W	15	Sandstone	11/14/1979	BAILER TEST		1.44	0.04	0.3		35		0.01		
ww 391-79	57 N	84 W	15	Sandstone	11/15/1979	BAILER TEST		1.86	0.06	0.26		56		0.00		
ww 392-79	57 N	84 W	9	Sandstone	2/26/1979	Jacob Drawdown, Theis Drawdown	11	38.49	2.02			23				
ww 393	57 N	84 W	9	Sandstone	2/26/1979	Theis drawdown	11	38.5	2.02	2267		18.5		122.54		
ww 394	57 N	84 W	9	Sandstone	2/26/1979	Theis drawdown	11	38.5	2.02	7373		20		368.65		
ww 395-79	57 N	84 W	15	Sandstone	4/20/1979	Jacob Drawdown, Theis Drawdown	3	15.76	0.32	58.55		18		3.25		
Pit 5																
ww 409-79	57 N	84 W	10	Monarch	12/19/1979	BAILER TEST		0.21	0.04	0.14		20		0.01		
ww 555-80	57 N	84 W	9	Monarch	3/4/1980	BAILER TEST, Jacobs		1.08	0.13	1.59		20		0.08		
ww 562-80	57 N	84 W	10	Monarch	3/5/1980	BAILER TEST		0.43	0.05	0.11		20		0.01		
DIETZ - 1																
463	57 N	84 W	25	Dietz 1	6/9/1980	Jacob time drawdown and recovery	6.58	2.45	0.03	5.09	1.24	20		0.25	0.06	1.40E-04
	57 N	84 W	25	Dietz 1	6/9/1980	Jacob time drawdown and recovery	6.58	2.45		9.4	7.29	30		0.31	0.24	
464	57 N	84 W	26	Dietz 1	6/11/1980	Jacob time drawdown and recovery	5.5	0.71	0.01	1.4	1.6	17		0.08	0.09	
BH 688	57 N	84 W	24	Dietz 1	11/13/1981	Jacob time drawdown and recovery	5.55	6.43	0.14	21.61	24.14	20		1.08	1.21	
DIETZ - 2																
469	57 N	84 W	24	Dietz 2	7/3/1980	Jacob time drawdown and recovery	5.39	3.38	0.06	2.64	2.67	17		0.16	0.16	
596	57 N	84 W	14	Dietz 2	6/19/1981	Jacob time drawdown	5.42	16.21	0.27	33.9	33.1	13		2.61	2.55	
BH 647	57 N	84 W	24	Dietz 2	1/2/1981	Jacob time drawdown and recovery. Theis Non-Equilibrium	8.92	3.72	0.1	6.63	32.82	20		0.33	1.64	5.00E-05
	57 N	84 W	24	Dietz 2	1/2/1981	Jacob time drawdown and recovery. Theis Non-Equilibrium	8.92	3.72	0.1	38.84	32.99	15		2.59	2.20	

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Table D6.2-2A. Summary of Big Horn Coal Mine Aquifer Test Data (Continued)

Test Well Number	Township	Range	Section	Geologic Formation	Date of Test	Type of Analysis	Length of Test (hours)	Production Rate (gpm)	Aquifer Parameters							
									Spec. Cap. (gpm/ft)	Drawdown Trans. (ft^2/day)	Recovery Trans. (ft^2/day)	Perforation (ft)	Aquif Thick (ft)	Drawdown Hyd Cond (ft/day)	Recovery Hyd Cond (ft/day)	Storage Coefficient
SPOIL WELLS																
obs. 655	57 N	84 W	22	Spoils	7/21/1981	Jacob time drawdown and recovery. Theis non-equilibrium. Time-calculated recovery	26	36.99	NA	2902	2665.1	40		72.55	66.63	6.00E-03
656	57 N	84 W	22	Spoils	7/14/1981	Jacob time recovery	5.83	1.29	0.05	11 gpd/ft	1.49	40			0.04	
BH 657-81	57 N	84 W	15	Spoils	10/6/1981	Slug	1.58	0.65	0.12	8.82	6.75	40		0.22	0.17	
BH 658-81	57 N	84 W	15	Spoils	10/6/1981	Slug	1.92			3.46		40		0.09		
BH 745-82	57 N	84 W	15	Spoils	7/9/1982	Jacob time drawdown and recovery	4.73	1.67	0.6		1965	20			98.25	
BH 746-81	57 N	84 W	15	Spoils	7/9/1982	Jacob time drawdown and recovery. Theis non-equilibrium. Time-calculated recovery	6.36	1.67	0.6	2267.65	2947	20		113.38	147.35	
DIETZ - 3																
582	57 N	84 W	14	Dietz 3	3/27/1980	Jacob time drawdown and recovery	4.75	7.03	0.1	127.2	60.5	20		6.36	3.03	
468	57 N	84 W	14	Dietz 3	2/22/1980	Jacob time drawdown and recovery	5.67	7.75	0.16	54.71	49.73	40		1.37	1.24	
576	57 N	84 W	14	Dietz 3	5/8/1980	Jacob time drawdown	6.25	1.72	0.04	3.25	1.55	20		0.16	0.08	
575-80	57 N	84 W	14	Dietz 3	3/26/1980	Jacob time recovery	5	0.743	0.02	0.3	0.13	20		0.02	0.01	
BH 462 A	57 N	84 W	27	Dietz 3/ Monarch	5/9/1980	Theis non-equilibrium.	6.88	19.46		708.12	144.7	40		17.703	3.6175	4.60E-04
MONARCH COAL																
231	57 N	84 W	14	Monarch	4/21/1977	Jacob time recovery	1.93	6.8	0.25		1.03	20		0.00	0.05	
232	57 N	84 W	14	Monarch	4/21/1977	Jacob time drawdown and recovery	1.1	4.6	0.17	6.38	7.97	20		0.32	0.40	
BH 467	57 N	84 W	24	Monarch	2/26/1980	Jacob time drawdown and recovery	5.5	7.70	0.27	118.16	108.71	21		5.63	5.18	
496	57 N	84 W	14	Monarch	4/3/1980	Jacob time drawdown and recovery	4.75	3.66	0.09	31.5	36.9	25		1.26	1.48	
584	57 N	84 W	14	Monarch	4/9/1980	Jacob time drawdown and recovery	5.67	8.11	0.18	102.2	106.01	24		4.26	4.42	

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Table D6.2-2A. Summary of Big Horn Coal Mine Aquifer Test Data (Continued)

Test Well Number	Township	Range	Section	Geologic Formation	Date of Test	Type of Analysis	Length of Test (hours)	Production Rate (gpm)	Aquifer Parameters							
									Spec. Cap. (gpm/ft)	Drawdown Trans. (ft^2/day)	Recovery Trans. (ft^2/day)	Perforation (ft)	Aquif Thick (ft)	Drawdown Hyd Cond (ft/day)	Recovery Hyd Cond (ft/day)	Storage Coefficient
Alluvium																
230				Alluvium	4/22/1977	Jacob time recovery	0.68	15	25		3506	38			92.26	
207A	57 N	84 W	14	Alluvium	4/24/1980	Jacob time drawdown and recovery	4.5	14.1	8.76	8294.1	9952.9	20		414.71	497.65	
198	57 N	84 W	14	Alluvium	2/19/1979	Jacob time drawdown	12.47	69	10.42	2062.9	7162	20		103.15	358.10	0.14
627	57 N	84 W	13	Alluvium	8/3/1981	Jacob time drawdown and recovery	24.5	39.1	16.29	3811.2	13265.8	20		190.56	663.29	
640	57 N	84 W	13	Alluvium	7/24/1981	Jacob time drawdown and recovery	6	39.57	8.72	3491.5	9975.6	15		232.77	665.04	
623	57 N	84 W	13	Alluvium	7/30/1981 7/29/1981	Jacob time drawdown and recovery. Theis non-equilibrium.	47.63	39.65		3195	6006.1	20		159.75	300.31	0.6
624	58 N	85 W	13	Alluvium	7/30/1981 7/29/1981	Jacob time drawdown and recovery. Theis non-equilibrium.	45.63	39.65		3144.8	4279.5	29.5		106.60	145.07	0.62
625	58 N	85 W	13	Alluvium	7/30/1981 7/29/1981	Jacob time drawdown and recovery. Theis non-equilibrium.	47.63	39.65		4373	7951	20		218.65	397.55	0.14
626	58 N	85 W	13	Alluvium	7/30/1981 7/29/1981	Jacob time drawdown and recovery. Theis non-equilibrium.	45.63	39.65		6332.2	26912	20		316.61	1345.60	0.12
645	57 N	84 W	13	Alluvium	7/30/1981 7/29/1981	Jacob time drawdown and recovery	29.63	39.65	10.54	3107	3998.3	10		310.70	399.83	
634	57 N	84 W		Alluvium	8/6/1981	Jacob time drawdown.Theis non-equilibrium.	22.5	38.39		5507.9	2985.6	20		275.40	149.28	0.08
639	57 N	84 W	11	Alluvium	86/6/1981	Jacob time drawdown and recovery. Theis non-equilibrium.	21.28	37.82		4889.5	6208.5	20		244.48	310.43	0.19
635	57 N	84 W	11	Alluvium	8/6/1981	Jacob time drawdown and recovery	27.67	38.39	18.11	2759.6	4169.1	20		137.98	208.46	
636	57 N	84 W	11	Alluvium	8/4/1981	Jacob time drawdown and recovery. Theis non-equilibrium.	41.75	37.82		6775.8	4305.9	18		376.43	239.22	0.47
637	57 N	84 W	11	Alluvium	8/4/1981	Jacob time drawdown and recovery. Theis non-equilibrium.	41.75	37.82		3824.7	4767.2	18		212.48	264.84	0.1
638	57 N	84 W	11	Alluvium	8/4/1981	Jacob time drawdown and recovery. Theis non-equilibrium.	39.75	37.82		5296.7	4224.1	20		264.84	211.21	0.1
644	57 N	84 W	11	Alluvium	8/4/1981	Jacob time drawdown and recovery	22.5	37.82	7.34	4171.3	4683.6	20		208.57	234.18	

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Table D6.2-3. Groundwater Quality Monitoring Results For Alluvium

Parameter	Units	578418-AL				578512-AL				578513-AL			
		3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14
Field													
Field Conductivity	µmhos/cm	1179	3050			5180	5460	5370	5530	4870	5130	4900	4686
Field pH	s.u.	8.72	7.67			8.02	7.22	7.59	7.33	7.95	7.18	7.57	7.26
Field turbidity	NTUs	257	38.2			3.51	20	173	21.6	2.05	0.57	0.93	0.17
Depth to Water	ft	20.65	20.78	Dry	Dry	4.03	3.81	3.67	3.61	9.51	9.36	7.66	6.18
Temperature	Deg C	12.3	9.6			13.4	10.5	9.6	16.3	12.3	10.2	9.9	17.5
General													
Alkalinity (as CaCO3)	mg/L	205	411			638	662	652	655	636	674	651	661
Ammonia	mg/L	<0.1	<0.1			<0.1	<0.1	0.2	0.2	<0.1	<0.1	<0.1	<0.1
Fluoride	mg/L	1.1	1.2			1	1	0.9	0.8	0.9	0.8	0.8	0.7
Hardness (as CaCO3)	mg/L	254	909			2840	2560	2920	2640	2340	2240	2350	2030
Hydroxide	mg/L	<5	<5			<5	<5	<5	<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	1160	2800			5650	5370	5340	5190	4800	4980	4670	4380
Laboratory pH	s.u.	8.4	8.3			8	8	7.9	8.1	8	8	7.9	8.1
Nitrate/Nitrite	mg/L	1.4	0.2			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Dissolved Solids	mg/L	760	2220			5210	5150	4590	5300	4530	4790	4610	3730
Sodium Adsorption Ratio (SAR)	unitless	4.3	4.8			4	4	3.9	3.6	4.3	4.1	3.9	4.1
Major Ions													
Calcium	mg/L	26	114			369	322	360	324	275	267	272	235
Magnesium	mg/L	46	152			466	427	490	444	401	383	406	352
Potassium	mg/L	13	22			26	23	23	20	33	26	25	29
Sodium	mg/L	159	332			490	465	488	431	474	448	435	426
Bicarbonate	mg/L	242	501			778	807	795	799	776	823	794	806
Carbonate	mg/L	<5	<5			<5	<5	<5	<5	<5	<5	<5	<5
Chloride	mg/L	9	14			17	17	22	16	22	22	24	17
Sulfate	mg/L	393	1200			2990	3130	2990	3050	2910	2740	2790	2460
Metals													
Aluminum, dissolved	mg/L	<0.1	<0.1			<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron, dissolved	mg/L	0.2	0.3			0.4	0.4	0.3	0.4	0.4	0.4	0.5	0.3
Cadmium, dissolved	mg/L	<0.001	<0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	<0.05			0.91	0.92	1.04	0.86	<0.05	<0.05	0.09	<0.05
Iron, total	mg/L	2.24	0.8			0.96	5.29	25.4	5.17	0.1	0.08	0.11	0.06
Lead, dissolved	mg/L	<0.02	<0.02			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	<0.02	0.03			2.28	1.92	2.13	1.72	0.37	0.35	0.31	0.23
Manganese, total	mg/L	0.16	0.07			2.2	2.69	2.71	2.34	0.62	0.47	0.39	0.29
Mercury, dissolved	mg/L	<0.001	<0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01			<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	0.006	<0.005			<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, dissolved	mg/L	<0.01	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
QA/QC													
Anion Sum	meq/L	12.67	33.73			75.49	78.95	75.89	77.06	73.93	71.21	71.79	64.97
Cation Sum	meq/L	12.32	33.2			78.72	71.99	80.14	71.97	68.24	65.04	66.52	59.95
Total Anion/Cation Balance	%	1.43	0.79			2.09	4.6	2.72	3.41	4	4.52	3.8	4.02
Total Dissolved Solids (calc)	mg/L	780	2080			4740	4780	4760	4680	4500	4290	4340	3920

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Table D6.2-3. Groundwater Quality Monitoring Results For Alluvium (Continued)

Parameter	Units	578420-AL-1				578524-AL-1				
		6/20/2018	7/11/2018	11/13/2018	1/10/2019	1/8/2018	4/19/2018	6/6/2018	7/12/2018	11/14/2018
Field										
Field Conductivity	µmhos/cm	704	770	934	852	1083	1106	1061	1130	1194
Field pH	s.u.	7.55	7.61	7.52	7.44	7.43	7.42	7.44	7.47	7.44
Field turbidity	NTUs	346	113	161	111	36.2	8.38	8.45	15.8	54.3
Depth to Water	ft	7.53	8.24	9.95	10.11	12.58	12.2	10.97	12.65	12.73
Temperature	Deg C	11.3	21	15.8	8.5	9	8.5	10.1	20.4	13.1
General										
Alkalinity (as CaCO3)	mg/L	328	316	360	328	421	424	419	450	464
Ammonia	mg/L	0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.2
Fluoride	mg/L	0.6	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.3
Hardness (as CaCO3)	mg/L	313	360	415	377	499	538	518	532	554
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	847	845	861	760	1190	1200	1200	1200	1060
Laboratory pH	s.u.	8.2	8.3	8.3	8.2	8.2	8.1	8.2	8.3	8.1
Nitrate/Nitrite	mg/L	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Dissolved Solids	mg/L	530	540	600	540	800	800	770	820	790
Sodium Adsorption Ratio (SAR)	unitless	1.7	0.9	0.84	0.83	1.6	1.1	1.2	1.1	1.15
Major Ions										
Calcium	mg/L	73	88	99	90	93	100	94	100	105
Magnesium	mg/L	32	34	41	37	65	70	69	69	71
Potassium	mg/L	1	2	3	3	7	4	4	4	5
Sodium	mg/L	70	38	40	37	83	61	65	60	62
Bicarbonate	mg/L	400	386	435	401	513	517	511	534	566
Carbonate	mg/L	<5	<5	<5	<5	<5	<5	<5	7	<5
Chloride	mg/L	5	3	5	3	4	4	4	4	5
Sulfate	mg/L	127	135	152	128	245	253	256	243	230
Metals										
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1	0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1
Boron, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.1
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	<0.05	<0.05	<0.05	3.17	4.81	5.04	2.85	3.62
Iron, total	mg/L	6.38	2.18	6.23	2.29	4.86	4.81	5.78	4.06	6.98
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	0.02	0.21	0.11	0.17	0.2	0.23	0.22	0.29	0.24
Manganese, total	mg/L	0.24	0.26	1.92	0.58	0.21	0.22	0.23	0.29	0.24
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
QA/QC										
Anion Sum	meq/L	9.39	9.26	10.5	9.33	13.65	13.87	13.83	14.18	14.21
Cation Sum	meq/L	9.33	8.92	10.09	9.23	13.77	13.53	13.3	13.38	13.94
Total Anion/Cation Balance	%	0.28	1.86	2	0.54	0.43	1.22	1.94	2.92	0.97
Total Dissolved Solids (calc)	mg/L	510	490	550	500	750	750	740	750	760

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Table D6.2-3. Groundwater Quality Monitoring Results For Alluvium (Continued)

Parameter	Units	578433-AL-1					578434-AL-1				578434-AL-2				
		9/11/2015	9/11/2015	12/1/2015	3/1/2016	5/20/2016	9/11/2015	12/1/2015	3/1/2016	5/20/2016	9/11/2015	12/1/2015	12/1/2015	3/1/2016	5/20/2016
Field															
Field Conductivity	µmhos/cm	1301	1301	1515	1776	1764	1431	1624	1513	1692	663	692	692	684	409
Field pH	s.u.	7.41	7.41	8	7.69	7.56	7.34	7.63	7.72	7.56	7.74	7.96	7.96	8.19	7.93
Field turbidity	NTUs	623	623	210	86.1	254	Over limit	175	111	131	513	43.2	43.2	39.8	34.4
Depth to Water	ft	7.2	7.2	6.89	7.15	6.29	5.36	5.04	5.2	4.59	5.84	5.63	5.63	5.69	4.76
Temperature	Deg C	13.1	13.1	10.8	13.3	19.7	16.7	10.2	10.5	18.7	19.2	8.8	8.8	7.2	16.5
General															
Alkalinity (as CaCO3)	mg/L	547	547	586	671	669	784	735	683	601	271	270	269	245	169
Ammonia	mg/L	0.1	0.3	0.2	0.3	0.2	0.5	0.3	0.3	0.2	<.1	<.1	<.1	<.1	<.1
Fluoride	mg/L	0.6	0.6	0.6	0.6	0.5	0.9	0.8	0.7	0.7	0.3	0.2	0.2	0.2	0.3
Hardness (as CaCO3)	mg/L	641	625	713	803	776	831	867	735	815	338	337	334	309	187
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	1440	1450	1590	1690	1970	1650	1730	1420	1880	689	690	698	647	432
Laboratory pH	s.u.	8.2	8.1	8	8.1	8	8	8	8.2	8	8.3	8.2	8.2	8.3	8.3
Nitrate/Nitrite	mg/L	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	0.3	0.5	0.6	0.6	<.1
Total Dissolved Solids	mg/L	1020	1020	1170	1330	1180	1110	1260	1030	1240	440	440	440	430	250
Sodium Adsorption Ratio (SAR)	unitless	1.7	1.7	1.8	2.0	1.9	1.5	1.5	1.3	1.4	0.6	0.6	0.6	0.6	0.4
Major Ions															
Calcium	mg/L	103	95	111	122	115	91	91	78	83	64	63	63	60	38
Magnesium	mg/L	94	95	106	121	119	147	156	131	148	4	43	43	39	22
Potassium	mg/L	5	6	5	5	6	4	3	3	3	4	3	3	3	3
Sodium	mg/L	97	100	114	130	124	102	101	83	90	24	23	23	22	13
Bicarbonate	mg/L	667	667	715	819	817	956	897	833	733	331	330	328	292	203
Carbonate	mg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chloride	mg/L	12	12	16	17	18	11	9	9	11	9	8	8	8	3
Sulfate	mg/L	291	294	348	402	422	246	345	219	456	108	102	102	98	41
Metals															
Aluminum, dissolved	mg/L	0.5	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Arsenic, dissolved	mg/L	<.005	0.009	<.005	0.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Barium, dissolved	mg/L	<.1	<.1	<.1	<.1	<.1	0.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1
Boron, dissolved	mg/L	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.4	<.1	<.1	<.1	<.1
Cadmium, dissolved	mg/L	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Chromium, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Copper, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Iron, dissolved	mg/L	1.97	0.74	0.9	0.78	0.78	0.7	6.28	5.99	6.65	2.24	<.05	<.05	<.05	<.05
Iron, total	mg/L	17.8	11.9	11.7	4.86	12.6	94.3	19.3	13.8	16.8	9.19	2.51	4.03	1.72	1.76
Lead, dissolved	mg/L	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
Manganese, dissolved	mg/L	1.19	1.09	1.3	1.53	1.43	1.06	0.57	0.37	0.37	<.02	0.03	0.03	<.02	0.07
Manganese, total	mg/L	1.37	1.32	1.45	1.6	1.7	3.68	0.66	0.43	0.5	0.32	0.32	0.36	0.46	0.44
Mercury, dissolved	mg/L	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001
Molybdenum, dissolved	mg/L	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
Nickel, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Selenium, dissolved	mg/L	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Zinc, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
QA/QC															
Anion Sum	meq/L	17.36	17.44	19.44	22.31	22.7	21.14	22.16	18.5	21.87	7.95	7.79	7.79	7.22	4.35
Cation Sum	meq/L	17.17	17.01	19.35	21.86	21.06	21.23	21.83	18.42	20.33	7.88	7.82	7.76	7.21	4.36
Total Anion/Cation Balance	%	0.54	1.23	0.23	1.02	3.72	0.2	0.75	0.22	3.65	0.41	0.2	0.19	0.04	0.2
Total Dissolved Solids (calc)	mg/L	930	930	1050	1200	1200	1070	1150	930	1150	420	410	410	380	250

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Table D6.2-3. Groundwater Quality Monitoring Results For Alluvium (Continued)

Parameter	Units	LAYA #1	LAYA #2	LAYA #3	TDAW-01	578415-AL-1	
		4/9/2019	7/26/2019	7/26/2019	7/11/2019	7/26/2019	11/8/2019
Field							
Field Conductivity	µmhos/cm	1954	3670	1071	1093	2270	2430
Field pH	s.u.	7.95	7.28	7.57	7.47	7.1	7.0
Field turbidity	NTUs	3.02	47.8	1.71	0.65	Over Limit	Over Limit
Depth to Water	ft	No Data	No Data	No Data	No Data	30.21	31.12
Temperature	Deg C	7.2	10.7	11	11.5	12.6	10.7
General							
Alkalinity (as CaCO3)	mg/L	1140	537	418	431	734	768
Ammonia	mg/L	4.7	0.3	<.1	<.1	0.2	0.2
Fluoride	mg/L	2	0.8	0.7	0.3	0.3	0.3
Hardness (as CaCO3)	mg/L	90	1800	516	524	1350	1560
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	1840	3530	1070	1140	2430	2500
Laboratory pH	s.u.	8.4	7.9	8.2	8.2	7.9	8.0
Nitrate/Nitrite	mg/L	<.1	<.1	0.3	<.1	<.1	<.1
Total Dissolved Solids	mg/L	1270	3480	720	730	2030	2190
Sodium Adsorption Ratio (SAR)	unitless	22.5	2.7	0.6	0.9	0.8	0.98
Major Ions							
Calcium	mg/L	13	248	92	98	224	245
Magnesium	mg/L	14	288	70	68	192	230
Potassium	mg/L	19	14	2	4	16	15
Sodium	mg/L	491	267	31	45	68	89
Bicarbonate	mg/L	1350	655	510	526	895	937
Carbonate	mg/L	24	<5	<5	<5	<5	<5
Chloride	mg/L	36	18	4	5	10	10
Sulfate	mg/L	<1	1870	203	178	845	900
Metals							
Aluminum, dissolved	mg/L	<.1	<.1	<.1	<.1	<.1	<.1
Arsenic, dissolved	mg/L	<.005	<.005	<.005	<.005	<.005	<.005
Barium, dissolved	mg/L	0.4	<.1	<.1	<.1	<.1	<.1
Boron, dissolved	mg/L	0.1	0.5	0.2	0.1	0.3	0.4
Cadmium, dissolved	mg/L	<.001	<.001	<.001	<.001	<.001	<.001
Chromium, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01
Copper, dissolved	mg/L	<.01	<.01	<.01	<.01	<.01	<.01
Iron, dissolved	mg/L	<.05	<.05	<.05	<.05	<.05	0.13
Iron, total	mg/L	0.15	1.65	<.05	0.07	111	114
Lead, dissolved	mg/L	<.02	<.02	<.02	<.02	<.02	<.02
Manganese, dissolved	mg/L	0.03	0.34	<.02	0.41	1.51	1.20
Manganese, total	mg/L	0.03	0.49	<.02	0.41	3.95	3.07
Mercury, dissolved	mg/L	<.001	<.001	<.001	<.001	<.001	<.001
Molybdenum, dissolved	mg/L	<.02	<.02	<.02	<.02	<.02	<.02
Nickel, dissolved	mg/L	<.01	<.01	<.01	<.01	0.01	0.01
Selenium, dissolved	mg/L	<.005	<.005	<.005	<.005	<.005	<.005
Zinc, dissolved	mg/L	<.01	<.01	<.01	0.04	<.01	<.01
QA/QC							
Anion Sum	meq/L	23.96	50.17	12.76	12.47	32.54	34.39
Cation Sum	meq/L	23.94	48.03	11.72	12.54	30.31	35.37
Total Anion/Cation Balance	%	0.04	2.17	4.26	0.27	3.55	1.40
Total Dissolved Solids (calc)	mg/L	1260	3020	650	660	1790	1950

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Table D6.2-4. Groundwater Quality Monitoring Results For Carney

Parameter	Units	578408-CRN				578409-CRN				578409-CRN-OB			
		3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14
Field													
Field Conductivity	µmhos/cm	2440	2650	2600	2700					1977	2390	1960	1944
Field pH	s.u.	7.79	6.88	7.22	6.91					8.04	7.25	7.62	7.38
Field turbidity	NTUs	370	355	65.9	64.7					91.9	15.13	4.36	3.9
Depth to Water	ft	87.66	87.7	87.7	87.71	Well 578409-CRN-OB Sampled				85.99	90.76	90.78	89.87
Temperature	Deg C	13.3	10.4	9.1	13.7					10.3	10.2	11.9	14.6
General													
Alkalinity (as CaCO3)	mg/L	577	584	605	613					421	509	473	510
Ammonia	mg/L	<0.1	0.2	0.4	0.6					1.5	4.2	5.1	5.2
Fluoride	mg/L	0.7	0.7	0.7	0.7					0.5	0.6	0.6	0.6
Hardness (as CaCO3)	mg/L	1300	1380	1430	1420					879	730	665	588
Hydroxide	mg/L	<5	<5	<5	<5					<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	2290	2470	2480	2440					2020	2200	2100	1950
Laboratory pH	s.u.	7.9	7.9	7.9	7.6					8.1	8.2	8.1	7.9
Nitrate/Nitrite	mg/L	<0.1	<0.1	<0.1	<0.1					<0.1	<0.1	<0.1	<0.1
Total Dissolved Solids	mg/L	1870	2000	2040	2190					1510	1560	1450	1410
Sodium Adsorption Ratio (SAR)	unitless	1	0.9	0.9	0.9					2.3	3.6	4.3	4.2
Major Ions													
Calcium	mg/L	165	173	177	175					127	110	101	91
Magnesium	mg/L	214	232	240	238					136	111	100	88
Potassium	mg/L	27	30	29	29					18	22	21	20
Sodium	mg/L	82	79	82	79					156	226	253	235
Bicarbonate	mg/L	705	712	738	748					513	621	577	622
Carbonate	mg/L	<5	<5	<5	<5					<5	<5	<5	<5
Chloride	mg/L	8	9	8	9					12	11	12	10
Sulfate	mg/L	918	963	973	969					778	753	655	637
Metals													
Aluminum, dissolved	mg/L	<0.1	<0.1	0.2	<0.1					<0.1	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005					<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1					<0.1	<0.1	<0.1	<0.1
Boron, dissolved	mg/L	0.5	0.5	0.5	0.5					0.2	0.2	0.2	0.2
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001					<0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01					<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01					<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	0.05	0.14	0.13					<0.05	<0.05	<0.05	<0.05
Iron, total	mg/L	4.57	2.85	1.05	0.96					1.36	0.19	0.12	0.33
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02					<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	0.44	0.64	0.51	0.4					0.09	0.19	0.14	0.11
Manganese, total	mg/L	0.54	0.81	0.5	0.43					0.17	0.23	0.15	0.12
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001					<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02					<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01					<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005					<0.005	<0.005	<0.005	<0.005
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01					<0.01	0.01	<0.01	<0.01
QA/QC													
Anion Sum	meq/L	30.94	31.99	32.63	32.71					24.97	26.19	23.47	23.75
Cation Sum	meq/L	30.16	31.87	32.9	32.52					24.94	24.97	25.19	22.83
Total Anion/Cation Balance	%	1.27	0.19	0.4	0.28					0.05	2.38	3.53	1.98
Total Dissolved Solids (calc)	mg/L	1760	1830	1870	1870					1480	1540	1430	1390

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Table D6.2-4. Groundwater Quality Monitoring Results For Carney (Continued)

Parameter	Units	578417-CRN				578418-CRN				578510-CRN			
		3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14
Field													
Field Conductivity	µmhos/cm	1421	1483	1347	1375								
Field pH	s.u.	8.16	7.39	7.76	7.56								
Field turbidity	NTUs	302	615	971	998								
Depth to Water	ft	133.05	133.31	133.13	133.55	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Temperature	Deg C	14.6	9.9	9.5	18								
General													
Alkalinity (as CaCO3)	mg/L	465	508	449	430								
Ammonia	mg/L	2.7	3.6	1.7	0.5								
Fluoride	mg/L	1.9	1.9	1.9	1.8								
Hardness (as CaCO3)	mg/L	147	150	151	143								
Hydroxide	mg/L	<5	<5	<5	<5								
Laboratory conductivity	µmhos/cm	1420	1450	1400	1370								
Laboratory pH	s.u.	8.3	8.3	8.2	8.3								
Nitrate/Nitrite	mg/L	<0.1	<0.1	2.3	4.6								
Total Dissolved Solids	mg/L	880	880	890	870								
Sodium Adsorption Ratio (SAR)	unitless	9.8	9.2	10	8.9								
Major Ions													
Calcium	mg/L	19	19	18	17								
Magnesium	mg/L	24	25	26	24								
Potassium	mg/L	15	17	16	15								
Sodium	mg/L	272	258	282	245								
Bicarbonate	mg/L	563	607	548	513								
Carbonate	mg/L	<5	6	<5	6								
Chloride	mg/L	7	8	8	7								
Sulfate	mg/L	242	255	250	258								
Metals													
Aluminum, dissolved	mg/L	0.9	0.4	0.3	<0.1								
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005								
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1								
Boron, dissolved	mg/L	0.1	0.1	0.1	<0.1								
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001								
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01								
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01								
Iron, dissolved	mg/L	0.21	0.22	0.08	<0.05								
Iron, total	mg/L	3.56	12.7	11.3	12.9								
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02								
Manganese, dissolved	mg/L	0.07	0.06	0.02	<0.02								
Manganese, total	mg/L	0.19	0.18	0.11	0.1								
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001								
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02								
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01								
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005								
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01								
QA/QC													
Anion Sum	meq/L	14.64	15.76	14.67	14.61								
Cation Sum	meq/L	15.37	14.66	15.81	13.95								
Total Anion/Cation Balance	%	2.42	3.6	3.74	2.29								
Total Dissolved Solids (calc)	mg/L	860	890	880	850								

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Table D6.2-4. Groundwater Quality Monitoring Results For Carney (Continued)

Parameter	Units	578511-CRN				578512-CRN				578513-CRN			
		3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14
Field													
Field Conductivity	µmhos/cm	3280	3800	3690	4050								
Field pH	s.u.	8.33	7.41	7.66	7.42								
Field turbidity	NTUs	86.7	72.6	28.3	88.5								
Depth to Water	ft	119.53	119.63	119.59	119.58	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Temperature	Deg C	16.8	10	12.3	18.2								
General													
Alkalinity (as CaCO3)	mg/L	525	678	737	823								
Ammonia	mg/L	6.8	6.7	7.6	6.4								
Fluoride	mg/L	1.1	1.1	1	0.9								
Hardness (as CaCO3)	mg/L	565	552	542	581								
Hydroxide	mg/L	<5	<5	<5	<5								
Laboratory conductivity	µmhos/cm	3400	3570	3660	3810								
Laboratory pH	s.u.	8.2	8.2	8	8.2								
Nitrate/Nitrite	mg/L	7.9	1.7	<0.1	<0.1								
Total Dissolved Solids	mg/L	2400	2910	3150	2650								
Sodium Adsorption Ratio (SAR)	unitless	9.8	11.6	12.6	12.4								
Major Ions													
Calcium	mg/L	85	79	76	78								
Magnesium	mg/L	86	86	86	94								
Potassium	mg/L	26	28	24	25								
Sodium	mg/L	535	625	675	690								
Bicarbonate	mg/L	641	827	899	1000								
Carbonate	mg/L	<5	<5	<5	<5								
Chloride	mg/L	24	26	27	27								
Sulfate	mg/L	1110	1270	1230	1340								
Metals													
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1								
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005								
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1								
Boron, dissolved	mg/L	0.3	0.2	0.2	0.2								
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001								
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01								
Copper, dissolved	mg/L	<0.01	<0.01	0.02	<0.01								
Iron, dissolved	mg/L	<0.05	<0.05	0.07	0.18								
Iron, total	mg/L	0.18	1.03	0.38	1.63								
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02								
Manganese, dissolved	mg/L	0.19	0.48	0.53	0.47								
Manganese, total	mg/L	0.24	0.66	0.7	0.51								
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001								
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02								
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01								
Selenium, dissolved	mg/L	0.005	<0.005	<0.005	<0.005								
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01								
QA/QC													
Anion Sum	meq/L	34.94	40.99	41.22	45.05								
Cation Sum	meq/L	35.74	38.92	41.37	42.72								
Total Anion/Cation Balance	%	1.12	2.58	0.18	2.65								
Total Dissolved Solids (calc)	mg/L	2220	2530	2560	2740								

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Table D6.2-4. Groundwater Quality Monitoring Results For Carney (Continued)

Parameter	Units	578420-CRN-PUMP-1					578524-CRN-PUMP-1
		7/3/2018	7/11/2018	11/13/2018	1/10/2019	4/9/2019	6/7/2018
Field							
Field Conductivity	µmhos/cm	980	999	1098	1099	1098	1033
Field pH	s.u.	7.85	7.71	7.69	7.76	7.81	7.68
Field turbidity	NTUs	148	6.61	4.62	3.95	20.7	22.5
Depth to Water	ft		7.81	9.2	9.39	8.94	
Temperature	Deg C	16.6	21.4	14.2	9.1	12.8	14.5
General							
Alkalinity (as CaCO3)	mg/L	363	379	424	424	421	588
Ammonia	mg/L	2.6	1.9	2.7	2.5	2.9	4.1
Fluoride	mg/L	0.6	0.7	0.8	0.9	1.1	1.9
Hardness (as CaCO3)	mg/L	252	279	249	234	220	53
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	1030	1090	1040	996	1040	1150
Laboratory pH	s.u.	8.3	8.3	8.4	8.4	8.3	8.4
Nitrate/Nitrite	mg/L	<0.1	<0.1	<0.1	<0.1	<.1	<0.1
Total Dissolved Solids	mg/L	640	680	700	700	690	700
Sodium Adsorption Ratio (SAR)	unitless	3.13	2.89	4.28	4.11	4.94	16.5
Major Ions							
Calcium	mg/L	48	54	45	43	38	8
Magnesium	mg/L	32	35	33	31	30	8
Potassium	mg/L	14	12	14	13	14	9
Sodium	mg/L	114	111	155	145	169	276
Bicarbonate	mg/L	440	450	506	490	510	685
Carbonate	mg/L	<5	6	6	13	<6	16
Chloride	mg/L	4	4	4	4	4	5
Sulfate	mg/L	182	186	162	166	168	33
Metals							
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1	0.2	0.1	<.1	0.1
Boron, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<.1	<0.1
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<.01	<0.01
Iron, dissolved	mg/L	<0.05	<0.05	0.13	<0.05	<.05	<0.05
Iron, total	mg/L	1.21	0.18	0.53	0.35	1.1	0.41
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<.02	<0.02
Manganese, dissolved	mg/L	0.21	0.26	0.28	0.49	0.37	0.02
Manganese, total	mg/L	0.24	0.27	0.28	0.5	0.36	0.02
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<.005	0.038
Zinc, dissolved	mg/L	0.07	<0.01	<0.01	<0.01	<.01	<0.01
QA/QC							
Anion Sum	meq/L	11.19	11.59	12.01	12.08	12.10	12.67
Cation Sum	meq/L	10.55	10.86	12.28	11.49	12.29	13.58
Total Anion/Cation Balance	%	2.94	3.24	1.13	2.49	0.79	3.46
Total Dissolved Solids (calc)	mg/L	610	630	670	660	680	690

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Table D6.2-5. Groundwater Quality Monitoring Results For Masters

Parameter	Units	578408-MST				578409-MST				578409-MST-OB			
		3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14
Field													
Field Conductivity	µmhos/cm	2380	2430	1984	1982	2450	2470	2310	2390				
Field pH	s.u.	7.38	6.53	6.87	6.62	8.49	7.7	8.05	7.82				
Field turbidity	NTUs	552	518	53.7	20.3	78.1	1.45	1.86	0.36				
Depth to Water	ft	104.49	105.89	102.93	99.82	101.18	101.1	101.21	100.95	Well 578409-MST Sampled			
Water Elevation	ft AMSL	3786.01	3784.61	3787.57	3790.68	3611.22	3611.3	3611.19	3611.45				
Temperature	Deg C	13.7	10.3	9.4	14.5	13.9	10.7	12.8	17.2				
General													
Alkalinity (as CaCO3)	mg/L	464	472	496	462	577	655	658	655				
Ammonia	mg/L	3.1	4.2	5.4	5	2	4	3.3	3.1				
Fluoride	mg/L	0.5	0.5	0.5	0.5	1.4	1.5	1.5	1.4				
Hardness (as CaCO3)	mg/L	1040	1040	1020	950	171	91	89	86				
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5	<5	<5				
Laboratory conductivity	µmhos/cm	2230	2230	2120	1980	2300	2260	2230	2150				
Laboratory pH	s.u.	7.6	7.8	7.6	7.8	8.4	8.4	8.4	8.2				
Nitrate/Nitrite	mg/L	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1	0.5				
Total Dissolved Solids	mg/L	1720	1690	1650	1570	1500	1510	1430	1520				
Sodium Adsorption Ratio (SAR)	unitless	1.9	1.7	1.6	1.4	16.1	22	24.2	24.2				
Major Ions													
Calcium	mg/L	129	124	120	112	29	16	16	15				
Magnesium	mg/L	174	177	175	163	24	12	12	12				
Potassium	mg/L	29	30	28	27	15	16	15	14				
Sodium	mg/L	140	129	114	101	484	484	525	516				
Bicarbonate	mg/L	566	576	605	563	685	773	775	799				
Carbonate	mg/L	<5	<5	<5	<5	9	12	13	<5				
Chloride	mg/L	8	7	7	7	10	9	9	9				
Sulfate	mg/L	891	858	767	742	560	497	449	477				
Metals													
Aluminum, dissolved	mg/L	0.8	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1				
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005				
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Boron, dissolved	mg/L	0.4	0.4	0.4	0.4	0.2	0.1	0.1	0.1				
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				
Iron, dissolved	mg/L	0.68	0.61	0.59	0.37	0.12	<0.05	<0.05	<0.05				
Iron, total	mg/L	5.95	3.53	1.41	0.77	1.13	0.06	<0.05	<0.05				
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02				
Manganese, dissolved	mg/L	0.92	0.29	0.15	0.07	0.08	0.21	0.23	0.2				
Manganese, total	mg/L	0.94	0.36	0.16	0.07	0.11	0.22	0.24	0.23				
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02				
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005				
Zinc, dissolved	mg/L	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01				
QA/QC													
Anion Sum	meq/L	28.07	27.54	26.09	24.9	23.58	23.78	22.83	23.37				
Cation Sum	meq/L	27.86	27.07	26.43	24.45	25.01	23.29	25.21	24.74				
Total Anion/Cation Balance	%	0.36	0.85	0.64	0.91	2.94	1.04	4.94	2.83				
Total Dissolved Solids (calc)	mg/L	1650	1610	1510	1430	1470	1430	1420	1440				

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Table D6.2-5. Groundwater Quality Monitoring Results For Masters (Continued)

Parameter	Units	578417-MST				578418-MST				578510-MST			
		3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14
Field													
Field Conductivity	µmhos/cm												
Field pH	s.u.												
Field turbidity	NTUs												
Depth to Water	ft	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Water Elevation	ft AMSL												
Temperature	Deg C												
General													
Alkalinity (as CaCO3)	mg/L												
Ammonia	mg/L												
Fluoride	mg/L												
Hardness (as CaCO3)	mg/L												
Hydroxide	mg/L												
Laboratory conductivity	µmhos/cm												
Laboratory pH	s.u.												
Nitrate/Nitrite	mg/L												
Total Dissolved Solids	mg/L												
Sodium Adsorption Ratio (SAR)	unitless												
Major Ions													
Calcium	mg/L												
Magnesium	mg/L												
Potassium	mg/L												
Sodium	mg/L												
Bicarbonate	mg/L												
Carbonate	mg/L												
Chloride	mg/L												
Sulfate	mg/L												
Metals													
Aluminum, dissolved	mg/L												
Arsenic, dissolved	mg/L												
Barium, dissolved	mg/L												
Boron, dissolved	mg/L												
Cadmium, dissolved	mg/L												
Chromium, dissolved	mg/L												
Copper, dissolved	mg/L												
Iron, dissolved	mg/L												
Iron, total	mg/L												
Lead, dissolved	mg/L												
Manganese, dissolved	mg/L												
Manganese, total	mg/L												
Mercury, dissolved	mg/L												
Molybdenum, dissolved	mg/L												
Nickel, dissolved	mg/L												
Selenium, dissolved	mg/L												
Zinc, dissolved	mg/L												
QA/QC													
Anion Sum	meq/L												
Cation Sum	meq/L												
Total Anion/Cation Balance	%												
Total Dissolved Solids (calc)	mg/L												

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Table D6.2-5. Groundwater Quality Monitoring Results For Masters (Continued)

Parameter	Units	578511-MST				578512-MST				578513-MST			
		3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14	3Q13	4Q13	1Q14	2Q14
Field													
Field Conductivity	µmhos/cm	2300	4180							4110	4230	3920	4130
Field pH	s.u.	8.57	7.52							7.51	6.77	7.12	6.87
Field turbidity	NTUs	35	171							9.82	2.96	2.06	2.22
Depth to Water	ft	150.1	150.12	DRY	DRY	DRY	DRY	DRY	DRY	108.2	108.54	108.82	107.94
Water Elevation	ft AMSL	3746.30	3746.28							3742.40	3742.06	3741.78	3742.66
Temperature	Deg C	17.6	9.9							14.6	10.6	10.7	17.2
General													
Alkalinity (as CaCO3)	mg/L	443	1230							604	611	605	607
Ammonia	mg/L	4.5	6.9							10.6	9.1	10.4	9.4
Fluoride	mg/L	0.9	1.1							0.6	0.7	0.6	0.6
Hardness (as CaCO3)	mg/L	382	506							1040	1030	1080	974
Hydroxide	mg/L	<5	<5							<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	2280	3970							4290	4010	3900	3820
Laboratory pH	s.u.	8.3	8.3							7.8	7.8	7.6	8
Nitrate/Nitrite	mg/L	8	<0.1							<0.1	<0.1	<0.1	0.3
Total Dissolved Solids	mg/L	1500	2740							3370	3120	3090	2970
Sodium Adsorption Ratio (SAR)	unitless	7.9	15.3							8.3	7.9	8.2	7.4
Major Ions													
Calcium	mg/L	59	74							128	124	129	117
Magnesium	mg/L	57	78							175	175	184	166
Potassium	mg/L	19	29							32	34	32	30
Sodium	mg/L	353	793							613	586	622	533
Bicarbonate	mg/L	540	1470							736	745	738	740
Carbonate	mg/L	<5	11							<5	<5	<5	<5
Chloride	mg/L	16	30							15	16	18	15
Sulfate	mg/L	624	1050							1740	1780	1700	1690
Metals													
Aluminum, dissolved	mg/L	<0.1	<0.1							<0.1	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005							<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1							<0.1	<0.1	<0.1	<0.1
Boron, dissolved	mg/L	0.3	0.2							0.3	0.3	0.3	0.3
Cadmium, dissolved	mg/L	<0.001	<0.001							<0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01							<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01							<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	0.47							0.19	0.4	0.55	0.05
Iron, total	mg/L	0.29	25.6							0.34	0.51	0.74	0.18
Lead, dissolved	mg/L	<0.02	<0.02							<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	0.09	0.23							0.09	0.08	0.07	0.05
Manganese, total	mg/L	0.11	0.68							0.13	0.09	0.08	0.05
Mercury, dissolved	mg/L	<0.001	<0.001							<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02							<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01							<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005							<0.005	<0.005	<0.005	<0.005
Zinc, dissolved	mg/L	<0.01	<0.01							0.01	<0.01	<0.01	<0.01
QA/QC													
Anion Sum	meq/L	22.91	47.25							48.85	49.79	47.95	47.84
Cation Sum	meq/L	23.8	45.33							48.99	46.96	50.18	44.11
Total Anion/Cation Balance	%	1.9	2.06							0.15	2.92	2.27	4.05
Total Dissolved Solids (calc)	mg/L	1430	2790							3070	3080	3040	2920

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Table D6.2-6. Groundwater Quality Monitoring Results For Masters/Carney Commingled

Parameter	Units	578415-MST/CRN			
		3Q13	4Q13	1Q14	2Q14
Field					
Field Conductivity	µmhos/cm	2590	1952	1930	1778
Field pH	s.u.	8.56	7.68	8.11	7.91
Field turbidity	NTUs	330	225	8.38	3.55
Depth to Water	ft	122.85	122.68	122.01	121.23
Temperature	Deg C	12.8	10.5	10.5	15.1
General					
Alkalinity (as CaCO3)	mg/L	958	707	679	710
Ammonia	mg/L	1	1.6	2.1	2.3
Fluoride	mg/L	1.7	1.9	2	2
Hardness (as CaCO3)	mg/L	72	56	48	43
Hydroxide	mg/L	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	2720	1950	1850	1750
Laboratory pH	s.u.	8.4	8.4	8.4	8.3
Nitrate/Nitrite	mg/L	1.2	<0.1	<0.1	<0.1
Total Dissolved Solids	mg/L	1640	1180	1140	1210
Sodium Adsorption Ratio (SAR)	unitless	29	25.1	28.1	29
Major Ions					
Calcium	mg/L	15	12	10	9
Magnesium	mg/L	8	6	6	5
Potassium	mg/L	9	10	9	9
Sodium	mg/L	567	431	449	434
Bicarbonate	mg/L	1110	831	805	859
Carbonate	mg/L	27	16	12	<5
Chloride	mg/L	24	13	14	11
Sulfate	mg/L	374	280	249	263
Metals					
Aluminum, dissolved	mg/L	<0.1	0.7	<0.1	<0.1
Arsenic, dissolved	mg/L	0.007	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1
Boron, dissolved	mg/L	0.1	0.1	<0.1	<0.1
Cadmium, dissolved	mg/L	0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	0.21	0.06	0.15
Iron, total	mg/L	3.67	0.95	0.29	0.35
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	0.05	0.1	0.09	0.07
Manganese, total	mg/L	0.14	0.17	0.1	0.08
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	0.03	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	0.005	<0.005	<0.005	0.005
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
QA/QC					
Anion Sum	meq/L	27.78	20.43	19.27	20.1
Cation Sum	meq/L	26.41	20.12	20.86	20.13
Total Anion/Cation Balance	%	2.52	0.77	3.97	0.07
Total Dissolved Solids (calc)	mg/L	1580	1180	1140	1160

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Table D6.2-7. Groundwater Quality Monitoring Results For Masters Coal Underburden

Parameter	Units	578409-UBN			
		3Q13	4Q13	1Q14	2Q14
Field					
Field Conductivity	µmhos/cm	4110	4220	3920	3990
Field pH	s.u.	8.74	7.76	8.04	7.79
Field turbidity	NTUs	4.61	3.62	59.7	1.01
Depth to Water	ft	108.44	110.2	110.25	110.4
Temperature	Deg C	10.9	11.4	12.9	14.5
General					
Alkalinity (as CaCO3)	mg/L	435	459	460	466
Ammonia	mg/L	<0.1	0.7	1.7	2.2
Fluoride	mg/L	1	1	1.1	1
Hardness (as CaCO3)	mg/L	373	395	479	522
Hydroxide	mg/L	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	3880	4010	3840	3620
Laboratory pH	s.u.	8.5	8.3	8.2	8.1
Nitrate/Nitrite	mg/L	13.6	7.5	4.9	3.2
Total Dissolved Solids	mg/L	2860	2820	2760	2830
Sodium Adsorption Ratio (SAR)	unitless	18	16.9	15.6	13.5
Major Ions					
Calcium	mg/L	67	70	80	85
Magnesium	mg/L	50	53	68	75
Potassium	mg/L	12	14	15	35
Sodium	mg/L	801	771	784	707
Bicarbonate	mg/L	505	553	561	569
Carbonate	mg/L	13	<5	<5	<5
Chloride	mg/L	34	32	30	28
Sulfate	mg/L	1620	1600	1530	1560
Metals					
Aluminum, dissolved	mg/L	<0.1	<0.1	0.2	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1
Boron, dissolved	mg/L	0.2	0.3	0.3	0.5
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	<0.05	<0.05	0.3	<0.05
Iron, total	mg/L	0.09	<0.05	1.88	<0.05
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	0.04	0.16	0.41	0.36
Manganese, total	mg/L	0.05	0.19	1	0.58
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	0.03	0.03	0.04	0.03
Nickel, dissolved	mg/L	<0.01	<0.01	0.01	0.03
Selenium, dissolved	mg/L	0.012	0.01	0.006	0.005
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01
QA/QC					
Anion Sum	meq/L	44.37	44.01	42.33	42.92
Cation Sum	meq/L	42.6	41.79	44.17	42.24
Total Anion/Cation Balance	%	2.03	2.58	2.12	0.79
Total Dissolved Solids (calc)	mg/L	2900	2850	2810	2790

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Table D6.2-8. Groundwater Quality Comparison of Alluvial Wells for WDEQ Standards

Parameter	Units	WDEQ Class I													
		Standard	578418-AL	578512-AL	578513-AL	578420-AL-1	578524-AL-1	578433-AL-1	578434-AL-1	578434-AL-2	LAYA #1	578415-AL-1	TDAW-01	LAYA #2	LAYA #3
General															
Alkalinity (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia	mg/L	**0.5**	0	0	0	0	0	0	0	0	1	0	0	0	0
Fluoride	mg/L	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardness (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroxide	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory conductivity	µmhos/cm	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory pH	s.u.	**8.5**	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrate/Nitrite	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Dissolved Solids	mg/L	**500**	2	4	4	2	4	5	4	0	1	2	1	1	1
Sodium Adsorption Ration (SAR)	unitless	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Major Ions															
Calcium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Potassium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloride	mg/L	**250**	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	mg/L	**250**	2	4	4	0	2	5	2	0	0	2	0	1	0
Metals															
Aluminum, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic, dissolved	mg/L	**0.05**	0	0	0	0	0	0	0	0	0	0	0	0	0
Barium, dissolved	mg/L	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0
Boron, dissolved	mg/L	**0.75**	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium, dissolved	mg/L	**0.005**	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium, dissolved	mg/L	**0.1**	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper, dissolved	mg/L	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron, dissolved	mg/L	**0.3**	0	4	0	0	4	5	4	1	0	0	0	0	0
Iron, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese, dissolved	mg/L	**0.05**	0	4	4	1	4	5	4	1	0	2	1	1	0
Manganese, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury, dissolved	mg/L	**0.002**	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium, dissolved	mg/L	**0.05**	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc, dissolved	mg/L	**5**	0	0	0	0	0	0	0	0	0	0	0	0	0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

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Table D6.2-8. Groundwater Quality Comparison of Alluvial Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class II													
		Standard	578418-AL	578512-AL	578513-AL	578420-AL-1	578524-AL-1	578433-AL-1	578434-AL-1	578434-AL-2	LAYA #1	578415-AL-1	TDAW-01	LAYA #2	LAYA #3
General															
Alkalinity (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluoride	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardness (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroxide	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory conductivity	µmhos/cm	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory pH	s.u.	**9**	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrate/Nitrite	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Dissolved Solids	mg/L	**2000**	1	4	4	0	0	0	0	0	0	2	0	1	0
Sodium Adsorption Ration (SAR)	unitless	**8**	0	0	0	0	0	0	0	0	1	0	0	0	0
Major Ions															
Calcium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Potassium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloride	mg/L	**100**	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	mg/L	**200**	2	4	4	0	4	5	4	0	0	2	0	1	1
Metals															
Aluminum, dissolved	mg/L	**5**	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic, dissolved	mg/L	**0.1**	0	0	0	0	0	0	0	0	0	0	0	0	0
Barium, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Boron, dissolved	mg/L	**0.75**	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium, dissolved	mg/L	**0.01**	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium, dissolved	mg/L	**0.1**	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper, dissolved	mg/L	**0.2**	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron, dissolved	mg/L	**5**	0	0	0	0	1	0	3	0	0	0	0	0	0
Iron, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead, dissolved	mg/L	**5**	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese, dissolved	mg/L	**0.2**	0	4	4	1	3	5	4	0	0	2	1	1	0
Manganese, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel, dissolved	mg/L	**0.2**	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium, dissolved	mg/L	**0.02**	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc, dissolved	mg/L	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

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Table D6.2-8. Groundwater Quality Comparison of Alluvial Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class III													
		Standard	578418-AL	578512-AL	578513-AL	578420-AL-1	578524-AL-1	578433-AL-1	578434-AL-1	578434-AL-2	LAYA #1	578415-AL-1	TDAW-01	LAYA #2	LAYA #3
General															
Alkalinity (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluoride	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardness (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroxide	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory conductivity	µmhos/cm	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory pH	s.u.	**8.5**	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrate/Nitrite	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Dissolved Solids	mg/L	**5000**	0	3	0	0	0	0	0	0	0	0	0	0	0
Sodium Adsorption Ration (SAR)	unitless	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Major Ions															
Calcium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Potassium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloride	mg/L	**2000**	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	mg/L	**3000**	0	2	0	0	0	0	0	0	0	0	0	0	0
Metals															
Aluminum, dissolved	mg/L	**5**	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic, dissolved	mg/L	**0.2**	0	0	0	0	0	0	0	0	0	0	0	0	0
Barium, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Boron, dissolved	mg/L	**5**	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium, dissolved	mg/L	**0.05**	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium, dissolved	mg/L	**0.05**	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper, dissolved	mg/L	**0.5**	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead, dissolved	mg/L	**0.1**	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury, dissolved	mg/L	**0.00005**	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium, dissolved	mg/L	**0.05**	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc, dissolved	mg/L	**25**	0	0	0	0	0	0	0	0	0	0	0	0	0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

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Table D6.2-9. Groundwater Quality Comparison of Alluvial Wells for EPA Standards

Parameter	Units	EPA Primary													
		Standard	578418-AL	578512-AL	578513-AL	578420-AL-1	578524-AL-1	578433-AL-1	578434-AL-1	578434-AL-2	LAYA #1	578415-AL-1	TDAW-01	LAYA #2	LAYA #3
General															
Alkalinity (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluoride	mg/L	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardness (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroxide	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory conductivity	µmhos/cm	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory pH	s.u.	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrate/Nitrite	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Dissolved Solids	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium Adsorption Ration (SAR)	unitless	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Major Ions															
Calcium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Potassium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloride	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Metals															
Aluminum, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic, dissolved	mg/L	**0.01**	0	0	0	0	0	0	0	0	0	0	0	0	0
Barium, dissolved	mg/L	**2**	0	0	0	0	0	0	0	0	0	0	0	0	0
Boron, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium, dissolved	mg/L	**0.005**	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper, dissolved	mg/L	**1.3**	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead, dissolved	mg/L	**0.015**	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury, dissolved	mg/L	**0.002**	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium, dissolved	mg/L	**0.05**	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0

Pink — Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

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Table D6.2-9. Groundwater Quality Comparison of Alluvial Wells for EPA Standards (Continued)

Parameter	Units	EPA Secondary Standard	578418-AL	578512-AL	578513-AL	578420-AL-1	578524-AL-1	578433-AL-1	578434-AL-1	578434-AL-2	LAYA #1	578415-AL-1	TDAW-01	LAYA #2	LAYA #3
General															
Alkalinity (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Fluoride	mg/L	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardness (as CaCO3)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroxide	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory conductivity	µmhos/cm	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Laboratory pH	s.u.	8.5	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrate/Nitrite	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Dissolved Solids	mg/L	500	2	4	4	2	4	5	4	0	1	2	1	1	1
Sodium Adsorption Ration (SAR)	unitless	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Major Ions															
Calcium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Magnesium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Potassium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Sodium	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Carbonate	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloride	mg/L	250	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate	mg/L	250	2	4	4	0	2	5	2	0	0	2	0	1	0
Metals															
Aluminum, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Arsenic, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Barium, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Boron, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadmium, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromium, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper, dissolved	mg/L	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron, dissolved	mg/L	0.3	0	4	0	0	4	5	4	1	0	0	0	0	0
Iron, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Lead, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Manganese, dissolved	mg/L	0.05	0	4	4	1	4	5	4	1	0	2	1	1	0
Manganese, total	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercury, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Molybdenum, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Nickel, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Selenium, dissolved	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0	0
Zinc, dissolved	mg/L	5	0	0	0	0	0	0	0	0	0	0	0	0	0

Pink Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

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Table D6.2-10. Groundwater Quality Comparison of Underburden Wells for WDEQ Standards

Parameter	Units	WDEQ Class I		WDEQ Class II		WDEQ Class III	
		Standard	578409-UBN	Standard	578409-UBN	Standard	578409-UBN
General							
Alkalinity (as CaCO3)	mg/L	---	0	---	0	---	0
Ammonia	mg/L	0.5	3	---	0	---	0
Fluoride	mg/L	4	0	---	0	---	0
Hardness (as CaCO3)	mg/L	---	0	---	0	---	0
Hydroxide	mg/L	---	0	---	0	---	0
Laboratory conductivity	µmhos/cm	---	0	---	0	---	0
Laboratory pH	s.u.	8.5	0	9	0	8.5	0
Nitrate/Nitrite	mg/L	---	0	---	0	---	0
Total Dissolved Solids	mg/L	500	4	2000	4	5000	0
Sodium Adsorption Ratio (SAR)	unitless	---	0	8	4	---	0
Major Ions							
Calcium	mg/L	---	0	---	0	---	0
Magnesium	mg/L	---	0	---	0	---	0
Potassium	mg/L	---	0	---	0	---	0
Sodium	mg/L	---	0	---	0	---	0
Bicarbonate	mg/L	---	0	---	0	---	0
Carbonate	mg/L	---	0	---	0	---	0
Chloride	mg/L	250	0	100	0	2000	0
Sulfate	mg/L	250	4	200	4	3000	0
Metals							
Aluminum, dissolved	mg/L	---	0	5	0	5	0
Arsenic, dissolved	mg/L	0.05	0	0.1	0	0.2	0
Barium, dissolved	mg/L	2	0	---	0	---	0
Boron, dissolved	mg/L	0.75	0	0.75	0	5	0
Cadmium, dissolved	mg/L	0.005	0	0.01	0	0.05	0
Chromium, dissolved	mg/L	0.1	0	0.1	0	0.05	0
Copper, dissolved	mg/L	1	0	0.2	0	0.5	0
Iron, dissolved	mg/L	0.3	0	5	0	---	0
Iron, total	mg/L	---	0	---	0	---	0
Lead, dissolved	mg/L	---	0	5	0	0.1	0
Manganese, dissolved	mg/L	0.05	3	0.2	2	---	0
Manganese, total	mg/L	---	0	---	0	---	0
Mercury, dissolved	mg/L	0.002	0	---	0	0.00005	0
Molybdenum, dissolved	mg/L	---	0	---	0	---	0
Nickel, dissolved	mg/L	---	0	0.2	0	---	0
Selenium, dissolved	mg/L	0.05	0	0.02	0	0.05	0
Zinc, dissolved	mg/L	5	0	2	0	25	0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1.

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Table D6.2-11. Groundwater Quality Comparison of Underburden Wells for EPA Standards

Parameter	Units	EPA Primary		EPA Secondary	
		Standard	578409-UBN	Standard	578409-UBN
General					
Alkalinity (as CaCO3)	mg/L	---	0	---	0
Ammonia	mg/L	---	0	---	0
Fluoride	mg/L	4	0	2	0
Hardness (as CaCO3)	mg/L	---	0	---	0
Hydroxide	mg/L	---	0	---	0
Laboratory conductivity	µmhos/cm	---	0	---	0
Laboratory pH	s.u.	---	0	8.5	0
Nitrate/Nitrite	mg/L	---	0	---	0
Total Dissolved Solids	mg/L	---	0	500	4
Sodium Adsorption Ratio (SAR)	unitless	---	0	---	0
Major Ions					
Calcium	mg/L	---	0	---	0
Magnesium	mg/L	---	0	---	0
Potassium	mg/L	---	0	---	0
Sodium	mg/L	---	0	---	0
Bicarbonate	mg/L	---	0	---	0
Carbonate	mg/L	---	0	---	0
Chloride	mg/L	---	0	250	0
Sulfate	mg/L	---	0	250	4
Metals					
Aluminum, dissolved	mg/L	---	0	---	0
Arsenic, dissolved	mg/L	0.01	0	---	0
Barium, dissolved	mg/L	2	0	---	0
Boron, dissolved	mg/L	---	0	---	0
Cadmium, dissolved	mg/L	0.005	0	---	0
Chromium, dissolved	mg/L	---	0	---	0
Copper, dissolved	mg/L	1.3	0	1	0
Iron, dissolved	mg/L	---	0	0.3	0
Iron, total	mg/L	---	0	---	0
Lead, dissolved	mg/L	0.015	0	---	0
Manganese, dissolved	mg/L	---	0	0.05	3
Manganese, total	mg/L	---	0	---	0
Mercury, dissolved	mg/L	0.002	0	---	0
Molybdenum, dissolved	mg/L	---	0	---	0
Nickel, dissolved	mg/L	---	0	---	0
Selenium, dissolved	mg/L	0.05	0	---	0
Zinc, dissolved	mg/L	---	0	5	0

Pink Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

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Table D6.2-12. Groundwater Quality Comparison of Masters Coal Seam Wells for WDEQ Standards

Parameter	Units	WDEQ Class I								
		Standard	578408-MST	578409-MST	578409-MST-OB	578418-MST	578510-MST	578511-MST	578512-MST	578513-MST
General					Not Sampled	DRY	DRY		DRY	
Alkalinity (as CaCO3)	mg/L	---	0	0				0		0
Ammonia	mg/L	0.5	4	4				2		3
Fluoride	mg/L	4	0	0				0		0
Hardness (as CaCO3)	mg/L	---	0	0				0		0
Hydroxide	mg/L	---	0	0				0		0
Laboratory conductivity	µmhos/cm	---	0	0				0		0
Laboratory pH	s.u.	8.5	0	0				0		0
Nitrate/Nitrite	mg/L	---	0	0				0		0
Total Dissolved Solids	mg/L	500	4	4				2		3
Sodium Adsorption Ratio (SAR)	unitless	---	0	0				0		0
Major Ions										
Calcium	mg/L	---	0	0				0		0
Magnesium	mg/L	---	0	0				0		0
Potassium	mg/L	---	0	0				0		0
Sodium	mg/L	---	0	0				0		0
Bicarbonate	mg/L	---	0	0				0		0
Carbonate	mg/L	---	0	0				0		0
Chloride	mg/L	250	0	0				0		0
Sulfate	mg/L	250	4	4				2		3
Metals										
Aluminum, dissolved	mg/L	---	0	0				0		0
Arsenic, dissolved	mg/L	0.05	0	0				0		0
Barium, dissolved	mg/L	2	0	0				0		0
Boron, dissolved	mg/L	0.75	0	0				0		0
Cadmium, dissolved	mg/L	0.005	0	0				0		0
Chromium, dissolved	mg/L	0.1	0	0				0		0
Copper, dissolved	mg/L	1	0	0				0		0
Iron, dissolved	mg/L	0.3	4	0				1		2
Iron, total	mg/L	---	0	0				0		0
Lead, dissolved	mg/L	---	0	0				0		0
Manganese, dissolved	mg/L	0.05	4	4				2		3
Manganese, total	mg/L	---	0	0				0		0
Mercury, dissolved	mg/L	0.002	0	0				0		0
Molybdenum, dissolved	mg/L	---	0	0				0		0
Nickel, dissolved	mg/L	---	0	0				0		0
Selenium, dissolved	mg/L	0.05	0	0				0		0
Zinc, dissolved	mg/L	5	0	0				0		0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

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Table D6.2-12. Groundwater Quality Comparison of Masters Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class II								
		Standard	578408-MST	578409-MST	578409-MST-OB	578418-MST	578510-MST	578511-MST	578512-MST	578513-MST
General					Not Sampled	DRY	DRY		DRY	
Alkalinity (as CaCO3)	mg/L	---	0	0				0		0
Ammonia	mg/L	---	0	0				0		0
Fluoride	mg/L	---	0	0				0		0
Hardness (as CaCO3)	mg/L	---	0	0				0		0
Hydroxide	mg/L	---	0	0				0		0
Laboratory conductivity	µmhos/cm	---	0	0				0		0
Laboratory pH	s.u.	9	0	0				0		0
Nitrate/Nitrite	mg/L	---	0	0				0		0
Total Dissolved Solids	mg/L	2000	0	0				1		3
Sodium Adsorption Ratio (SAR)	unitless	8	0	4				1		2
Major Ions										
Calcium	mg/L	---	0	0				0		0
Magnesium	mg/L	---	0	0				0		0
Potassium	mg/L	---	0	0				0		0
Sodium	mg/L	---	0	0				0		0
Bicarbonate	mg/L	---	0	0				0		0
Carbonate	mg/L	---	0	0				0		0
Chloride	mg/L	100	0	0				0		0
Sulfate	mg/L	200	4	4				2		3
Metals										
Aluminum, dissolved	mg/L	5	0	0				0		0
Arsenic, dissolved	mg/L	0.1	0	0				0		0
Barium, dissolved	mg/L	---	0	0				0		0
Boron, dissolved	mg/L	0.75	0	0				0		0
Cadmium, dissolved	mg/L	0.01	0	0				0		0
Chromium, dissolved	mg/L	0.1	0	0				0		0
Copper, dissolved	mg/L	0.2	0	0				0		0
Iron, dissolved	mg/L	5	0	0				0		0
Iron, total	mg/L	---	0	0				0		0
Lead, dissolved	mg/L	5	0	0				0		0
Manganese, dissolved	mg/L	0.2	2	2				1		0
Manganese, total	mg/L	---	0	0				0		0
Mercury, dissolved	mg/L	---	0	0				0		0
Molybdenum, dissolved	mg/L	---	0	0				0		0
Nickel, dissolved	mg/L	0.2	0	0				0		0
Selenium, dissolved	mg/L	0.02	0	0				0		0
Zinc, dissolved	mg/L	2	0	0				0		0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

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Table D6.2-12. Groundwater Quality Comparison of Masters Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class III								
		Standard	578408-MST	578409-MST	578409-MST-OB	578418-MST	578510-MST	578511-MST	578512-MST	578513-MST
General					Not Sampled	DRY	DRY		DRY	
Alkalinity (as CaCO3)	mg/L	---	0	0				0		0
Ammonia	mg/L	---	0	0				0		0
Fluoride	mg/L	---	0	0				0		0
Hardness (as CaCO3)	mg/L	---	0	0				0		0
Hydroxide	mg/L	---	0	0				0		0
Laboratory conductivity	µmhos/cm	---	0	0				0		0
Laboratory pH	s.u.	8.5	0	0				0		0
Nitrate/Nitrite	mg/L	---	0	0				0		0
Total Dissolved Solids	mg/L	5000	0	0				0		0
Sodium Adsorption Ratio (SAR)	unitless	---	0	0				0		0
Major Ions										
Calcium	mg/L	---	0	0				0		0
Magnesium	mg/L	---	0	0				0		0
Potassium	mg/L	---	0	0				0		0
Sodium	mg/L	---	0	0				0		0
Bicarbonate	mg/L	---	0	0				0		0
Carbonate	mg/L	---	0	0				0		0
Chloride	mg/L	2000	0	0				0		0
Sulfate	mg/L	3000	0	0				0		0
Metals										
Aluminum, dissolved	mg/L	5	0	0				0		0
Arsenic, dissolved	mg/L	0.2	0	0				0		0
Barium, dissolved	mg/L	---	0	0				0		0
Boron, dissolved	mg/L	5	0	0				0		0
Cadmium, dissolved	mg/L	0.05	0	0				0		0
Chromium, dissolved	mg/L	0.05	0	0				0		0
Copper, dissolved	mg/L	0.5	0	0				0		0
Iron, dissolved	mg/L	---	0	0				0		0
Iron, total	mg/L	---	0	0				0		0
Lead, dissolved	mg/L	0.1	0	0				0		0
Manganese, dissolved	mg/L	---	0	0				0		0
Manganese, total	mg/L	---	0	0				0		0
Mercury, dissolved	mg/L	0.00005	0	0				0		0
Molybdenum, dissolved	mg/L	---	0	0				0		0
Nickel, dissolved	mg/L	---	0	0				0		0
Selenium, dissolved	mg/L	0.05	0	0				0		0
Zinc, dissolved	mg/L	25	0	0				0		0

Pink: Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

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Table D6.2-13. Groundwater Quality Comparison of Masters Coal Seam Wells for EPA Standards

Parameter	Units	EPA Primary								
		Standard	578408-MST	578409-MST	578409-MST-OB	578418-MST	578510-MST	578511-MST	578512-MST	578513-MST
General					Not Sampled	DRY	DRY		DRY	
Alkalinity (as CaCO3)	mg/L	---	0	0				0		0
Ammonia	mg/L	---	0	0				0		0
Fluoride	mg/L	4	0	0				0		0
Hardness (as CaCO3)	mg/L	---	0	0				0		0
Hydroxide	mg/L	---	0	0				0		0
Laboratory conductivity	µmhos/cm	---	0	0				0		0
Laboratory pH	s.u.	---	0	0				0		0
Nitrate/Nitrite	mg/L	---	0	0				0		0
Total Dissolved Solids	mg/L	---	0	0				0		0
Sodium Adsorption Ratio (SAR)	unitless	---	0	0				0		0
Major Ions										
Calcium	mg/L	---	0	0				0		0
Magnesium	mg/L	---	0	0				0		0
Potassium	mg/L	---	0	0				0		0
Sodium	mg/L	---	0	0				0		0
Bicarbonate	mg/L	---	0	0				0		0
Carbonate	mg/L	---	0	0				0		0
Chloride	mg/L	---	0	0				0		0
Sulfate	mg/L	---	0	0				0		0
Metals										
Aluminum, dissolved	mg/L	---	0	0				0		0
Arsenic, dissolved	mg/L	0.01	0	0				0		0
Barium, dissolved	mg/L	2	0	0				0		0
Boron, dissolved	mg/L	---	0	0				0		0
Cadmium, dissolved	mg/L	0.005	0	0				0		0
Chromium, dissolved	mg/L	---	0	0				0		0
Copper, dissolved	mg/L	1.3	0	0				0		0
Iron, dissolved	mg/L	---	0	0				0		0
Iron, total	mg/L	---	0	0				0		0
Lead, dissolved	mg/L	0.015	0	0				0		0
Manganese, dissolved	mg/L	---	0	0				0		0
Manganese, total	mg/L	---	0	0				0		0
Mercury, dissolved	mg/L	0.002	0	0				0		0
Molybdenum, dissolved	mg/L	---	0	0				0		0
Nickel, dissolved	mg/L	---	0	0				0		0
Selenium, dissolved	mg/L	0.05	0	0				0		0
Zinc, dissolved	mg/L	---	0	0				0		0

Pink Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

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Table D6.2-13. Groundwater Quality Comparison of Masters Coal Seam Wells for EPA Standards

Parameter	Units	EPA Secondary Standard	578408-MST	578409-MST	578409-MST-OB	578418-MST	578510-MST	578511-MST	578512-MST	578513-MST
General					Not Sampled	DRY	DRY		DRY	
Alkalinity (as CaCO3)	mg/L	---	0	0				0		0
Ammonia	mg/L	---	0	0				0		0
Fluoride	mg/L	2	0	0				0		0
Hardness (as CaCO3)	mg/L	---	0	0				0		0
Hydroxide	mg/L	---	0	0				0		0
Laboratory conductivity	µmhos/cm	---	0	0				0		0
Laboratory pH	s.u.	8.5	0	0				0		0
Nitrate/Nitrite	mg/L	---	0	0				0		0
Total Dissolved Solids	mg/L	500	4	4				2		3
Sodium Adsorption Ratio (SAR)	unitless	---	0	0				0		0
Major Ions										
Calcium	mg/L	---	0	0				0		0
Magnesium	mg/L	---	0	0				0		0
Potassium	mg/L	---	0	0				0		0
Sodium	mg/L	---	0	0				0		0
Bicarbonate	mg/L	---	0	0				0		0
Carbonate	mg/L	---	0	0				0		0
Chloride	mg/L	250	0	0				0		0
Sulfate	mg/L	250	4	4				2		3
Metals										
Aluminum, dissolved	mg/L	---	0	0				0		0
Arsenic, dissolved	mg/L	---	0	0				0		0
Barium, dissolved	mg/L	---	0	0				0		0
Boron, dissolved	mg/L	---	0	0				0		0
Cadmium, dissolved	mg/L	---	0	0				0		0
Chromium, dissolved	mg/L	---	0	0				0		0
Copper, dissolved	mg/L	1	0	0				0		0
Iron, dissolved	mg/L	0.3	4	0				1		2
Iron, total	mg/L	---	0	0				0		0
Lead, dissolved	mg/L	---	0	0				0		0
Manganese, dissolved	mg/L	0.05	4	4				2		3
Manganese, total	mg/L	---	0	0				0		0
Mercury, dissolved	mg/L	---	0	0				0		0
Molybdenum, dissolved	mg/L	---	0	0				0		0
Nickel, dissolved	mg/L	---	0	0				0		0
Selenium, dissolved	mg/L	---	0	0				0		0
Zinc, dissolved	mg/L	5	0	0				0		0

Pink — Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

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Table D6.2-14. Groundwater Quality Comparison of Masters/Carney Commingled Coal Seam Wells for WDEQ Standards

Parameter	Units	WDEQ Class I		WDEQ Class II		WDEQ Class III	
		Standard	578415-MST/CRN	Standard	578415-MST/CRN	Standard	578415-MST/CRN
General							
Alkalinity (as CaCO3)	mg/L	---	0	---	0	---	0
Ammonia	mg/L	0.5	4	---	0	---	0
Fluoride	mg/L	4	0	---	0	---	0
Hardness (as CaCO3)	mg/L	---	0	---	0	---	0
Hydroxide	mg/L	---	0	---	0	---	0
Laboratory conductivity	µmhos/cm	---	0	---	0	---	0
Laboratory pH	s.u.	8.5	0	9	0	8.5	0
Nitrate/Nitrite	mg/L	---	0	---	0	---	0
Total Dissolved Solids	mg/L	500	4	2000	0	5000	0
Sodium Adsorption Ratio (SAR)	unitless	---	0	8	4	---	0
Major Ions							
Calcium	mg/L	---	0	---	0	---	0
Magnesium	mg/L	---	0	---	0	---	0
Potassium	mg/L	---	0	---	0	---	0
Sodium	mg/L	---	0	---	0	---	0
Bicarbonate	mg/L	---	0	---	0	---	0
Carbonate	mg/L	---	0	---	0	---	0
Chloride	mg/L	250	0	100	0	2000	0
Sulfate	mg/L	250	3	200	4	3000	0
Metals							
Aluminum, dissolved	mg/L	---	0	5	0	5	0
Arsenic, dissolved	mg/L	0.05	0	0.1	0	0.2	0
Barium, dissolved	mg/L	2	0	---	0	---	0
Boron, dissolved	mg/L	0.75	0	0.75	0	5	0
Cadmium, dissolved	mg/L	0.005	0	0.01	0	0.05	0
Chromium, dissolved	mg/L	0.1	0	0.1	0	0.05	0
Copper, dissolved	mg/L	1	0	0.2	0	0.5	0
Iron, dissolved	mg/L	0.3	0	5	0	---	0
Iron, total	mg/L	---	0	---	0	---	0
Lead, dissolved	mg/L	---	0	5	0	0.1	0
Manganese, dissolved	mg/L	0.05	3	0.2	0	---	0
Manganese, total	mg/L	---	0	---	0	---	0
Mercury, dissolved	mg/L	0.002	0	---	0	0.00005	0
Molybdenum, dissolved	mg/L	---	0	---	0	---	0
Nickel, dissolved	mg/L	---	0	0.2	0	---	0
Selenium, dissolved	mg/L	0.05	0	0.02	0	0.05	0
Zinc, dissolved	mg/L	5	0	2	0	25	0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

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Table D6.2-15. Groundwater Quality Comparison of Masters/Carney Commingled Coal Seam Wells for EPA Standards

Parameter	Units	EPA Primary		EPA Secondary	
		Standard	578415-MST/CRN	Standard	578415-MST/CRN
General					
Alkalinity (as CaCO3)	mg/L	---	0	---	0
Ammonia	mg/L	---	0	---	0
Fluoride	mg/L	4	0	2	0
Hardness (as CaCO3)	mg/L	---	0	---	0
Hydroxide	mg/L	---	0	---	0
Laboratory conductivity	µmhos/cm	---	0	---	0
Laboratory pH	s.u.	---	0	8.5	0
Nitrate/Nitrite	mg/L	---	0	---	0
Total Dissolved Solids	mg/L	---	0	500	4
Sodium Adsorption Ratio (SAR)	unitless	---	0	---	0
Major Ions					
Calcium	mg/L	---	0	---	0
Magnesium	mg/L	---	0	---	0
Potassium	mg/L	---	0	---	0
Sodium	mg/L	---	0	---	0
Bicarbonate	mg/L	---	0	---	0
Carbonate	mg/L	---	0	---	0
Chloride	mg/L	---	0	250	0
Sulfate	mg/L	---	0	250	3
Metals					
Aluminum, dissolved	mg/L	---	0	---	0
Arsenic, dissolved	mg/L	0.01	0	---	0
Barium, dissolved	mg/L	2	0	---	0
Boron, dissolved	mg/L	---	0	---	0
Cadmium, dissolved	mg/L	0.005	0	---	0
Chromium, dissolved	mg/L	---	0	---	0
Copper, dissolved	mg/L	1.3	0	1	0
Iron, dissolved	mg/L	---	0	0.3	0
Iron, total	mg/L	---	0	---	0
Lead, dissolved	mg/L	0.015	0	---	0
Manganese, dissolved	mg/L	---	0	0.05	3
Manganese, total	mg/L	---	0	---	0
Mercury, dissolved	mg/L	0.002	0	---	0
Molybdenum, dissolved	mg/L	---	0	---	0
Nickel, dissolved	mg/L	---	0	---	0
Selenium, dissolved	mg/L	0.05	0	---	0
Zinc, dissolved	mg/L	---	0	5	0

Pink — Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

TFN 8 2/350
RECD 10-25-18

Scanned, 02/28/2020

Table D6.2-16. Groundwater Quality Comparison of Carney Coal Seam Wells for WDEQ Standards

Parameter	Units	WDEQ Class I						
		Standard	578408-CRN	578409-CRN	578409-CRN-OB	578417-CRN	578418-CRN	578510-CRN
General				**Not Sampled**			**DRY**	**DRY**
Alkalinity (as CaCO3)	mg/L	---	0		0	0		
Ammonia	mg/L	**0.5**	1		4	3		
Fluoride	mg/L	**4**	0		0	0		
Hardness (as CaCO3)	mg/L	---	0		0	0		
Hydroxide	mg/L	---	0		0	0		
Laboratory conductivity	µmhos/cm	---	0		0	0		
Laboratory pH	s.u.	**8.5**	0		0	0		
Nitrate/Nitrite	mg/L	---	0		0	0		
Total Dissolved Solids	mg/L	**500**	4		4	4		
Sodium Adsorption Ratio (SAR)	unitless	---	0		0	0		
Major Ions								
Calcium	mg/L	---	0		0	0		
Magnesium	mg/L	---	0		0	0		
Potassium	mg/L	---	0		0	0		
Sodium	mg/L	---	0		0	0		
Bicarbonate	mg/L	---	0		0	0		
Carbonate	mg/L	---	0		0	0		
Chloride	mg/L	**250**	0		0	0		
Sulfate	mg/L	**250**	4		4	2		
Metals								
Aluminum, dissolved	mg/L	---	0		0	0		
Arsenic, dissolved	mg/L	**0.05**	0		0	0		
Barium, dissolved	mg/L	**2**	0		0	0		
Boron, dissolved	mg/L	**0.75**	0		0	0		
Cadmium, dissolved	mg/L	**0.005**	0		0	0		
Chromium, dissolved	mg/L	**0.1**	0		0	0		
Copper, dissolved	mg/L	**1**	0		0	0		
Iron, dissolved	mg/L	**0.3**	0		0	0		
Iron, total	mg/L	---	0		0	0		
Lead, dissolved	mg/L	---	0		0	0		
Manganese, dissolved	mg/L	**0.05**	4		4	2		
Manganese, total	mg/L	---	0		0	0		
Mercury, dissolved	mg/L	**0.002**	0		0	0		
Molybdenum, dissolved	mg/L	---	0		0	0		
Nickel, dissolved	mg/L	---	0		0	0		
Selenium, dissolved	mg/L	**0.05**	0		0	0		
Zinc, dissolved	mg/L	**5**	0		0	0		

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

TFN 6 2/025
RECD 09-20-19

Scanned, 02/28/2020

Table D6.2-16. Groundwater Quality Comparison of Carney Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class I					
		Standard	578511-CRN	578512-CRN	578513-CRN	578420-CRN-PUMP-1	578524-CRN-PUMP-1
General				DRY	DRY		
Alkalinity (as CaCO3)	mg/L	---	0			0	0
Ammonia	mg/L	**0.5**	4			5	1
Fluoride	mg/L	**4**	0			0	0
Hardness (as CaCO3)	mg/L	---	0			0	0
Hydroxide	mg/L	---	0			0	0
Laboratory conductivity	µmhos/cm	---	0			0	0
Laboratory pH	s.u.	**8.5**	0			0	0
Nitrate/Nitrite	mg/L	---	0			0	0
Total Dissolved Solids	mg/L	**500**	4			5	1
Sodium Adsorption Ratio (SAR)	unitless	---	0			0	0
Major Ions							
Calcium	mg/L	---	0			0	0
Magnesium	mg/L	---	0			0	0
Potassium	mg/L	---	0			0	0
Sodium	mg/L	---	0			0	0
Bicarbonate	mg/L	---	0			0	0
Carbonate	mg/L	---	0			0	0
Chloride	mg/L	**250**	0			0	0
Sulfate	mg/L	**250**	4			0	0
Metals							
Aluminum, dissolved	mg/L	---	0			0	0
Arsenic, dissolved	mg/L	**0.05**	0			0	0
Barium, dissolved	mg/L	**2**	0			0	0
Boron, dissolved	mg/L	**0.75**	0			0	0
Cadmium, dissolved	mg/L	**0.005**	0			0	0
Chromium, dissolved	mg/L	**0.1**	0			0	0
Copper, dissolved	mg/L	**1**	0			0	0
Iron, dissolved	mg/L	**0.3**	0			0	0
Iron, total	mg/L	---	0			0	0
Lead, dissolved	mg/L	---	0			0	0
Manganese, dissolved	mg/L	**0.05**	4			5	0
Manganese, total	mg/L	---	0			0	0
Mercury, dissolved	mg/L	**0.002**	0			0	0
Molybdenum, dissolved	mg/L	---	0			0	0
Nickel, dissolved	mg/L	---	0			0	0
Selenium, dissolved	mg/L	**0.05**	0			0	0
Zinc, dissolved	mg/L	**5**	0			0	0

Pink	Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

TFN 6 2/025
RECD 09-20-19

DEQ Ex. 3-119

Scanned, 02/28/2020

Table D6.2-16. Groundwater Quality Comparison of Carney Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class II						
		Standard	578408-CRN	578409-CRN	578409-CRN-OB	578417-CRN	578418-CRN	578510-CRN
General				**Not Sampled**			**DRY**	**DRY**
Alkalinity (as CaCO3)	mg/L	---	0		0	0		
Ammonia	mg/L	---	0		0	0		
Fluoride	mg/L	---	0		0	0		
Hardness (as CaCO3)	mg/L	---	0		0	0		
Hydroxide	mg/L	---	0		0	0		
Laboratory conductivity	µmhos/cm	---	0		0	0		
Laboratory pH	s.u.	**9**	0		0	0		
Nitrate/Nitrite	mg/L	---	0		0	0		
Total Dissolved Solids	mg/L	**2000**	2		0	0		
Sodium Adsorption Ratio (SAR)	unitless	**8**	0		0	4		
Major Ions								
Calcium	mg/L	---	0		0	0		
Magnesium	mg/L	---	0		0	0		
Potassium	mg/L	---	0		0	0		
Sodium	mg/L	---	0		0	0		
Bicarbonate	mg/L	---	0		0	0		
Carbonate	mg/L	---	0		0	0		
Chloride	mg/L	**100**	0		0	0		
Sulfate	mg/L	**200**	4		4	4		
Metals								
Aluminum, dissolved	mg/L	**5**	0		0	0		
Arsenic, dissolved	mg/L	**0.1**	0		0	0		
Barium, dissolved	mg/L	---	0		0	0		
Boron, dissolved	mg/L	**0.75**	0		0	0		
Cadmium, dissolved	mg/L	**0.01**	0		0	0		
Chromium, dissolved	mg/L	**0.1**	0		0	0		
Copper, dissolved	mg/L	**0.2**	0		0	0		
Iron, dissolved	mg/L	**5**	0		0	0		
Iron, total	mg/L	---	0		0	0		
Lead, dissolved	mg/L	**5**	0		0	0		
Manganese, dissolved	mg/L	**0.2**	4		0	0		
Manganese, total	mg/L	---	0		0	0		
Mercury, dissolved	mg/L	---	0		0	0		
Molybdenum, dissolved	mg/L	---	0		0	0		
Nickel, dissolved	mg/L	**0.2**	0		0	0		
Selenium, dissolved	mg/L	**0.02**	0		0	0		
Zinc, dissolved	mg/L	**2**	0		0	0		

Pink	Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

TFN 6 2/025
RECD 09-20-19

Scanned, 02/28/2020

Table D6.2-16. Groundwater Quality Comparison of Carney Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class II					
		Standard	578511-CRN	578512-CRN	578513-CRN	578420-CRN-PUMP-1	578524-CRN-PUMP-1
General				DRY	DRY		
Alkalinity (as CaCO3)	mg/L	---	0			0	0
Ammonia	mg/L	---	0			0	0
Fluoride	mg/L	---	0			0	0
Hardness (as CaCO3)	mg/L	---	0			0	0
Hydroxide	mg/L	---	0			0	0
Laboratory conductivity	µmhos/cm	---	0			0	0
Laboratory pH	s.u.	**9**	0			0	0
Nitrate/Nitrite	mg/L	---	0			0	0
Total Dissolved Solids	mg/L	**2000**	4			0	0
Sodium Adsorption Ratio (SAR)	unitless	**8**	4			0	1
Major Ions							
Calcium	mg/L	---	0			0	0
Magnesium	mg/L	---	0			0	0
Potassium	mg/L	---	0			0	0
Sodium	mg/L	---	0			0	0
Bicarbonate	mg/L	---	0			0	0
Carbonate	mg/L	---	0			0	0
Chloride	mg/L	**100**	0			0	0
Sulfate	mg/L	**200**	4			0	0
Metals							
Aluminum, dissolved	mg/L	**5**	0			0	0
Arsenic, dissolved	mg/L	**0.1**	0			0	0
Barium, dissolved	mg/L	---	0			0	0
Boron, dissolved	mg/L	**0.75**	0			0	0
Cadmium, dissolved	mg/L	**0.01**	0			0	0
Chromium, dissolved	mg/L	**0.1**	0			0	0
Copper, dissolved	mg/L	**0.2**	0			0	0
Iron, dissolved	mg/L	**5**	0			0	0
Iron, total	mg/L	---	0			0	0
Lead, dissolved	mg/L	**5**	0			0	0
Manganese, dissolved	mg/L	**0.2**	3			5	0
Manganese, total	mg/L	---	0			0	0
Mercury, dissolved	mg/L	---	0			0	0
Molybdenum, dissolved	mg/L	---	0			0	0
Nickel, dissolved	mg/L	**0.2**	0			0	0
Selenium, dissolved	mg/L	**0.02**	0			0	1
Zinc, dissolved	mg/L	**2**	0			0	0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

TFN 6 2/025
RECD 09-20-19

DEQ Ex. 3-121

Scanned, 02/28/2020

Table D6.2-16. Groundwater Quality Comparison of Carney Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class III						
		Standard	578408-CRN	578409-CRN	578409-CRN-OB	578417-CRN	578418-CRN	578510-CRN
General				**Not Sampled**			**DRY**	**DRY**
Alkalinity (as CaCO3)	mg/L	---	0		0	0		
Ammonia	mg/L	---	0		0	0		
Fluoride	mg/L	---	0		0	0		
Hardness (as CaCO3)	mg/L	---	0		0	0		
Hydroxide	mg/L	---	0		0	0		
Laboratory conductivity	µmhos/cm	---	0		0	0		
Laboratory pH	s.u.	**8.5**	0		0	0		
Nitrate/Nitrite	mg/L	---	0		0	0		
Total Dissolved Solids	mg/L	**5000**	0		0	0		
Sodium Adsorption Ratio (SAR)	unitless	---	0		0	0		
Major Ions								
Calcium	mg/L	---	0		0	0		
Magnesium	mg/L	---	0		0	0		
Potassium	mg/L	---	0		0	0		
Sodium	mg/L	---	0		0	0		
Bicarbonate	mg/L	---	0		0	0		
Carbonate	mg/L	---	0		0	0		
Chloride	mg/L	**2000**	0		0	0		
Sulfate	mg/L	**3000**	0		0	0		
Metals								
Aluminum, dissolved	mg/L	**5**	0		0	0		
Arsenic, dissolved	mg/L	**0.2**	0		0	0		
Barium, dissolved	mg/L	---	0		0	0		
Boron, dissolved	mg/L	**5**	0		0	0		
Cadmium, dissolved	mg/L	**0.05**	0		0	0		
Chromium, dissolved	mg/L	**0.05**	0		0	0		
Copper, dissolved	mg/L	**0.5**	0		0	0		
Iron, dissolved	mg/L	---	0		0	0		
Iron, total	mg/L	---	0		0	0		
Lead, dissolved	mg/L	**0.1**	0		0	0		
Manganese, dissolved	mg/L	---	0		0	0		
Manganese, total	mg/L	---	0		0	0		
Mercury, dissolved	mg/L	**0.00005**	0		0	0		
Molybdenum, dissolved	mg/L	---	0		0	0		
Nickel, dissolved	mg/L	---	0		0	0		
Selenium, dissolved	mg/L	**0.05**	0		0	0		
Zinc, dissolved	mg/L	**25**	0		0	0		

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

TFN 6 2/025
RECD 09-20-19

DEQ Ex. 3-122

Scanned, 02/28/2020

Table D6.2-16. Groundwater Quality Comparison of Carney Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	WDEQ Class III					
		Standard	578511-CRN	578512-CRN	578513-CRN	578420-CRN-PUMP-1	578524-CRN-PUMP-1
General				DRY	DRY		
Alkalinity (as CaCO3)	mg/L	---	0			0	0
Ammonia	mg/L	---	0			0	0
Fluoride	mg/L	---	0			0	0
Hardness (as CaCO3)	mg/L	---	0			0	0
Hydroxide	mg/L	---	0			0	0
Laboratory conductivity	µmhos/cm	---	0			0	0
Laboratory pH	s.u.	**8.5**	0			0	0
Nitrate/Nitrite	mg/L	---	0			0	0
Total Dissolved Solids	mg/L	**5000**	0			0	0
Sodium Adsorption Ratio (SAR)	unitless	---	0			0	0
Major Ions							
Calcium	mg/L	---	0			0	0
Magnesium	mg/L	---	0			0	0
Potassium	mg/L	---	0			0	0
Sodium	mg/L	---	0			0	0
Bicarbonate	mg/L	---	0			0	0
Carbonate	mg/L	---	0			0	0
Chloride	mg/L	**2000**	0			0	0
Sulfate	mg/L	**3000**	0			0	0
Metals							
Aluminum, dissolved	mg/L	**5**	0			0	0
Arsenic, dissolved	mg/L	**0.2**	0			0	0
Barium, dissolved	mg/L	---	0			0	0
Boron, dissolved	mg/L	**5**	0			0	0
Cadmium, dissolved	mg/L	**0.05**	0			0	0
Chromium, dissolved	mg/L	**0.05**	0			0	0
Copper, dissolved	mg/L	**0.5**	0			0	0
Iron, dissolved	mg/L	---	0			0	0
Iron, total	mg/L	---	0			0	0
Lead, dissolved	mg/L	**0.1**	0			0	0
Manganese, dissolved	mg/L	---	0			0	0
Manganese, total	mg/L	---	0			0	0
Mercury, dissolved	mg/L	**0.00005**	0			0	0
Molybdenum, dissolved	mg/L	---	0			0	0
Nickel, dissolved	mg/L	---	0			0	0
Selenium, dissolved	mg/L	**0.05**	0			0	0
Zinc, dissolved	mg/L	**25**	0			0	0

Pink — Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

TFN 6 2/025
RECD 09-20-19

DEQ Ex. 3-123

Scanned, 02/28/2020

Table D6.2-17. Groundwater Quality Comparison of Carney Coal Seam Wells for EPA Standards

Parameter	Units	EPA Primary							
		Standard	578408-CRN	578409-CRN	578409-CRN-OB	578417-CRN	578418-CRN	578510-CRN	578511-CRN
General				**Not Sampled**			**DRY**	**DRY**	
Alkalinity (as CaCO3)	mg/L	---	0		0	0			0
Ammonia	mg/L	---	0		0	0			0
Fluoride	mg/L	**4**	0		0	0			0
Hardness (as CaCO3)	mg/L	---	0		0	0			0
Hydroxide	mg/L	---	0		0	0			0
Laboratory conductivity	µmhos/cm	---	0		0	0			0
Laboratory pH	s.u.	---	0		0	0			0
Nitrate/Nitrite	mg/L	---	0		0	0			0
Total Dissolved Solids	mg/L	---	0		0	0			0
Sodium Adsorption Ratio (SAR)	unitless	---	0		0	0			0
Major Ions									
Calcium	mg/L	---	0		0	0			0
Magnesium	mg/L	---	0		0	0			0
Potassium	mg/L	---	0		0	0			0
Sodium	mg/L	---	0		0	0			0
Bicarbonate	mg/L	---	0		0	0			0
Carbonate	mg/L	---	0		0	0			0
Chloride	mg/L	---	0		0	0			0
Sulfate	mg/L	---	0		0	0			0
Metals									
Aluminum, dissolved	mg/L	---	0		0	0			0
Arsenic, dissolved	mg/L	**0.01**	0		0	0			0
Barium, dissolved	mg/L	**2**	0		0	0			0
Boron, dissolved	mg/L	---	0		0	0			0
Cadmium, dissolved	mg/L	**0.005**	0		0	0			0
Chromium, dissolved	mg/L	---	0		0	0			0
Copper, dissolved	mg/L	**1.3**	0		0	0			0
Iron, dissolved	mg/L	---	0		0	0			0
Iron, total	mg/L	---	0		0	0			0
Lead, dissolved	mg/L	**0.015**	0		0	0			0
Manganese, dissolved	mg/L	---	0		0	0			0
Manganese, total	mg/L	---	0		0	0			0
Mercury, dissolved	mg/L	**0.002**	0		0	0			0
Molybdenum, dissolved	mg/L	---	0		0	0			0
Nickel, dissolved	mg/L	---	0		0	0			0
Selenium, dissolved	mg/L	**0.05**	0		0	0			0
Zinc, dissolved	mg/L	---	0		0	0			0

Pink Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

TFN 6 2/025
REC'D 09-20-19

DEQ Ex. 3-124

Scanned, 02/28/2020

Table D6.2-17. Groundwater Quality Comparison of Carney Coal Seam Wells for EPA Standards (Continued)

Parameter	Units	EPA Primary				
		Standard	578512-CRN	578513-CRN	578420-CRN-PUMP-1	578524-CRN-PUMP-1
General			**DRY**	**DRY**		
Alkalinity (as CaCO3)	mg/L	---			0	0
Ammonia	mg/L	---			0	0
Fluoride	mg/L	**4**			0	0
Hardness (as CaCO3)	mg/L	---			0	0
Hydroxide	mg/L	---			0	0
Laboratory conductivity	µmhos/cm	---			0	0
Laboratory pH	s.u.	---			0	0
Nitrate/Nitrite	mg/L	---			0	0
Total Dissolved Solids	mg/L	---			0	0
Sodium Adsorption Ratio (SAR)	unitless	---			0	0
Major Ions						
Calcium	mg/L	---			0	0
Magnesium	mg/L	---			0	0
Potassium	mg/L	---			0	0
Sodium	mg/L	---			0	0
Bicarbonate	mg/L	---			0	0
Carbonate	mg/L	---			0	0
Chloride	mg/L	---			0	0
Sulfate	mg/L	---			0	0
Metals						
Aluminum, dissolved	mg/L	---			0	0
Arsenic, dissolved	mg/L	**0.01**			0	0
Barium, dissolved	mg/L	**2**			0	0
Boron, dissolved	mg/L	---			0	0
Cadmium, dissolved	mg/L	**0.005**			0	0
Chromium, dissolved	mg/L	---			0	0
Copper, dissolved	mg/L	**1.3**			0	0
Iron, dissolved	mg/L	---			0	0
Iron, total	mg/L	---			0	0
Lead, dissolved	mg/L	**0.015**			0	0
Manganese, dissolved	mg/L	---			0	0
Manganese, total	mg/L	---			0	0
Mercury, dissolved	mg/L	**0.002**			0	0
Molybdenum, dissolved	mg/L	---			0	0
Nickel, dissolved	mg/L	---			0	0
Selenium, dissolved	mg/L	**0.05**			0	0
Zinc, dissolved	mg/L	---			0	0

Pink Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

TFN 6 2/025
RECD 09-20-19

Scanned, 02/28/2020

Table D6.2-17. Groundwater Quality Comparison of Carney Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	EPA Secondary Standard	578408-CRN	578409-CRN	578409-CRN-OB	578417-CRN	578418-CRN	578510-CRN	578511-CRN
General				**Not Sampled**			**DRY**	**DRY**	
Alkalinity (as CaCO3)	mg/L	---	0		0	0			0
Ammonia	mg/L	---	0		0	0			0
Fluoride	mg/L	**2**	0		0	0			0
Hardness (as CaCO3)	mg/L	---	0		0	0			0
Hydroxide	mg/L	---	0		0	0			0
Laboratory conductivity	µmhos/cm	---	0		0	0			0
Laboratory pH	s.u.	**8.5**	0		0	0			0
Nitrate/Nitrite	mg/L	---	0		0	0			0
Total Dissolved Solids	mg/L	**500**	4		4	4			4
Sodium Adsorption Ratio (SAR)	unitless	---	0		0	0			0
Major Ions									
Calcium	mg/L	---	0		0	0			0
Magnesium	mg/L	---	0		0	0			0
Potassium	mg/L	---	0		0	0			0
Sodium	mg/L	---	0		0	0			0
Bicarbonate	mg/L	---	0		0	0			0
Carbonate	mg/L	---	0		0	0			0
Chloride	mg/L	**250**	0		0	0			0
Sulfate	mg/L	**250**	4		4	2			4
Metals									
Aluminum, dissolved	mg/L	---	0		0	0			0
Arsenic, dissolved	mg/L	---	0		0	0			0
Barium, dissolved	mg/L	---	0		0	0			0
Boron, dissolved	mg/L	---	0		0	0			0
Cadmium, dissolved	mg/L	---	0		0	0			0
Chromium, dissolved	mg/L	---	0		0	0			0
Copper, dissolved	mg/L	**1**	0		0	0			0
Iron, dissolved	mg/L	**0.3**	0		0	0			0
Iron, total	mg/L	---	0		0	0			0
Lead, dissolved	mg/L	---	0		0	0			0
Manganese, dissolved	mg/L	**0.05**	4		4	2			4
Manganese, total	mg/L	---	0		0	0			0
Mercury, dissolved	mg/L	---	0		0	0			0
Molybdenum, dissolved	mg/L	---	0		0	0			0
Nickel, dissolved	mg/L	---	0		0	0			0
Selenium, dissolved	mg/L	---	0		0	0			0
Zinc, dissolved	mg/L	**5**	0		0	0			0

Pink — Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

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Table D6.2-17. Groundwater Quality Comparison of Carney Coal Seam Wells for WDEQ Standards (Continued)

Parameter	Units	EPA Secondary				
		Standard	578512-CRN	578513-CRN	578420-CRN-PUMP-1	578524-CRN-PUMP-1
General			**DRY**	**DRY**		
Alkalinity (as CaCO3)	mg/L	---			0	0
Ammonia	mg/L	---			0	0
Fluoride	mg/L	**2**			0	0
Hardness (as CaCO3)	mg/L	---			0	0
Hydroxide	mg/L	---			0	0
Laboratory conductivity	µmhos/cm	---			0	0
Laboratory pH	s.u.	**8.5**			0	0
Nitrate/Nitrite	mg/L	---			0	0
Total Dissolved Solids	mg/L	**500**			5	1
Sodium Adsorption Ratio (SAR)	unitless	---			0	0
Major Ions						
Calcium	mg/L	---			0	0
Magnesium	mg/L	---			0	0
Potassium	mg/L	---			0	0
Sodium	mg/L	---			0	0
Bicarbonate	mg/L	---			0	0
Carbonate	mg/L	---			0	0
Chloride	mg/L	**250**			0	0
Sulfate	mg/L	**250**			0	0
Metals						
Aluminum, dissolved	mg/L	---			0	0
Arsenic, dissolved	mg/L	---			0	0
Barium, dissolved	mg/L	---			0	0
Boron, dissolved	mg/L	---			0	0
Cadmium, dissolved	mg/L	---			0	0
Chromium, dissolved	mg/L	---			0	0
Copper, dissolved	mg/L	**1**			0	0
Iron, dissolved	mg/L	**0.3**			0	0
Iron, total	mg/L	---			0	0
Lead, dissolved	mg/L	---			0	0
Manganese, dissolved	mg/L	**0.05**			5	0
Manganese, total	mg/L	---			0	0
Mercury, dissolved	mg/L	---			0	0
Molybdenum, dissolved	mg/L	---			0	0
Nickel, dissolved	mg/L	---			0	0
Selenium, dissolved	mg/L	---			0	0
Zinc, dissolved	mg/L	**5**			0	0

Pink Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

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Table D6.2-18. Summary of Groundwater Rights Within the Permit Area and the Adjacent 3 Miles[1,2]

Permitted Water Use[3]	Number of Wells	Percent of Total (%)
Coal Bed Methane	86	17.92
Coal Bed Methane and Irrigation	8	1.67
Coal Bed Methane and Miscellaneous	2	0.42
Coal Bed Methane and Stock Watering	101	21.04
Domestic	116	24.17
Domestic and Irrigation	2	0.42
Domestic, Irrigation, and Stock Watering	1	0.21
Domestic and Stock Watering	52	10.83
Industrial and Miscellaneous	1	0.21
Irrigation	1	0.21
Irrigation, Miscellaneous, and Stock Watering	1	0.21
Irrigation and Stock Watering	2	0.42
Miscellaneous	20	4.17
Stock Watering	85	17.71
Other	2	0.42
Total	**480**	**100.00**

Notes: [1]Summary does not include cancelled, expired, abandoned, or suspended water rights. Refer to Adjudication Appendix B for a full summary of groundwater rights.

[2]Wells may not be currently active.

[3]Summary excludes monitoring wells.

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Table D6.2-19. Groundwater Quality Monitoring Results For Spoil

Parameter	Units	578415-SPL-1				578415-SPL-2			
		6/4/2018	7/11/2018	11/13/2018	1/10/2019	6/4/2018	7/11/2018	11/13/2018	1/10/2019
Field									
Field Conductivity	µmhos/cm	3970	4180	5360	5060	1782	1786	1884	1848
Field pH	s.u.	6.88	6.85	6.73	6.71	7.93	7.81	7.74	7.68
Field turbidity	NTUs	34.6	45	3.55	37.5		31.3	193	31.5
Depth to Water	ft	15.88	16.09	18.1	18.23	64.3	70.8	70.95	70.65
Water Elevation	ft AMSL	3587.78	3587.57	3585.56	3585.43	3547.23	3540.73	3540.58	3540.88
Temperature	Deg C	16.2	21.3	12.7	9.6	15.1	24.6	13.3	9.9
General									
Alkalinity (as CaCO3)	mg/L	941	964	962	1000	1080	1100	1170	1120
Ammonia	mg/L	5.4	4.2	8.5	7.6	5.7	5.6	4.8	5.6
Fluoride	mg/L	0.5	0.5	0.5	0.4	1.4	1.4	1.4	1.5
Hardness (as CaCO3)	mg/L	2210	2270	2510	2480	88	84	82	80
Hydroxide	mg/L	<5	<5	<5	<5	<5	<5	<5	<5
Laboratory conductivity	µmhos/cm	4640	4760	4540	4140	1970	1950	1800	1750
Laboratory pH	s.u.	7.7	7.7	7.9	7.9	8.4	8.5	8.5	8.5
Nitrate/Nitrite	mg/L	0.3	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Total Dissolved Solids	mg/L	3960	4570	4710	4800	1240	1210	1160	1190
Sodium Adsorption Ratio (SAR)	unitless	3.23	2.8	3.33	3.17	22.9	22.2	23	22.2
Major Ions									
Calcium	mg/L	375	395	430	422	18	17	16	16
Magnesium	mg/L	310	313	349	347	11	10	10	10
Potassium	mg/L	52	46	58	52	15	14	16	16
Sodium	mg/L	350	307	384	364	494	467	477	456
Bicarbonate	mg/L	1150	1180	1170	1220	1270	1280	1350	1260
Carbonate	mg/L	<5	<5	<5	<5	25	33	37	49
Chloride	mg/L	15	15	26	24	16	17	18	16
Sulfate	mg/L	2200	2200	2480	2510	26	7	2	2
Metals									
Aluminum, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	0.3	<0.1	<0.1	<0.1
Arsenic, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Barium, dissolved	mg/L	<0.1	<0.1	<0.1	<0.1	0.3	0.3	0.2	0.3
Boron, dissolved	mg/L	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1
Cadmium, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, dissolved	mg/L	0.13	0.06	2.09	2.43	0.1	<0.05	<0.05	0.07
Iron, total	mg/L	0.54	0.5	2.44	3.09	37.7	0.72	2.27	0.67
Lead, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese, dissolved	mg/L	1	1.06	1.09	1.12	0.16	<0.02	0.04	<0.02
Manganese, total	mg/L	1.16	1.04	1.2	1.18	1.19	0.03	0.08	0.03
Mercury, dissolved	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Molybdenum, dissolved	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nickel, dissolved	mg/L	0.02	0.02	0.05	0.04	<0.01	<0.01	<0.01	<0.01
Selenium, dissolved	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc, dissolved	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
QA/QC									
Anion Sum	meq/L	65.17	65.61	71.65	72.93	22.76	22.71	23.91	22.91
Cation Sum	meq/L	61.1	60.34	68.99	67.31	24.04	22.76	23.14	22.22
Total Anion/Cation Balance	%	3.22	4.17	1.89	4.01	2.74	0.1	1.62	1.51
Total Dissolved Solids (calc)	mg/L	3870	3860	4310	4320	1230	1190	1240	1190

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Table D6.2-20. Groundwater Quality Comparison of Spoil Wells for WDEQ Standards

Parameter	Units	WDEQ Class I			WDEQ Class II			WDEQ Class III		
		Standard	578415-SPL-1	578415-SPL-2	Standard	578415-SPL-1	578415-SPL-2	Standard	578415-SPL-1	578415-SPL-2
General										
Alkalinity (as CaCO3)	mg/L	---	0	0	---	0	0	---	0	0
Ammonia	mg/L	**0.5**	2	2	---	0	0	---	0	0
Fluoride	mg/L	**4**	0	0	---	0	0	---	0	0
Hardness (as CaCO3)	mg/L	---	0	0	---	0	0	---	0	0
Hydroxide	mg/L	---	0	0	---	0	0	---	0	0
Laboratory conductivity	µmhos/cm	---	0	0	---	0	0	---	0	0
Laboratory pH	s.u.	**8.5**	0	0	**9**	0	0	**8.5**	0	0
Nitrate/Nitrite	mg/L	---	0	0	---	0	0	---	0	0
Total Dissolved Solids	mg/L	**500**	2	2	**2000**	2	0	**5000**	0	0
Sodium Adsorption Ration (SA	unitless	---	0	0	**8**	0	2	---	0	0
Major Ions										
Calcium	mg/L	---	0	0	---	0	0	---	0	0
Magnesium	mg/L	---	0	0	---	0	0	---	0	0
Potassium	mg/L	---	0	0	---	0	0	---	0	0
Sodium	mg/L	---	0	0	---	0	0	---	0	0
Bicarbonate	mg/L	---	0	0	---	0	0	---	0	0
Carbonate	mg/L	---	0	0	---	0	0	---	0	0
Chloride	mg/L	**250**	0	0	**100**	0	0	**2000**	0	0
Sulfate	mg/L	**250**	2	0	**200**	2	0	**3000**	0	0
Metals										
Aluminum, dissolved	mg/L	---	0	0	**5**	0	0	**5**	0	0
Arsenic, dissolved	mg/L	**0.05**	0	0	**0.1**	0	0	**0.2**	0	0
Barium, dissolved	mg/L	**2**	0	0	---	0	0	---	0	0
Boron, dissolved	mg/L	**0.75**	0	0	**0.75**	0	0	**5**	0	0
Cadmium, dissolved	mg/L	**0.005**	0	0	**0.01**	0	0	**0.05**	0	0
Chromium, dissolved	mg/L	**0.1**	0	0	**0.1**	0	0	**0.05**	0	0
Copper, dissolved	mg/L	**1**	0	0	**0.2**	0	0	**0.5**	0	0
Iron, dissolved	mg/L	**0.3**	0	0	**5**	0	0	---	0	0
Iron, total	mg/L	---	0	0	---	0	0	---	0	0
Lead, dissolved	mg/L	---	0	0	**5**	0	0	**0.1**	0	0
Manganese, dissolved	mg/L	**0.05**	2	1	**0.2**	2	0	---	0	0
Manganese, total	mg/L	---	0	0	---	0	0	---	0	0
Mercury, dissolved	mg/L	**0.002**	0	0	---	0	0	**0.00005**	0	0
Molybdenum, dissolved	mg/L	---	0	0	---	0	0	---	0	0
Nickel, dissolved	mg/L	---	0	0	**0.2**	0	0	---	0	0
Selenium, dissolved	mg/L	**0.05**	0	0	**0.02**	0	0	**0.05**	0	0
Zinc, dissolved	mg/L	**5**	0	0	**2**	0	0	**25**	0	0

Pink Indicates the number of baseline samples whose results exceed the underground water class use suitability as defined by WQD, Chapter 8, Table 1

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Table D6.2-21. Groundwater Quality Comparison of Spoil Wells for EPA Standards

Parameter	Units	EPA Primary			EPA Secondary		
		Standard	578415-SPL-1	578415-SPL-2	Standard	578415-SPL-1	578415-SPL-2
General							
Alkalinity (as CaCO3)	mg/L	---	0	0	---	0	0
Ammonia	mg/L	---	0	0	---	0	0
Fluoride	mg/L	**4**	0	0	**2**	0	0
Hardness (as CaCO3)	mg/L	---	0	0	---	0	0
Hydroxide	mg/L	---	0	0	---	0	0
Laboratory conductivity	µmhos/cm	---	0	0	---	0	0
Laboratory pH	s.u.	---	0	0	**8.5**	0	0
Nitrate/Nitrite	mg/L	---	0	0	---	0	0
Total Dissolved Solids	mg/L	---	0	0	**500**	2	2
Sodium Adsorption Ration (SA	unitless	---	0	0	---	0	0
Major Ions							
Calcium	mg/L	---	0	0	---	0	0
Magnesium	mg/L	---	0	0	---	0	0
Potassium	mg/L	---	0	0	---	0	0
Sodium	mg/L	---	0	0	---	0	0
Bicarbonate	mg/L	---	0	0	---	0	0
Carbonate	mg/L	---	0	0	---	0	0
Chloride	mg/L	---	0	0	**250**	0	0
Sulfate	mg/L	---	0	0	**250**	2	0
Metals							
Aluminum, dissolved	mg/L	---	0	0	---	0	0
Arsenic, dissolved	mg/L	**0.01**	0	0	---	0	0
Barium, dissolved	mg/L	**2**	0	0	---	0	0
Boron, dissolved	mg/L	---	0	0	---	0	0
Cadmium, dissolved	mg/L	**0.005**	0	0	---	0	0
Chromium, dissolved	mg/L	---	0	0	---	0	0
Copper, dissolved	mg/L	**1.3**	0	0	**1**	0	0
Iron, dissolved	mg/L	---	0	0	**0.3**	0	0
Iron, total	mg/L	---	0	0	---	0	0
Lead, dissolved	mg/L	**0.015**	0	0	---	0	0
Manganese, dissolved	mg/L	---	0	0	**0.05**	2	1
Manganese, total	mg/L	---	0	0	---	0	0
Mercury, dissolved	mg/L	**0.002**	0	0	---	0	0
Molybdenum, dissolved	mg/L	---	0	0	---	0	0
Nickel, dissolved	mg/L	---	0	0	---	0	0
Selenium, dissolved	mg/L	**0.05**	0	0	---	0	0
Zinc, dissolved	mg/L	---	0	0	**5**	0	0

Pink — Indicates the number of baseline samples whose results exceed the EPA Primary or Secondary MCLs

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Table D6.2-22. Ground Water Comparison of Brook, Big Horn, and Wyoming Coal Mines Aquifer Tests.

	Hydraulic Conductivities (ft/day)														
	Alluvium			*Coal*			*Spoils/Backfill*			*Overburden*			*Underburden*		
Statistics	Brook Mine	Big Horn Mine	Wyoming Coal Mines	Brook Mine	Big Horn Mine	Wyoming Coal Mines*	Brook Mine	Big Horn Mine	Wyoming Coal Mines	Brook Mine	Big Horn Mine	Wyoming Coal Mines	Brook Mine	Big Horn Mine	Wyoming Coal Mines
Mean	21.27	235.85	6.79	4.81	2.23	1.23	NA	46.56	99.38	NA	98.89	85.48	NA	NA	12.98
Median	18.98	225.71	2.02	0.38	0.33	0.35	NA	36.39	1.47	NA	3.25	0.80	NA	NA	1.67
Minimum	6.72	103.15	0.01	0.01	0.01	0.01	NA	0.09	0.01	NA	0.00	0.01	NA	NA	0.01
Maximum	39.34	414.71	166.50	55.68	17.70	9.76	NA	113.38	6416.67	NA	368.65	7085.07	NA	NA	242.00
Standard Deviation	11.79	89.33	17.14	15.29	4.12	2.06	NA	56.12	715.21	NA	159.71	626.61	NA	NA	40.44
Number of Observations	5	16	112	13	20	408	0	4	81	0	5	329	0	0	104
Lower end of 95% Confidence Interval	10.93	192.08	3.61	0.00	0.42	1.03	NA	0.00	0.00	NA	0.00	17.77	NA	NA	5.20
Upper end of 95% Confidence Interval	31.60	279.62	9.96	13.12	4.04	1.43	NA	101.56	255.13	NA	238.89	153.19	NA	NA	20.75

*The full Wyoming Coal Mines dataset included 471 obervations. However, the majority of the observations (408) had hydraulic conductivities less than 10 ft/day. 14 of the observations were greater than 1000 ft/day, up to 55,000 ft/day. The high value observations were 4 to 5 orders of magnitude greater than the majority of observations and significantly biased the statistics. The high value observations are thought to be from tests conducted in highly fractured coal which is not typical of the coals tested in Brooke Mine. As such, the statistics presented here are based on the 408 observations less than 10 ft/day (87% of the dataset).

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Table D6.2-23 Overburden Drill Hole and Well Saturation Zone Analysis

Core/Drill Hole/Well	Well Depth (ft)	Saturation	Saturation Determination
R-12001	121	Dry	Dry
R-12002	162	Dry	Dry
R-12003	142	Dry	Dry
R-12004	240	Dry	Dry
R13-024	983	Dry	Dry
R-12005	240	Dry	Dry
R-12007	39	Partially Saturated	Partially Saturated
R-12018D	142	Dry	Dry
R-12008	201	Dry	Dry
R-12020	494	Dry	Dry
578511-CRN	128	Dry	Dry
R-12012	136	Dry	Dry
R-12010	120	Dry	No Carney indicated in drill hole or cross section
R-12014	220	Dry	No Carney coal indicated in drill hole or cross section. Possible Carney Burn.
R-12013	300	Dry	Dry, Carney burn at 120-135
R-12011	92	Dry	Dry
R-12009-A	65	Dry	No Carney indicated in drill hole or cross section. Carney suspected below drilling completion at 65'.
R-12019D	140	Partially Saturated	Partially Saturated
R-12015	221	Dry	Dry
R-12006	300	Dry	Dry
R-13-020	302	Partially Saturated	Partially Saturated
R13-023	202	Dry	Dry
R13-016	904	Dry	Dry
R13-012	202	Partially Saturated	Partially Saturated, right above coal.
R13-011	222	Dry	Dry
R13-018	141	Dry	Dry
R13-019	210	Dry	Dry
Ambre-02	120	Partially Saturated	Partially saturated at bottom of silty clay
Ambre-03	96	Partially Saturated	Partially saturated
Ambre-04	120	Dry	Dry
578409-CRN-OB (observation)	110	Fully Saturated	Well is for observation and drilling log completion

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Table D6.2-24 Carney Drill Hole and Well Saturation Zone Analysis

Core/Drill Hole/Well	Well Depth (ft)	Saturation	Saturation Determination
R-12001	121	Dry	Dry, no indication of water in log and outside area of saturation.
578510-CRN	91	Dry	Partially saturated based off water levels.
R-12003	142	Dry	Dry no indication of water in the core log and outside area of saturation.
R-12002	162	Dry	Dry, potentiometry map will be revised to reflect this edit.
R-12004	240	Dry	Dry, potentiometry map will be revised to reflect this edit.
R13-024	983	Fully Saturated	Fully saturated based off drill log and revised potentiometry map.
R-12018D	142	Fully Saturated	Fully saturated based on potentiometry map
R-12008	201	Partially Saturated	Partially saturated based on potentiometry map.
578511-CRN	128	Fully Saturated	Fully saturated based on water levels.
R-12007	39	Partially Saturated	Dry, potentiometry map will be revised to reflect this edit.
R-12013	300	Dry	Dry based off log, potentiometry map and cross sections.
R-12014	220	Dry	Dry based off log, potentiometry map and cross sections.
R-12010	120	Dry	Dry based on the absence of Carney coal.
578512-CRN / R-12012	136	Dry	Dry based off log, potentiometry map and cross sections.
R-12020	494	Fully Saturated	Fully Saturated based off potentiometry map and cross sections.
R-12005	240	Dry	Dry no indication of water in the core log, potentiometry map or cross section.
R-12011	92	Dry	Dry log did not indicate water and the potentiometric surface is estimated below carney coal level.
578513-CRN	116	Partially Saturated	Partially saturated based off water levels.
R-12009-A	65	Dry	Dry, drill hole ended above carney coal seam.
R-12019D	140	Fully Saturated	Cross section C-C' shows that both upper and lower carney are approximately the same level as R-12015 so inferred saturation level would be the same.
R-12015	221	Fully Saturated	Fully saturated based off the drill log indicating water in it and potentiometry surface at/above upper carney coal surface.
R13-020	302	Dry	Dry
578418-CRN	153	Partially Saturated	Partially saturated based off water levels.
R-12006	300	Dry	Dry
R13-023	202	Dry	Dry based off log, potentiometry map and cross section.
R13-011	222	Fully Saturated	Fully saturated based on logs, potentiometry maps and cross sections.
578417-CRN	142	Partially Saturated	Partially saturated based on water levels and cross sections.
R13-019	210	Fully Saturated	Fully saturated based on potentiometry maps and cross sections.
R13-012	202	Partially Saturated	Partially saturated based on potentiometry map and cross sections.
R13-016	904	Dry	Dry based off log, potentiometry map and cross section.
578408-CRN/R13-018	141	Partially Saturated	Partially Saturated based on water levels.
Ambre-02	120	Fully Saturated	Fully saturated based on cross section and potentionmetry maps.
Ambre-03	96	Fully Saturated	Fully saturated based on cross section and potentionmetry maps.
Ambre-04	120	Partially Saturated	Partially saturated based off a combination of potentiometry map, cross sections and drill log.
578409-CRN	109	Fully Saturated	Fully saturated based off water levels and well development.
BE284-78		Fully Saturated	Fully saturated based off cross sections and potentionmetry maps.
578415-CRN	182	Fully Saturated	Fully saturated based off a combination of the potentiometry map and water levels

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Table D6.2-25 Underburden Drill Hole and Well Saturation Zone Analysis

Core/Drill Hole/Well	Well Depth (ft)	Saturation	Saturation Determination
R-12001	121	Dry	Dry because this is outside area of saturation, Log cuts off before underburden.
578510-MST	146	Fully Saturated	Fully to partially saturated based off water levels.
R-12003	142	Dry	Dry no indication of water in the core log.
R-12002	162	Fully Saturated	Fully saturated based off cross sections.
R-12004	240	Fully Saturated	Fully Saturated based off cross section and potentiometry map.
R13-024	983	Fully Saturated	Fully Saturated based off cross section and potentiometry map.
R-12018D	142	Fully Saturated	Partially to Fully Saturated based off cross section and potentiometry map.
R-12008	201	Fully Saturated	Fully saturated based off cross section and potentiometry map.
578511-MST	157	Fully Saturated	Fully saturated based off water levels
R-12007	39	Fully Saturated	Fully Saturated based off cross section and potentiometry map
R-12013	300	Fully Saturated	Masters not indicated in log/cross section
R-12014	220	Fully Saturated	Masters not indicated in log/cross section
R-12010	120	Fully Saturated	Fully saturated based off potentiometry map.
578512-MST / R-12012	136	Partially Saturated	Partially saturated based on water levels.
R-12020	494	Fully Saturated	Fully Saturated based off cross section and potentiometry map
R-12005	240	Fully Saturated	Fully Saturated based off cross section and potentiometry map
R-12011	92	Fully Saturated	Fully saturated based off log, cross section and potentiometry map
578513-MST	142	Fully Saturated	Fully Saturated based off cross section and potentiometry map
R-12009-A	65	Fully Saturated	Fully saturated based off potentiometry map.
R-12019D	140	Fully Saturated	Fully saturated based off potentiometry map.
R-12015	221	Fully Saturated	Fully Saturated based off potentiometry map.
R-13-020	302	Dry	Dry
578418-MST	183	Partially Saturated	Partially Saturated based off water levels and cross sections
R-12006	300	Dry	Dry based on saturation boundary, log and cross sections
R13-023	202	Dry	Dry based on saturation boundary, log and cross sections
R13-011	222	Fully Saturated	Fully saturated based on potentiometry map and cross sections
578417-MST	164	Partially Saturated	Partially saturated based off water levels and cross sections
R13-019	210	Fully Saturated	Fully saturated based off potentiometry maps and cross sections
R13-012	202	Partially Saturated	Partially saturated based off potentiometry maps and cross sections
R13-016	904	Dry	Dry based on saturation boundary, log and cross sections
578408-MST/R13-018	141	Fully Saturated	Fully saturated based off potentiometry maps and cross sections
Ambre-02	120	Fully Saturated	Fully saturated based off potentiometry map
Ambre-03	96	Fully Saturated	Fully saturated based off potentiometry map map
Ambre-04	120	Fully Saturated	Fully saturated based off cross section and potentiometry map
578409-MST	122	Fully Saturated	Fully saturated based off water levels, cross ssections and potentiometry map
BE284-78		Fully Saturated	Fully saturated based off cross sections.
578415-MST	182	Fully Saturated	Fully saturated based off water levels, cross ssections and potentiometry map

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Table D6.2-26 Slater Creek Alluvial Drill Hole and Well Saturation Zone Analysis

Core/Drill Hole/Well	Well Depth (ft)	Saturation	Saturation Determination
578512-AL	22	Partially Saturated	Partially Saturated
578513-AL	22	Partially Saturated	Partially Saturated
578418-AL	27	Partially Saturated	Partially Saturated

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RECD MAR 04, 2019

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Table D6.2-27 Spoil Drill Hole and Well Saturation Zone Analysis

Core/Drill Hole/Well	Elevation (ft AMSL)	Well Depth (ft)	Geologic Formation	Screened Interval (ft)	Saturation
578415-SPL-1	3603.7	62	Spoil	31-41	Partially Saturated
578415-SPL-2	3611.5	120	Spoil	100-110	Partially Saturated

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RECD MAR 04, 2019

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Table D6.2-28 Groundwater Comparison of Aquifer and Slug Tests.

	Aquifer Tests Addendum D6-8		*Slug Tests 2018*	
	CRN	***MST***	***CRN***	***MST***
	Hydraulic Conductivity (ft/day)	*Hydraulic Conductivity (ft/day)*	*Hydraulic Conductivity (ft/day)*	*Hydraulic Conductivity (ft/day)*
Minimum	0.28	0.48	0.022	0.016
Maximum	0.33	0.60	0.98	[1]55.68
Average	0.31	0.54	0.36	9.83

Note: [1]WWC believes that the hydraulic conductivity of 55.68 ft/day is an anomaly that may be related to a local fracture in the coal.

TFNS 2/825
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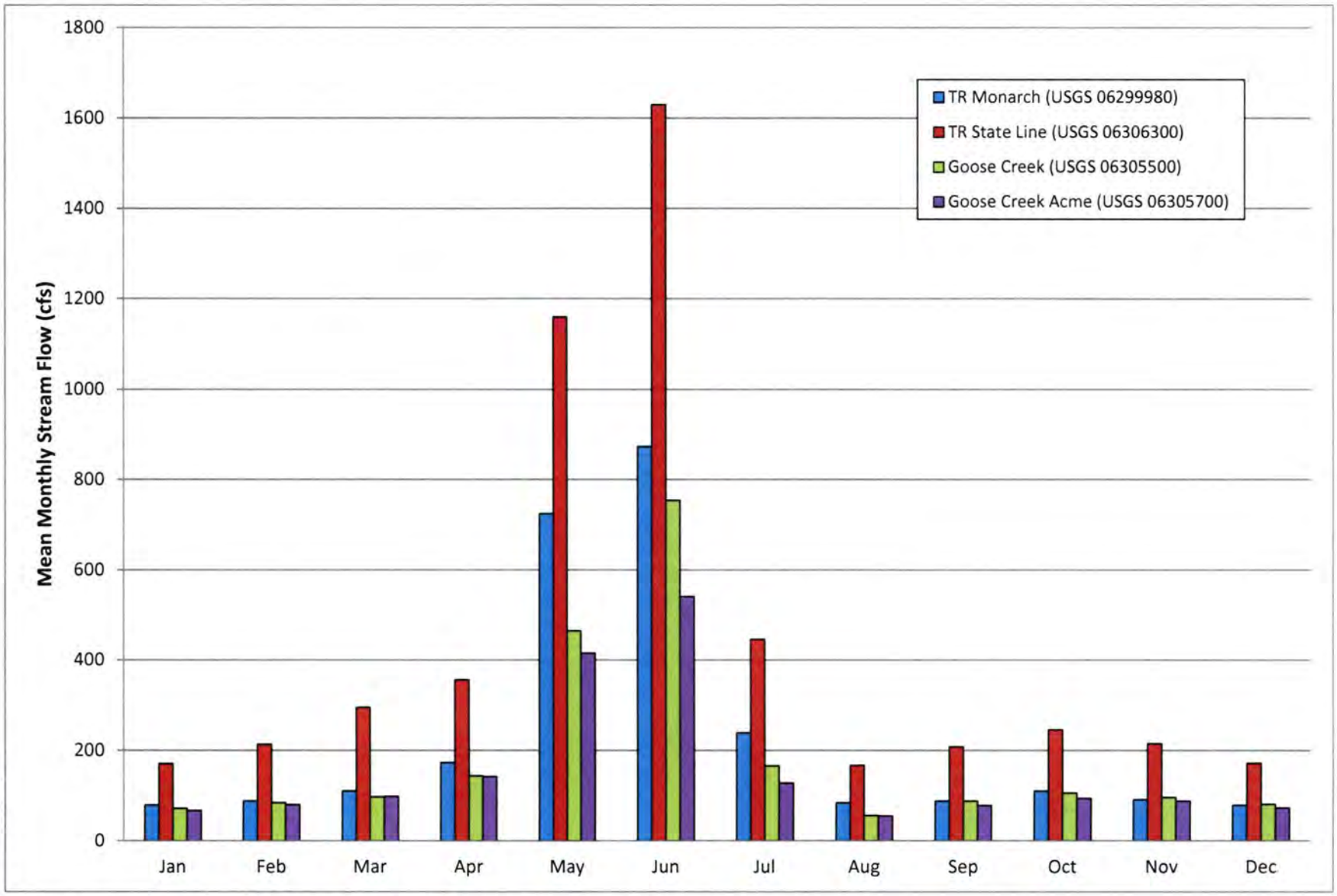

Figure D6.1-1. Tongue River and Goose Creek Mean Monthly Flow

Source: USGS National Water Information System: Web Interface

TFNS 2/025
RECD MAR 04, 2019

Scanned, 02/28/2020

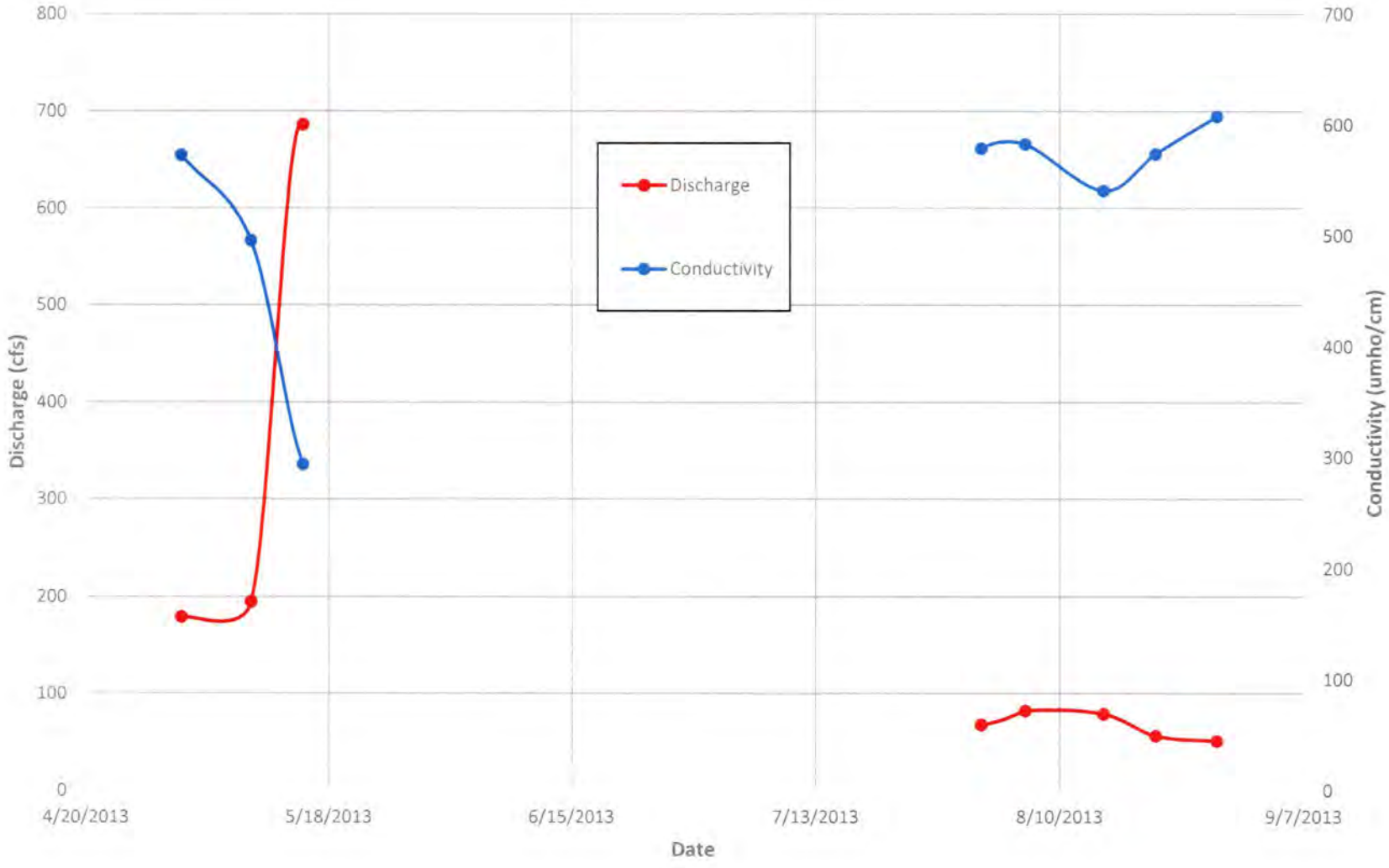

Figure D6.1-2. TR03 2013 Conductivity and Discharge Levels

Source: Sheridan County Conservation District 2013 Tongue River Watershed Interim Monitoring Report

TFR G 2/C25
RECD 10-25-18

Scanned, 02/28/2020

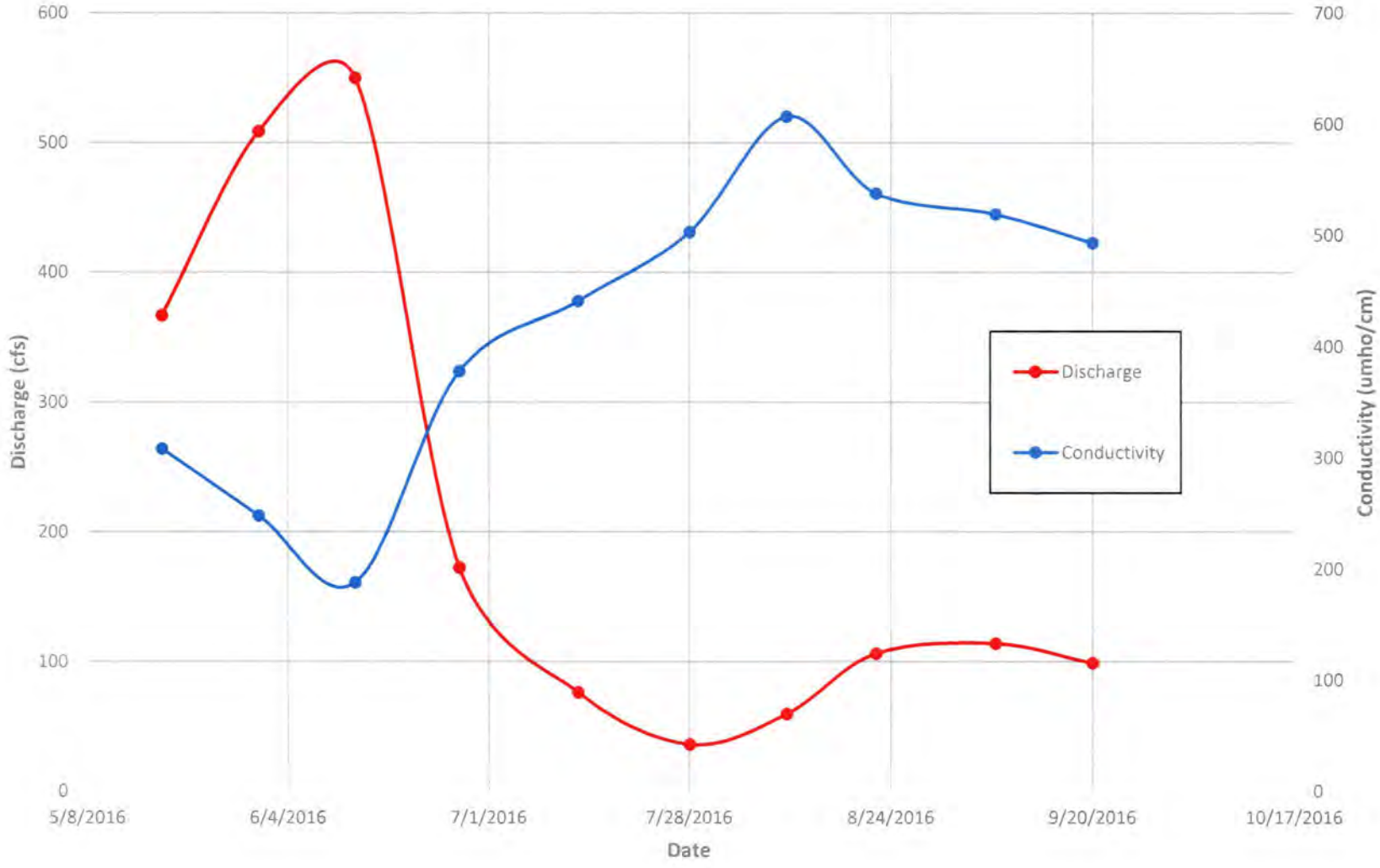

Figure D6.1-3. TR03 2016 Conductivity and Discharge Levels

Source: Sheridan County Conservation District 2016 Tongue River Watershed Interim Monitoring Report

TFN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

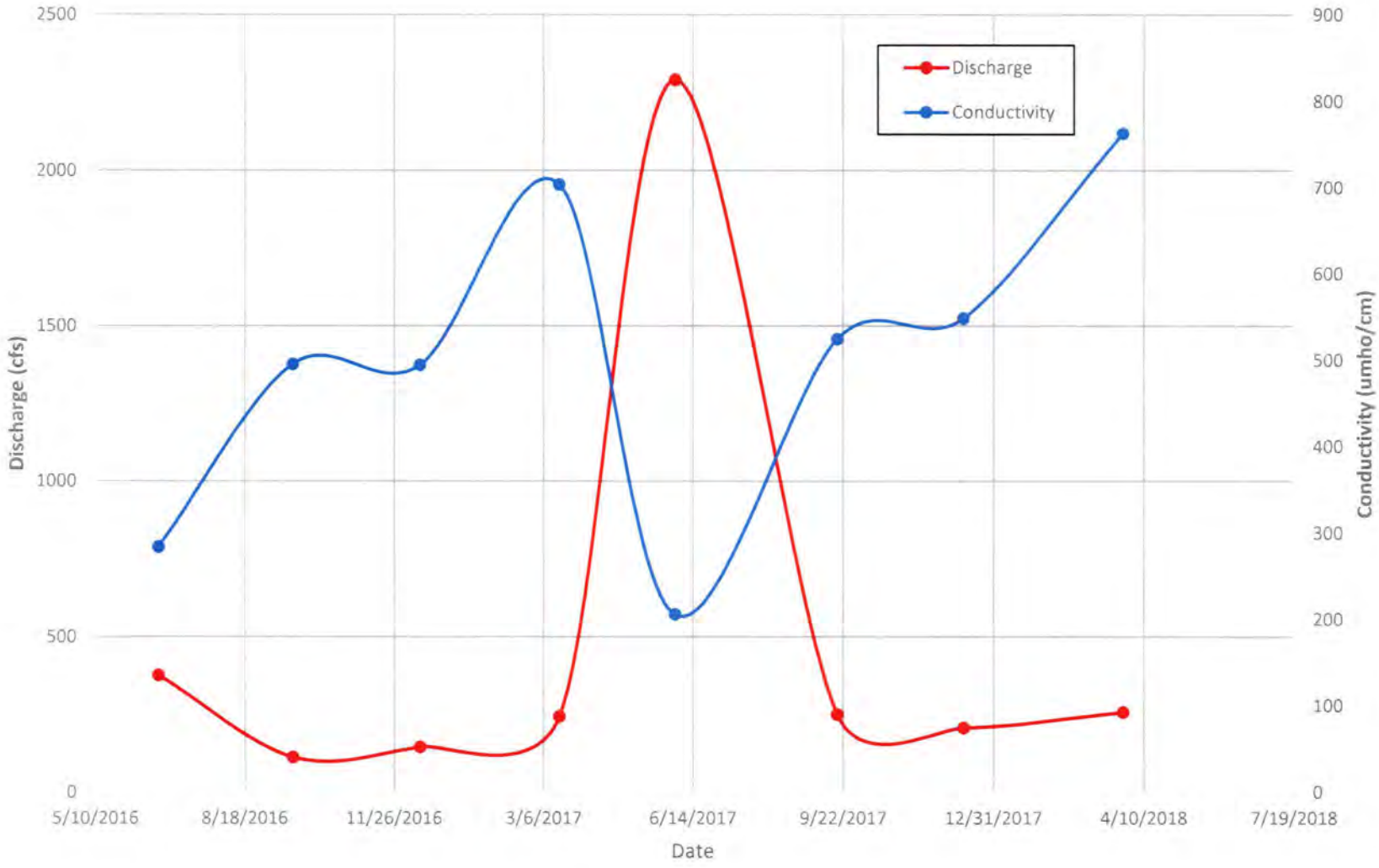

Figure D6.1-4. TR2B 2016-2018 Conductivity and Discharge Levels
Source: Big Horn Coal Annual Reports

TFR G 2/
RECD 10-25-18

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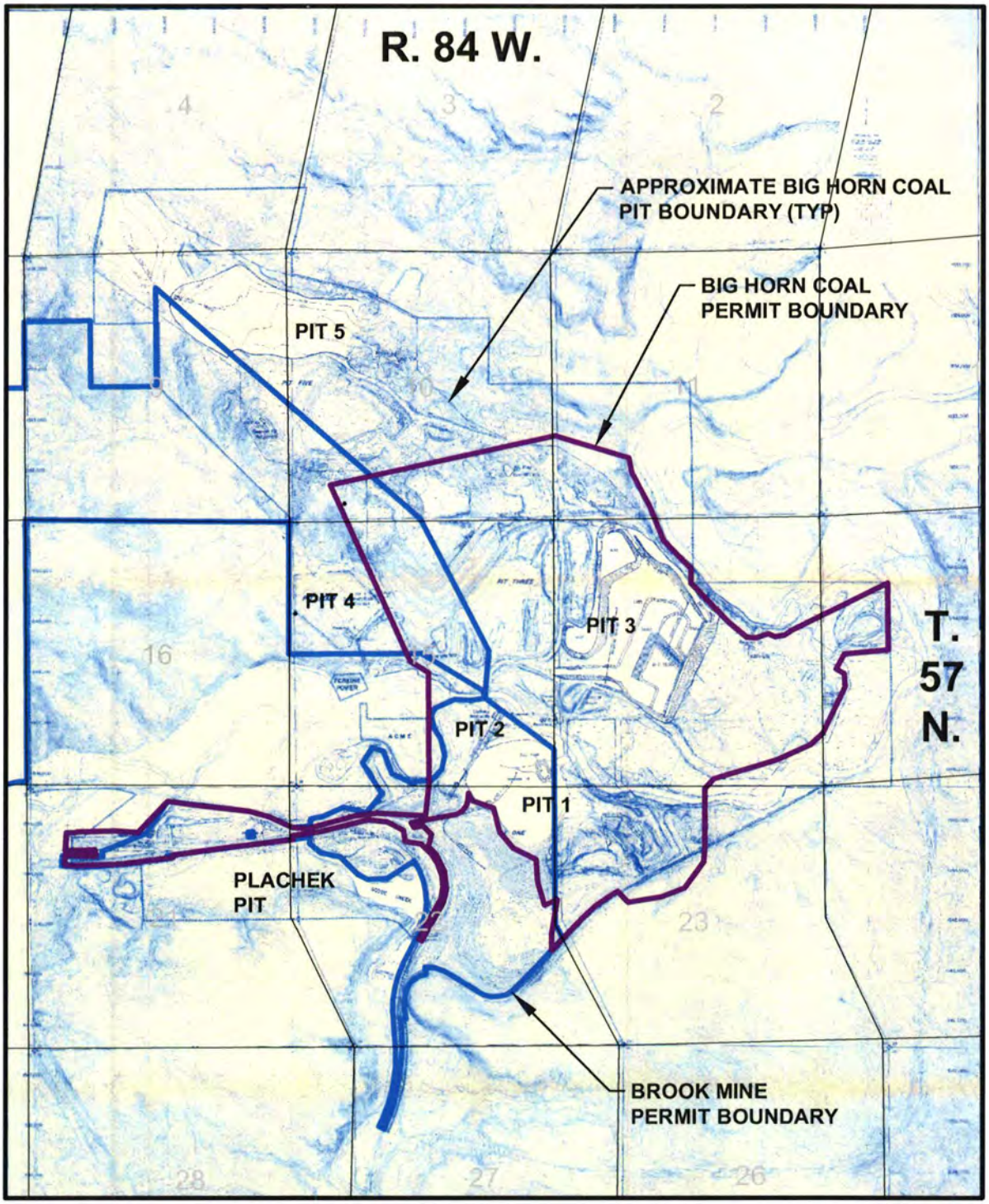

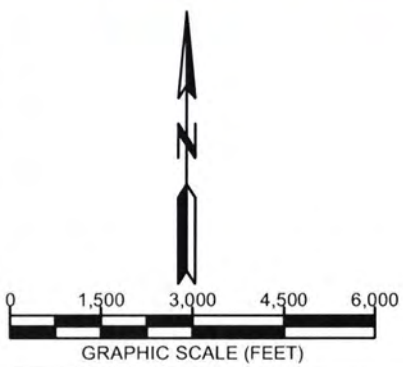

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Figure D6.2-1 Big Horn Coal Mine Pit Locations
October 2018

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-143

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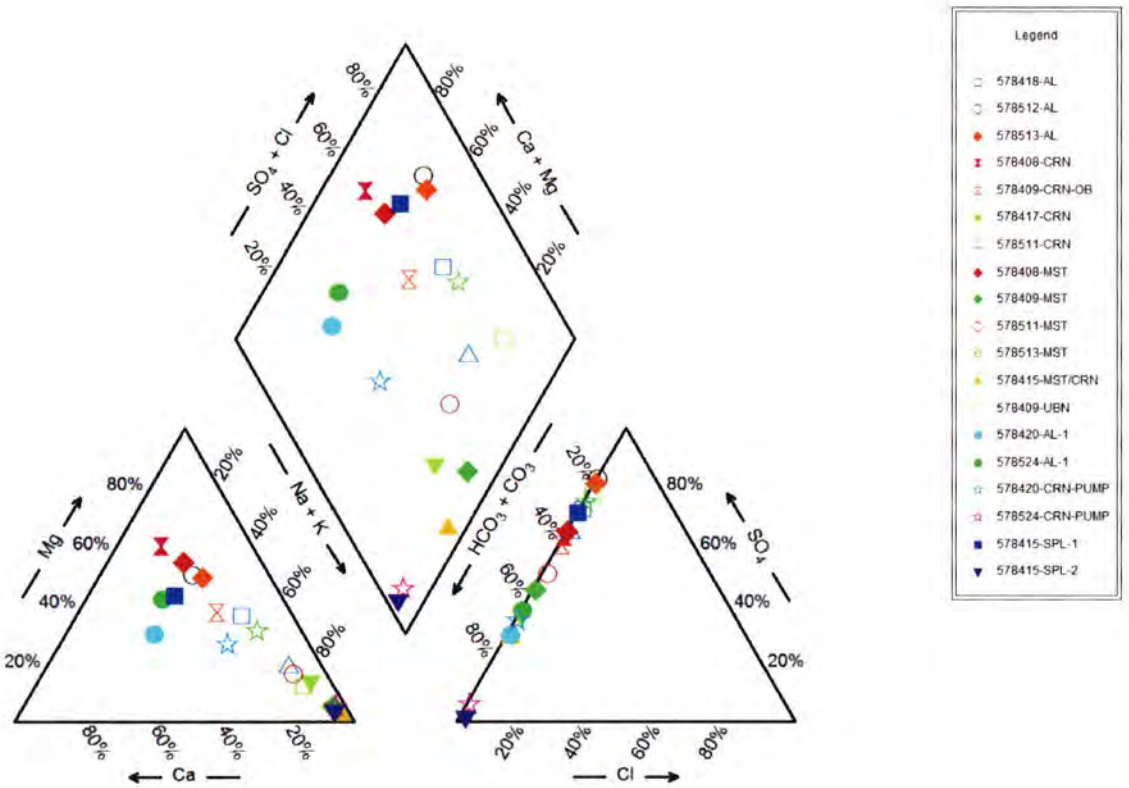

Figure D6.2-2. Groundwater Monitoring Well Results Piper Diagram

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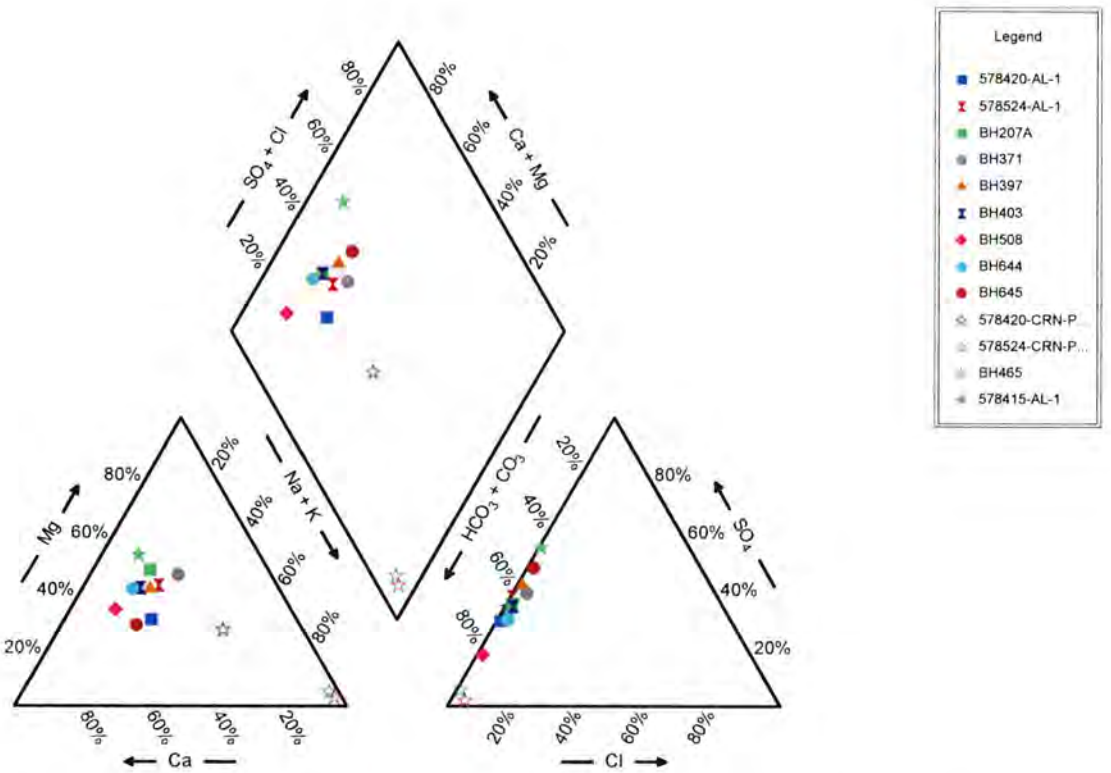

Figure D6.2-3. Tongue River Alluvium and Carney Coal Piper Diagram

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RECD DEC 13, 2019

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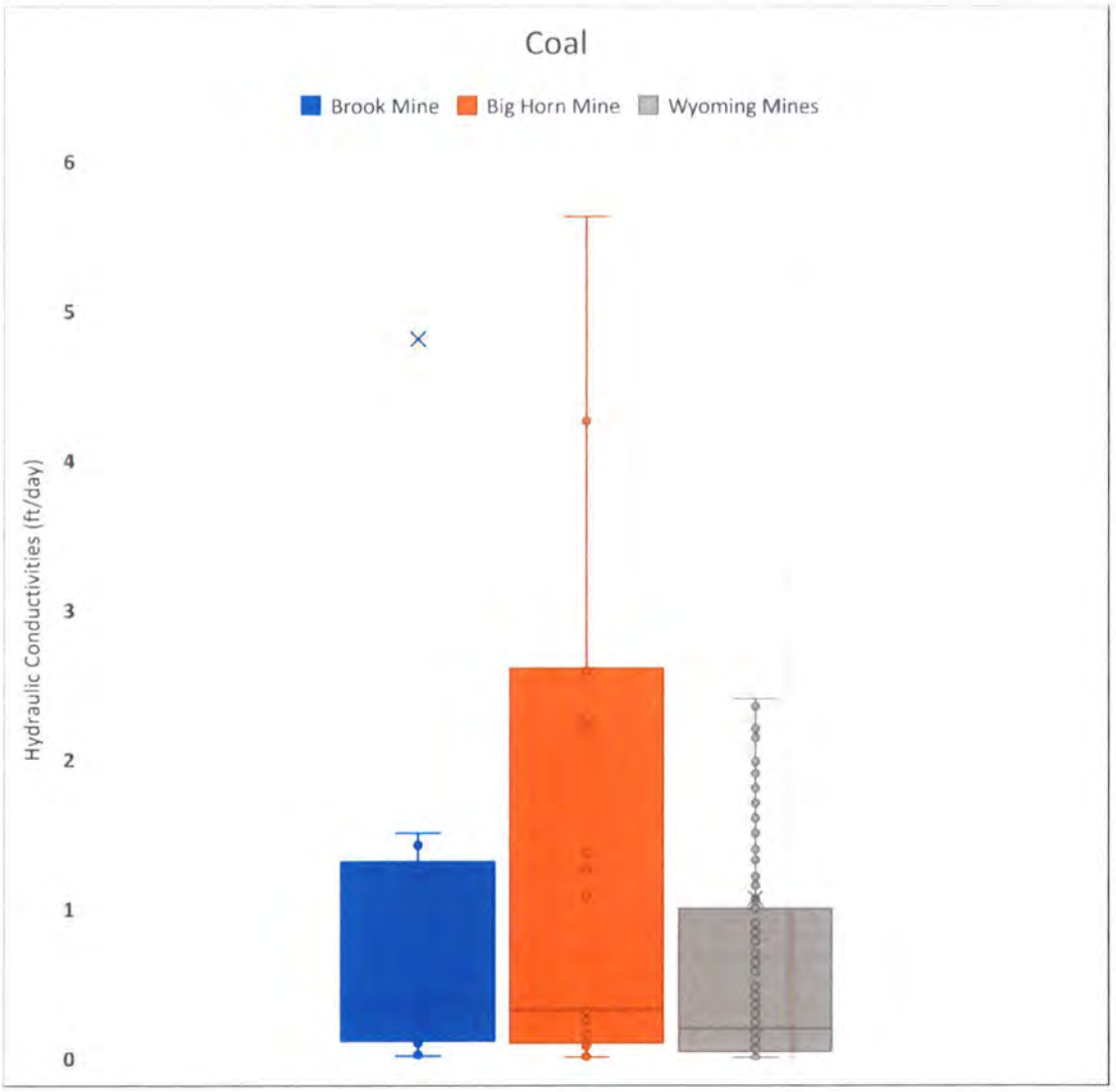

Figure D6.2-4 Comparison of Coal Aquifer Tests

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RECD MAY 23, 2019

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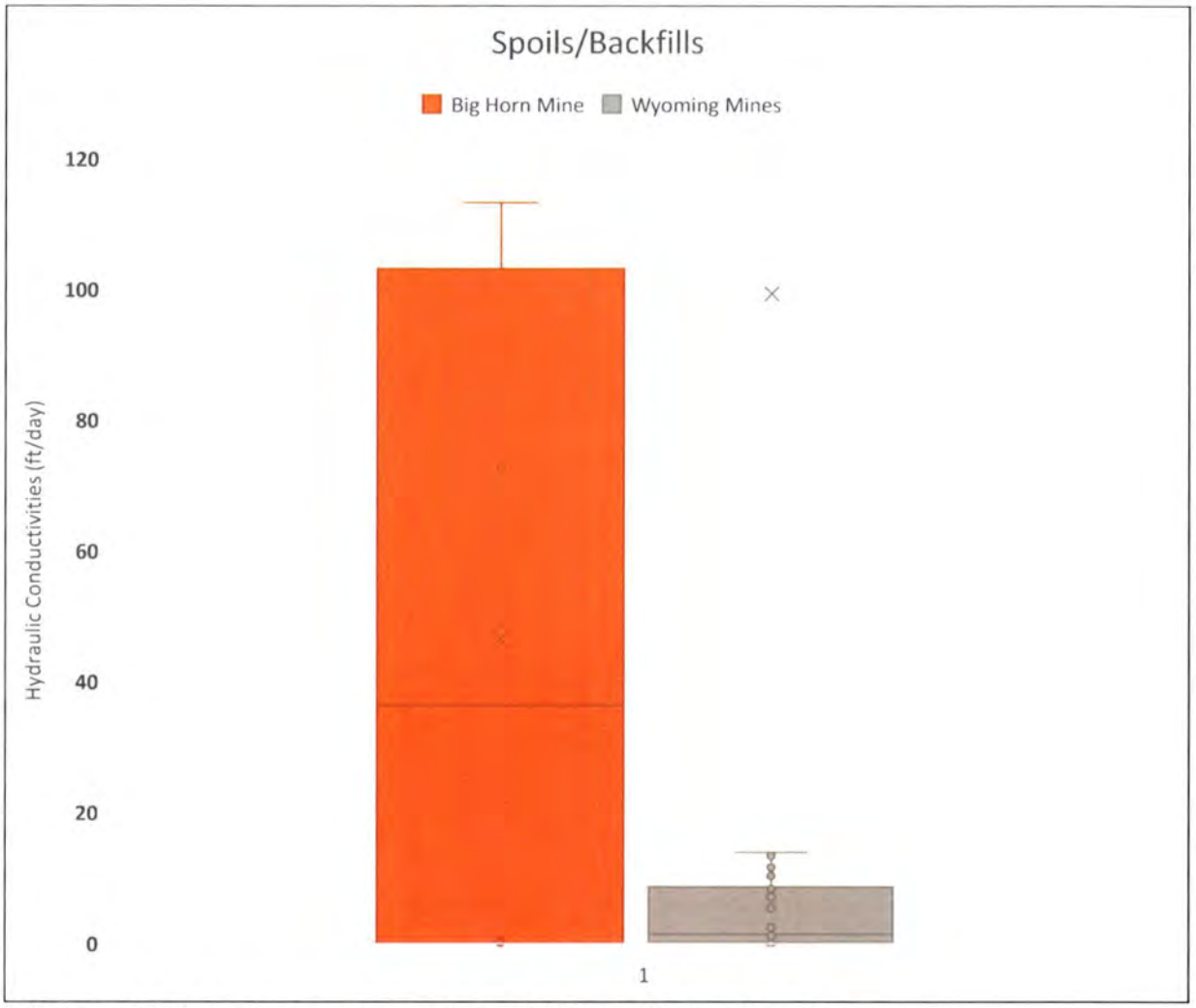

Figure D6.2-5. Comparison of Spoil/Backfill Aquifer Tests

TFNS 2/025
RECD MAR 04, 2019

Scanned, 02/28/2020

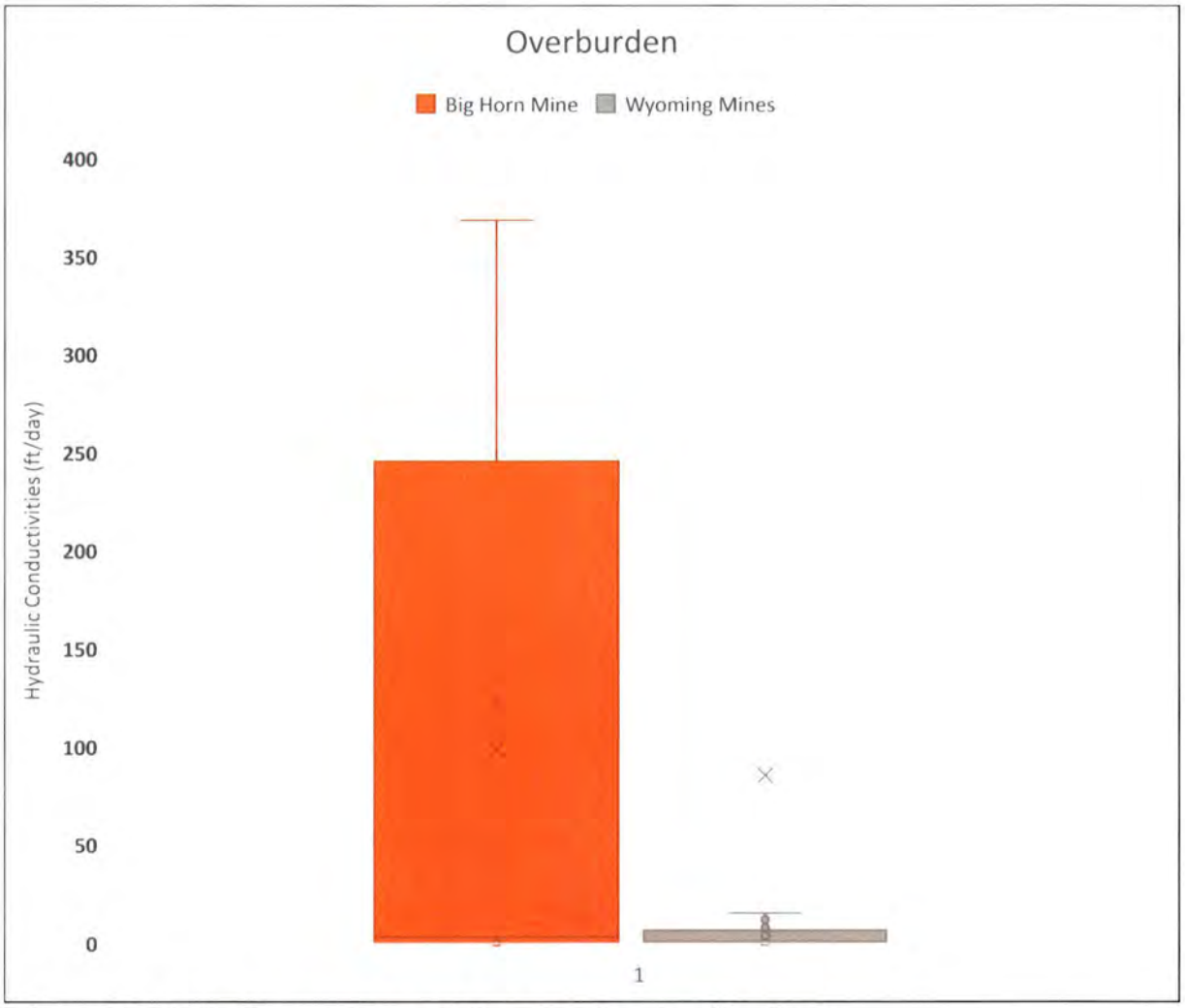

Figure D6.2-6. Comparison of Overburden Aquifer Tests

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RECD MAR 04, 2019

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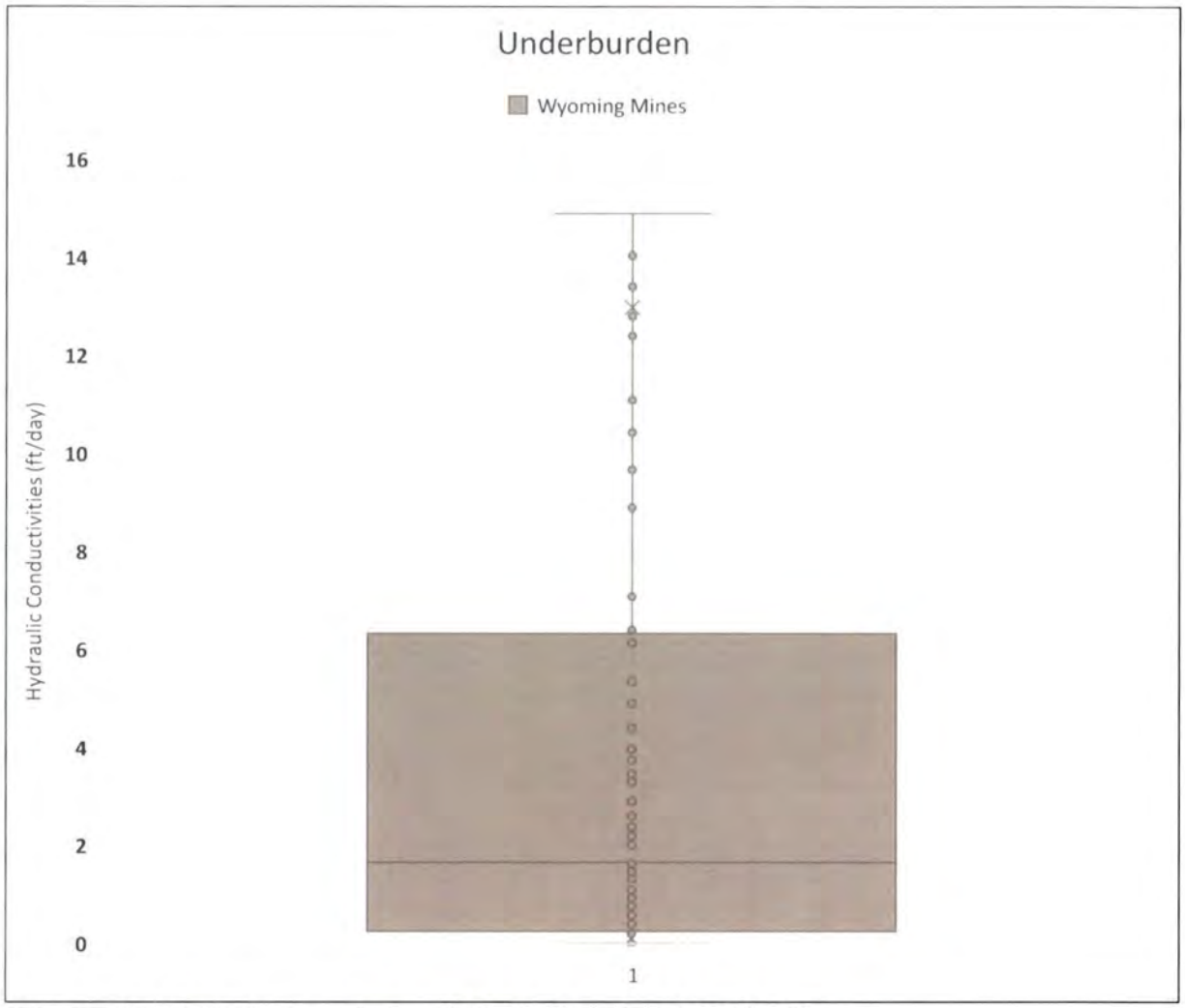

Figure D6.2-7. Comparison of Underburden Aquifer Tests

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RECD MAR 04, 2019

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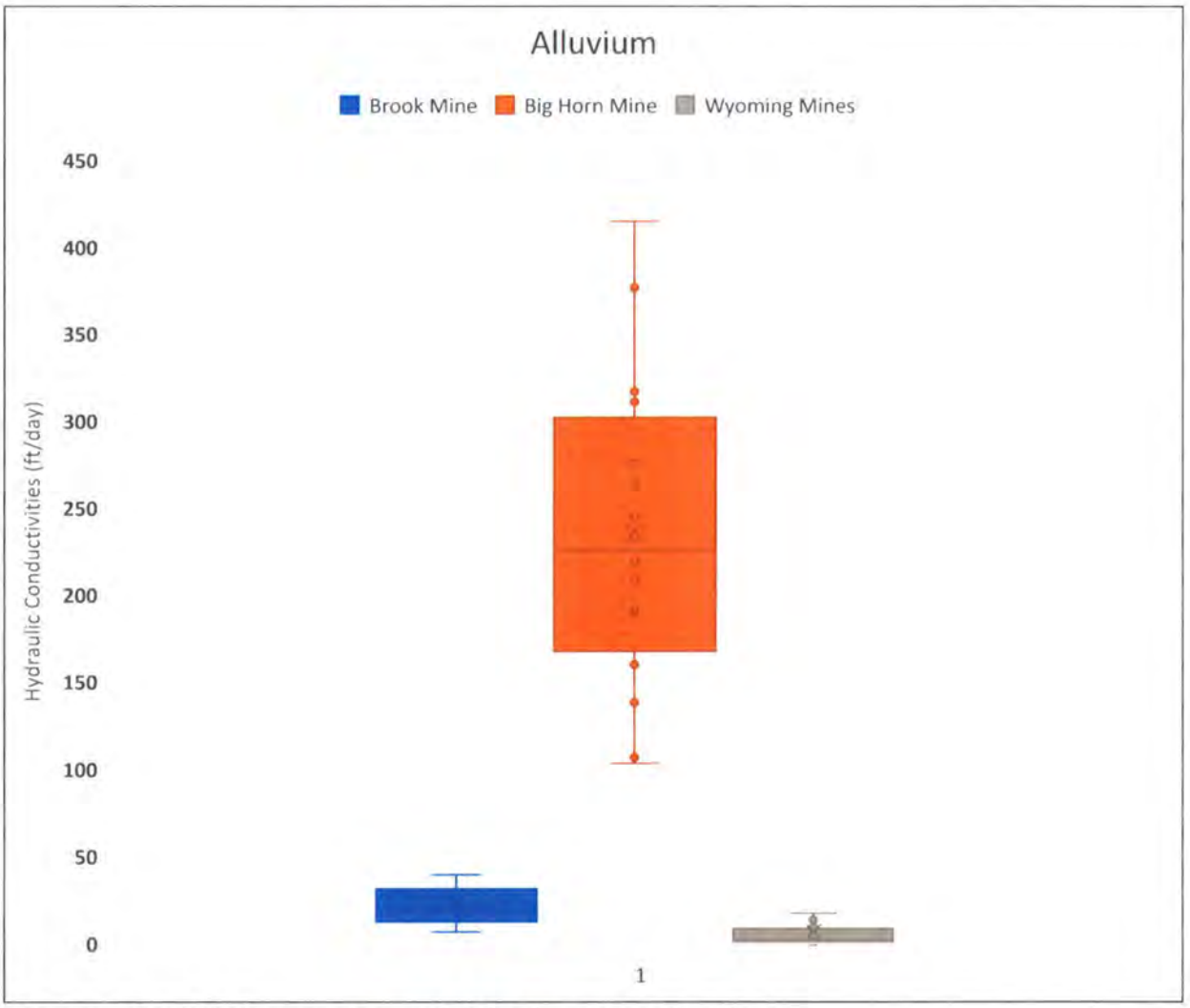

Figure D6.2-8.Comparison of Alluvium Aquifer Tests

TFNS 2/025
RECD MAR 04, 2019

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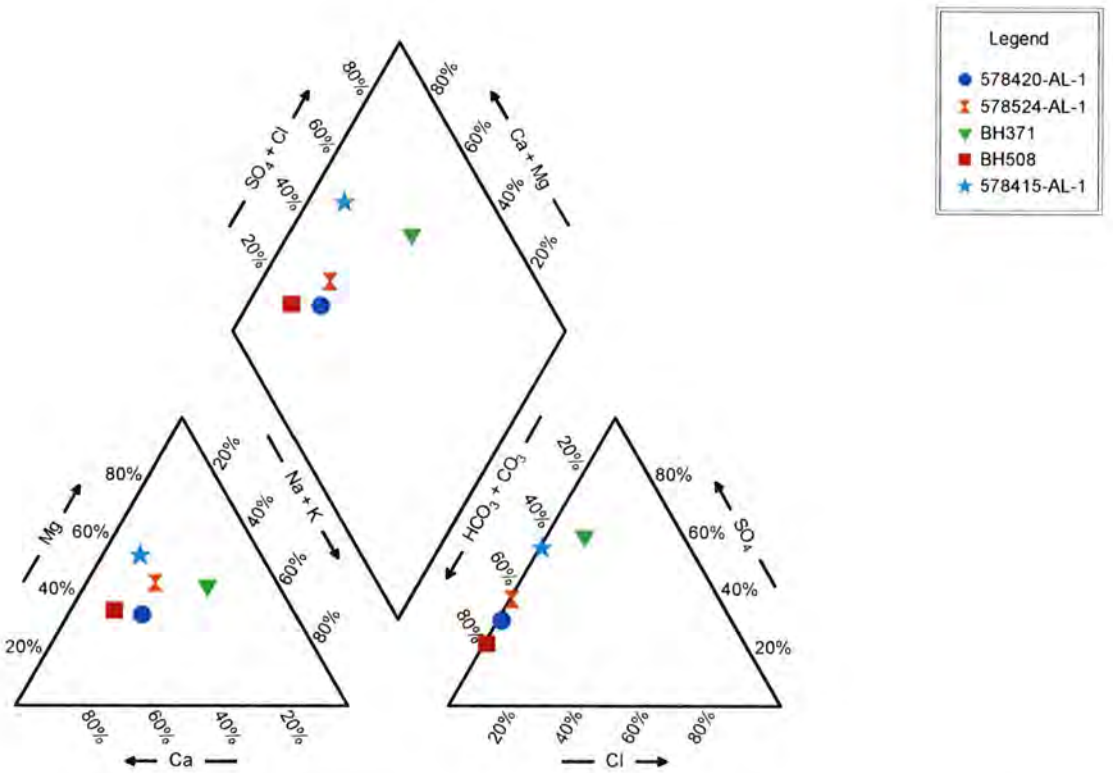
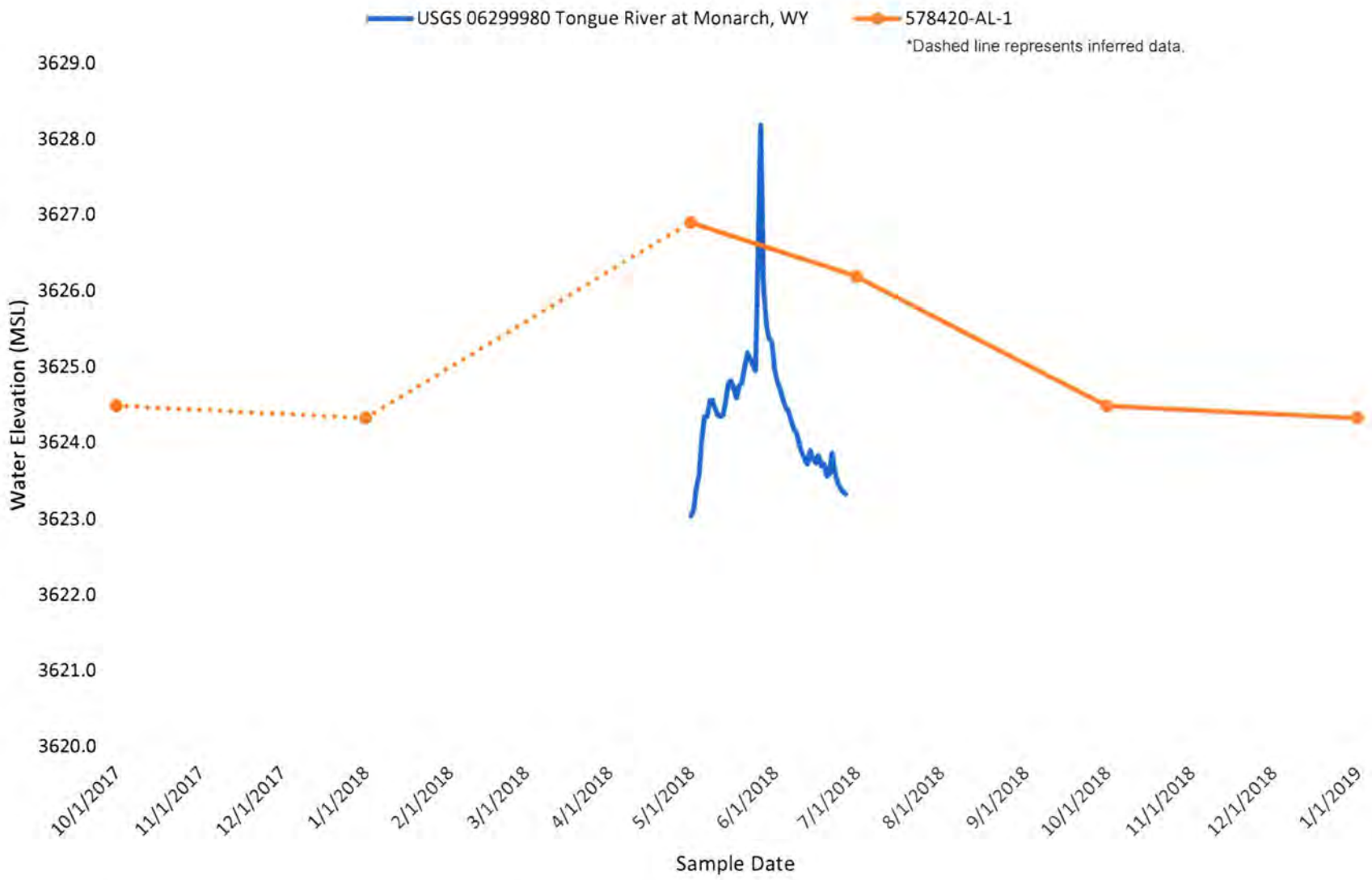


Figure D6.2-9. Tongue River and Big Horn Coal Alluvium Wells Piper Diagram

TFNG 2/025
RECD DEC 13,2019

DEQ Ex. 3-151

Scanned, 02/28/2020



RECD MAY 29, 2019
TFNS 2/325

Figure D6.2-10 Stage comparison of Tongue River and Tongue River Alluvium

Scanned, 02/28/2020

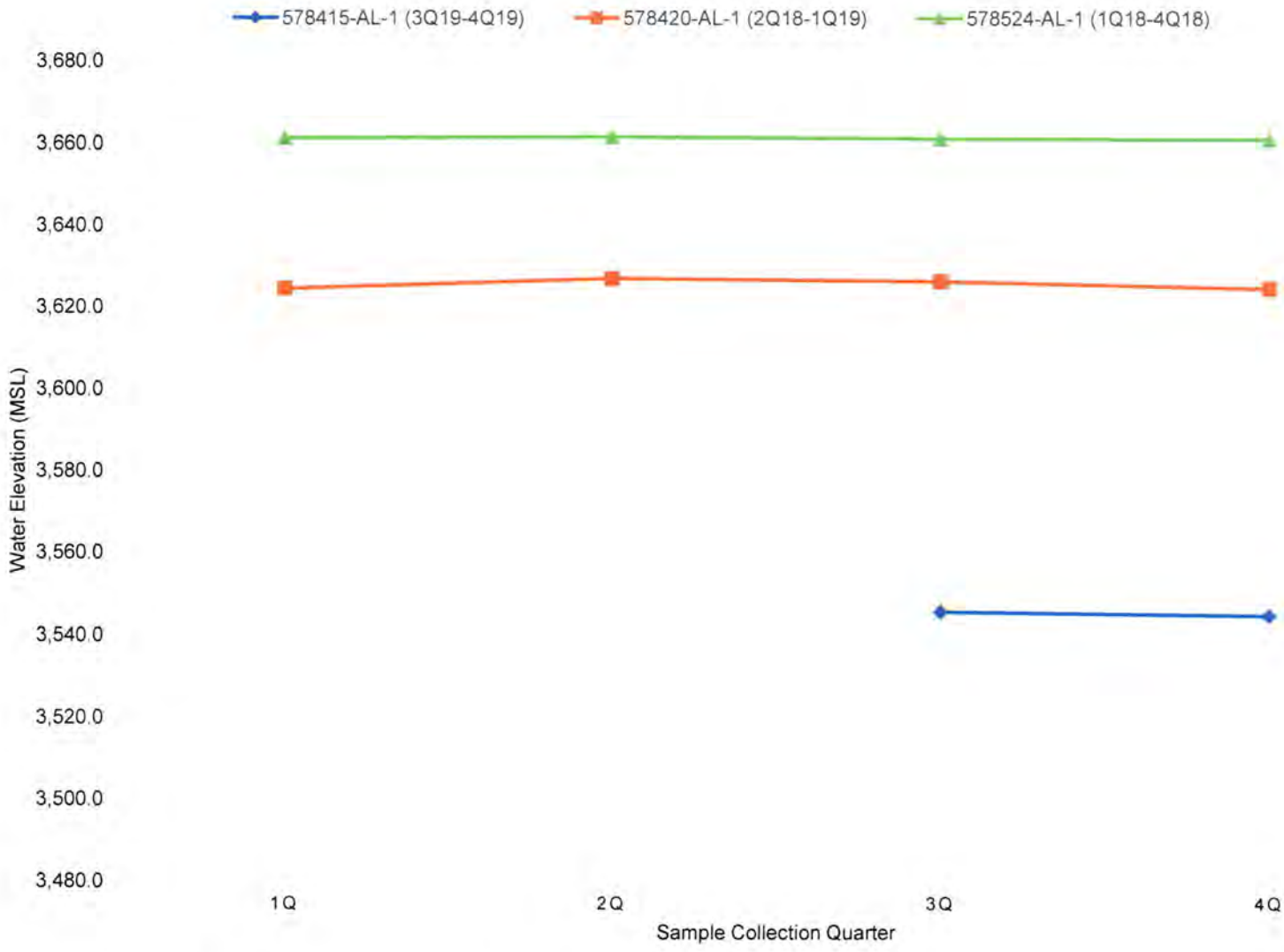


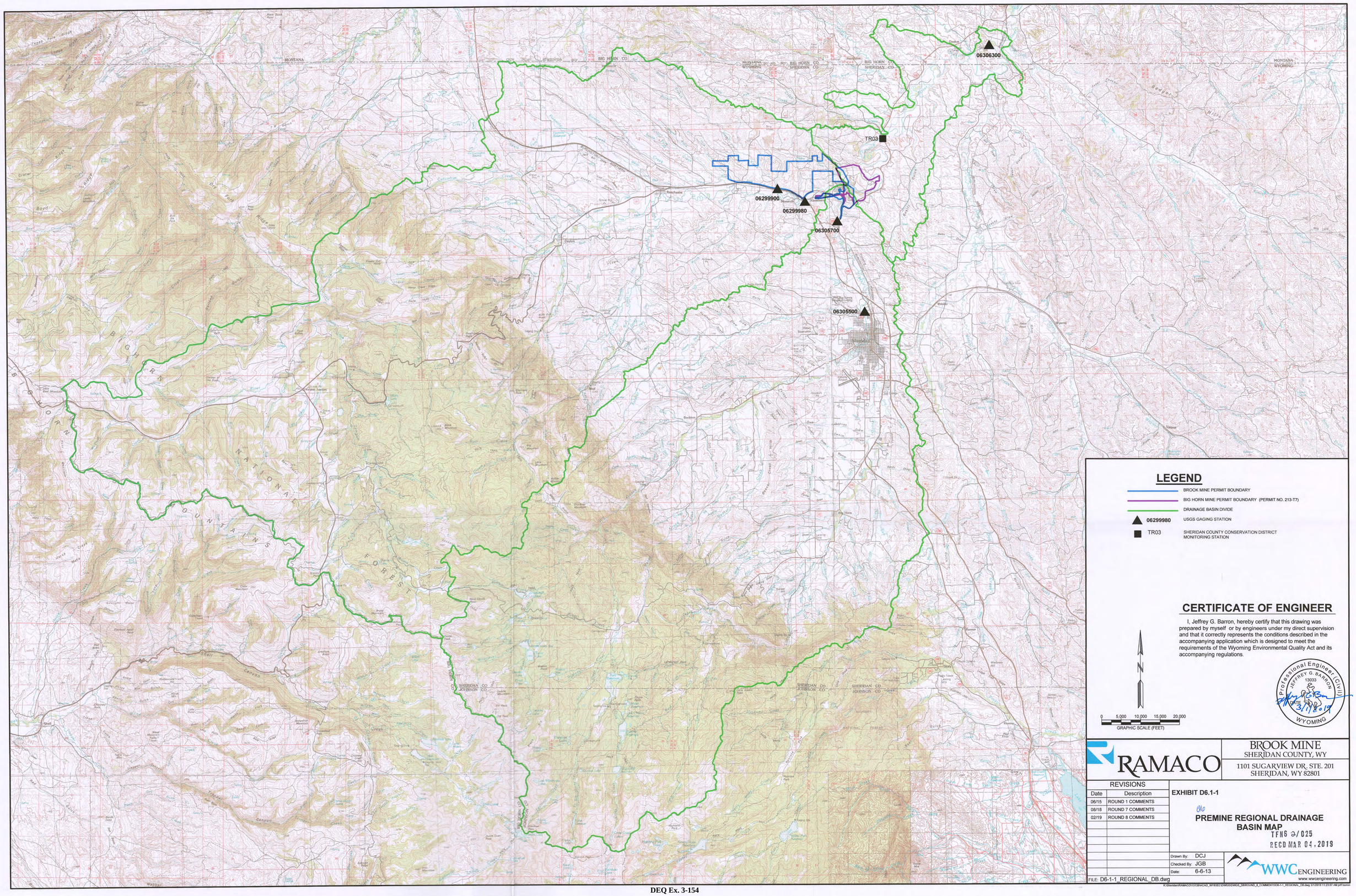
Figure D6.2-11. Tongue River Alluvial Monitor Well Water Levels

Notes:1. Alluvial well locations are depicted on Exhibit D6.2-1.

2. Water levels for 1st and 2nd quarter for alluvial well 578415-AL-1 have yet to be collected.

3. Collection period for individual wells shown in parenthesis.

TFNG 2/025
RECD DEC 13,2019



LEGEND

- BROOK MINE PERMIT BOUNDARY
- BIG HORN MINE PERMIT BOUNDARY (PERMIT NO. 213-T7)
- DRAINAGE BASIN DIVIDE
- 06299980 — USGS GAGING STATION
- TR03 — SHERIDAN COUNTY CONSERVATION DISTRICT MONITORING STATION

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) — JEFFREY G. BARRON — 13003 — STATE OF WYOMING — 3/1/2019

N

0 5,000 10,000 15,000 20,000
GRAPHIC SCALE (FEET)

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR, STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
08/18	ROUND 7 COMMENTS
02/19	ROUND 8 COMMENTS

EXHIBIT D6.1-1

D6

PREMINE REGIONAL DRAINAGE BASIN MAP

TFN 6 9/025
RECD MAR 04, 2019

Drawn By: DCJ
Checked By: JGB
Date: 6-6-13

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FILE: D6-1-1_REGIONAL_DB.dwg

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T. 9 S. R.86 W. R.85 W.

T. 9 S. T. 10 S. R. 37 E. R. 38 E.

T. 9 S. T. 10 S. R. 38 E. R. 39 E.

R.85 W. R.84 W.

T. 58 N. T. 57 N.

T. 57 N. R.86 W. R.85 W.

R.85 W. R.84 W.

R.85 W. R.84 W.

T. 57 N. T. 56 N.

R.86 W. R.85 W.

SCNBRANCH

SCSBRANCH

SC3

SC2

SC1

EFEC

HWC3

HWC2

HWC1

GC1

TRD5

TRD4

TRD3

TRD2

TRD1

TR2

TR1

SCSUB5

SCSUB4

SCSUB3

SCSUB2

SCSUB1

HWCSUB5

HWCSUB4

HWCSUB3

HWCSUB2

HWCSUB1

HART BROS RESERVOIR

EAST SIDE DITCH NO. 2

HART BROTHERS DITCHES

BALDWIN RESERVOIR

BALDWIN DITCH

PERRIE RESERVOIR

PERRIE DITCH

DAN SCOTT NO. 3 STOCK RESERVOIR

TSCHIRGI #2 STOCK RESERVOIR

SOLTIS STATE NO. 1 STOCK RESERVOIR

EARLEY CR. DITCH NO. 1

UPPER 10 STOCK RESERVOIR

SCOTT #1 STOCK RESERVOIR

LANDEN DITCH

HALL DITCH

HALL RESERVOIR

LEGERSKI BROS #1 STOCK RESERVOIR

WELCH #4 STOCK RESERVOIR

BLACK MOUNTAIN NO. 3 STOCK RESERVOIR

LEGERSKI #1 STOCK RESERVOIR

EARLEY CR. DITCH NO. 2

SM578512-SW-1

SM578409-SW-1

BROCK SMITH #1 STOCK RESERVOIR

BADGER DITCH

WAGNER NO. 3 DITCH

ROGER DITCH

SM578415-SW-1

PIT 2 RESERVOIR

SHERIDAN COUNTY ELECTRIC COMPANY TUNNEL

PADLOCK SPRINKLER SYSTEM #5-T

SANITARY TREATMENT FACILITIES NO. 1

MONROE & WILLIAMS

PADLOCK SPRINKLER SYSTEM #5-C

MCKINLEY DITCH

BIG HORN NO. 8 RESERVOIR

BIG HORN NO. 14 RESERVOIR

PADLOCK SPRINKLER SYSTEM #5-T, #7-T AND #8-T

BIG HORN NO. 9-T RESERVOIR

BIG HORN NO. 6 RESERVOIR

575513-IRR-DITCH

SM578418-SW-1

SMITH DOMESTIC PUMP

KOOI COAL MINING CO.'S WATER SUPPLY DITCH

MCPHILLAMEY DITCH

KOOI POND RESERVOIR

VANNOY PIPELINE

578524-TR-1

JOHNSON DOMESTIC PUMP

BLEVINS DOMESTIC PUMP DIVERSION

SEDIMENT STOCK RESERVOIR

YORK DITCH (ENL. OF)

ADDLEMAN SPRINKLER

VANESSA DOMESTIC PUMP

LONG'S DITCH #1

LONG'S DITCH #2

BUYOK IRRIGATION SYSTEM

JANE BUYOK DOMESTIC PUMP

PADLOCK SPRINKLER SYSTEM #1-T AND #6-T

MONARCH PIPELINE

WYOMING COAL MINING CO.'S WATER SUPPLY DITCH--DR41299

WATER HAUL

578420-TR-1

BIRCHLY DITCH (ENL OF)

MONARCH SLOUGH RESERVOIR

LONG'S DITCH NO. 1 ENLARGEMENT

SEAN CARROL NO. 2 STOCK RESERVOIR

SEAN CARROL NO. 3 STOCK RESERVOIR

SEAN CARROL NO. 1 STOCK RESERVOIR

LONG'S STOCK RESERVOIR

BIRCHBY DITCH

HOWD DITCH

PADLOCK SPRINKLER SYSTEM #3-G AND #4-G

13-2374 (POND #10) RESERVOIR

DELAPP NO. 4

DELAPP NO. 2 STOCK RESERVOIR

14-2374 (POND #11) STOCK RESERVOIR

DELAPP NO.1 STOCK RESERVOIR

JOHN JENSIK #1 STOCK RESERVOIR

JENSIK #2 STOCK RESERVOIR

PADLOCK SPRINKLER SYSTEM #1-G AND #2-G

23-2674 STOCK RESERVOIR

B134035 & B134036 CB WATER HAUL

LAST PROSPECT DITCH

14-2674 STOCK RESERVOIR

34-2674 STOCK RESERVOIR

44-2674 STOCK RESERVOIR

KUZARA SPRINKLER SYSTEM NO. 5

KUZARA SPRINKLER SYSTEM NO. 4

KUZARA SPRINKLER SYSTEM NO. 3

LAST PROSPECT RESERVOIR

STRIP MINE STOCK RESERVOIR

578434-GC1

DELAPP NO. 3 STOCK RESERVOIR

HWC1-70

57-84-22-NWSW

57-84-22-SESW

57-84-28-NESW

57-84-28-SESW

57-84-14-SWSW

57-84-15-SWSW

57-85-2-SWSW

57-85-11-WSE

57-85-11-WWNE

57-84-7-NWNW

57-84-7-SWNE

57-85-14-NESE

57-85-15-WSW

57-84-5-SWNE

LEGEND

- BROOK MINE PERMIT BOUNDARY
- BIG HORN COAL PERMIT BOUNDARY (PERMIT NO. 213-T7)
- MAJOR DRAINAGE DIVIDE
- MINOR DRAINAGE DIVIDE
- TRD4 — DRAINAGE BASIN ID
- DELAPP NO. 4 — RESERVOIR WITH SURFACE WATER RIGHT
- SM578522-SW-1 — SURFACE WATER MONITORING STATION
- 57-84-28-NESW — UNPERMITTED RESERVOIR
- PADLOCK SPRINKLER SYSTEM #1-G AND #2-G — POINT OF DIVERSION WITH SURFACE WATER RIGHT
- HWC1-79 — BIG HORN MINE FORMER SURFACE WATER MONITORING STATION

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) JEFFREY G. BARRON 13033 REGISTERED WYOMING

DATE SIGNED 10/18/2018

GRAPHIC SCALE (FEET) 0 1,000 2,000 3,000 4,000 C.I. = VARIES

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
10/15	ROUND 2 COMMENTS
12/15	ROUND 3 COMMENTS
07/18	ROUND 7 COMMENTS

EXHIBIT D6.1-2

TFN 6 2/025
RECD 10-25-18

PREMINE DRAINAGE BASINS

Drawn By: DCJ
Checked By: JGB
Date: 6-6-13

FILE: D6-1-2_PRE_DB.dwg

WWC ENGINEERING
www.wwcengineering.com

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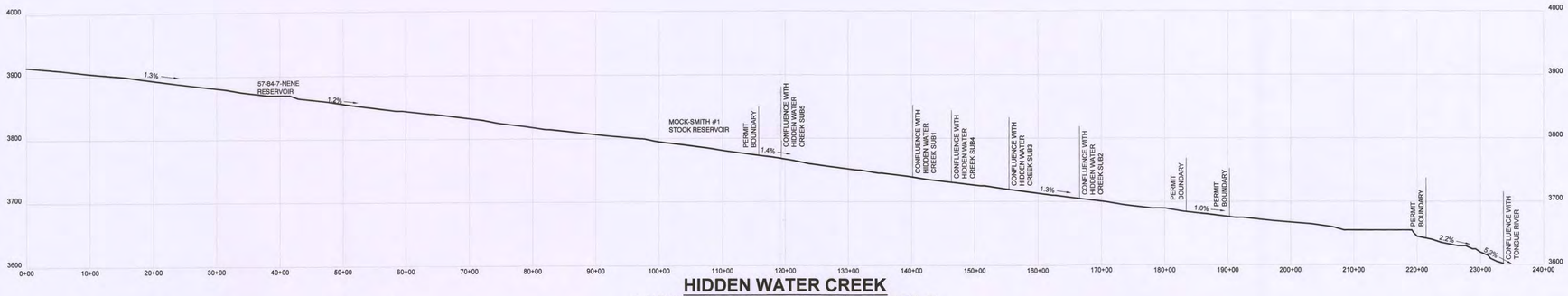
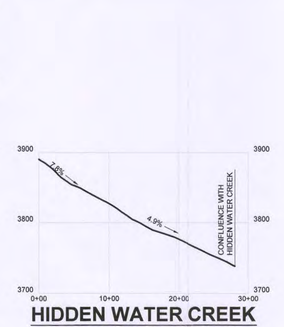


HIDDEN WATER CREEK LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



HIDDEN WATER CREEK SUB1 LONGITUDINAL CHANNEL PROFILE

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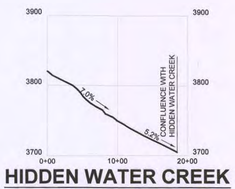
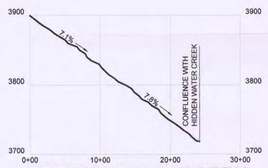


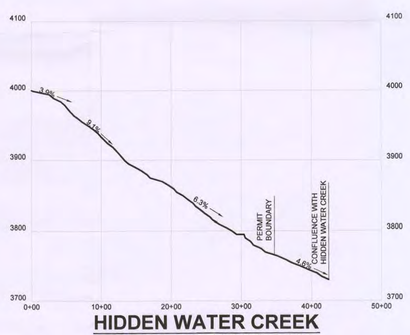
HIDDEN WATER CREEK SUB2 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



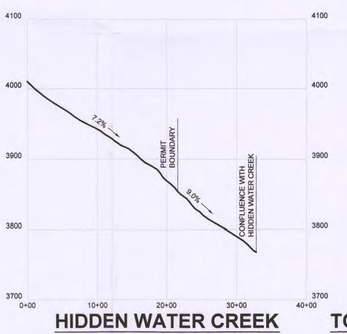
HIDDEN WATER CREEK SUB3 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



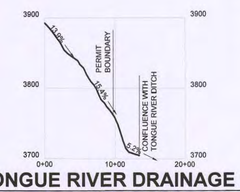
HIDDEN WATER CREEK SUB4 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



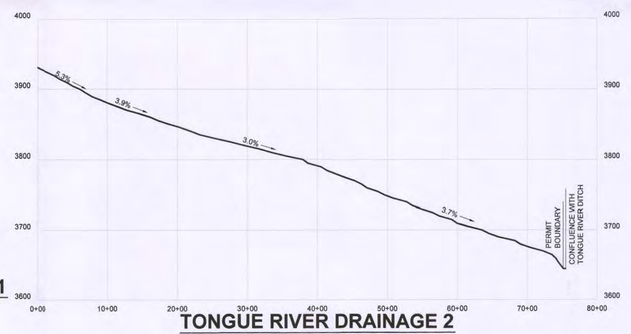
HIDDEN WATER CREEK SUB5 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



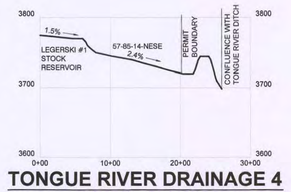
TONGUE RIVER DRAINAGE 1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



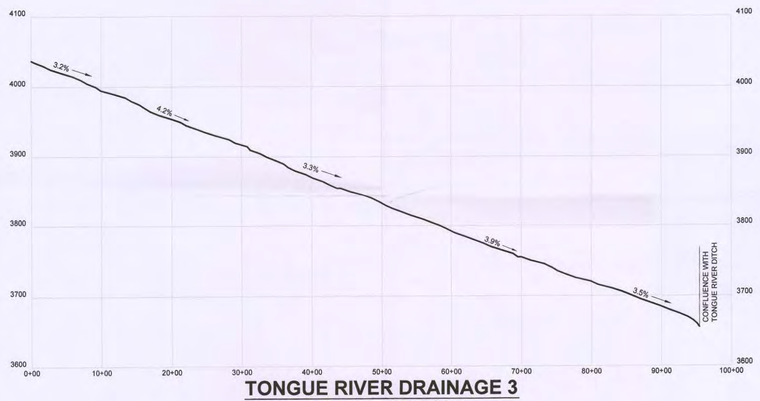
TONGUE RIVER DRAINAGE 2 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



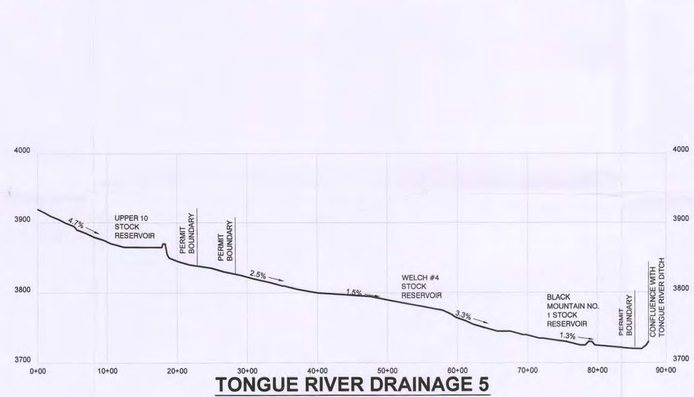
TONGUE RIVER DRAINAGE 4 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



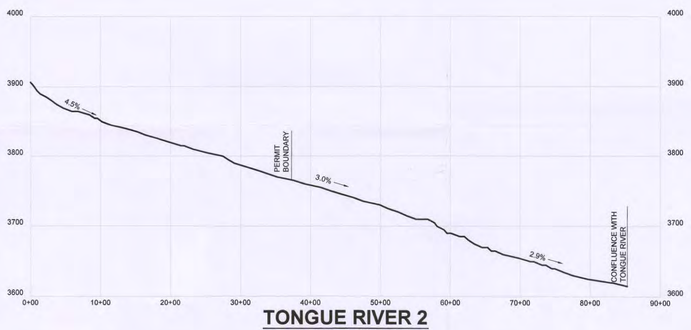
TONGUE RIVER DRAINAGE 3 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



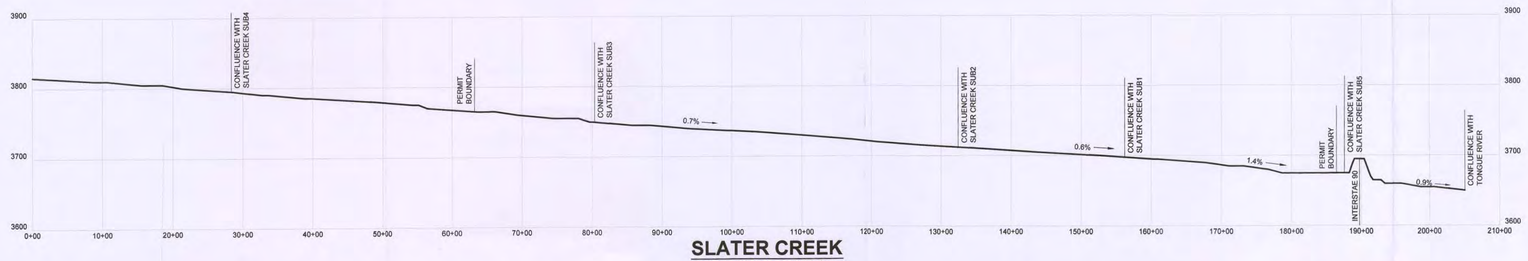
TONGUE RIVER DRAINAGE 5 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



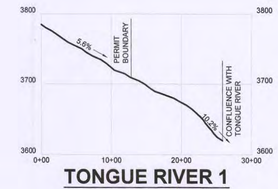
TONGUE RIVER 2 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



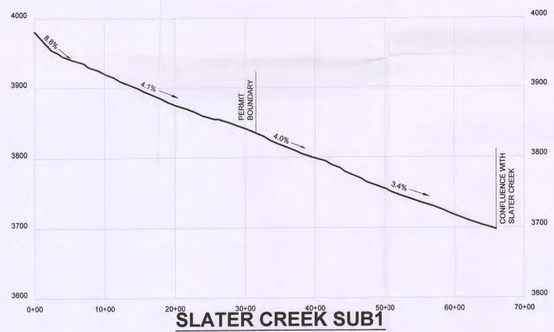
SLATER CREEK LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



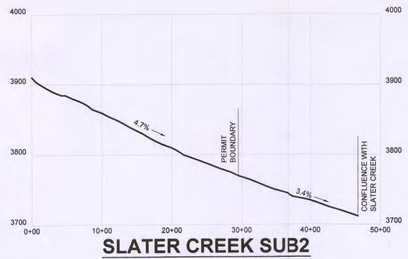
TONGUE RIVER 1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



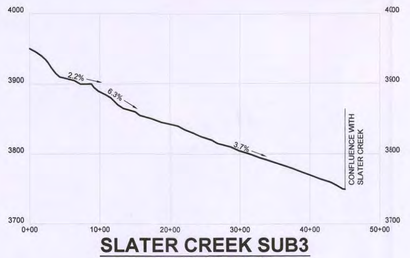
SLATER CREEK SUB1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



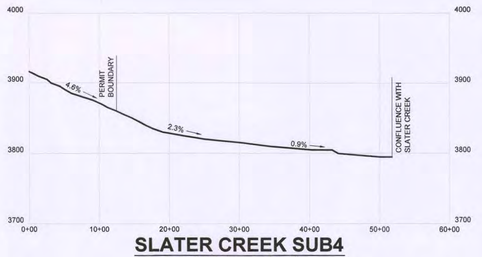
SLATER CREEK SUB2 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



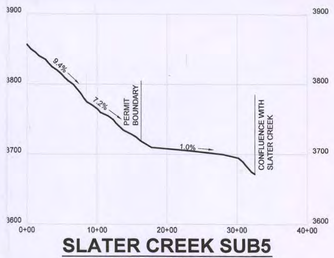
SLATER CREEK SUB3 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



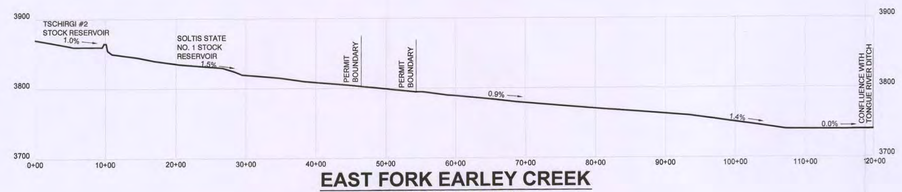
SLATER CREEK SUB4 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



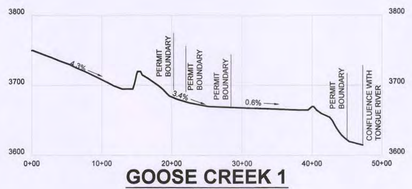
SLATER CREEK SUB5 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



EAST FORK EARLEY CREEK LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



GOOSE CREEK 1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (CH) JEFFREY G. BARRON 13033 REGISTERED WYOMING

DATE ISSUED 6/10/2014

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description

EXHIBIT D6.1-3

TFN 6 2/025
RECD NOV 14, 2014

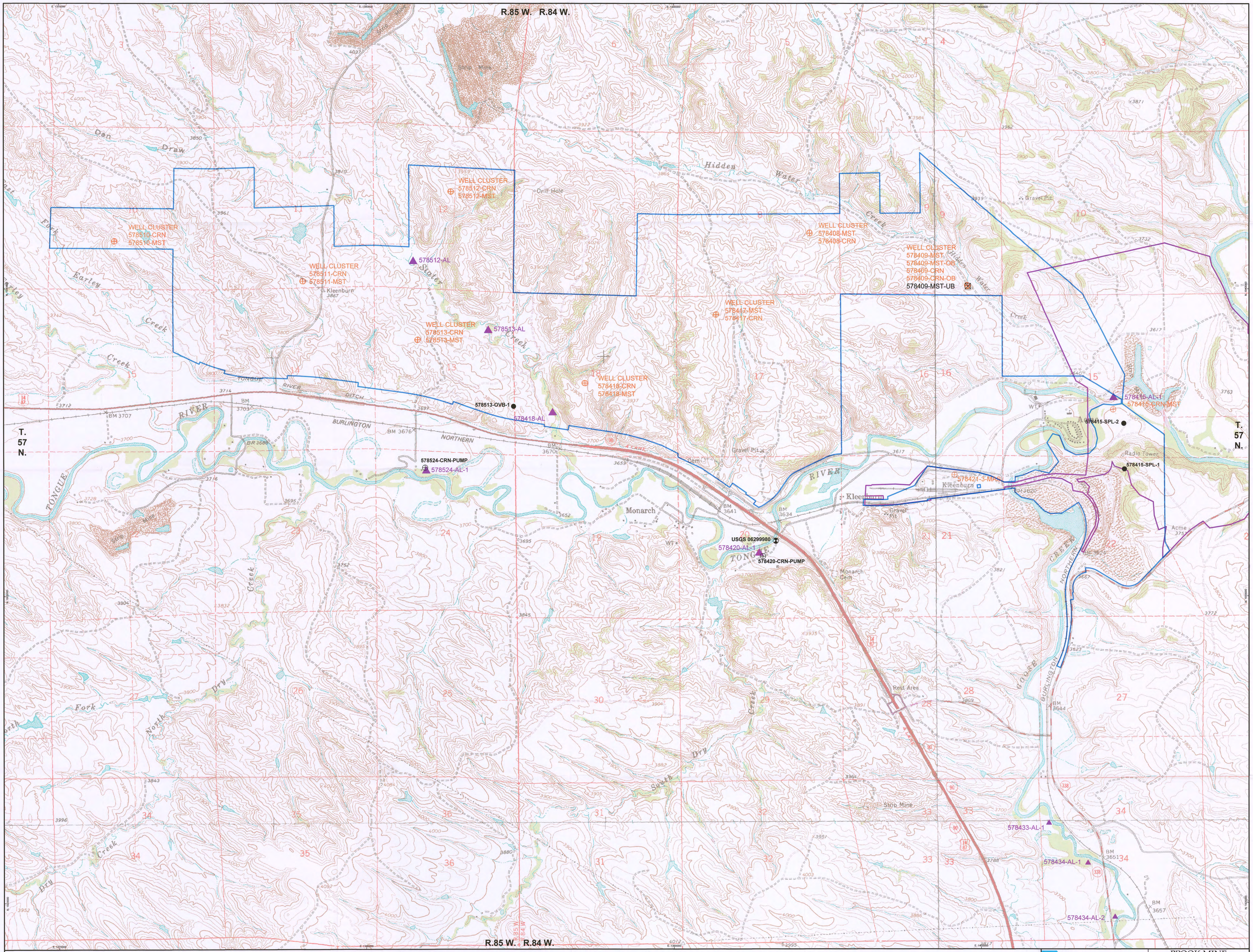
PREMINE STREAM PROFILES

Drawn By: DCJ
Checked By: JGB
Date: 6-6-13

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-1-3_CHANNELPROF.dwg

K:\Sheridan\RAMACO\7139\ACAD_WWSE\DWGS_D6\D6-1-3_CHANNELPROF.dwg 10/8/2014 2:12:45 PM cristina gonzalez



LEGEND

(blue line)	BROOK MINE PERMIT BOUNDARY
(purple line)	BIG HORN MINE PERMIT BOUNDARY (PERMIT NO. 213-T7)
578409-MST-UB ☒	UNDERBURDEN MONITOR WELL
578415-CRN-MST ⊕	COAL MONITOR WELL
578418-AL ▲	ALLUVIAL MONITOR WELL
578420-CRN-PUMP ⊕	CARNEY PUMPING WELL
USGS 06299980 ⊗	USGS GAGING STATION
578415-SPL-1 ●	SPOIL MONITOR WELL

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) JEFFREY G. BARRON 13033 WYOMING
DATE 12/13/2019

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 20'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
12/19	ROUND 11 COMMENTS

EXHIBIT D6.2-1

PREMINE MONITOR WELL LOCATIONS

TFN6 2/025
RECD DEC 13, 2019

Drawn By: DCJ
Checked By: JGB
Date: 6-6-13

FILE: D6-2-1_MON_LOC.dwg

WWC ENGINEERING
www.wwcengineering.com

R.85 W. R.84 W.

T. 58 N.
T. 57 N.

578512-MST 3821
578510-MST 3821
578511-MST 3746
578513-MST 3742
578418-MST 3701
578408-MST 3784
578417-MST 3768
578409-MST 3611
578415-CRN-MST 3492

3840 3820 3800 3780 3760 3740 3720 3700 3680 3660 3640 3620 3600 3580 3560 3540 3520 3500 3480

Slater Creek
East Fork Earley Creek
Dart Draw
Hidden Water Creek
Tongue River
Tongue River Ditch
Burlington Northern
Monarch
Kleenburg
Acme
Gravel Pit
Oil Well
Oil Wells
Strip Mine
Drill Hole
Rest Area
Radio Tower
Cem
BM 3707
BM 3676
BM 3670
BM 3641
BM 3634
BM 3623
BM 3644
BR 3686
Goose Creek
North Fork Dry Creek

R.85 W. R.84 W.

LEGEND

- BROOK MINE PERMIT BOUNDARY
- POTENTIOMETRIC CONTOUR
- POTENTIOMETRIC CONTOUR (INFERRED)
- D / U — FAULT LOCATION - APPROXIMATE
- FAULT LOCATION - INFERRED
- FAULT LOCATION - CONCEALED
- 578408-MST 3784 — MASTERS SEAM MONITOR WELL WITH OBSERVED WATER LEVEL

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) — JEFFREY G. BARRON — 13033 — STATE OF WYOMING
DATE: 3/11/2019

N

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 20'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR, STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
08/18	ROUND 7 COMMENTS
2/19	ROUND 8 COMMENTS

EXHIBIT D6.2-2

MASTERS SEAM
PREMINE POTENTIOMETRY

TFNS 9/025
RECD MAR 04 2019

Drawn By: DCJ
Checked By: JGB
Date: 6-6-13

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-2-2_MASTERS_POT.dwg

R.85 W. R.84 W.

T. 58 N.

T. 57 N.

578511-CRN 3776

578513-CRN 3733

578408-CRN 3803

578417-CRN 3796

578418-CRN 3738

578409-CRN 3622

578415-CRN-MST 3492

578524-CRN-PUMP 3659

578420-CRN-PUMP 3626

P62333.OW 3727

P106680.OW 3610

P63975.OW 3640

Slater Creek

East Fork Dart Draw

Hidden Water Creek

Tongue River

Burlington Northern

Goose Creek

Monarch

Kleenburg

Acme

Monarch Dam

Rest Area

Gravel Pit

Oil Wells

Strip Mine

Drill Hole

R.85 W. R.84 W.

LEGEND

- BROOK MINE PERMIT BOUNDARY
- POTENTIOMETRIC CONTOUR
- POTENTIOMETRIC CONTOUR (INFERRED)
- FAULT LOCATION - INFERRED
- FAULT LOCATION - CONCEALED
- EDGE OF SATURATION ZONE OF COAL SEAM
- APPROXIMATE LOCATION OF CARNEY SPLIT
- APPROXIMATE OUTCROP LINE

D / U — FAULT LOCATION - APPROXIMATE

578417-CRN 3796 — CARNEY SEAM MONITOR WELL WITH OBSERVED WATER LEVEL

P106680.OW 3610 — SEO MONITOR WELL WITH OBSERVED WATER LEVEL

NOTE:
P106680.0W WELL COMPLETED IN CARNEY SEAM. WATER LEVEL ELEVATION IS APPROXIMATE.

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) JEFFREY G. BARRON 13033 WYOMING

DATE: 3/7/2019

GRAPHIC SCALE (FEET) 0 500 1,000 1,500 2,000 C.I. = 20'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR, STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS

EXHIBIT D6.2-3

TFNS 2/025
RECD MAR 04, 2019

CARNEY SEAM
PREMINE POTENTIOMETRY

Drawn By: DCJ
Checked By: JGB
Date: 10-15-14

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-2-3_CARNEY_POT.dwg

DEQ Ex. 3-159

R.85 W. R.84 W.

T. 57 N.

E. 1370000 E. 1380000 E. 1390000 E. 1400000

N. 1940000 N. 1930000 N. 1920000

R-12001 R-12002 R-12003 R-12004 R-12005 R-12007 R-12008 R-12009-A R-12010 R-12011 R-12012 R-12013 R-12014 R-12015 R-12018D R-12019D R-12020 R13-011 R13-012 R13-016 R13-018 R13-019 R13-020 R13-023 R13-026 R-12006 578513-OVB-1 AMBRE-02 AMBRE-03 AMBRE-04 578415-SPL-1 578415-SPL-2

BIGHORN MINE
CONABLE PROSPECT MINE
KLEENBURN COAL TIPPLE MINE
MASTERS MINE
RIVERSIDE MINE
BLACK MOUNTAIN MINE
ACME NUMBER THREE MINE
CARNEY MINE NUMBER FORTY-FOUR
ACME NUMBER ONE MINE
ACME NUMBER TWO MINE
ACME NUMBER FORTY-TWO MINE
BIGHORN MINE
BIG HORN NUMBER ONE MINE
TONGUE RIVER STONE COMPANY MINE
MODEL MINE
HOTCHKISS NUMBER TWO MINE
ZOWADA PIT AND PLACHET PIT MINE
NEW ACME MINE
WELCH MINE
WELCH STRIP MINE
GUERNSEY STONE QUARRY
KOOI NUMBER FORTY-SIX MINE
OLD MONARCH MINE
MONARCH NUMBER FIVE MINE
BUFFALO STRIP MINE
NEW MONARCH MINE
DIETZ NUMBER ONE MINE
DIETZ NUMBER FIVE AND EIGHT MINE
DIETZ MINE
DIETZ NUMBER FOUR MINE
DIETZ NUMBER TWO MINE

LEGEND

- BROOK MINE PERMIT BOUNDARY
- BIG HORN COAL PERMIT BOUNDARY (PERMIT NO. 213-T7)
- TAYLOR QUARRY PERMIT BOUNDARY (PERMIT NO. SP-757)
- CARNEY SEAM REMOVED BY HISTORIC MINING
- DIETZ MINE — HISTORIC MINE LOCATION
- R-12011 — EXPLORATION BOREHOLE
- 578513-OVB-1 — OVERBURDEN PIEZOMETER
- DRY OVERBURDEN ZONE
- PARTIALLY SATURATED OVERBURDEN ZONE
- SATURATED OVERBURDEN ZONE

NOTES:
1. AN AQUIFER FOR THIS APPLICATION IS DEFINED AS A DRILLED HOLE CAPABLE OF PRODUCING 0.5 GPM OR GREATER.
2. SEE ADDENDUM D5-3 EXHIBIT 1 FOR FAULT LOCATIONS.

N

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 5'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR, STE. 201
SHERIDAN, WY 82801

REVISIONS

Date	Description

EXHIBIT D6.2-4

TFNS 3/025
RECD MAR 04,2019
09

OVERBURDEN AQUIFER WATER SATURATION ZONES

Drawn By: DCJ
Checked By: JGB
Date: 06/18

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-2-4_OVB_SAT.dwg

K:\Sheridan\RAMACO\131397\ACAD_WYSE\D6\D6-2-4_OVB_SAT.dwg 3/2/2019 2:27:19 PM jgill

DEQ Ex. 3-160

R.85 W. R.84 W.

T. 57 N.

E. 1370000 E. 1380000 E. 1390000 E. 1400000

N. 1950000 N. 1940000 N. 1930000 N. 1920000

BIGHORN MINE
CONABLE PROSPECT MINE
KLEENBURN COAL TIPPLE MINE
MASTERS MINE
RIVERSIDE MINE
BLACK MOUNTAIN MINE
ACME NUMBER THREE MINE
CARNEY MINE NUMBER FORTY-FOUR
ACME NUMBER ONE MINE
ACME NUMBER TWO MINE
ACME NUMBEF FORTY-TWO MINE
BIG HORN NUMBER ONE MINE
TONGUE RIVER STONE COMPANY MINE
MODEL MINE
HOTCHKISS NUMER TWO MINE
ZOWADA PIT AND PLACHET PIT MINE
NEW ACME MINE
WELCH MINE
WELCH STRIP MINE
GUERNSEY STONE QUARRY
KOOI NUMBER FORTY-SIX MINE
OLD MONARCH MINE
MONARCH NUMBER FIVE MINE
BUFFALO STRIP MINE
NEW MONARCH MINE
DIETZ NUMBER ONE MINE
DIETZ NUMBER FIVE AND EIGHT MINE
DIETZ MINE
DIETZ NUMBER FOUR MINE
DIETZ NUMBER TWO MINE

R-12001 R-12001-CORE 578510-MST 578510-CRN
R-12002 R-12002-CORE
R-12003 R-12003-CORE
R-12004 R-12004-CORE
R13-024 R-13-024/CORE
578511-CRN 578511-MST
R-12005 R-12005-CORE
R12007 R-12007C-CORE
R-12008 R-12008-CORE
R-12018D R-12018D-CORE
R-12020 R-12020-CORE
578513-MST 578513-CRN
R-12011 R-12011-CORE
R-12009-J
R-12012 R-12012-CORE 578512-MST 578512-CRN
R-12010
R-12014
R-12013
R-12015 R-12015-CORE
R-12019D R-12019D-CORE
578418-MST 578418-CRN
R-12006 R-12006-CORE
R-13-020
OG-04
R13-012 R13-012/CORE 578417-MST 578417-CRN
R13-023 R13-023/CORE
OG-03
OG-05
R13-016
R13-018 R13-018/CORE 578408-MST 578408-CRN
R13-019 R13-019/CORE
OG-06
OG-08
OG-07
AMB-02-CORE-MASTERS
AMBRE-02
AMBRE-03
AMBRE-04
578409-CRN
OG-02
OG-10
578415-CRN/MST
R13-026 R13-026/CORE
R13-025 R13-025/CORE
OG-22
OG-23
AMBRE-05
AMBRE-06
AMBRE-07
AMBRE-10
AMBRE-09
AMBRE-11
AMBRE-01
OG-11
OG-01
OG-09
OG-20
3305031

LEGEND

- BROOK MINE PERMIT BOUNDARY
- BIG HORN COAL PERMIT BOUNDARY (PERMIT NO. 213-T7)
- TAYLOR QUARRY PERMIT BOUNDARY (PERMIT NO. SP-757)
- CARNEY NO COAL LINE
- CARNEY SEAM REMOVED BY HISTORIC MINING
- HISTORIC MINE LOCATION
- R-12011 EXPLORATION BOREHOLE
- 578418-CRN MONITOR WELL
- R13-011/CORE CORE LOCATION
- OG-03 OIL AND GAS COMMISSION WELL
- BE320-78 HISTORIC EXPLORATION BOREHOLE
- DRY CARNEY ZONE
- PARTIALLY SATURATED CARNEY ZONE
- SATURATED CARNEY ZONE

NOTES:
1. AN AQUIFER FOR THIS APPLICATION IS DEFINED AS A DRILLED HOLE CAPABLE OF PRODUCING 0.5 GPM OR GREATER.
2. SEE ADDENDUM D5-3 EXHIBIT 1 FOR FAULT LOCATIONS.
3. SATURATION MAPPING WITHIN HISTORIC MINE AREAS IS INFERRED.

GRAPHIC SCALE (FEET) 0 500 1,000 1,500 2,000 C.I. = 5'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR, STE. 201
SHERIDAN, WY 82801

REVISIONS

Date	Description
02/19	ROUND 8 COMMENTS

EXHIBIT D6.2-5

TFN 8 2/025
RECD MAR 04, 2019
10

CARNEY SEAM WATER SATURATION ZONES

Drawn By: MBM
Checked By: JGB
Date: 2/8/18

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-2-5_CARNEY_SAT.dwg

K:\Sheridan\Projects\20131393\CAD_WWE\ENGINEERING\D6_SERIOUS\D6_2_CARNEY_SAT.dwg 8/2/2018 2:11:49 PM jgill admin

DEQ Ex. 3-161

R.85 W. R.84 W.

T. 57 N.

R-12001 578510-MST R-12002 R-12003 R-12004 R13-024 R12007 578511-MST R-12018D R-12008 R-12020 R-12005 R-12009-A R-12019D R-12015 R-12006 578418-MST R-12011 578513-MST R-12012 578512-MST R-12014 R-12010 R-12013 R-13-020 R13-016 R13-018 578408-MST R13-019 R13-012 578417-MST R13-011 R13-023 R13-026 AMBRE-02 AMBRE-03 AMBRE-04 578409-MST AMBRE-05 AMBRE-06 AMBRE-07 AMBRE-10 AMBRE-09 AMBRE-11 AMBRE-01 578421-3-MAS 578415-CRN/MST

BIGHORN MINE
CONABLE PROSPECT MINE
KLEENBURN COAL TIPPLE MINE
MASTERS MINE
RIVERSIDE MINE
BLACK MOUNTAIN MINE
ACME NUMBER THREE MINE
CARNEY MINE NUMBER FORTY-FOUR
ACME NUMBER ONE MINE
ACME NUMBER TWO MINE
ACME NUMBER FORTY-TWO MINE
BIGHORN MINE
BIG HORN NUMBER ONE MINE
TONGUE RIVER STONE COMPANY MINE
MODEL MINE
HOTCHKISS NUMBER TWO MINE
ZOWADA PIT AND PLACHET PIT MINE
NEW ACME MINE
DIETZ NUMBER FIVE AND EIGHT MINE
DIETZ NUMBER ONE MINE
DIETZ MINE
DIETZ NUMBER FOUR MINE
DIETZ NUMBER TWO MINE
WELCH MINE
WELCH STRIP MINE
GUERNSEY STONE QUARRY
KOOI NUMBER FORTY-SIX MINE
OLD MONARCH MINE
MONARCH NUMBER FIVE MINE
BUFFALO STRIP MINE
NEW MONARCH MINE

E. 1370000 E. 1380000 E. 1390000 E. 1400000
N. 1950000 N. 1940000

R.85 W. R.84 W.

LEGEND

- BROOK MINE PERMIT BOUNDARY
- BIG HORN COAL PERMIT BOUNDARY (PERMIT NO. 213-T7)
- TAYLOR QUARRY PERMIT BOUNDARY (PERMIT NO. SP-757)
- MASTER COAL SEAM OUTCROP LINE
- CARNEY SEAM REMOVED BY HISTORIC MINING
- DIETZ MINE — HISTORIC MINE LOCATION
- R-12011 — EXPLORATION BOREHOLE
- 578418-CRN — MONITOR WELL
- BE278-78 — HISTORIC DRILLHOLE
- DRY UNDERBURDEN ZONE
- PARTIALLY SATURATED UNDERBURDEN ZONE
- SATURATED UNDERBURDEN ZONE

NOTES:
1. AN AQUIFER FOR THIS APPLICATION IS DEFINED AS A DRILLED HOLE CAPABLE OF PRODUCING 0.5 GPM OR GREATER.
2. SEE ADDENDUM D5-3 EXHIBIT 1 FOR FAULT LOCATIONS.

N

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 5'

RAMACO
BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR, STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
02/19	ROUND 8 COMMENTS

EXHIBIT D6.2-6

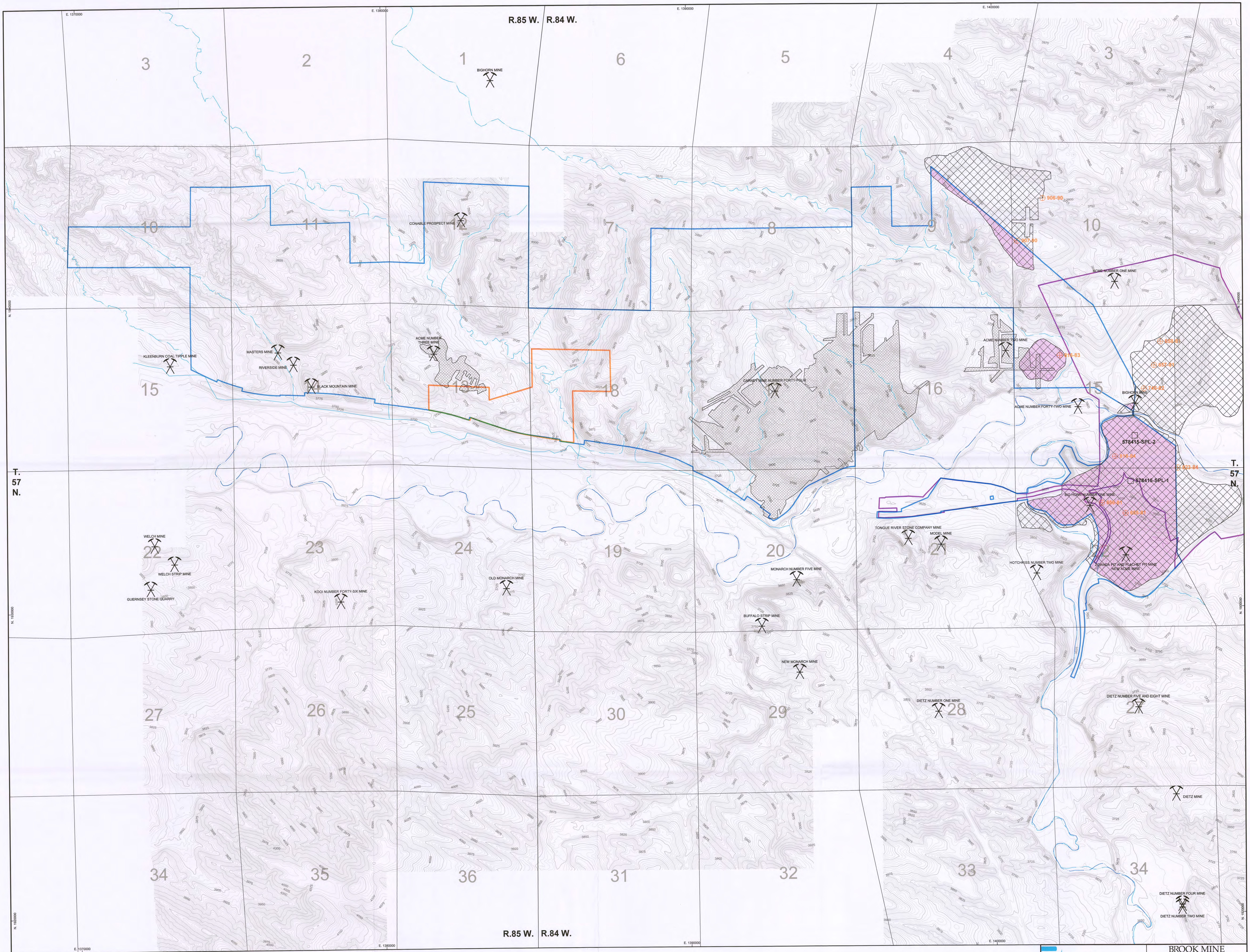
TFNS 2/025
RECD MAR 04, 2019

UNDERBURDEN (MASTER COAL SEAM) AQUIFER WATER SATURATION ZONES

Drawn By: DCJ
Checked By: JGB
Date: 06/18

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-2-6_UNDERBURDEN_SAT.dwg



LEGEND

- BROOK MINE PERMIT BOUNDARY
- BIG HORN COAL PERMIT BOUNDARY (PERMIT NO. 213-T7)
- TAYLOR QUARRY PERMIT BOUNDARY (PERMIT NO. SP-757)
- 578415-SPL-2 MONITOR WELL
- 657-81 BIG HORN COAL SPOIL MONITORING WELL
- CARNEY SEAM REMOVED BY HISTORIC MINING
- DIETZ MINE HISTORIC MINE LOCATION
- PARTIALLY SATURATED SPOIL ZONE
- BIG HORN COAL RECLAIMED BACKFILLED SPOIL

NOTES:
1. AN AQUIFER FOR THIS APPLICATION IS DEFINED AS A DRILLED HOLE CAPABLE OF PRODUCING 0.5 GPM OR GREATER.
2. SEE ADDENDUM D5-3 EXHIBIT 1 FOR FAULT LOCATIONS.
3. BIG HORN COAL SPOILS MAPPED FROM 2002 GROUNDAWTER RESTORATION DEMONSTRATION.

GRAPHIC SCALE (FEET) 0 500 1,000 1,500 2,000
C.I. = 5'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
02/19	ROUND 8 COMMENTS

EXHIBIT D6.2-7

TFN6 2/025
RECD MAR 04, 2019

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SPOIL AQUIFER WATER SATURATION ZONES

Drawn By: DCJ
Checked By: JGB
Date: 06/18

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-2-7_SPOIL_SAT.dwg

R.85 W. R.84 W.

T. 57 N.

E. 1370000 E. 1380000 E. 1390000 E. 1400000

N. 1940000 N. 1930000 N. 1920000

BIGHORN MINE
CONABLE PROSPECT MINE
578512-AL
578513-AL
578418-AL
ACME NUMBER THREE MINE
KLEENBURN COAL TIPPLE MINE
MASTERS MINE
RIVERSIDE MINE
BLACK MOUNTAIN MINE
CARNEY MINE NUMBER FORTY-FOUR
ACME NUMBER ONE MINE
ACME NUMBER TWO MINE
ACME NUMBER FORTY-TWO MINE
BIGHORN MINE
BIG HORN NUMBER ONE MINE
TONGUE RIVER STONE COMPANY MINE
MODEL MINE
HOTCHKISS NUMBER TWO MINE
TOWADA PIT AND PLACHET PIT MINE
NEW ACME MINE
WELCH MINE
WELCH STRIP MINE
GUERNSEY STONE QUARRY
KOOI NUMBER FORTY-SIX MINE
OLD MONARCH MINE
MONARCH NUMBER FIVE MINE
BUFFALO STRIP MINE
NEW MONARCH MINE
DIETZ NUMBER ONE MINE
DIETZ NUMBER FIVE AND EIGHT MINE
DIETZ MINE
DIETZ NUMBER FOUR MINE
DIETZ NUMBER TWO MINE

LEGEND

- BROOK MINE PERMIT BOUNDARY
- BIG HORN COAL PERMIT BOUNDARY (PERMIT NO. 213-T7)
- TAYLOR QUARRY PERMIT BOUNDARY (PERMIT NO. SP-757)
- 578418-AL MONITOR WELL - ALLUVIUM
- CARNEY SEAM REMOVED BY HISTORIC MINING
- DIETZ MINE HISTORIC MINE LOCATION
- PARTIALLY SATURATED SLATER CREEK ALLUVIUM ZONE

NOTES:
1. AN AQUIFER FOR THIS APPLICATION IS DEFINED AS A DRILLED HOLE CAPABLE OF PRODUCING 0.5 GPM OR GREATER.
2. SEE ADDENDUM D5-3 EXHIBIT 1 FOR FAULT LOCATIONS.

N

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 5'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR, STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description

EXHIBIT D6.2-8

TFNS 3/025
RECD MAR 04 2019
13

SLATER CREEK
ALLUVIUM AQUIFER WATER
SATURATION ZONES

Drawn By: DCJ
Checked By: JGB
Date: 06/18

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-2-8_AVF_SAT.dwg

K:\Sheridan\RAMACO\131199\ACAD_WYMEC\DWG\D6\D6-2-8_AVF_SAT.dwg 6/20/2018 2:23:29 PM jeff.kenner

DEQ Ex. 3-164

R.85 W. R.84 W.

SM578512-AL-1
3756.8
12-BH-2
12-BH-1
SM578512-SW-1
SM578513-AL-1
3717.1
13-BH-2
13-BH-1
18-BH-1
18-BH-2
SM578418-AL-1
3668.4
SM578418-SW-1
SM578409-SW-1
SM578415-SW-1
578415-AL-1
3624.3
578513-IRR-DITCH
578524-TR-1
578524-AL-1
3681.1
578420-AL-1
3624.6
578420-TR-1
578433-AL-1
3638.4
578434-GC-1
578434-AL-1
3645.3
578434-AL-2
3649.4
UPPER 10 STOCK RESERVOIR
WELCH #4 STOCK RESERVOIR
LEGERSKI #1 STOCK RESERVOIR
BLACK MOUNTAIN NO. 1 STOCK RESERVOIR
ENHANCEMENT STOCK POND 1
REPLACEMENT STOCK POND 1
PERMANENT IMPOUNDMENT #1 RESERVOIR
APPROXIMATE LOCATION OF FRENCH DRAIN
PIT 3 RESERVOIR
BIG HORN NO. 2 RESERVOIR
BIG HORN NO. 14 RESERVOIR
Kleenburg
Acme
Monarch
Stip Mine
Rest Area
Gravel Pit
Drill Hole
Dan Draw
East Fork Barley Creek
Barley Creek
Hidden Water Creek
TONGUE RIVER
BURLINGTON NORTHERN
Slater Creek
Goose Creek
North Fork Dry Creek
South Fork Dry Creek
T. 57 N.
R.85 W. R.84 W.

SOURCE: USDA/NAIP 2012 AERIAL PHOTOGRAPHY.

LEGEND

- BROOK MINE PERMIT BOUNDARY
- 1/2 MILE BUFFER BOUNDARY
- AERIAL EXTENT OF POTENTIAL ALLUVIAL VALLEY FLOORS
- DECLARED AVF AS PART OF STATE DECISION DOCUMENT FOR PERMIT 213-T1
- DECLARED AVF AS PART OF STATE DECISION DOCUMENT FOR PERMIT 497-T1
- 578434-GC-1 SURFACE WATER MONITORING STATION
- SM578418-AL-1 ALLUVIAL MONITORING WELL
- 13-BH-1 ALLUVIAL BORE HOLE
- BH536 3661.1 GROUND WATER MONITORING STATION

GRAPHIC SCALE (FEET): 0, 500, 1,000, 1,500, 2,000

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
02/19	ROUND 8 COMMENTS
12/19	ROUND 11 COMMENTS
01/2020	ROUND 12 COMMENTS

EXHIBIT D6.2-9

PREMINE POTENTIOMETRY OF TONGUE RIVER AND SLATER CREEK

TPHS 27025
RECD JAN 27, 2020

Drawn By: RAV
Checked By: JGB
Date: 8/25/2014

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-2_9_RIVER_POT.dwg

DEQ Ex. 3-165

Scanned, 02/28/2020

ADDENDUM D6-1

HEC-HMS Model

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

HEC-HMS INPUTS

TFN 6 2/025
RECD NOV 14,2014

Scanned, 02/28/2020


```
Basin: Sheridan_Mine
     Last Modified Date: 2 May 2014
     Last Modified Time: 15:15:00
     Version: 3.5
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Allow Blending: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Subbasin: SCSBranch
     Canvas X: -7504.761904761905
     Canvas Y: 3895.2380952380954
     Label X: -19.0
     Label Y: 20.0
     Area: 3.71
     Downstream: SCBRANCH_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0

     Transform: SCS
     Lag: 153.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: SCNBranch
     Canvas X: -5409.523809523809
     Canvas Y: 4504.761904761905
     Area: 2.40
     Downstream: SCBRANCH_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0
```

TFN 6 2/025
RECD NOV 14,2014

Scanned, 02/28/2020


```
     Transform: SCS
     Lag: 108.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCBRANCH_R
     Canvas X: -5504.761904761905
     Canvas Y: 1952.3809523809523
     From Canvas X: -6304.761904761905
     From Canvas Y: 3552.3809523809523
     Downstream: SC3_R

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 12676
     Energy Slope: 0.011
     Width: 30
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SC3
     Canvas X: -6742.857142857143
     Canvas Y: 2047.6190476190477
     Label X: -1.0
     Label Y: -2.0
     Area: 2.95
     Downstream: SC3_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0

     Transform: SCS
     Lag: 117.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SC3_R
     Canvas X: -4438.095238095238
     Canvas Y: 1019.0476190476184
     From Canvas X: -5504.761904761905
```

TFN 6 2/025
DECD NOV 14,2014

Scanned, 02/28/2020


```
     From Canvas Y: 1952.3809523809523
     Downstream: SC2_R

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 10310
     Energy Slope: 0.0097
     Width: 30
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SC2
     Canvas X: -6190.476190476191
     Canvas Y: 657.1428571428569
     Area: 3.81
     Downstream: SC2_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0

     Transform: SCS
     Lag: 119.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SC2_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -4438.095238095238
     From Canvas Y: 1019.0476190476184
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 23923
     Energy Slope: 0.0071
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:
```

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020


```
Subbasin: SC1
     Canvas X: -3161.9047619047615
     Canvas Y: -1800.0
     Area: 1.98
     Downstream: SC_Out

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0

     Transform: SCS
     Lag: 214.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: SCSub1
     Canvas X: -247.6190476190477
     Canvas Y: 2428.5714285714284
     Area: 0.42
     Downstream: SCS1_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 77
     Initial Abstraction: 0

     Transform: SCS
     Lag: 44.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS1_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -571.4285714285716
     From Canvas Y: 1704.7619047619046
     Label X: 1.0
     Label Y: 38.0
     Downstream: SC_Out

     Route: Muskingum Cunge
```

TFN 6 2/025
RECD NOV 14,2014

Scanned, 02/28/2020


```
     Channel: Trapezoid
     Length: 4555
     Energy Slope: 0.0110
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SCSub2
     Canvas X: -1600.0
     Canvas Y: 2657.142857142857
     Area: 0.41
     Downstream: SCS2_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 75
     Initial Abstraction: 0

     Transform: SCS
     Lag: 30.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS2_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -1771.4285714285716
     From Canvas Y: 1857.1428571428569
     Label X: -26.0
     Label Y: 23.0
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 7487
     Energy Slope: 0.0087
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SCSub4
     Canvas X: -6171.428571428572
```

TEN 6 2/025
RECD NOV 14,2014

Scanned, 02/28/2020


```
     Canvas Y: -504.7619047619046
     Label X: -2.0
     Label Y: 0.0
     Area: 0.34
     Downstream: SCS4_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 84
     Initial Abstraction: 0

     Transform: SCS
     Lag: 40.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS4_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -4971.428571428572
     From Canvas Y: -314.2857142857147
     Label X: -42.0
     Label Y: -14.0
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 18990
     Energy Slope: 0.0076
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SCSub3
     Canvas X: -3276.190476190476
     Canvas Y: 2619.047619047619
     Area: 0.31
     Downstream: SCS3_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
```

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020


```
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 39.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS3_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -2990.476190476191
     From Canvas Y: 1914.2857142857142
     Label X: -35.0
     Label Y: 1.0
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 13461
     Energy Slope: 0.0074
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SCSub5
     Canvas X: 476.19047619047706
     Canvas Y: 1323.8095238095239
     Area: 0.13
     Downstream: SCS5_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 75
     Initial Abstraction: 0

     Transform: SCS
     Lag: 28.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS5_R
     Canvas X: -1980.9523809523807
```

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020


```
     Canvas Y: -1285.7142857142862
     From Canvas X: -228.57142857142844
     From Canvas Y: 542.8571428571431
     Label X: -12.0
     Label Y: 5.0
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 1166
     Energy Slope: 0.0214
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: SC_Out
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     Label X: 0.0
     Label Y: 1.0
     Downstream: TONGUE_RIVER
End:

Subbasin: EF EC
     Canvas X: -7662.60162601626
     Canvas Y: -2947.1544715447153
     Label X: 13.0
     Label Y: -5.0
     Area: 1.84
     Downstream: TONGUE_RIVER

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 87
     Initial Abstraction: 0

     Transform: SCS
     Lag: 119.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD5
     Canvas X: -6585.365853658536
     Canvas Y: -2398.373983739837
     Area: 0.93
```

TFN 6 2/025
RECD NOV 14,2014

Scanned, 02/28/2020


```
     Downstream: TONGUE_RIVER

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 84
     Initial Abstraction: 0

     Transform: SCS
     Lag: 59.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD3
     Canvas X: 345.5284552845533
     Canvas Y: -1260.162601626016
     Area: 0.59
     Downstream: TONGUE_RIVER

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 71
     Initial Abstraction: 0

     Transform: SCS
     Lag: 75.2
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TR_Sub1
     Canvas X: 1599.496221662469
     Canvas Y: -1020.1511335012592
     Label X: 2.0
     Label Y: -5.0
     Area: 0.52
     Downstream: TONGUE_RIVER

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
```

TFN 6 2/025
RECD NOV 14,2014

Scanned, 02/28/2020


```
     Curve Number: 74
     Initial Abstraction: 0

     Transform: SCS
     Lag: 36.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD2
     Canvas X: 1422.7642276422757
     Canvas Y: -731.707317073171
     Area: 0.51
     Downstream: TONGUE_RIVER

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 73
     Initial Abstraction: 0

     Transform: SCS
     Lag: 71.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD4
     Canvas X: -5284.552845528455
     Canvas Y: -1849.5934959349588
     Area: 0.27
     Downstream: TONGUE_RIVER

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 83
     Initial Abstraction: 0

     Transform: SCS
     Lag: 35.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:
```

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020


```
Subbasin: TR_Sub2
     Canvas X: 2662.6016260162596
     Canvas Y: -792.6829268292686
     Label X: 3.0
     Label Y: 1.0
     Area: 0.24
     Downstream: TONGUE_RIVER

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 72
     Initial Abstraction: 0

     Transform: SCS
     Lag: 71.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD1
     Canvas X: -447.1544715447153
     Canvas Y: -650.4065040650403
     Label X: 4.0
     Label Y: 1.0
     Area: 0.04
     Downstream: TONGUE_RIVER

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 72
     Initial Abstraction: 0

     Transform: SCS
     Lag: 14.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: TONGUE_RIVER
     Canvas X: -894.3089430894306
     Canvas Y: -4146.341463414634
End:

Subbasin: HWC3
```

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```
     Canvas X: 438.0952380952385
     Canvas Y: 4200.0
     Area: 3.29
     Downstream: HWCUpper

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 126.0
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCUpper
     Canvas X: 2012.1951219512193
     Canvas Y: 2399.6515679442505
     From Canvas X: 457.1428571428569
     From Canvas Y: 3761.904761904762
     Label X: -22.0
     Label Y: 18.0
     Downstream: HWCLower

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 12103
     Energy Slope: 0.0112
     Width: 20
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWC2
     Canvas X: 2628.5714285714294
     Canvas Y: 3076.190476190476
     Area: 3.19
     Downstream: HWCLower

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
```

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```
     Initial Abstraction: 0

     Transform: SCS
     Lag: 124.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCLower
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 2012.1951219512193
     From Canvas Y: 2399.6515679442505
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 12103
     Energy Slope: 0.0148
     Width: 25
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWC1
     Canvas X: 4152.380952380952
     Canvas Y: -1476.1904761904761
     Label X: 3.0
     Label Y: -2.0
     Area: 0.81
     Downstream: HWC_Out

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 106.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: HWCSub1
     Canvas X: 1142.8571428571431
     Canvas Y: 238.09523809523762
```

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```
     Area: 0.19
     Downstream: HWCS1_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 26.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS1_R
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 2247.6190476190477
     From Canvas Y: 180.95238095238074
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 9170
     Energy Slope: 0.0147
     Width: 25
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWCSub4
     Canvas X: 5752.380952380952
     Canvas Y: 3819.0476190476193
     Area: 0.18
     Downstream: HWCS4_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 75
     Initial Abstraction: 0

     Transform: SCS
     Lag: 34.8
```

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```
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS4_R
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 5447.619047619048
     From Canvas Y: 3057.142857142857
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 8604
     Energy Slope: 0.0145
     Width: 25
     Side Slope: 4
     Mannings n: 0.030
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWCSub2
     Canvas X: 6971.4285714285725
     Canvas Y: 657.1428571428569
     Area: 0.14
     Downstream: HWCS2_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 77
     Initial Abstraction: 0

     Transform: SCS
     Lag: 20.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS2_R
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 6380.952380952382
     From Canvas Y: 180.95238095238074
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
```

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```
     Length: 6582
     Energy Slope: 0.0152
     Width: 25
     Side Slope: 4
     Mannings n: 0.030
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWCSub5
     Canvas X: 3695.2380952380954
     Canvas Y: 4428.571428571428
     Area: 0.12
     Downstream: HWCS5_R

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 19.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS5_R
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 4209.523809523809
     From Canvas Y: 3838.095238095238
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 11153
     Energy Slope: 0.0148
     Width: 25
     Side Slope: 4
     Mannings n: 0.030
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWCSub3
     Canvas X: 6476.190476190477
     Canvas Y: 2752.3809523809523
     Area: 0.07
     Downstream: HWCS3_R
```

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```
     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 25.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS3_R
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 5980.952380952382
     From Canvas Y: 2009.5238095238096
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 7721
     Energy Slope: 0.0149
     Width: 25
     Side Slope: 4
     Mannings n: 0.030
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: HWC_Out
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
End:

Subbasin: GC1
     Canvas X: 6422.764227642276
     Canvas Y: -3821.1382113821146
     Area: 0.34
     Downstream: GOOSE_CREEK

     Canopy: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 81
     Initial Abstraction: 0
```

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```
     Transform: SCS
     Lag: 55.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: GOOSE_CREEK
     Canvas X: 4796.747967479674
     Canvas Y: -3211.382113821139
End:

Basin Schematic Properties:
     Last View N: 5000.0
     Last View S: -5000.0
     Last View W: -5000.0
     Last View E: 5000.0
     Maximum View N: 5000.0
     Maximum View S: -5000.0
     Maximum View W: -5000.0
     Maximum View E: 5000.0
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Yes
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
     Fix Element Locations: No
     Fix Hydrologic Order: No
End:
```

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HEC-HMS RESULTS

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2-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	95.7	01Jun2014, 14:27	33.3
GC1	0.34	21.1	01Jun2014, 13:18	4.6
GOOSE_CREEK	0.34	21.1	01Jun2014, 13:18	4.6
HWCLower	6.48	193.9	01Jun2014, 15:12	68.9
HWCSub1	0.19	15.1	01Jun2014, 12:48	2.0
HWCSub2	0.14	13.4	01Jun2014, 12:45	1.6
HWCSub3	0.07	5.7	01Jun2014, 12:48	0.8
HWCSub4	0.18	11.8	01Jun2014, 12:57	1.9
HWCSub5	0.12	11.5	01Jun2014, 12:42	1.3
HWCS1_R	0.19	15.1	01Jun2014, 13:30	2.1
HWCS2_R	0.14	13.3	01Jun2014, 13:15	1.6
HWCS3_R	0.07	5.7	01Jun2014, 13:42	0.8
HWCS4_R	0.18	11.7	01Jun2014, 13:42	1.9
HWCS5_R	0.12	14.2	01Jun2014, 13:39	1.3
HWCUpper	3.29	99.8	01Jun2014, 15:03	35.0
HWC_Out	7.99	229.5	01Jun2014, 15:00	85.2
HWC1	0.81	27.0	01Jun2014, 14:18	8.7
HWC2	3.19	97.8	01Jun2014, 14:33	33.9
HWC3	3.29	99.9	01Jun2014, 14:33	35.0
SCBRANCH_R	6.11	197.4	01Jun2014, 15:03	74.1
SCNBranch	2.40	90.5	01Jun2014, 14:18	29.2
SCSBranch	3.71	113.0	01Jun2014, 15:00	44.9
SCSub1	0.42	23.8	01Jun2014, 13:09	4.5
SCSub2	0.41	29.0	01Jun2014, 12:54	4.2
SCSub3	0.31	19.3	01Jun2014, 13:03	3.3
SCSub4	0.34	29.7	01Jun2014, 13:03	5.3
SCSub5	0.14	10.4	01Jun2014, 12:51	1.4
SCS1_R	0.42	23.8	01Jun2014, 13:33	4.5
SCS2_R	0.41	28.8	01Jun2014, 13:33	4.2
SCS3_R	0.31	19.9	01Jun2014, 14:15	3.4
SCS4_R	0.34	32.3	01Jun2014, 14:36	5.3
SCS5_R	0.14	10.4	01Jun2014, 12:57	1.4
SC_Out	16.45	497.6	01Jun2014, 15:36	197.7
SC1	1.96	47.1	01Jun2014, 15:42	22.8
SC2	3.81	135.1	01Jun2014, 14:27	46.1
SC2_R	12.87	419.7	01Jun2014, 15:45	156.0
SC3	2.95	105.9	01Jun2014, 14:27	35.8
SC3_R	9.06	296.7	01Jun2014, 15:09	109.9
TONGUE_RIVER	21.38	595.6	01Jun2014, 15:18	266.6
TRD1	0.03	2.8	01Jun2014, 12:39	0.3
TRD2	0.51	20.3	01Jun2014, 13:36	5.0
TRD3	0.59	19.9	01Jun2014, 13:42	5.2
TRD4	0.27	24.5	01Jun2014, 12:57	4.0
TRD5	0.93	58.8	01Jun2014, 13:27	13.7
TR_Sub1	0.52	31.5	01Jun2014, 13:00	5.1
TR_Sub2	0.24	8.7	01Jun2014, 13:39	2.2

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2-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	194.2	01Jun2014, 22:00	73.7
GC1	0.34	48.4	01Jun2014, 20:51	10.6
GOOSE_CREEK	0.34	48.4	01Jun2014, 20:51	10.6
HWCLower	6.48	407.5	01Jun2014, 22:39	167.0
HWCSub1	0.19	37.0	01Jun2014, 20:18	4.9
HWCSub2	0.14	33.0	01Jun2014, 20:15	3.7
HWCSub3	0.07	13.8	01Jun2014, 20:18	1.8
HWCSub4	0.18	28.0	01Jun2014, 20:27	4.5
HWCSub5	0.12	28.2	01Jun2014, 20:12	3.1
HWCS1_R	0.19	36.9	01Jun2014, 20:48	4.9
HWCS2_R	0.14	32.9	01Jun2014, 20:36	3.7
HWCS3_R	0.07	13.8	01Jun2014, 20:54	1.8
HWCS4_R	0.18	28.0	01Jun2014, 21:00	4.5
HWCS5_R	0.12	28.7	01Jun2014, 20:51	3.1
HWCUpper	3.29	209.1	01Jun2014, 22:33	84.8
HWC_Out	7.99	474.2	01Jun2014, 22:30	205.9
HWC1	0.81	58.3	01Jun2014, 21:48	20.9
HWC2	3.19	205.1	01Jun2014, 22:06	82.2
HWC3	3.29	209.2	01Jun2014, 22:09	84.8
SCBRANCH_R	6.11	400.7	01Jun2014, 22:33	176.3
SCNBranch	2.40	191.9	01Jun2014, 21:51	69.3
SCSBranch	3.71	228.8	01Jun2014, 22:39	107.1
SCSub1	0.42	59.6	01Jun2014, 20:39	11.2
SCSub2	0.41	69.4	01Jun2014, 20:24	10.2
SCSub3	0.31	45.7	01Jun2014, 20:33	8.0
SCSub4	0.34	69.1	01Jun2014, 20:33	12.0
SCSub5	0.13	23.4	01Jun2014, 20:21	3.2
SCS1_R	0.42	59.4	01Jun2014, 20:57	11.2
SCS2_R	0.41	68.8	01Jun2014, 20:51	10.2
SCS3_R	0.31	45.4	01Jun2014, 21:36	8.0
SCS4_R	0.34	73.4	01Jun2014, 21:45	12.0
SCS5_R	0.13	23.3	01Jun2014, 20:27	3.2
SC_Out	16.46	1022.4	01Jun2014, 23:06	473.2
SC1	1.98	95.0	01Jun2014, 23:48	57.1
SC2	3.81	284.0	01Jun2014, 22:03	110.0
SC2_R	12.87	870.6	01Jun2014, 23:09	371.4
SC3	2.95	222.3	01Jun2014, 22:00	85.1
SC3_R	9.06	608.8	01Jun2014, 22:39	261.5
TONGUE_RIVER	21.40	1253.9	01Jun2014, 22:54	632.0
TRD1	0.04	9.5	01Jun2014, 20:09	0.9
TRD2	0.51	43.9	01Jun2014, 21:09	11.8
TRD3	0.59	45.5	01Jun2014, 21:12	12.7
TRD4	0.27	57.6	01Jun2014, 20:30	9.1
TRD5	0.93	143.0	01Jun2014, 20:54	32.8
TR_Sub1	0.52	75.2	01Jun2014, 20:30	12.4
TR_Sub2	0.24	19.9	01Jun2014, 21:09	5.3

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5-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	171.0	01Jun2014, 14:24	60.7
GC1	0.34	39.2	01Jun2014, 13:18	8.7
GOOSE_CREEK	0.34	39.2	01Jun2014, 13:18	8.7
HWCLower	6.48	373.9	01Jun2014, 15:03	133.5
HWCSub1	0.19	28.9	01Jun2014, 12:48	4.0
HWCSub2	0.14	25.4	01Jun2014, 12:45	3.0
HWCSub3	0.07	11.0	01Jun2014, 12:48	1.5
HWCSub4	0.18	22.6	01Jun2014, 12:57	3.6
HWCSub5	0.12	21.9	01Jun2014, 12:42	2.5
HWCS1_R	0.19	28.8	01Jun2014, 13:24	4.0
HWCS2_R	0.14	25.4	01Jun2014, 13:09	3.0
HWCS3_R	0.07	10.9	01Jun2014, 13:30	1.5
HWCS4_R	0.18	22.5	01Jun2014, 13:33	3.6
HWCS5_R	0.12	22.3	01Jun2014, 13:24	2.5
HWCUpper	3.29	191.3	01Jun2014, 14:57	67.8
HWC_Out	7.99	442.3	01Jun2014, 14:54	165.0
HWC1	0.81	51.7	01Jun2014, 14:18	16.9
HWC2	3.19	187.3	01Jun2014, 14:33	65.7
HWC3	3.29	191.4	01Jun2014, 14:33	67.7
SCBRANCH_R	6.11	373.6	01Jun2014, 14:54	141.7
SCNBranch	2.40	170.7	01Jun2014, 14:15	55.8
SCSBranch	3.71	213.7	01Jun2014, 15:00	85.9
SCSub1	0.42	45.6	01Jun2014, 13:09	8.8
SCSub2	0.41	55.6	01Jun2014, 12:54	8.2
SCSub3	0.31	36.9	01Jun2014, 13:03	6.5
SCSub4	0.34	54.2	01Jun2014, 13:03	9.8
SCSub5	0.14	20.0	01Jun2014, 12:51	2.8
SCS1_R	0.42	45.5	01Jun2014, 13:27	8.8
SCS2_R	0.41	55.3	01Jun2014, 13:24	8.2
SCS3_R	0.31	36.7	01Jun2014, 14:03	6.5
SCS4_R	0.34	53.7	01Jun2014, 14:18	9.9
SCS5_R	0.14	19.9	01Jun2014, 12:57	2.8
SC_Out	16.45	947.4	01Jun2014, 15:21	378.5
SC1	1.96	89.8	01Jun2014, 15:39	43.9
SC2	3.81	255.2	01Jun2014, 14:27	88.1
SC2_R	12.87	803.0	01Jun2014, 15:30	298.4
SC3	2.95	200.0	01Jun2014, 14:24	68.5
SC3_R	9.06	564.1	01Jun2014, 15:00	210.2
TONGUE_RIVER	21.38	1159.6	01Jun2014, 15:03	507.2
TRD1	0.03	5.4	01Jun2014, 12:39	0.5
TRD2	0.51	39.2	01Jun2014, 13:36	9.8
TRD3	0.59	38.9	01Jun2014, 13:42	10.2
TRD4	0.27	45.1	01Jun2014, 12:57	7.5
TRD5	0.93	108.0	01Jun2014, 13:24	25.7
TR_Sub1	0.52	60.7	01Jun2014, 13:00	10.0
TR_Sub2	0.24	17.0	01Jun2014, 13:36	4.3

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5-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	298.3	01Jun2014, 22:00	112.3
GC1	0.34	77.0	01Jun2014, 20:51	16.7
GOOSE_CREEK	0.34	77.0	01Jun2014, 20:51	16.7
HWCLower	6.48	663.0	01Jun2014, 22:33	268.0
HWCSub1	0.19	60.2	01Jun2014, 20:18	7.9
HWCSub2	0.14	53.3	01Jun2014, 20:15	6.0
HWCSub3	0.07	22.5	01Jun2014, 20:18	2.9
HWCSub4	0.18	45.7	01Jun2014, 20:27	7.2
HWCSub5	0.12	45.9	01Jun2014, 20:12	5.0
HWCS1_R	0.19	60.0	01Jun2014, 20:45	7.9
HWCS2_R	0.14	53.1	01Jun2014, 20:33	6.0
HWCS3_R	0.07	22.4	01Jun2014, 20:48	2.9
HWCS4_R	0.18	45.6	01Jun2014, 20:54	7.2
HWCS5_R	0.12	45.1	01Jun2014, 20:45	5.0
HWCUpper	3.29	339.0	01Jun2014, 22:30	136.1
HWC_Out	7.99	771.6	01Jun2014, 22:27	330.5
HWC1	0.81	94.6	01Jun2014, 21:48	33.5
HWC2	3.19	332.7	01Jun2014, 22:06	131.9
HWC3	3.29	339.2	01Jun2014, 22:09	136.1
SCBRANCH_R	6.11	642.4	01Jun2014, 22:30	279.8
SCNBranch	2.40	307.7	01Jun2014, 21:48	109.9
SCSBranch	3.71	366.7	01Jun2014, 22:39	169.9
SCSub1	0.42	96.4	01Jun2014, 20:39	18.0
SCSub2	0.41	113.1	01Jun2014, 20:24	16.4
SCSub3	0.31	74.3	01Jun2014, 20:33	12.8
SCSub4	0.34	108.4	01Jun2014, 20:33	18.6
SCSub5	0.13	38.1	01Jun2014, 20:21	5.2
SCS1_R	0.42	96.2	01Jun2014, 20:54	18.0
SCS2_R	0.41	112.5	01Jun2014, 20:48	16.4
SCS3_R	0.31	73.6	01Jun2014, 21:27	12.8
SCS4_R	0.34	107.4	01Jun2014, 21:36	18.6
SCS5_R	0.13	37.9	01Jun2014, 20:24	5.2
SC_Out	16.46	1637.9	01Jun2014, 22:57	751.1
SC1	1.98	152.0	01Jun2014, 23:48	90.7
SC2	3.81	455.3	01Jun2014, 22:00	174.5
SC2_R	12.87	1405.3	01Jun2014, 23:00	589.4
SC3	2.95	356.3	01Jun2014, 22:00	135.1
SC3_R	9.06	979.5	01Jun2014, 22:33	414.9
TONGUE_RIVER	21.40	2024.2	01Jun2014, 22:45	998.6
TRD1	0.04	15.7	01Jun2014, 20:09	1.4
TRD2	0.51	72.1	01Jun2014, 21:09	19.1
TRD3	0.59	75.0	01Jun2014, 21:12	20.7
TRD4	0.27	90.7	01Jun2014, 20:30	14.2
TRD5	0.93	224.2	01Jun2014, 20:54	50.8
TR_Sub1	0.52	123.0	01Jun2014, 20:30	20.1
TR_Sub2	0.24	32.7	01Jun2014, 21:09	8.7

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10-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	225.6	01Jun2014, 14:24	80.9
GC1	0.34	52.9	01Jun2014, 13:18	11.8
GOOSE_CREEK	0.34	52.9	01Jun2014, 13:18	11.8
HWCLower	6.48	513.6	01Jun2014, 15:00	184.2
HWCSub1	0.19	40.2	01Jun2014, 12:48	5.5
HWCSub2	0.14	34.9	01Jun2014, 12:42	4.2
HWCSub3	0.07	15.0	01Jun2014, 12:48	2.0
HWCSub4	0.18	31.0	01Jun2014, 12:57	5.0
HWCSub5	0.12	30.0	01Jun2014, 12:42	3.5
HWCS1_R	0.19	40.0	01Jun2014, 13:18	5.5
HWCS2_R	0.14	34.7	01Jun2014, 13:06	4.2
HWCS3_R	0.07	14.8	01Jun2014, 13:24	2.0
HWCS4_R	0.18	30.9	01Jun2014, 13:27	5.0
HWCS5_R	0.12	29.7	01Jun2014, 13:21	3.5
HWCUpper	3.29	262.3	01Jun2014, 14:54	93.5
HWC_Out	7.99	606.2	01Jun2014, 14:48	227.7
HWC1	0.81	71.9	01Jun2014, 14:15	23.3
HWC2	3.19	256.8	01Jun2014, 14:30	90.7
HWC3	3.29	262.4	01Jun2014, 14:33	93.5
SCBRANCH_R	6.11	508.4	01Jun2014, 14:54	194.2
SCNBranch	2.40	231.9	01Jun2014, 14:15	76.5
SCSBranch	3.71	290.9	01Jun2014, 14:57	117.6
SCSub1	0.42	65.8	01Jun2014, 13:06	12.5
SCSub2	0.41	75.9	01Jun2014, 12:54	11.4
SCSub3	0.31	50.5	01Jun2014, 13:03	8.9
SCSub4	0.34	72.2	01Jun2014, 13:03	13.3
SCSub5	0.13	25.5	01Jun2014, 12:51	3.6
SCS1_R	0.42	65.7	01Jun2014, 13:24	12.5
SCS2_R	0.41	75.5	01Jun2014, 13:21	11.4
SCS3_R	0.31	50.1	01Jun2014, 14:03	8.9
SCS4_R	0.34	71.6	01Jun2014, 14:15	13.3
SCS5_R	0.13	25.4	01Jun2014, 12:54	3.6
SC_Out	16.46	1296.4	01Jun2014, 15:18	521.8
SC1	1.98	126.8	01Jun2014, 15:42	63.2
SC2	3.81	346.9	01Jun2014, 14:27	120.8
SC2_R	12.87	1096.7	01Jun2014, 15:27	408.8
SC3	2.95	271.8	01Jun2014, 14:24	93.8
SC3_R	9.06	769.0	01Jun2014, 14:57	288.0
TONGUE_RIVER	21.40	1587.5	01Jun2014, 15:00	697.4
TRD1	0.04	10.1	01Jun2014, 12:39	1.0
TRD2	0.51	51.6	01Jun2014, 13:36	13.2
TRD3	0.59	54.2	01Jun2014, 13:42	14.2
TRD4	0.27	60.3	01Jun2014, 12:57	10.1
TRD5	0.93	153.3	01Jun2014, 13:24	36.2
TR_Sub1	0.52	83.4	01Jun2014, 13:00	13.9
TR_Sub2	0.24	23.5	01Jun2014, 13:36	6.0

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10-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	375.8	01Jun2014, 22:00	141.0
GC1	0.34	99.0	01Jun2014, 20:51	21.3
GOOSE_CREEK	0.34	99.0	01Jun2014, 20:51	21.3
HWCLower	6.48	863.3	01Jun2014, 22:30	346.5
HWCSub1	0.19	78.3	01Jun2014, 20:18	10.2
HWCSub2	0.14	69.2	01Jun2014, 20:15	7.7
HWCSub3	0.07	29.3	01Jun2014, 20:18	3.7
HWCSub4	0.18	59.7	01Jun2014, 20:27	9.3
HWCSub5	0.12	59.7	01Jun2014, 20:12	6.4
HWCS1_R	0.19	78.1	01Jun2014, 20:42	10.2
HWCS2_R	0.14	68.9	01Jun2014, 20:30	7.7
HWCS3_R	0.07	29.1	01Jun2014, 20:45	3.7
HWCS4_R	0.18	59.5	01Jun2014, 20:51	9.3
HWCS5_R	0.12	58.8	01Jun2014, 20:42	6.4
HWCUpper	3.29	440.7	01Jun2014, 22:27	175.9
HWC_Out	7.99	1004.9	01Jun2014, 22:24	427.3
HWC1	0.81	123.0	01Jun2014, 21:48	43.3
HWC2	3.19	432.5	01Jun2014, 22:06	170.6
HWC3	3.29	441.0	01Jun2014, 22:09	175.9
SCBRANCH_R	6.11	829.6	01Jun2014, 22:27	359.3
SCNBranch	2.40	397.4	01Jun2014, 21:48	141.1
SCSBranch	3.71	473.3	01Jun2014, 22:39	218.2
SCSub1	0.42	125.2	01Jun2014, 20:39	23.2
SCSub2	0.41	147.6	01Jun2014, 20:24	21.2
SCSub3	0.31	96.7	01Jun2014, 20:33	16.6
SCSub4	0.34	138.1	01Jun2014, 20:33	23.5
SCSub5	0.13	49.7	01Jun2014, 20:21	6.7
SCS1_R	0.42	125.0	01Jun2014, 20:51	23.2
SCS2_R	0.41	146.7	01Jun2014, 20:45	21.3
SCS3_R	0.31	96.0	01Jun2014, 21:21	16.6
SCS4_R	0.34	136.8	01Jun2014, 21:33	23.5
SCS5_R	0.13	49.5	01Jun2014, 20:24	6.7
SC_Out	16.46	2114.5	01Jun2014, 22:51	964.6
SC1	1.98	196.1	01Jun2014, 23:45	116.4
SC2	3.81	588.0	01Jun2014, 22:00	224.1
SC2_R	12.87	1820.7	01Jun2014, 22:54	756.9
SC3	2.95	460.1	01Jun2014, 22:00	173.5
SC3_R	9.06	1266.9	01Jun2014, 22:30	532.8
TONGUE_RIVER	21.40	2619.5	01Jun2014, 22:39	1279.3
TRD1	0.04	20.5	01Jun2014, 20:09	1.9
TRD2	0.51	94.3	01Jun2014, 21:09	24.8
TRD3	0.59	98.5	01Jun2014, 21:12	27.0
TRD4	0.27	115.8	01Jun2014, 20:27	18.1
TRD5	0.93	285.6	01Jun2014, 20:54	64.4
TR_Sub1	0.52	160.8	01Jun2014, 20:30	26.1
TR_Sub2	0.24	42.8	01Jun2014, 21:09	11.3

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25-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	296.5	01Jun2014, 14:24	107.6
GC1	0.34	71.1	01Jun2014, 13:18	16.0
GOOSE_CREEK	0.34	71.1	01Jun2014, 13:18	16.0
HWCLower	6.48	703.7	01Jun2014, 14:57	254.0
HWCSub1	0.19	54.8	01Jun2014, 12:48	7.5
HWCSub2	0.14	47.4	01Jun2014, 12:42	5.7
HWCSub3	0.07	20.4	01Jun2014, 12:48	2.8
HWCSub4	0.18	42.4	01Jun2014, 12:57	6.9
HWCSub5	0.12	40.8	01Jun2014, 12:42	4.8
HWCS1_R	0.19	54.5	01Jun2014, 13:15	7.6
HWCS2_R	0.14	47.3	01Jun2014, 13:03	5.8
HWCS3_R	0.07	20.3	01Jun2014, 13:18	2.8
HWCS4_R	0.18	42.3	01Jun2014, 13:24	6.9
HWCS5_R	0.12	40.4	01Jun2014, 13:18	4.8
HWCUpper	3.29	358.7	01Jun2014, 14:54	128.9
HWC_Out	7.99	830.3	01Jun2014, 14:45	313.8
HWC1	0.81	98.2	01Jun2014, 14:15	32.1
HWC2	3.19	351.2	01Jun2014, 14:30	125.0
HWC3	3.29	358.9	01Jun2014, 14:33	128.9
SCBRANCH_R	6.11	690.1	01Jun2014, 14:51	265.6
SCNBranch	2.40	314.2	01Jun2014, 14:15	104.6
SCSBranch	3.71	394.9	01Jun2014, 14:57	160.9
SCSub1	0.42	89.5	01Jun2014, 13:06	17.2
SCSub2	0.41	103.9	01Jun2014, 12:54	15.7
SCSub3	0.31	68.8	01Jun2014, 13:03	12.3
SCSub4	0.34	95.8	01Jun2014, 13:03	17.9
SCSub5	0.13	34.9	01Jun2014, 12:51	5.0
SCS1_R	0.42	89.4	01Jun2014, 13:21	17.2
SCS2_R	0.41	103.3	01Jun2014, 13:18	15.7
SCS3_R	0.31	68.4	01Jun2014, 13:54	12.3
SCS4_R	0.34	95.0	01Jun2014, 14:09	17.9
SCS5_R	0.13	34.8	01Jun2014, 12:54	5.0
SC_Out	16.46	1761.4	01Jun2014, 15:12	713.8
SC1	1.98	172.7	01Jun2014, 15:39	86.5
SC2	3.81	470.2	01Jun2014, 14:24	165.2
SC2_R	12.87	1492.8	01Jun2014, 15:21	559.1
SC3	2.95	368.4	01Jun2014, 14:24	128.3
SC3_R	9.06	1045.2	01Jun2014, 14:54	393.9
TONGUE_RIVER	21.40	2171.3	01Jun2014, 14:54	950.9
TRD1	0.04	13.9	01Jun2014, 12:39	1.4
TRD2	0.51	71.0	01Jun2014, 13:36	18.3
TRD3	0.59	75.0	01Jun2014, 13:39	19.8
TRD4	0.27	80.4	01Jun2014, 12:57	13.7
TRD5	0.93	203.5	01Jun2014, 13:21	48.8
TR_Sub1	0.52	114.4	01Jun2014, 13:00	19.3
TR_Sub2	0.24	32.4	01Jun2014, 13:36	8.3

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Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	486.2	01Jun2014, 21:57	181.8
GC1	0.34	131.0	01Jun2014, 20:51	28.1
GOOSE_CREEK	0.34	131.0	01Jun2014, 20:51	28.1
HWCLower	6.48	1160.6	01Jun2014, 22:27	462.3
HWCSub1	0.19	105.3	01Jun2014, 20:18	13.6
HWCSub2	0.14	92.6	01Jun2014, 20:12	10.3
HWCSub3	0.07	39.4	01Jun2014, 20:18	5.0
HWCSub4	0.18	80.4	01Jun2014, 20:27	12.5
HWCSub5	0.12	80.2	01Jun2014, 20:12	8.6
HWCS1_R	0.19	104.8	01Jun2014, 20:39	13.6
HWCS2_R	0.14	92.3	01Jun2014, 20:30	10.3
HWCS3_R	0.07	39.1	01Jun2014, 20:42	5.0
HWCS4_R	0.18	80.0	01Jun2014, 20:48	12.5
HWCS5_R	0.12	79.0	01Jun2014, 20:39	8.6
HWCUpper	3.29	591.6	01Jun2014, 22:27	234.7
HWC_Out	7.99	1350.9	01Jun2014, 22:21	570.0
HWC1	0.81	165.1	01Jun2014, 21:45	57.8
HWC2	3.19	580.7	01Jun2014, 22:06	227.6
HWC3	3.29	591.9	01Jun2014, 22:09	234.7
SCBRANCH_R	6.11	1104.8	01Jun2014, 22:27	475.5
SCNBranch	2.40	529.2	01Jun2014, 21:48	186.8
SCSBranch	3.71	629.9	01Jun2014, 22:39	288.7
SCSub1	0.42	167.8	01Jun2014, 20:39	30.8
SCSub2	0.41	198.8	01Jun2014, 20:24	28.4
SCSub3	0.31	129.9	01Jun2014, 20:33	22.1
SCSub4	0.34	180.9	01Jun2014, 20:33	30.7
SCSub5	0.13	67.0	01Jun2014, 20:21	9.0
SCS1_R	0.42	167.4	01Jun2014, 20:51	30.8
SCS2_R	0.41	197.2	01Jun2014, 20:42	28.4
SCS3_R	0.31	129.0	01Jun2014, 21:15	22.1
SCS4_R	0.34	179.3	01Jun2014, 21:27	30.7
SCS5_R	0.13	66.7	01Jun2014, 20:24	9.0
SC_Out	16.46	2813.4	01Jun2014, 22:48	1276.9
SC1	1.98	260.8	01Jun2014, 23:45	154.1
SC2	3.81	782.8	01Jun2014, 22:00	296.5
SC2_R	12.87	2431.3	01Jun2014, 22:51	1001.6
SC3	2.95	612.6	01Jun2014, 21:57	229.6
SC3_R	9.06	1689.5	01Jun2014, 22:27	705.1
TONGUE_RIVER	21.40	3493.2	01Jun2014, 22:36	1688.8
TRD1	0.04	27.8	01Jun2014, 20:09	2.5
TRD2	0.51	127.6	01Jun2014, 21:09	33.4
TRD3	0.59	134.0	01Jun2014, 21:12	36.4
TRD4	0.27	152.4	01Jun2014, 20:27	23.6
TRD5	0.93	374.1	01Jun2014, 20:54	83.9
TR_Sub1	0.52	217.2	01Jun2014, 20:30	35.0
TR_Sub2	0.24	58.1	01Jun2014, 21:09	15.3

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50-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	351.3	01Jun2014, 14:21	128.6
GC1	0.34	85.4	01Jun2014, 13:18	19.4
GOOSE_CREEK	0.34	85.4	01Jun2014, 13:18	19.4
HWCLower	6.48	856.0	01Jun2014, 14:54	310.5
HWCSub1	0.19	66.5	01Jun2014, 12:48	9.2
HWCSub2	0.14	57.4	01Jun2014, 12:42	7.0
HWCSub3	0.07	24.8	01Jun2014, 12:48	3.4
HWCSub4	0.18	51.6	01Jun2014, 12:57	8.5
HWCSub5	0.12	49.5	01Jun2014, 12:42	5.8
HWCS1_R	0.19	66.1	01Jun2014, 13:12	9.2
HWCS2_R	0.14	57.0	01Jun2014, 13:03	7.0
HWCS3_R	0.07	24.6	01Jun2014, 13:18	3.4
HWCS4_R	0.18	51.4	01Jun2014, 13:21	8.5
HWCS5_R	0.12	49.1	01Jun2014, 13:15	5.8
HWCUpper	3.29	436.1	01Jun2014, 14:51	157.6
HWC_Out	7.99	1010.2	01Jun2014, 14:45	383.6
HWC1	0.81	119.3	01Jun2014, 14:12	39.2
HWC2	3.19	426.9	01Jun2014, 14:30	152.9
HWC3	3.29	436.2	01Jun2014, 14:33	157.6
SCBRANCH_R	6.11	834.8	01Jun2014, 14:48	322.9
SCNBranch	2.40	379.5	01Jun2014, 14:15	127.2
SCSBranch	3.71	477.7	01Jun2014, 14:57	195.7
SCSub1	0.42	108.5	01Jun2014, 13:06	21.0
SCSub2	0.41	126.3	01Jun2014, 12:54	19.2
SCSub3	0.31	83.5	01Jun2014, 13:03	15.0
SCSub4	0.34	114.2	01Jun2014, 13:03	21.5
SCSub5	0.13	42.4	01Jun2014, 12:51	6.1
SCS1_R	0.42	108.3	01Jun2014, 13:21	21.0
SCS2_R	0.41	125.7	01Jun2014, 13:15	19.3
SCS3_R	0.31	83.1	01Jun2014, 13:51	15.1
SCS4_R	0.34	113.1	01Jun2014, 14:03	21.5
SCS5_R	0.13	42.4	01Jun2014, 12:54	6.1
SC_Out	16.46	2131.6	01Jun2014, 15:09	868.1
SC1	1.98	209.4	01Jun2014, 15:39	105.1
SC2	3.81	568.3	01Jun2014, 14:24	200.9
SC2_R	12.87	1808.4	01Jun2014, 15:18	680.0
SC3	2.95	445.1	01Jun2014, 14:24	156.1
SC3_R	9.06	1264.9	01Jun2014, 14:54	479.0
TONGUE_RIVER	21.40	2637.1	01Jun2014, 14:51	1154.2
TRD1	0.04	17.0	01Jun2014, 12:39	1.7
TRD2	0.51	86.7	01Jun2014, 13:36	22.4
TRD3	0.59	91.8	01Jun2014, 13:39	24.4
TRD4	0.27	96.0	01Jun2014, 12:57	16.5
TRD5	0.93	242.7	01Jun2014, 13:21	58.7
TR_Sub1	0.52	139.3	01Jun2014, 13:00	23.6
TR_Sub2	0.24	39.6	01Jun2014, 13:36	10.2

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50-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	573.7	01Jun2014, 21:57	214.1
GC1	0.34	156.9	01Jun2014, 20:51	33.5
GOOSE_CREEK	0.34	156.9	01Jun2014, 20:51	33.5
HWCLower	6.48	1404.7	01Jun2014, 22:27	556.6
HWCSub1	0.19	127.4	01Jun2014, 20:18	16.3
HWCSub2	0.14	111.8	01Jun2014, 20:12	12.4
HWCSub3	0.07	47.6	01Jun2014, 20:18	6.0
HWCSub4	0.18	97.5	01Jun2014, 20:27	15.0
HWCSub5	0.12	97.0	01Jun2014, 20:12	10.3
HWCS1_R	0.19	126.9	01Jun2014, 20:39	16.3
HWCS2_R	0.14	111.5	01Jun2014, 20:27	12.4
HWCS3_R	0.07	47.3	01Jun2014, 20:42	6.0
HWCS4_R	0.18	97.2	01Jun2014, 20:48	15.1
HWCS5_R	0.12	96.0	01Jun2014, 20:39	10.3
HWCUpper	3.29	715.4	01Jun2014, 22:24	282.6
HWC_Out	7.99	1634.5	01Jun2014, 22:21	686.3
HWC1	0.81	199.7	01Jun2014, 21:45	69.6
HWC2	3.19	702.0	01Jun2014, 22:06	274.0
HWC3	3.29	715.6	01Jun2014, 22:06	282.6
SCBRANCH_R	6.11	1328.4	01Jun2014, 22:24	569.6
SCNBranch	2.40	636.3	01Jun2014, 21:48	223.7
SCSBranch	3.71	757.1	01Jun2014, 22:39	345.9
SCSub1	0.42	202.6	01Jun2014, 20:39	37.1
SCSub2	0.41	240.9	01Jun2014, 20:24	34.3
SCSub3	0.31	157.2	01Jun2014, 20:33	26.6
SCSub4	0.34	215.1	01Jun2014, 20:33	36.4
SCSub5	0.13	81.1	01Jun2014, 20:21	10.9
SCS1_R	0.42	202.2	01Jun2014, 20:48	37.1
SCS2_R	0.41	239.4	01Jun2014, 20:42	34.3
SCS3_R	0.31	156.0	01Jun2014, 21:12	26.6
SCS4_R	0.34	213.3	01Jun2014, 21:24	36.4
SCS5_R	0.13	80.9	01Jun2014, 20:24	10.9
SC_Out	16.46	3381.9	01Jun2014, 22:45	1529.6
SC1	1.98	313.4	01Jun2014, 23:45	184.6
SC2	3.81	941.1	01Jun2014, 22:00	355.2
SC2_R	12.87	2928.6	01Jun2014, 22:48	1199.8
SC3	2.95	736.6	01Jun2014, 21:57	275.0
SC3_R	9.06	2033.1	01Jun2014, 22:27	844.6
TONGUE_RIVER	21.40	4202.5	01Jun2014, 22:33	2019.8
TRD1	0.04	33.8	01Jun2014, 20:09	3.1
TRD2	0.51	155.1	01Jun2014, 21:09	40.4
TRD3	0.59	163.3	01Jun2014, 21:12	44.2
TRD4	0.27	181.7	01Jun2014, 20:27	28.1
TRD5	0.93	444.9	01Jun2014, 20:54	99.5
TR_Sub1	0.52	263.7	01Jun2014, 20:30	42.3
TR_Sub2	0.24	70.7	01Jun2014, 21:09	18.5

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100-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	407.1	01Jun2014, 14:21	150.1
GC1	0.34	100.1	01Jun2014, 13:18	22.9
GOOSE_CREEK	0.34	100.1	01Jun2014, 13:18	22.9
HWCLower	6.48	1015.6	01Jun2014, 14:54	370.0
HWCSub1	0.19	78.6	01Jun2014, 12:48	11.0
HWCSub2	0.14	67.8	01Jun2014, 12:42	8.3
HWCSub3	0.07	29.3	01Jun2014, 12:48	4.0
HWCSub4	0.18	61.1	01Jun2014, 12:57	10.1
HWCSub5	0.12	58.6	01Jun2014, 12:42	6.9
HWCS1_R	0.19	78.2	01Jun2014, 13:12	11.0
HWCS2_R	0.14	67.6	01Jun2014, 13:00	8.4
HWCS3_R	0.07	29.2	01Jun2014, 13:15	4.1
HWCS4_R	0.18	60.9	01Jun2014, 13:21	10.1
HWCS5_R	0.12	57.7	01Jun2014, 13:12	7.0
HWCUpper	3.29	516.9	01Jun2014, 14:51	187.8
HWC_Out	7.99	1197.9	01Jun2014, 14:42	457.1
HWC1	0.81	141.3	01Jun2014, 14:12	46.7
HWC2	3.19	506.0	01Jun2014, 14:30	182.1
HWC3	3.29	517.1	01Jun2014, 14:30	187.8
SCBRANCH_R	6.11	985.1	01Jun2014, 14:48	383.0
SCNBranch	2.40	447.3	01Jun2014, 14:15	150.9
SCSBranch	3.71	563.8	01Jun2014, 14:54	232.1
SCSub1	0.42	128.1	01Jun2014, 13:06	25.0
SCSub2	0.41	149.6	01Jun2014, 12:54	23.0
SCSub3	0.31	98.8	01Jun2014, 13:03	17.9
SCSub4	0.34	132.9	01Jun2014, 13:03	25.3
SCSub5	0.13	50.3	01Jun2014, 12:51	7.3
SCS1_R	0.42	127.8	01Jun2014, 13:18	25.0
SCS2_R	0.41	148.8	01Jun2014, 13:15	23.0
SCS3_R	0.31	98.3	01Jun2014, 13:48	17.9
SCS4_R	0.34	131.8	01Jun2014, 14:00	25.3
SCS5_R	0.13	50.1	01Jun2014, 12:54	7.3
SC_Out	16.46	2516.3	01Jun2014, 15:06	1029.7
SC1	1.98	247.6	01Jun2014, 15:39	124.7
SC2	3.81	670.1	01Jun2014, 14:24	238.3
SC2_R	12.87	2136.4	01Jun2014, 15:15	806.5
SC3	2.95	524.7	01Jun2014, 14:24	185.1
SC3_R	9.06	1493.6	01Jun2014, 14:51	568.1
TONGUE_RIVER	21.40	3122.0	01Jun2014, 14:48	1366.7
TRD1	0.04	20.2	01Jun2014, 12:39	2.0
TRD2	0.51	103.2	01Jun2014, 13:36	26.8
TRD3	0.59	109.6	01Jun2014, 13:39	29.2
TRD4	0.27	112.1	01Jun2014, 12:57	19.4
TRD5	0.93	282.8	01Jun2014, 13:21	68.9
TR_Sub1	0.52	165.4	01Jun2014, 13:00	28.2
TR_Sub2	0.24	47.2	01Jun2014, 13:36	12.3

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100-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	662.6	01Jun2014, 21:57	247.0
GC1	0.34	183.5	01Jun2014, 20:51	39.1
GOOSE_CREEK	0.34	183.5	01Jun2014, 20:51	39.1
HWCLower	6.48	1658.6	01Jun2014, 22:27	654.7
HWCSub1	0.19	150.5	01Jun2014, 20:18	19.2
HWCSub2	0.14	131.9	01Jun2014, 20:12	14.5
HWCSub3	0.07	56.2	01Jun2014, 20:18	7.1
HWCSub4	0.18	115.3	01Jun2014, 20:27	17.7
HWCSub5	0.12	114.5	01Jun2014, 20:12	12.1
HWCS1_R	0.19	149.5	01Jun2014, 20:39	19.2
HWCS2_R	0.14	131.5	01Jun2014, 20:27	14.5
HWCS3_R	0.07	55.9	01Jun2014, 20:39	7.1
HWCS4_R	0.18	114.9	01Jun2014, 20:48	17.7
HWCS5_R	0.12	112.9	01Jun2014, 20:36	12.1
HWCUpper	3.29	844.2	01Jun2014, 22:24	332.4
HWC_Out	7.99	1929.8	01Jun2014, 22:18	807.2
HWC1	0.81	235.7	01Jun2014, 21:45	81.8
HWC2	3.19	828.4	01Jun2014, 22:06	322.3
HWC3	3.29	844.6	01Jun2014, 22:06	332.4
SCBRANCH_R	6.11	1560.1	01Jun2014, 22:24	666.8
SCNBranch	2.40	747.2	01Jun2014, 21:48	261.9
SCSBranch	3.71	888.9	01Jun2014, 22:36	404.9
SCSub1	0.42	238.8	01Jun2014, 20:39	43.5
SCSub2	0.41	284.9	01Jun2014, 20:24	40.4
SCSub3	0.31	185.6	01Jun2014, 20:33	31.3
SCSub4	0.34	250.2	01Jun2014, 20:33	42.2
SCSub5	0.13	96.0	01Jun2014, 20:21	12.8
SCS1_R	0.42	238.4	01Jun2014, 20:48	43.5
SCS2_R	0.41	282.7	01Jun2014, 20:42	40.4
SCS3_R	0.31	184.0	01Jun2014, 21:12	31.3
SCS4_R	0.34	248.1	01Jun2014, 21:21	42.2
SCS5_R	0.13	95.7	01Jun2014, 20:24	12.8
SC_Out	16.46	3970.4	01Jun2014, 22:42	1790.9
SC1	1.98	367.9	01Jun2014, 23:45	216.1
SC2	3.81	1105.1	01Jun2014, 22:00	415.8
SC2_R	12.87	3444.4	01Jun2014, 22:45	1404.5
SC3	2.95	865.0	01Jun2014, 21:57	322.0
SC3_R	9.06	2389.7	01Jun2014, 22:24	988.8
TONGUE_RIVER	21.40	4936.3	01Jun2014, 22:30	2361.5
TRD1	0.04	40.2	01Jun2014, 20:09	3.6
TRD2	0.51	183.9	01Jun2014, 21:09	47.7
TRD3	0.59	194.3	01Jun2014, 21:12	52.4
TRD4	0.27	211.8	01Jun2014, 20:27	32.7
TRD5	0.93	517.3	01Jun2014, 20:54	115.5
TR_Sub1	0.52	312.3	01Jun2014, 20:30	49.9
TR_Sub2	0.24	84.0	01Jun2014, 21:09	21.9

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ADDENDUM D6-2

Miller Regression Analysis

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Peak Flow Estimates using Methods Presented by Miller, 2003

Drainage: **Hidden Water Creek**

Input Parameters:

Drainage Area (square miles) =	7.99
Region (See WRI Report 03-4107 Plate 1) =	2

Output Parameters:

2-Year Annual Peak Flow **80 cfs**

$$Q_2 = 29.9(AREA^{0.475})$$

5-Year Annual Peak Flow **208 cfs**

$$Q_5 = 80.9(AREA^{0.455})$$

10-Year Annual Peak Flow **339 cfs**

$$Q_{10} = 134(AREA^{0.447})$$

25-Year Annual Peak Flow **560 cfs**

$$Q_{25} = 225(AREA^{0.439})$$

50-Year Annual Peak Flow **766 cfs**

$$Q_{50} = 311(AREA^{0.434})$$

100-Year Annual Peak Flow **1,014 cfs**

$$Q_{100} = 415(AREA^{0.430})$$

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Peak Flow Estimates using Methods Presented by Miller, 2003

Drainage: **Slater Creek**

Input Parameters:

Drainage Area (square miles) =	16.46
Region (See WRI Report 03-4107 Plate 1) =	2

Output Parameters:

2-Year Annual Peak Flow **113 cfs**

$$Q_2 = 29.9(AREA^{0.475})$$

5-Year Annual Peak Flow **289 cfs**

$$Q_5 = 80.9(AREA^{0.455})$$

10-Year Annual Peak Flow **469 cfs**

$$Q_{10} = 134(AREA^{0.447})$$

25-Year Annual Peak Flow **769 cfs**

$$Q_{25} = 225(AREA^{0.439})$$

50-Year Annual Peak Flow **1,049 cfs**

$$Q_{50} = 311(AREA^{0.434})$$

100-Year Annual Peak Flow **1,384 cfs**

$$Q_{100} = 415(AREA^{0.430})$$

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ADDENDUM D6-3

HEC-RAS Model

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HEC-RAS RESULTS

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HEC-RAS Results: Hidden Water Creek Premine

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Mann Wtd Total	Hydr Radius
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	16164.28	2-YEAR	474.2	3854.2	3856.1	3856.1	3856.6	0.0119	5.72	82.89	84.47	1.02	0.028	0.98
1	16164.28	100-YEAR	1929.8	3854.2	3857.7	3857.7	3858.7	0.0080	8.24	242.37	124.4	0.96	0.026	1.95
1	16000	2-YEAR	474.2	3852.0	3853.1	3853.1	3853.5	0.0122	5.36	88.53	101.29	1.01	0.028	0.87
1	16000	100-YEAR	1929.8	3852.0	3854.4	3854.4	3855.3	0.0092	7.75	250.65	142.52	1	0.027	1.76
1	15500	2-YEAR	474.2	3845.1	3846.8	3846.7	3847.2	0.0092	5.02	94.42	96.02	0.89	0.028	0.98
1	15500	100-YEAR	1929.8	3845.1	3848.1	3848.1	3849.0	0.0094	7.55	255.94	149.48	1	0.027	1.71
1	15000	2-YEAR	474.2	3840.0	3841.4	3841.4	3841.8	0.0127	5.03	94.36	122.43	1.01	0.028	0.77
1	15000	100-YEAR	1929.8	3840.0	3842.6	3842.6	3843.4	0.0096	7.14	273.38	183.38	0.99	0.027	1.49
1	14500	2-YEAR	474.2	3831.8	3833.1	3833.1	3833.5	0.0120	5.34	88.8	101.12	1	0.028	0.88
1	14500	100-YEAR	1929.8	3831.8	3834.4	3834.4	3835.3	0.0094	7.46	260.75	162.16	0.99	0.027	1.61
1	14000	2-YEAR	474.2	3821.5	3823.6	3823.6	3824.1	0.0113	6.06	78.24	69.93	1.01	0.028	1.12
1	14000	100-YEAR	1929.8	3821.5	3825.3	3825.3	3826.4	0.0073	8.7	236.01	113.32	0.94	0.025	2.08
1	13500	2-YEAR	474.2	3813.9	3815.5	3815.4	3816.0	0.0086	5.41	87.72	76.23	0.89	0.028	1.15
1	13500	100-YEAR	1929.8	3813.9	3817.1	3817.1	3818.2	0.0078	8.59	233.11	112.19	0.96	0.026	2.07
1	13000	2-YEAR	474.2	3808.4	3810.5	3810.5	3811.1	0.0114	5.99	79.11	72.58	1.01	0.028	1.09
1	13000	100-YEAR	1929.8	3808.4	3812.1	3812.1	3813.2	0.0092	8.11	238.46	127.49	1.01	0.027	1.87
1	12500	2-YEAR	474.2	3801.5	3803.4	3803.4	3803.9	0.0118	5.64	84.1	86.77	1.01	0.028	0.97
1	12500	100-YEAR	1929.8	3801.5	3804.9	3804.9	3805.7	0.0075	7.63	269.3	170.76	0.92	0.024	1.57
1	12000	2-YEAR	474.2	3793.1	3794.5	3794.5	3794.9	0.0102	5.26	96.57	129.19	0.94	0.025	0.75
1	12000	100-YEAR	1929.8	3793.1	3795.8	3795.8	3796.5	0.0070	7.54	316.42	227.2	0.89	0.025	1.39
1	11500	2-YEAR	474.2	3782.9	3784.9	3784.9	3785.5	0.0114	6.01	78.97	72.15	1.01	0.028	1.09
1	11500	100-YEAR	1929.8	3782.9	3786.6	3786.6	3787.6	0.0082	8.25	239.48	128.74	0.97	0.025	1.86
1	11000	2-YEAR	474.2	3776.0	3778.0	3778.0	3778.6	0.0113	6.07	78.12	69.62	1.01	0.028	1.12

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HEC-RAS Results: Hidden Water Creek Premine

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Mann Wtd Total	Hydr Radius
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	11000	100-YEAR	1929.8	3776.0	3779.7	3779.7	3780.7	0.0092	8.14	237.02	116.52	1.01	0.028	2.02
1	10500	2-YEAR	474.2	3767.9	3769.2	3769.2	3769.7	0.0117	5.6	84.61	87.43	1	0.028	0.97
1	10500	100-YEAR	1929.8	3767.9	3770.7	3770.7	3771.7	0.0082	8.13	244.82	130.73	0.97	0.026	1.87
1	10000	2-YEAR	474.2	3759.2	3761.6	3761.6	3762.2	0.0115	6.04	78.46	71.18	1.01	0.028	1.1
1	10000	100-YEAR	1929.8	3759.2	3763.3	3763.3	3764.4	0.0074	8.55	240.2	119.82	0.94	0.025	2
1	9500	2-YEAR	474.2	3751.5	3753.7	3753.7	3754.3	0.0107	6.53	72.65	55.83	1.01	0.028	1.3
1	9500	100-YEAR	1929.8	3751.5	3755.7	3755.7	3757.0	0.0067	9.33	222.86	93.2	0.92	0.025	2.38
1	9000	2-YEAR	474.2	3744.0	3746.2	3746.2	3746.8	0.0112	6.25	75.91	64.35	1.01	0.028	1.18
1	9000	100-YEAR	1929.8	3744.0	3748.1	3748.1	3749.3	0.0084	8.93	216.57	89.06	1	0.028	2.42
1	8500	2-YEAR	474.2	3736.9	3739.0	3739.0	3739.6	0.0088	6.67	78.07	64.68	0.94	0.026	1.2
1	8500	100-YEAR	1929.8	3736.9	3740.9	3740.9	3742.1	0.0066	9.87	236.4	98.87	0.93	0.026	2.38
1	8000	2-YEAR	474.2	3730.7	3732.4	3732.4	3732.9	0.0117	5.66	83.78	85.68	1.01	0.028	0.98
1	8000	100-YEAR	1929.8	3730.7	3734.0	3734.0	3735.0	0.0075	8.33	247.65	128.43	0.94	0.025	1.93
1	7500	2-YEAR	474.2	3722.3	3724.2	3724.2	3724.7	0.0119	5.73	82.85	85.96	1.02	0.028	0.96
1	7500	100-YEAR	1929.8	3722.3	3725.7	3725.7	3726.8	0.0074	8.51	243.6	119.76	0.94	0.026	2.03
1	7000	2-YEAR	474.2	3714.7	3716.6	3716.6	3717.2	0.0095	6.11	82.07	80.27	0.95	0.025	1.02
1	7000	100-YEAR	1929.8	3714.7	3718.3	3718.3	3719.4	0.0065	8.87	271.34	156.79	0.9	0.024	1.73
1	6500	2-YEAR	474.2	3707.9	3709.4	3709.4	3710.0	0.0114	5.83	81.36	77.87	1	0.028	1.04
1	6500	100-YEAR	1929.8	3707.9	3711.0	3711.0	3712.1	0.0081	8.45	234.29	114.1	0.97	0.026	2.05
1	6000	2-YEAR	474.2	3700.7	3702.3	3702.3	3702.8	0.0114	5.55	86.68	98.46	0.99	0.027	0.88
1	6000	100-YEAR	1929.8	3700.7	3703.8	3703.8	3704.7	0.0073	8.17	265.04	149.53	0.93	0.026	1.77
1	5500	2-YEAR	474.2	3692.0	3693.4	3693.4	3693.9	0.0096	5.47	86.7	80	0.93	0.028	1.08
1	5500	100-YEAR	1929.8	3692.0	3694.9	3694.9	3696.0	0.0081	8.47	233.81	113.81	0.97	0.026	2.05

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HEC-RAS Results: Hidden Water Creek Premine

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Mann Wtd Total	Hydr Radius (ft)
1	5000	2-YEAR	474.2	3686.3	3688.1	3688.1	3688.5	0.0122	5.57	85.12	92.72	1.02	0.028	0.92
1	5000	100-YEAR	1929.8	3686.3	3689.5	3689.5	3690.6	0.0076	8.33	246.47	125.36	0.95	0.026	1.96
1	4500	2-YEAR	474.2	3679.7	3681.2	3681.0	3681.5	0.0078	4.71	100.75	100.35	0.83	0.028	1
1	4500	100-YEAR	1929.8	3679.7	3682.4	3682.4	3683.3	0.0092	7.81	248.45	139.1	1	0.027	1.78
1	4000	2-YEAR	474.2	3674.3	3676.5	3676.5	3677.1	0.0099	6.27	77.53	69.84	0.97	0.026	1.11
1	4000	100-YEAR	1929.8	3674.3	3678.3	3678.3	3679.4	0.0065	9.11	248.11	119.17	0.91	0.025	2.08
1	3500	2-YEAR	474.2	3669.4	3671.2	3671.1	3671.6	0.0080	5.02	94.41	87.19	0.85	0.028	1.08
1	3500	100-YEAR	1929.8	3669.4	3672.6	3672.6	3673.6	0.0074	8.3	249.92	132.67	0.93	0.025	1.88
1	3000	2-YEAR	474.2	3665.3	3666.5	3666.5	3666.9	0.0109	5.12	97.24	130.05	0.96	0.026	0.75
1	3000	100-YEAR	1929.8	3665.3	3667.8	3667.8	3668.5	0.0077	7.62	293.24	195.98	0.93	0.026	1.5
1	2500	2-YEAR	474.2	3653.6	3661.8		3661.8	0.0000	0.67	941.29	202.44	0.04	0.028	4.63
1	2500	100-YEAR	1929.8	3653.6	3664.2		3664.2	0.0001	1.82	1622.95	322.74	0.1	0.028	5.01
1	2000	2-YEAR	474.2	3656.0	3661.8		3661.8	0.0000	0.66	896.44	277.47	0.05	0.027	3.23
1	2000	100-YEAR	1929.8	3656.0	3664.1		3664.2	0.0001	1.53	1580.52	317.87	0.1	0.028	4.96
1	1500	2-YEAR	474.2	3658.0	3661.0	3661.0	3661.7	0.0105	6.91	68.67	47.6	1.01	0.028	1.43
1	1500	100-YEAR	1929.8	3658.0	3663.1	3663.1	3664.0	0.0056	8.2	283.24	153.66	0.83	0.024	1.83
1	1000	2-YEAR	474.2	3636.6	3639.5	3639.5	3640.3	0.0104	6.96	68.1	46.36	1.01	0.028	1.46
1	1000	100-YEAR	1929.8	3636.6	3641.7	3641.7	3643.2	0.0083	9.76	197.73	68.31	1.01	0.028	2.86
1	500	2-YEAR	474.2	3624.0	3626.5	3626.5	3627.3	0.0102	6.99	67.84	45.19	1.01	0.028	1.49
1	500	100-YEAR	1929.8	3624.0	3628.7	3628.7	3630.2	0.0084	9.64	200.25	70.85	1.01	0.028	2.79
1	250	2-YEAR	474.2	3608.9	3610.3	3610.3	3610.7	0.0118	5.22	91.92	115.27	0.99	0.027	0.8
1	250	100-YEAR	1929.8	3608.9	3613.0	3611.6	3613.3	0.0012	4.25	523.81	202.09	0.4	0.026	2.59

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HEC-RAS Results: Slater Creek Premine

Reach	River Sta	Profile												
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	13500	2-YEAR	1022.4	3806.0	3807.7		3808.2	0.0068	5.47	186.79	132.98	0.81	0.028	1.4
1	13500	100-YEAR	3970.4	3806.0	3809.4	3809.4	3810.1	0.0058	7.34	672.87	488.16	0.82	0.024	1.38
1	13000	2-YEAR	1022.4	3800.5	3802.7	3802.7	3803.3	0.0114	5.91	173.03	167.2	1.01	0.027	1.03
1	13000	100-YEAR	3970.4	3800.5	3804.5	3804.5	3805.2	0.0051	7.27	675.97	489.6	0.79	0.022	1.38
1	12500	2-YEAR	1022.4	3796.0	3797.2	3797.1	3797.4	0.0070	4.09	254.7	318.44	0.77	0.027	0.8
1	12500	100-YEAR	3970.4	3796.0	3798.1	3798.1	3798.9	0.0085	7.07	601.61	422.72	0.94	0.026	1.42
1	12000	2-YEAR	1022.4	3789.5	3791.3	3791.3	3791.8	0.0091	5.89	198.02	215.44	0.93	0.026	0.92
1	12000	100-YEAR	3970.4	3789.5	3792.7	3792.7	3793.5	0.0074	8.24	619.06	418.6	0.93	0.026	1.48
1	11500	2-YEAR	1022.4	3784.7	3786.4	3786.4	3786.6	0.0077	4.7	301.4	575.28	0.82	0.025	0.52
1	11500	100-YEAR	3970.4	3784.7	3787.1	3787.1	3787.6	0.0092	7.04	727.7	650.07	0.97	0.028	1.12
1	11000	2-YEAR	1022.4	3778.0	3779.7		3780.0	0.0044	4.13	247.53	194	0.64	0.028	1.28
1	11000	100-YEAR	3970.4	3778.0	3781.2	3780.9	3781.9	0.0044	6.73	653.9	377.22	0.73	0.023	1.73
1	10500	2-YEAR	1022.4	3771.5	3774.7	3774.6	3775.1	0.0066	5.41	220.77	233.2	0.8	0.025	0.95
1	10500	100-YEAR	3970.4	3771.5	3775.9	3775.9	3776.6	0.0090	7.49	605.64	404.77	0.98	0.028	1.49
1	10000	2-YEAR	1022.4	3764.6	3766.9	3766.9	3767.4	0.0121	5.57	183.72	197.44	1.02	0.028	0.93
1	10000	100-YEAR	3970.4	3764.6	3768.2	3768.2	3769.0	0.0093	7.01	573.78	400.25	0.98	0.026	1.43
1	9500	2-YEAR	1022.4	3757.3	3759.3		3759.5	0.0050	4.24	241.12	200.01	0.68	0.028	1.21
1	9500	100-YEAR	3970.4	3757.3	3760.9		3761.5	0.0041	6.29	652.97	318.32	0.7	0.025	2.05
1	9000	2-YEAR	1022.4	3752.0	3754.4	3754.4	3755.1	0.0105	6.78	150.8	108.25	1.01	0.028	1.39
1	9000	100-YEAR	3970.4	3752.0	3756.4	3756.4	3757.8	0.0083	9.5	418.09	151.95	1.01	0.028	2.74
1	8500	2-YEAR	1022.4	3746.0	3748.1		3748.2	0.0019	3.18	322.08	198.54	0.44	0.028	1.62
1	8500	100-YEAR	3970.4	3746.0	3749.8		3750.2	0.0024	5.55	759.08	314.27	0.55	0.025	2.41
1	8000	2-YEAR	1022.4	3744.0	3745.6	3745.5	3746.0	0.0081	4.9	214.06	241.13	0.85	0.026	0.89
1	8000	100-YEAR	3970.4	3744.0	3746.8	3746.8	3747.6	0.0077	7.8	564.07	330.58	0.93	0.026	1.71

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-207

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HEC-RAS Results: Slater Creek Premine

Reach	River Sta	Profile												
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	7500	2-YEAR	1022.4	3738.5	3740.9	3740.9	3741.5	0.0073	6.37	183.54	169.71	0.87	0.024	1.08
1	7500	100-YEAR	3970.4	3738.5	3742.6	3742.6	3743.5	0.0059	9.01	571.25	283.33	0.87	0.026	2.01
1	7227.464	2-YEAR	1022.4	3737.0	3738.7	3738.6	3739.0	0.0076	5.19	226.22	261.23	0.84	0.026	0.87
1	7227.464	100-YEAR	3970.4	3737.0	3739.9	3739.8	3740.7	0.0075	8.16	594.47	364.6	0.94	0.027	1.63
1	7000	2-YEAR	1022.4	3733.3	3735.7	3735.4	3735.9	0.0059	4.22	242.26	230.75	0.73	0.028	1.05
1	7000	100-YEAR	3970.4	3733.3	3736.9	3736.7	3737.6	0.0063	6.92	586.13	313.26	0.84	0.027	1.87
1	6500	2-YEAR	1022.4	3728.4	3730.6	3730.6	3731.1	0.0085	5.88	198.17	209.98	0.9	0.026	0.94
1	6500	100-YEAR	3970.4	3728.4	3732.0	3732.0	3732.9	0.0079	8.52	549.23	299.11	0.96	0.027	1.84
1	6000	2-YEAR	1022.4	3720.1	3721.8	3721.8	3722.3	0.0123	5.31	192.71	230.49	1.01	0.028	0.84
1	6000	100-YEAR	3970.4	3720.1	3723.1	3723.1	3724.0	0.0083	7.75	542.32	323.13	0.96	0.026	1.68
1	5500	2-YEAR	1022.4	3713.1	3714.9	3714.5	3715.1	0.0038	3.58	285.91	248.06	0.59	0.028	1.15
1	5500	100-YEAR	3970.4	3713.1	3716.6	3715.8	3717.0	0.0026	4.99	801.14	343.74	0.56	0.027	2.33
1	5000	2-YEAR	1022.4	3709.2	3711.1		3711.5	0.0064	5.05	202.43	155.06	0.78	0.028	1.3
1	5000	100-YEAR	3970.4	3709.2	3712.5	3712.5	3713.7	0.0080	8.82	457.89	197.99	0.98	0.027	2.31
1	4877.632	2-YEAR	1022.4	3708.4	3710.3		3710.7	0.0063	5.34	225.8	215.84	0.79	0.027	1.05
1	4877.632	100-YEAR	3970.4	3708.4	3711.5	3711.5	3712.6	0.0081	9.15	505.49	244.25	0.99	0.028	2.07
1	4196.757	2-YEAR	1022.4	3698.4	3700.7		3701.1	0.0060	5.29	200.91	165.6	0.77	0.026	1.21
1	4196.757	100-YEAR	3970.4	3698.4	3702.7		3703.4	0.0034	7.12	648.72	259.91	0.67	0.026	2.49
1	4000	2-YEAR	1022.4	3696.4	3699.2	3698.9	3699.7	0.0056	5.36	190.84	121.5	0.75	0.028	1.57
1	4000	100-YEAR	3970.4	3696.4	3701.0	3700.9	3702.2	0.0063	8.93	456.65	170.26	0.89	0.026	2.68
1	3500	2-YEAR	1022.4	3689.7	3691.9	3691.9	3692.7	0.0101	6.95	147.12	99.09	1.01	0.028	1.48
1	3500	100-YEAR	3970.4	3689.7	3694.1	3694.1	3695.5	0.0084	9.43	420.94	157.61	1.01	0.028	2.66
1	3000	2-YEAR	1022.4	3682.9	3685.3	3684.9	3685.7	0.0041	4.83	211.87	124.95	0.65	0.028	1.69
1	3000	100-YEAR	3970.4	3682.9	3687.7		3688.5	0.0037	7.36	539.34	154.55	0.69	0.028	3.47

TFN 6 2/025
RECD NOV 14, 2014

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HEC-RAS Results: Slater Creek Premine

Reach	River Sta	Profile											
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	2500	2-YEAR	1022.4	3677.2	3681.1	3681.1	3682.0	0.0097	7.56	135.32	77.04	1	0.028	1.74
1	2500	100-YEAR	3970.4	3677.2	3683.6	3683.6	3685.2	0.0079	10.28	386.4	119.86	1.01	0.028	3.2
1	2000	2-YEAR	1022.4	3672.0	3675.1	3675.1	3676.0	0.0095	7.81	130.9	70.37	1.01	0.028	1.85
1	2000	100-YEAR	3970.4	3672.0	3677.8	3677.8	3679.5	0.0073	10.62	380.01	113.5	0.98	0.027	3.33
1	1275.216	2-YEAR	1022.4	3660.0	3663.2	3663.2	3664.2	0.0093	8.06	126.89	63.94	1.01	0.028	1.97
1	1275.216	100-YEAR	3970.4	3660.0	3666.1	3666.1	3667.9	0.0060	10.97	385.57	117.5	0.92	0.025	3.26
1	1000	2-YEAR	1022.4	3656.0	3657.7	3657.7	3658.2	0.0109	6.1	168.28	154.5	1	0.027	1.09
1	1000	100-YEAR	3970.4	3656.0	3659.3	3659.3	3660.5	0.0075	9.02	470.04	204.58	0.96	0.026	2.29
1	500	2-YEAR	1022.4	3650.7	3653.0	3652.5	3653.3	0.0031	4.16	252.9	167.94	0.57	0.027	1.5
1	500	100-YEAR	3970.4	3650.7	3655.5	3654.2	3656.0	0.0018	5.86	742.78	222.17	0.51	0.026	3.34

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RECD NOV 14, 2014

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HEC-RAS SECTIONS

TFN 6 2/025
RECD NOV 14, 2014

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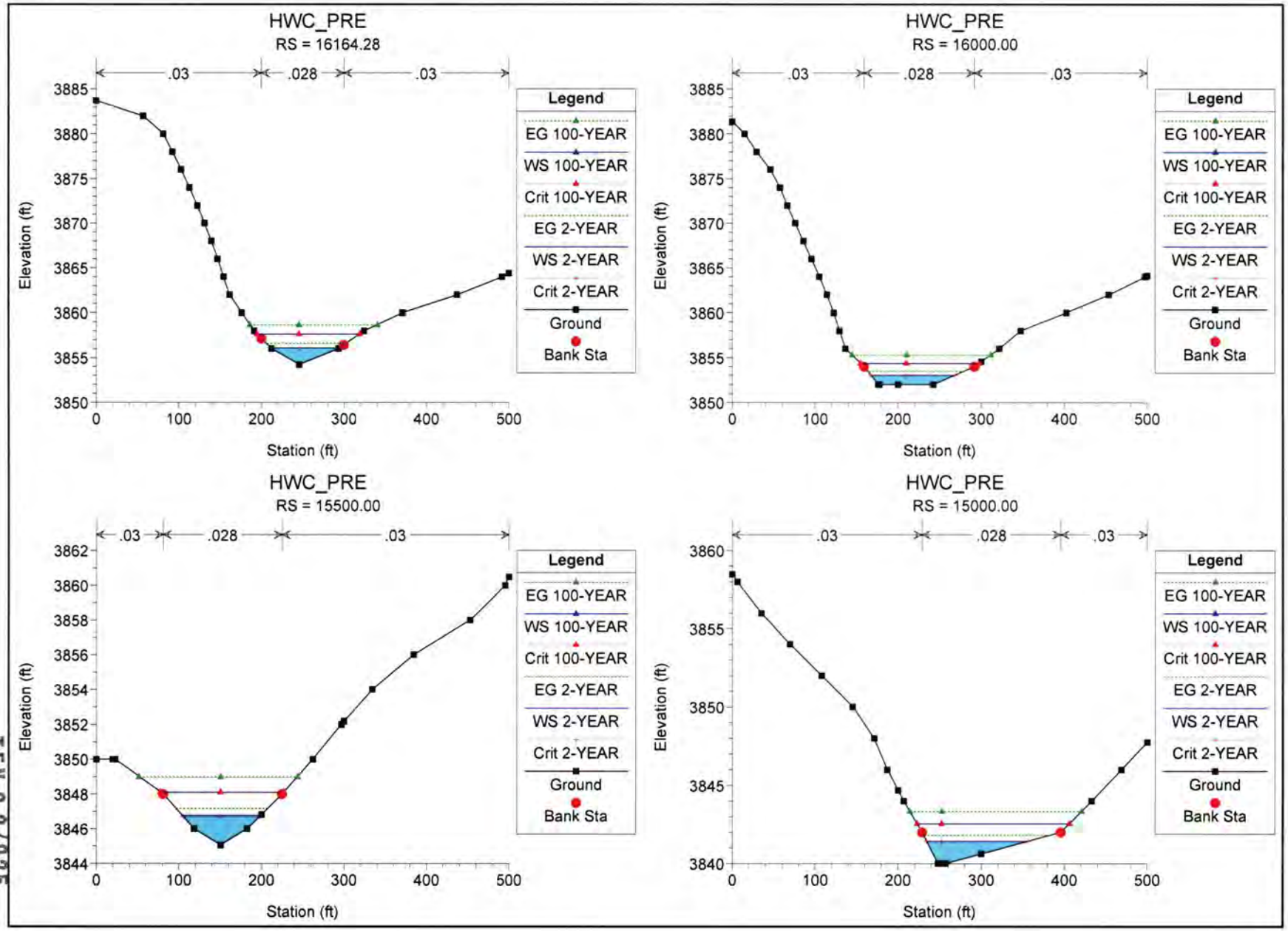

TFN 6 2/025
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DEQ Ex. 3-211

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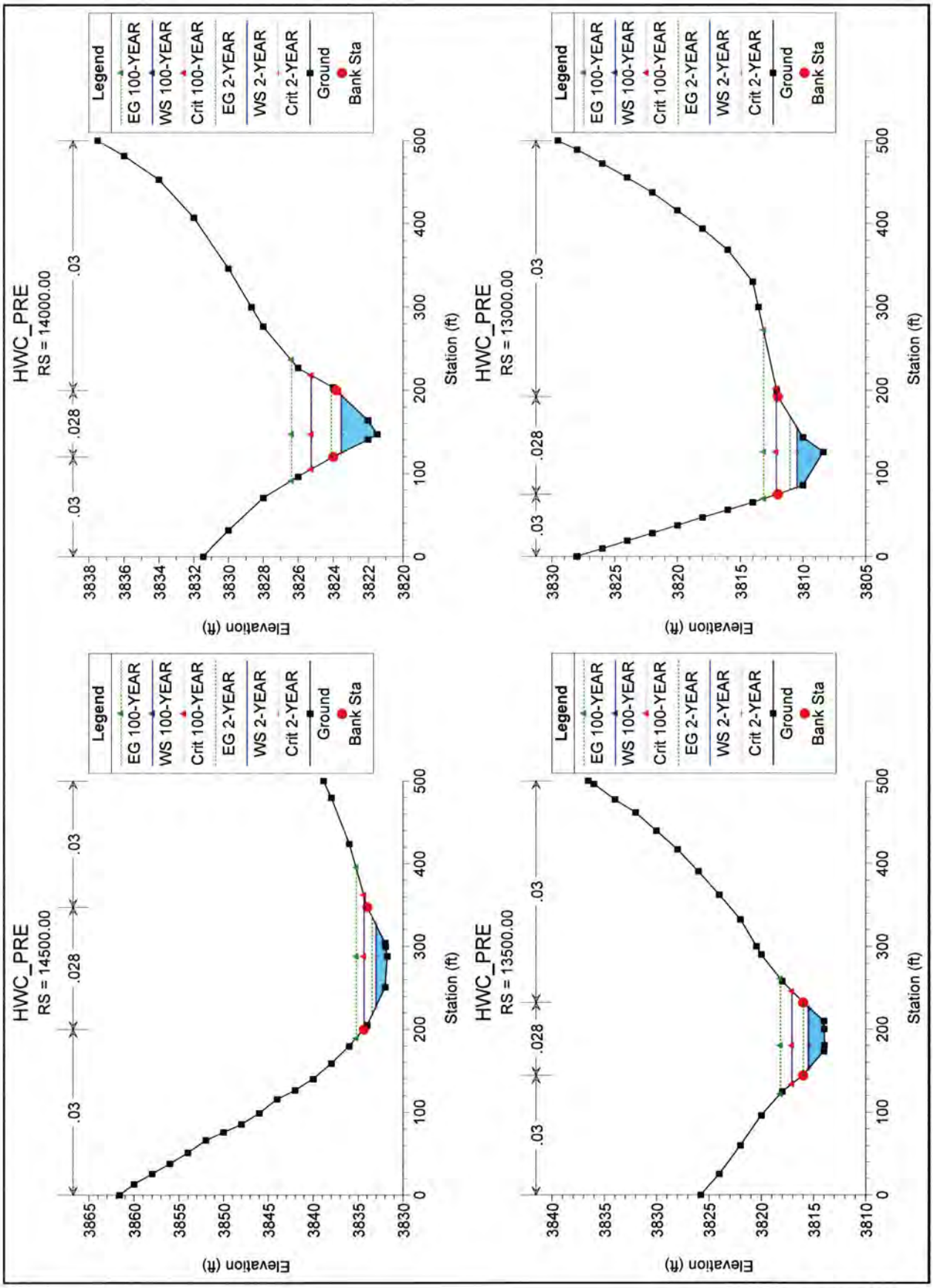

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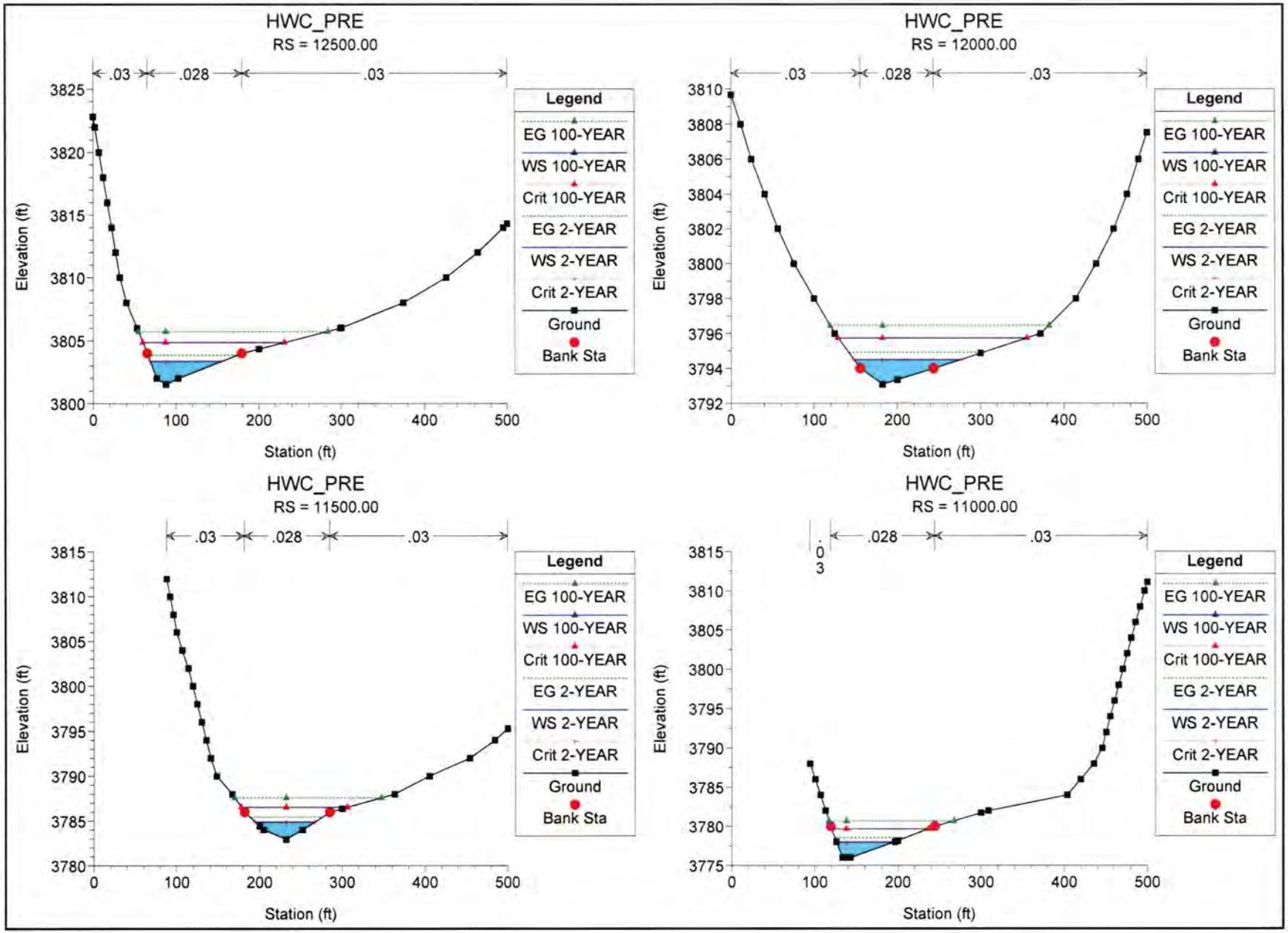

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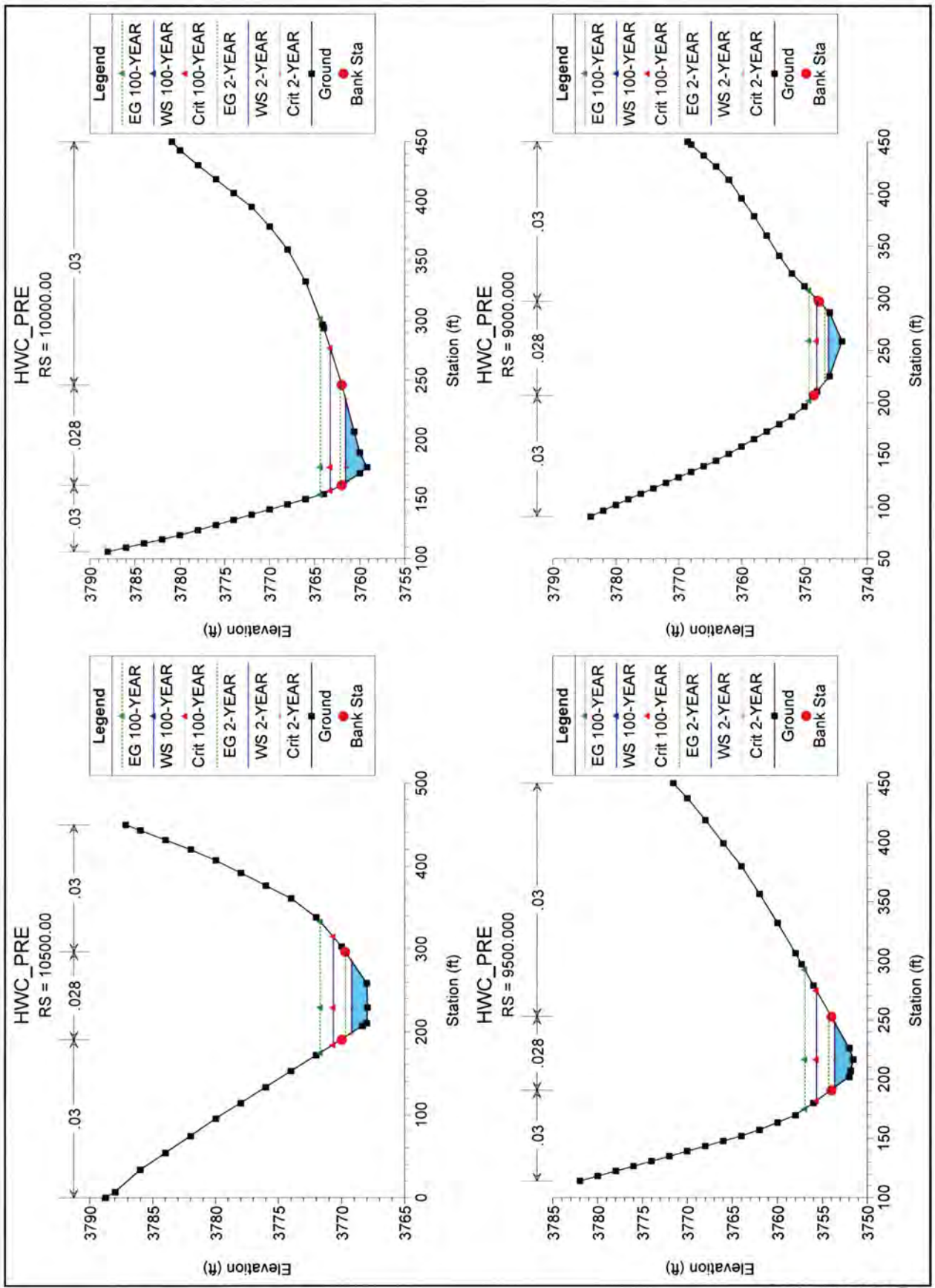
DEQ Ex. 3-213



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TFN 6 2/025
RECD NOV 14, 2014

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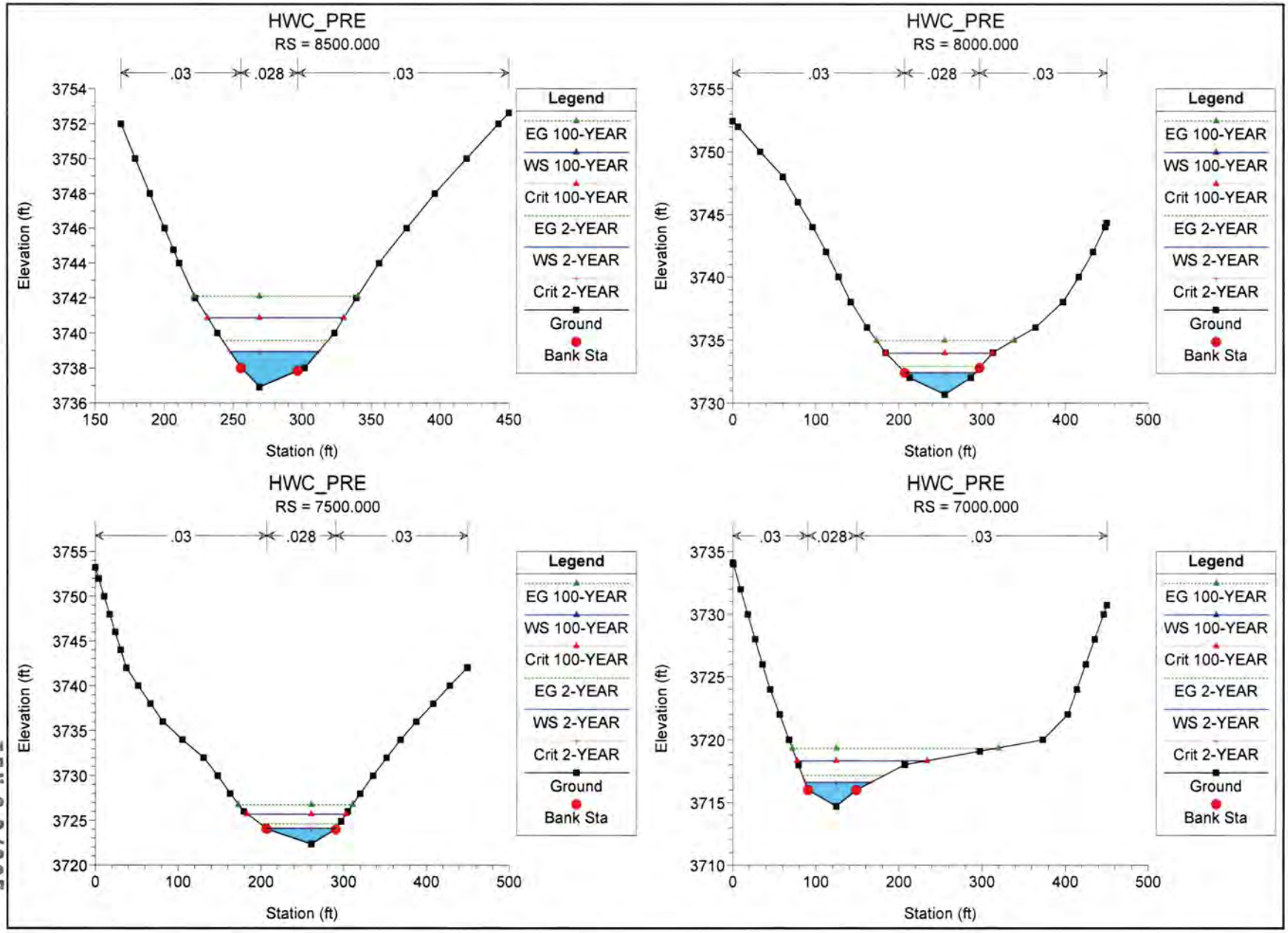

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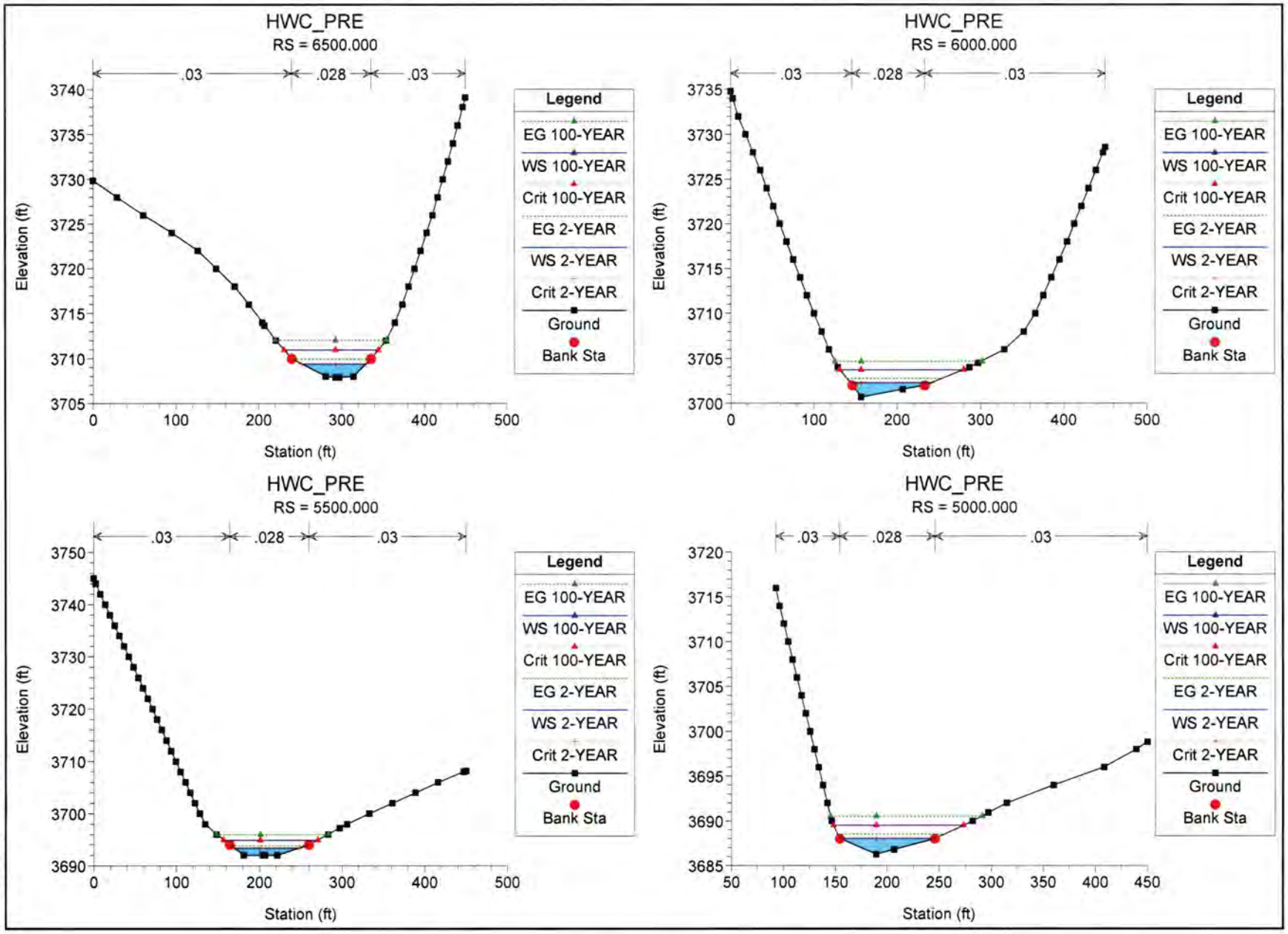

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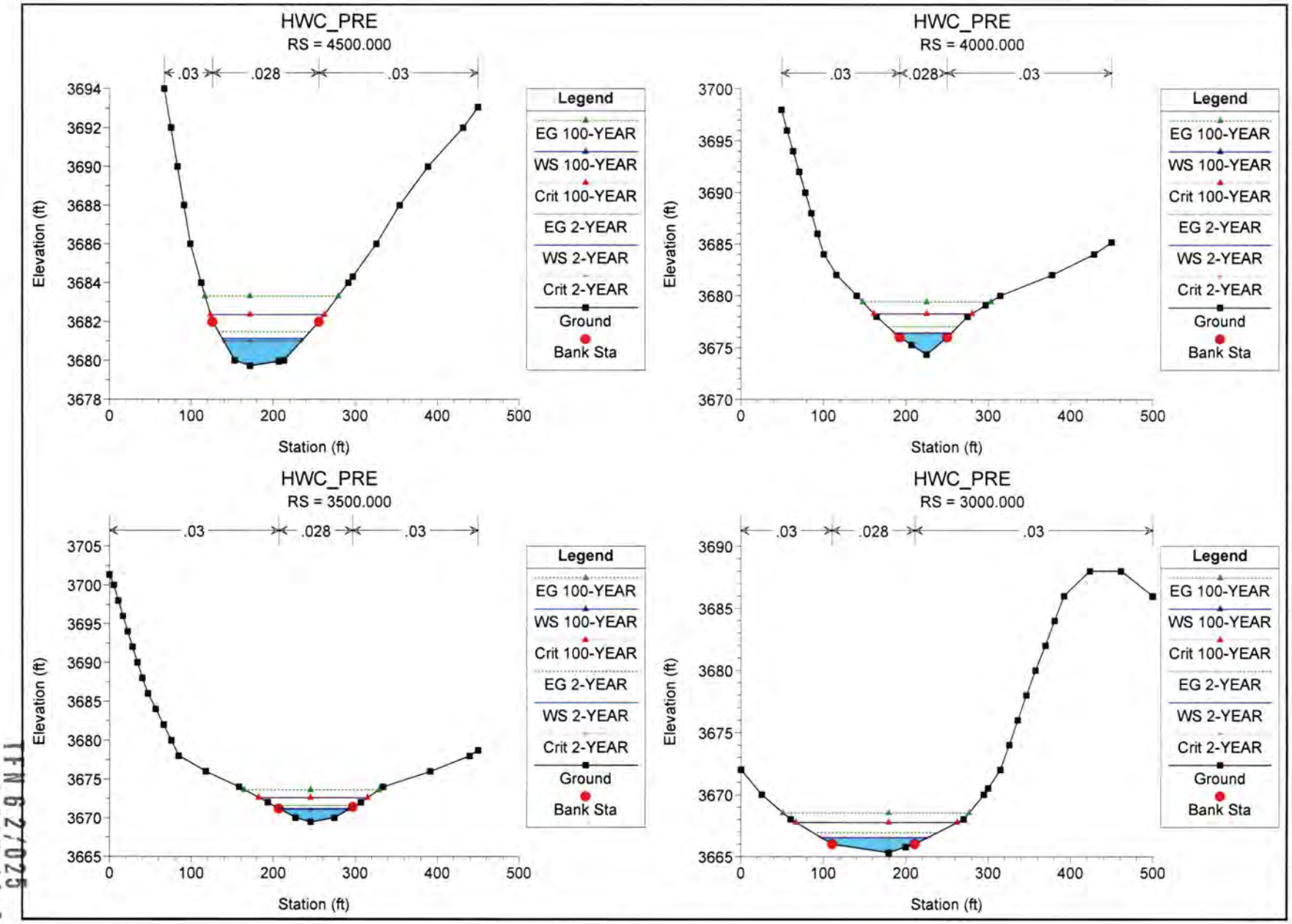

TFN 6 2/025
RECD NOV 14, 2014

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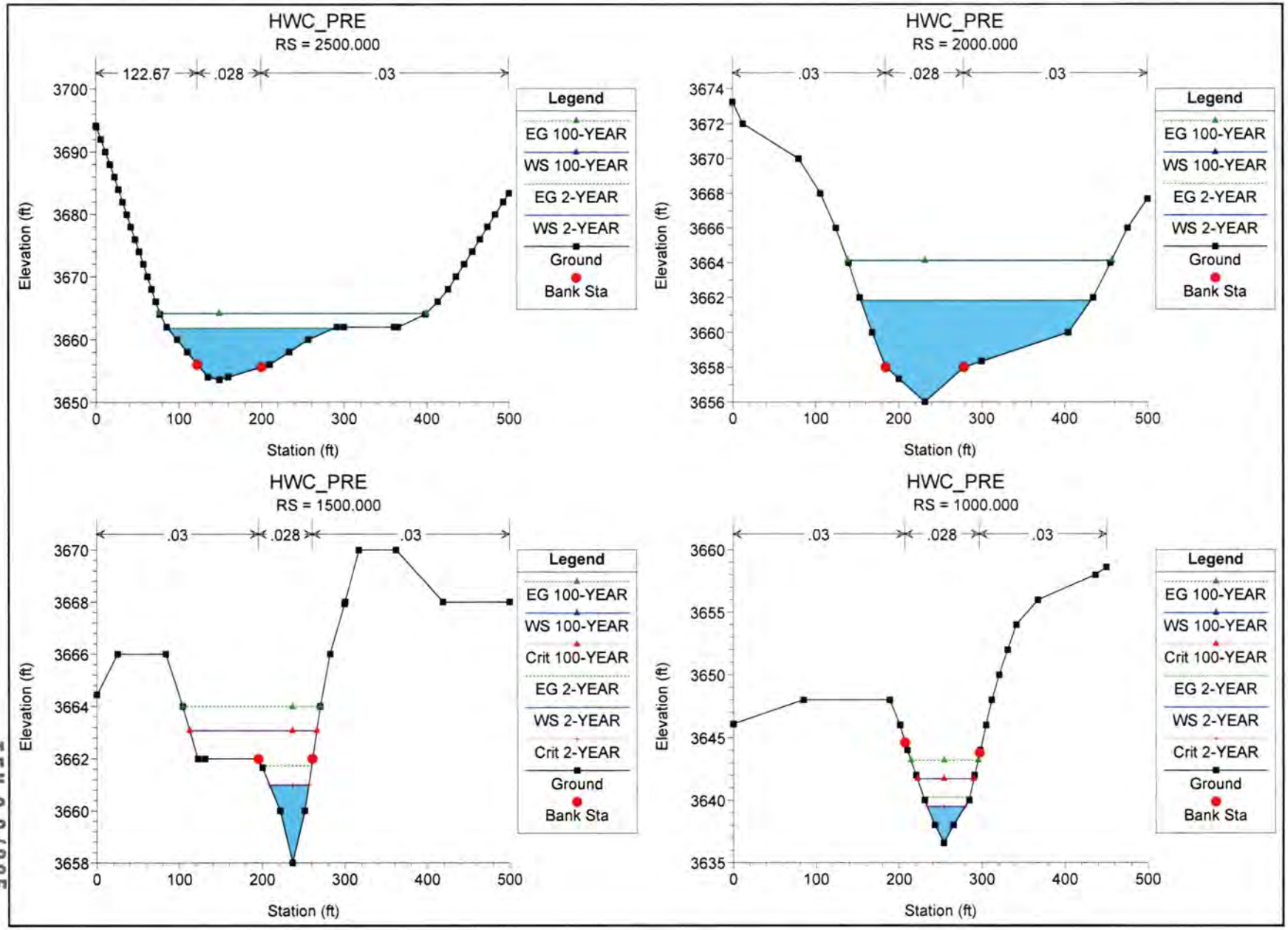

TFN 6 2/025
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DEQ Ex. 3-218

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RECD NOV 14, 2014

DEQ Ex. 3-219

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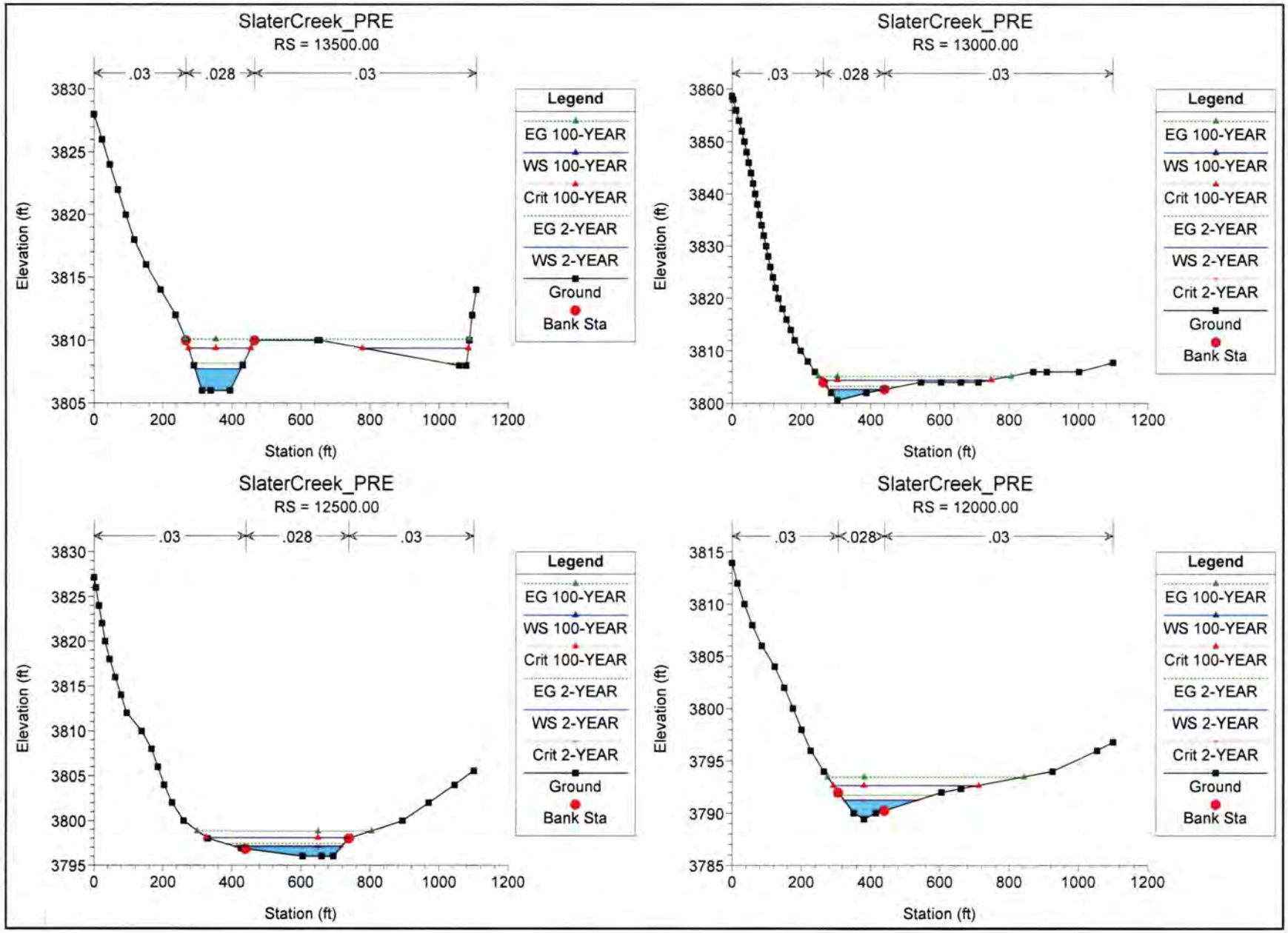

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-220

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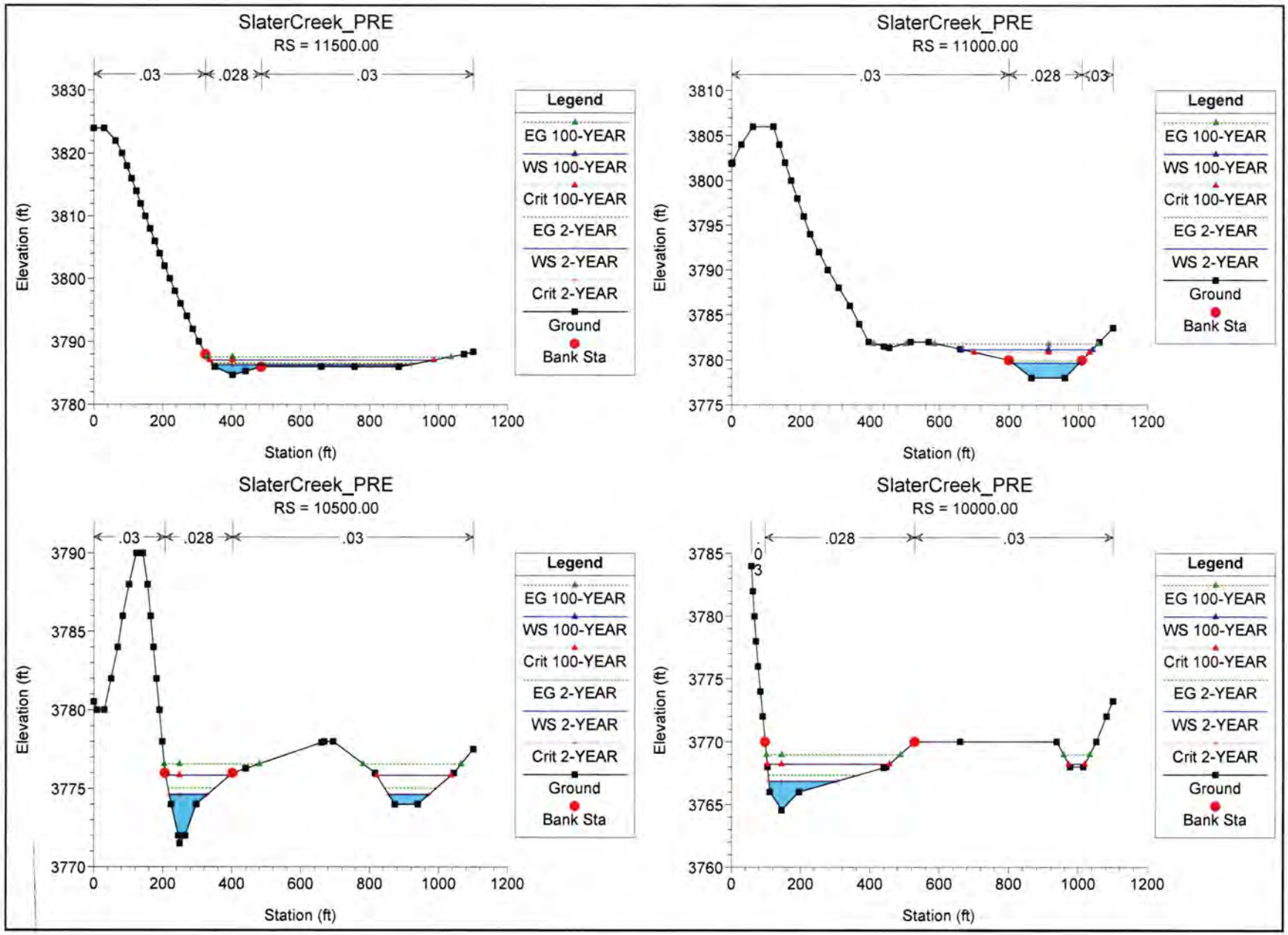

TFN 6 2/025
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DEQ Ex. 3-221

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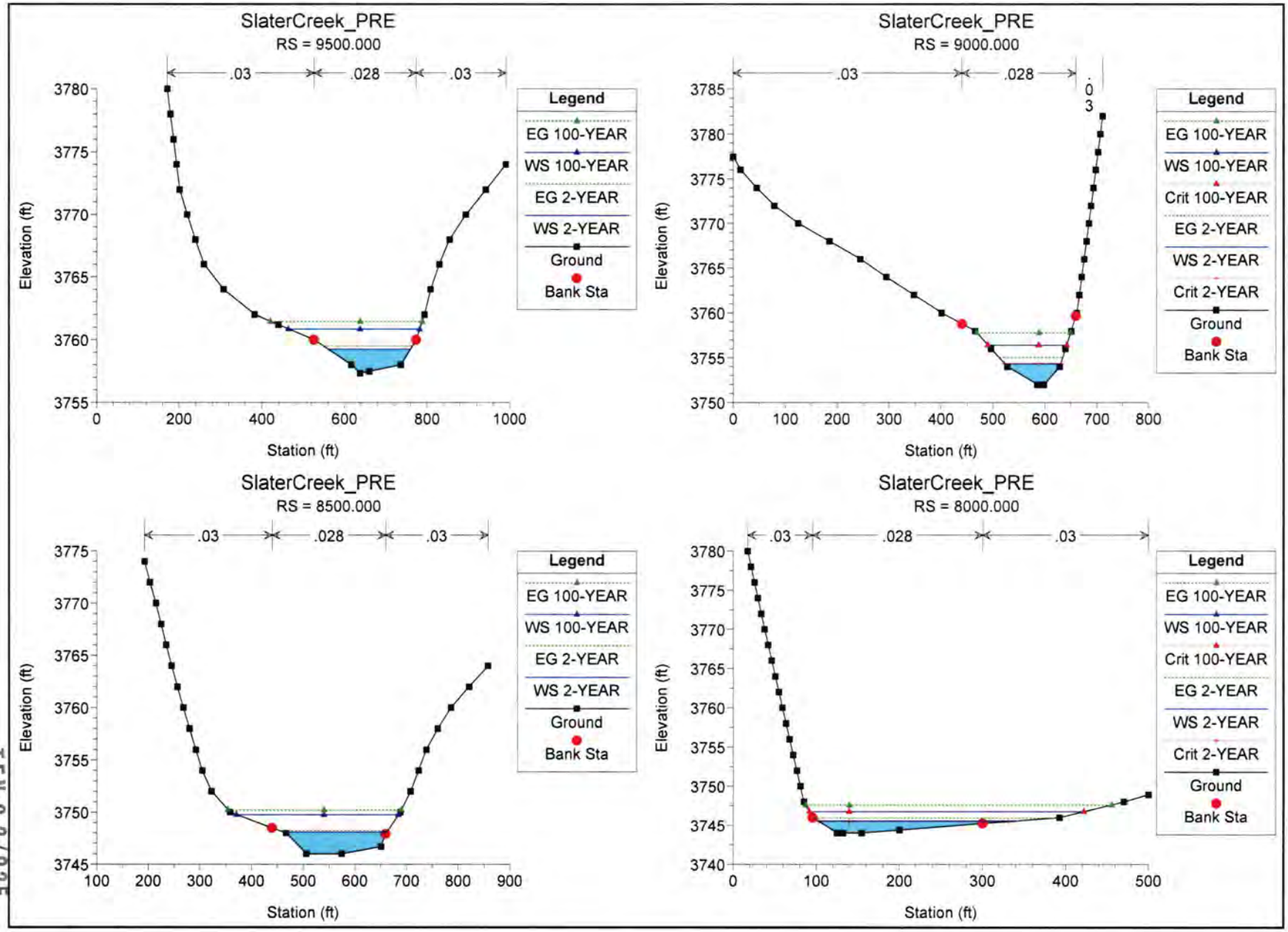

TFN 6 2/025
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DEQ Ex. 3-222

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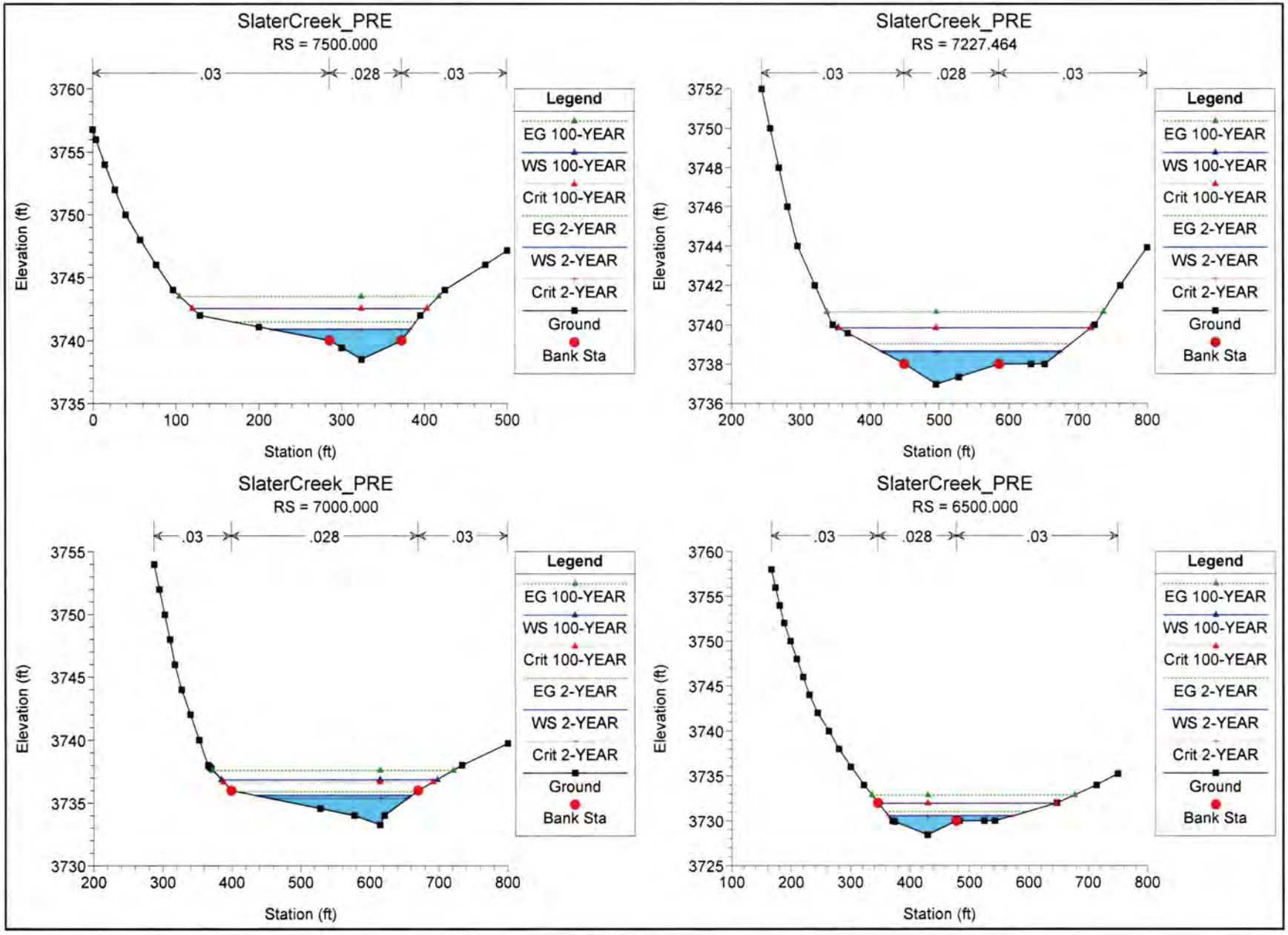

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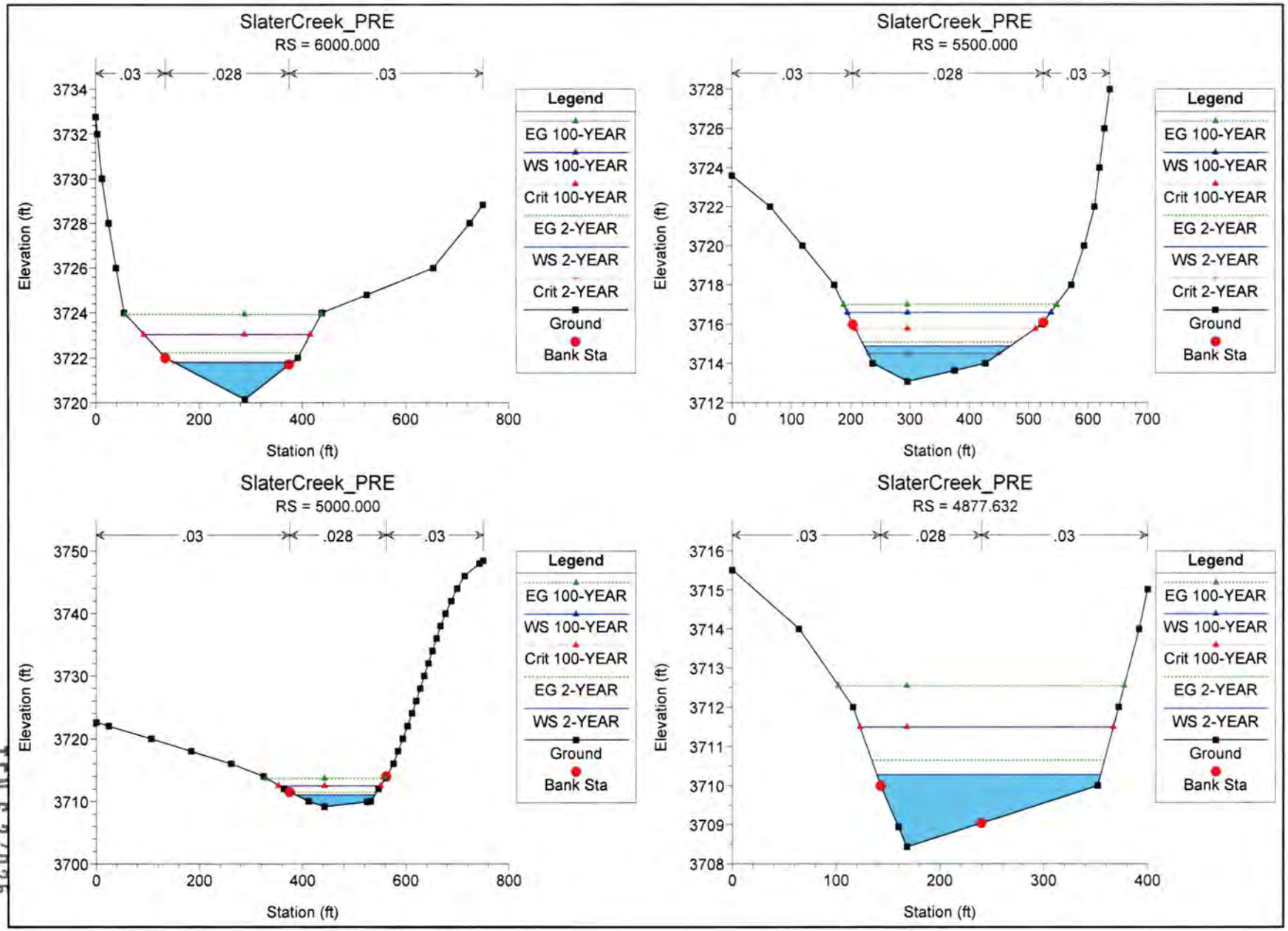

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-224

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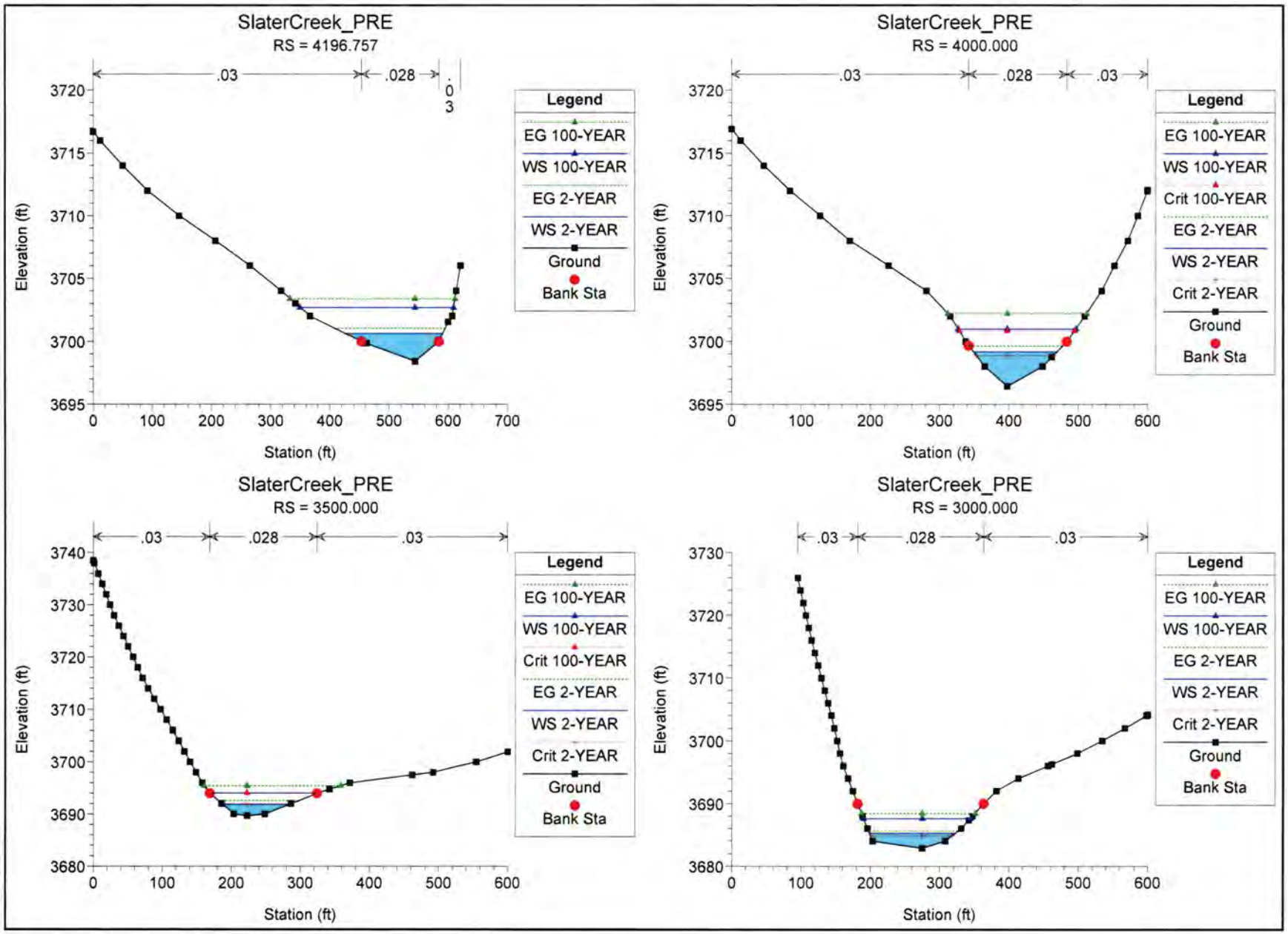

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-225

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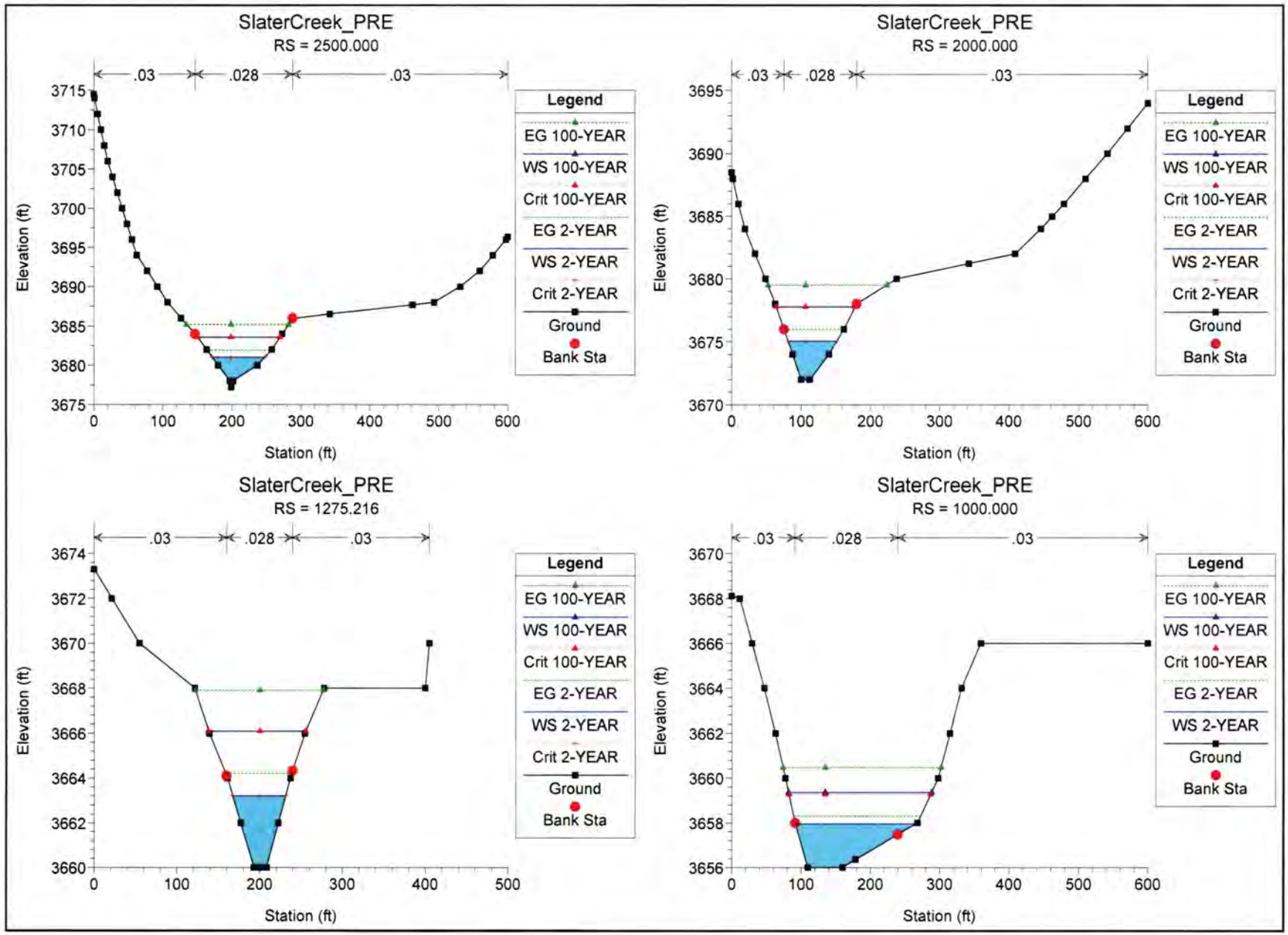

TFN 6 2/025
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DEQ Ex. 3-226

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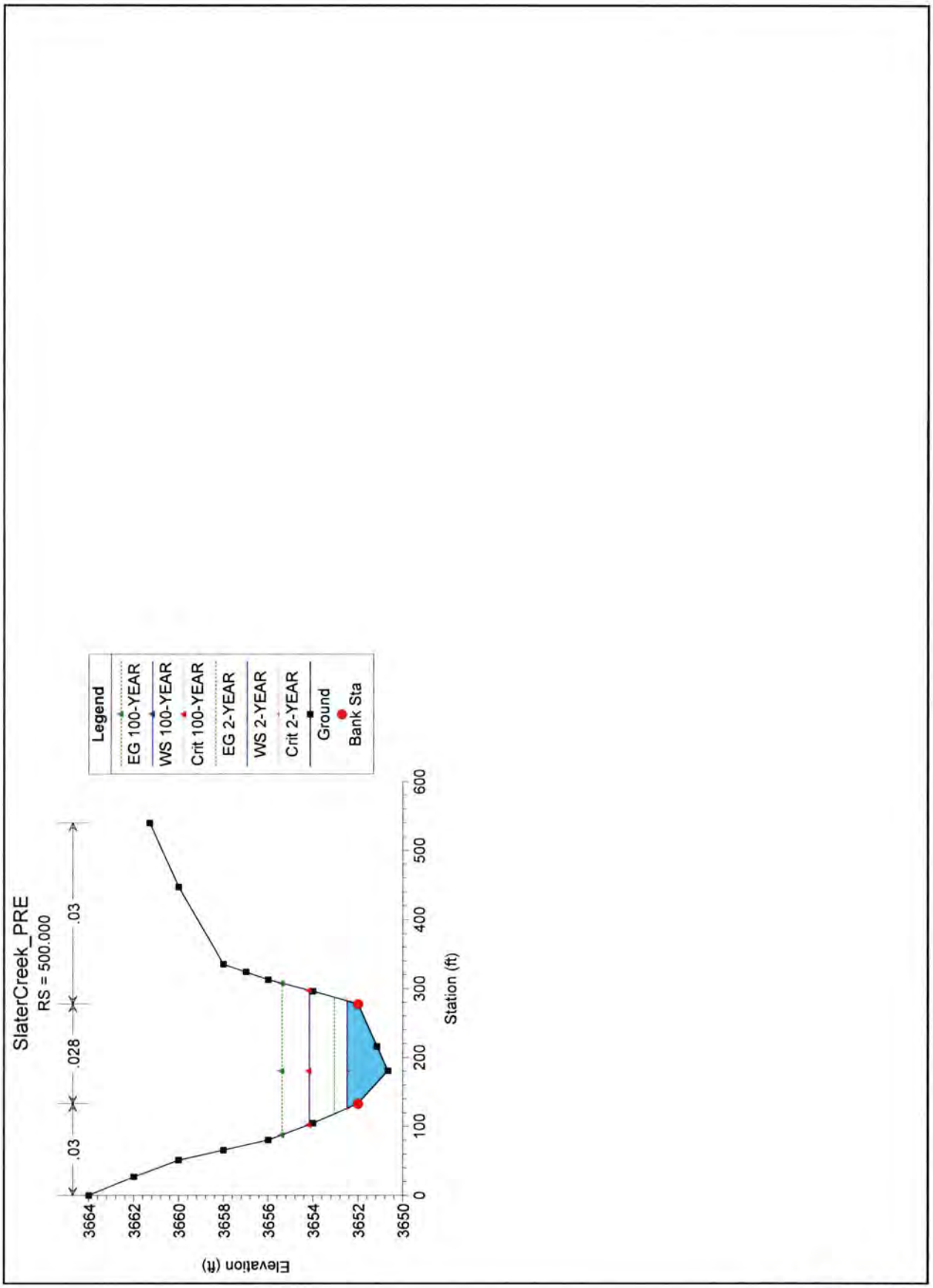

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-227

R.85 W. R.84 W.

T. 57 N.

HIDDEN WATER CREEK

SLATER CREEK

E. 1376000 E. 1380000 E. 1384000 E. 1388000 E. 1392000 E. 1396000 E. 1400000 E. 1404000

N. 1944000 N. 1940000 N. 1936000 N. 1932000 N. 1928000

10 11 12 7 8 9 10

15 14 13 18 17 16 15

22 23 24 19 20 21 22

R.85 W. R.84 W.

T. 57 N.

LEGEND

- BROOK MINE PERMIT BOUNDARY
- 20+00 HEC-RAS CROSS SECTION
- STREAM

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) JEFFREY G. BARRON 13033 WYOMING DATE: 10/17/2014

N

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 5'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description

ADDENDUM D6-3
EXHIBIT 1

TFN 6 2/025
RECD Nov 14, 2014

PREMINE HEC-RAS CROSS SECTION LOCATIONS

Drawn By: DCJ
Checked By: JGB
Date: 7-15-14

WWC ENGINEERING
www.wwcengineering.com

FILE: D6-3_1_HEC_XSEC_LOC.dwg

K:\Sheridan\RAMACO\13139\ACAD_WYSEC\DWGS_D6\ADDENDUM\D6-3_1_HEC_XSEC_LOC.dwg 10/14/2014 10:44:43 AM dave johnson

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ADDENDUM D6-4

Surface Water Hydrographs

TFN 6 2/025
RECD NOV 14, 2014

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Table D6-1. Collected Surface Water Flow Data

Date	Max Daily Flowrate			
	Slater Creek		Hidden Water Creek	
	SM578512-SW-1	**SM578418-SW-1**	**SM578415-SW-1**	**SM578409-SW-1**
9/17/13		0.00		
9/18/13		0.00		
9/19/13		0.00		
9/20/13		0.00		
9/21/13		0.00		
9/22/13		0.00		
9/23/13		0.00		
9/24/13		0.00		
9/25/13		0.00		
9/26/13		0.00		
9/27/13		0.00		
9/28/13		0.00		
9/29/13		0.00		
9/30/13	0.00	0.00	0.00	0.00
10/1/13	0.00	0.00	0.00	0.00
10/2/13	0.00	0.00	0.00	0.00
10/3/13	0.00	0.00	0.00	0.00
10/4/13	0.00	0.00	0.00	0.00
10/5/13	0.00	0.00	0.00	0.00
10/6/13	0.00	0.00	0.00	0.00
10/7/13	0.00	0.00	0.00	0.00
10/8/13	0.00	0.00	0.00	0.00
10/9/13	0.00	0.00	0.00	0.00
10/10/13	0.00	0.00	0.00	0.00
10/11/13	0.00	0.00	0.00	0.00
10/12/13	0.00	0.00	0.00	0.00
10/13/13	0.00	0.00	0.00	0.00
10/14/13	0.00	0.00	0.00	0.00
10/15/13	0.00	0.00	0.00	0.00
10/16/13	0.00	0.00	0.00	0.00
10/17/13	0.00	0.00	0.00	0.00
10/18/13	0.00	0.00	0.00	0.00
10/19/13	0.00	0.00	0.00	0.00
10/20/13	0.00	0.00	0.00	0.00
10/21/13	0.00	0.00	0.00	0.00
10/22/13	0.00	0.00	0.00	0.00
10/23/13	0.00	0.00	0.00	0.00
10/24/13	0.00	0.00	0.00	0.00
10/25/13	0.00	0.00	0.00	0.00
10/26/13	0.00	0.00	0.00	0.00
10/27/13	0.00	0.00	0.00	0.00
10/28/13	0.00	0.00	0.00	0.00

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

Table D6-1. Collected Surface Water Flow Data

Date	Max Daily Flowrate			
	Slater Creek		Hidden Water Creek	
	SM578512-SW-1	**SM578418-SW-1**	**SM578415-SW-1**	**SM578409-SW-1**
10/29/13	0.00	0.00	0.00	0.00
10/30/13	0.00	0.00	0.00	0.00
10/31/13	0.00	0.00	0.00	0.00
4/22/14		1.23		0.00
4/23/14		1.16		0.00
4/24/14	1.56	2.24	0.00	0.00
4/25/14	1.21	2.25	0.00	0.00
4/26/14	1.09	2.17	0.00	0.00
4/27/14	1.13	2.08	0.00	0.00
4/28/14	0.78	1.17	0.00	0.00
4/29/14	0.93	1.61	0.00	0.00
4/30/14	0.24	1.07	0.00	0.00
5/1/14	0.09	0.21	0.00	0.00
5/2/14	0.19	0.37	0.00	0.00
5/3/14	0.23	0.34	0.00	0.00
5/4/14	0.52	0.69	0.00	0.00
5/5/14	0.67	1.03	0.00	0.00
5/6/14	1.51	1.40	0.00	0.00
5/7/14	6.89	8.65	0.00	0.00
5/8/14	7.23	8.77	0.00	0.00
5/9/14	4.31	4.09	0.00	0.00
5/10/14	8.17	7.78	0.00	0.00
5/11/14	4.86	4.18	0.00	0.00
5/12/14	2.66	1.75	0.00	0.00
5/13/14	2.52	1.60	0.00	0.00
5/14/14	1.20	0.63	0.00	0.00
5/15/14	1.13	0.48	0.00	0.00
5/16/14	1.50	0.67	0.00	0.00
5/17/14	2.28	1.02	0.00	0.00
5/18/14	2.45	1.07	0.00	0.00
5/19/14	2.21	0.92	0.00	0.00
5/20/14	1.87	0.69	0.00	0.00
5/21/14	1.72	0.60	0.00	0.00
5/22/14	1.56	0.56	0.00	0.00
5/23/14	1.47	0.60	0.00	0.00
5/24/14	1.87	0.78	0.00	0.00
5/25/14	2.30	1.04	0.00	0.00
5/26/14	1.16	0.75	0.00	0.00
5/27/14	0.65	0.51	0.00	0.00
5/28/14	2.59	1.33	0.00	0.00
5/29/14	2.43	1.36	0.00	0.00
5/30/14	2.09	1.22	0.00	0.00
5/31/14	2.47	1.51	0.00	0.00

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Table D6-1. Collected Surface Water Flow Data

Date	Max Daily Flowrate			
	Slater Creek		Hidden Water Creek	
	SM578512-SW-1	**SM578418-SW-1**	**SM578415-SW-1**	**SM578409-SW-1**
6/1/14	2.38	1.56	0.00	0.00
6/2/14	2.11	1.34	0.00	0.00
6/3/14	2.43	1.52	0.00	0.00
6/4/14	2.07	1.50	0.00	0.00
6/5/14	2.82	1.85	0.00	0.00
6/6/14	1.56	1.83	0.00	0.00
6/7/14	1.92	1.48	0.00	0.00
6/8/14	2.13	1.65	0.00	0.00
6/9/14	1.53	1.35	0.00	0.00
6/10/14	1.34	1.20	0.00	0.00
6/11/14	1.61	1.16	0.00	0.00
6/12/14	2.04	1.11	0.00	0.00
6/13/14	1.72	1.11	0.00	0.00
6/14/14	2.12	0.94	0.00	0.00
6/15/14	1.84	1.29	0.00	0.00
6/16/14	1.59	0.94	0.00	0.00
6/17/14	2.46	0.93	0.00	0.00
6/18/14	1.99	1.29	0.00	0.00
6/19/14	1.90	1.02	0.00	0.00
6/20/14	1.04	0.99	0.00	0.00
6/21/14	2.47	0.84	0.00	0.00
6/22/14	1.89	1.40	0.00	0.00
6/23/14	2.12	0.90	0.00	0.00
6/24/14	1.86	0.78	0.00	0.00
6/25/14	1.27	0.56	0.00	0.00
6/26/14	1.23	0.20	0.00	0.00
6/27/14	2.66	0.07	0.00	0.00
6/28/14	2.75	0.36	0.00	0.00
6/29/14	2.31	0.39	0.00	0.00
6/30/14	1.12	0.06	0.00	0.00
7/1/14	0.55	0.00	0.00	0.00
7/2/14	0.39	0.00	0.00	0.00
7/3/14	0.41	0.00	0.00	0.00
7/4/14	0.26	0.00	0.00	0.00
7/5/14	0.13	0.00	0.00	0.00
7/6/14	0.09	0.00	0.00	0.00
7/7/14	0.11	0.00	0.00	0.00
7/8/14	0.01	0.00	0.00	0.00
7/9/14	0.08	0.00	0.00	0.00
7/10/14	0.04	0.00	0.00	0.00
7/11/14	0.06	0.00	0.00	0.00
7/12/14	0.14	0.00	0.00	0.00
7/13/14	0.00	0.00	0.00	0.00

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Table D6-1. Collected Surface Water Flow Data

Date	Max Daily Flowrate			
	Slater Creek		Hidden Water Creek	
	SM578512-SW-1	**SM578418-SW-1**	**SM578415-SW-1**	**SM578409-SW-1**
7/14/14	0.00	0.00	0.00	0.00
7/15/14	0.00	0.00	0.00	0.00
7/16/14	0.00	0.00	0.00	0.00
7/17/14	0.00	0.00	0.00	0.00
7/18/14	0.00	0.00	0.00	0.00
7/19/14	0.00	0.00	0.00	0.00
7/20/14	0.00	0.00	0.00	0.00
7/21/14	0.00	0.00	0.00	0.00
7/22/14	0.00	0.00	0.00	0.00
7/23/14	0.00	0.00	0.00	0.00
7/24/14	0.00	0.00	0.00	0.00
7/25/14	0.00	0.00	0.00	0.00
7/26/14	0.00	0.00	0.00	0.00
7/27/14	0.00	0.00	0.00	0.00
7/28/14	0.00	0.00	0.00	0.00
7/29/14	0.00	0.00	0.00	0.00
7/30/14	0.00	0.00	0.00	0.00
7/31/14	0.00	0.00	0.00	0.00
8/1/14	0.00	0.00	0.00	0.00
8/2/14	0.00	0.00	0.00	0.00
8/3/14	0.00	0.00	0.00	0.00
8/4/14	0.00	0.00	0.00	0.00
8/5/14	0.00	0.00	0.00	0.00
8/6/14	0.00	0.00	0.00	0.00
8/7/14	0.00	0.00	0.00	0.00
8/8/14	0.00	0.00	0.00	0.00
8/9/14	0.00	0.00	0.00	0.00
8/10/14	0.00	0.00	0.00	0.00
8/11/14	0.00	0.00	0.00	0.00
8/12/14	0.00	0.00	0.00	0.00
8/13/14	0.00	0.00	0.00	0.00
8/14/14	0.00	0.00	0.00	0.00
8/15/14	0.00	0.00	0.00	0.00
8/16/14	0.00	0.00	0.00	0.00
8/17/14	0.00	0.00	0.00	0.00
8/18/14	0.00	0.00	0.00	0.00
8/19/14	0.00	0.00	0.00	0.00
8/20/14	0.00	0.00	0.00	0.00
8/21/14	0.00	0.00	0.00	0.00
8/22/14	0.14	0.00	0.00	0.00
8/23/14	0.28	0.00	0.00	0.00
8/24/14	0.01	0.00	0.00	0.00
8/25/14	0.00	0.00	0.00	0.00

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Table D6-1. Collected Surface Water Flow Data

Date	Max Daily Flowrate			
	Slater Creek		Hidden Water Creek	
	SM578512-SW-1	**SM578418-SW-1**	**SM578415-SW-1**	**SM578409-SW-1**
8/26/14	0.00	0.00	0.00	0.00
8/27/14	0.00	0.00	0.00	0.00
8/28/14	0.00	0.00	0.00	0.00
8/29/14	0.00	0.00	0.00	0.00
8/30/14	0.01	0.00	0.00	0.00
8/31/14	0.00	0.00	0.00	0.00
9/1/14	0.01	0.00	0.00	0.00
9/2/14	0.00	0.00	0.00	0.00
9/3/14	0.00	0.00	0.00	0.00
9/4/14	0.00	0.00	0.00	0.00
9/5/14	0.00	0.00	0.00	0.00
9/6/14	0.00	0.00	0.00	0.00
9/7/14	0.03	0.00	0.00	0.00
9/8/14	0.02	0.00	0.00	0.00
Peak Flowrate (cfs)	**8.17**	**8.77**	**0.00**	**0.00**
Average Flowrate (cfs)[1]	**0.63**	**0.41**	**0.00**	**0.00**

Notes: [1]Average flowrate is calculated using all flow data collected.

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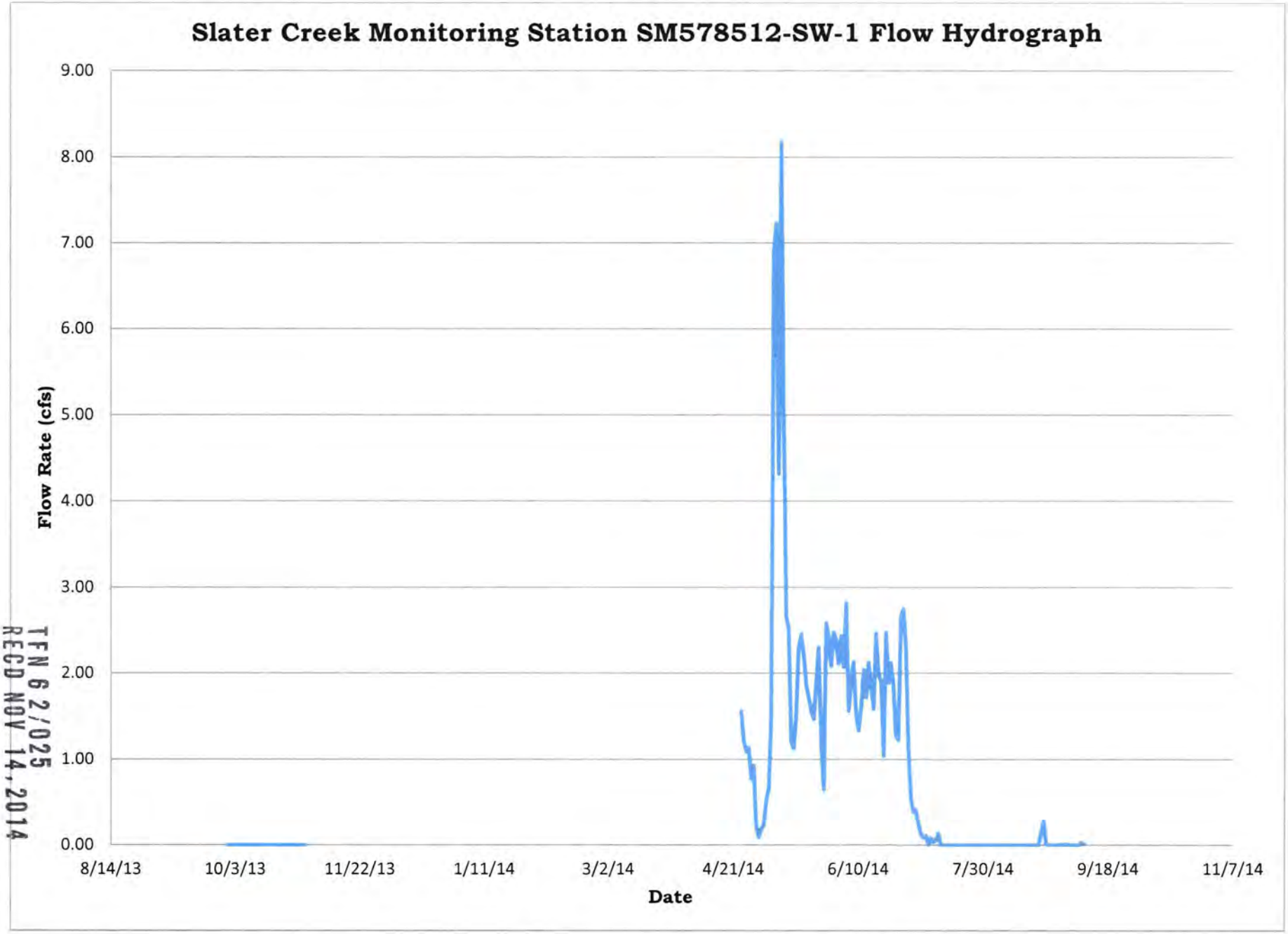

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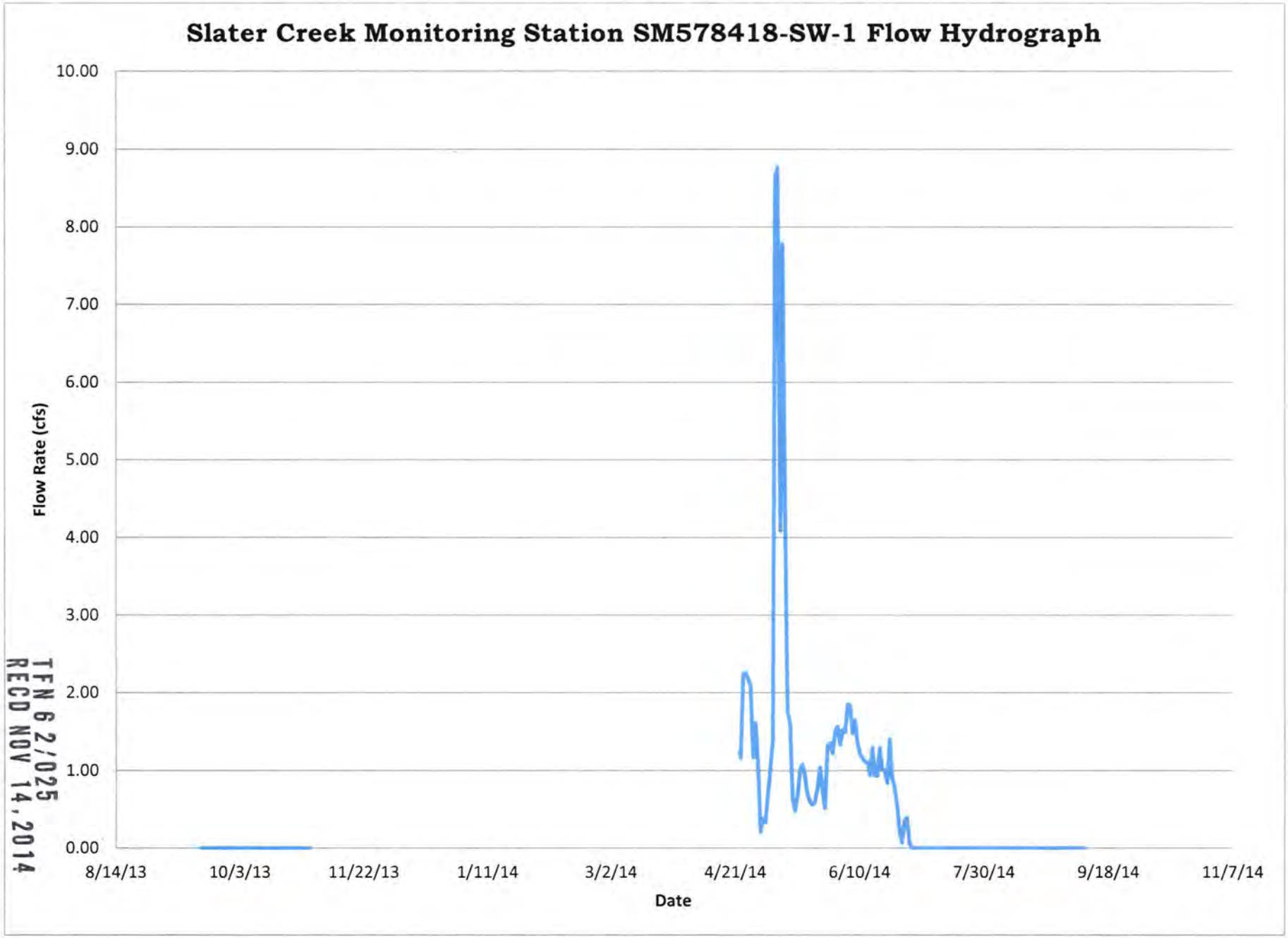

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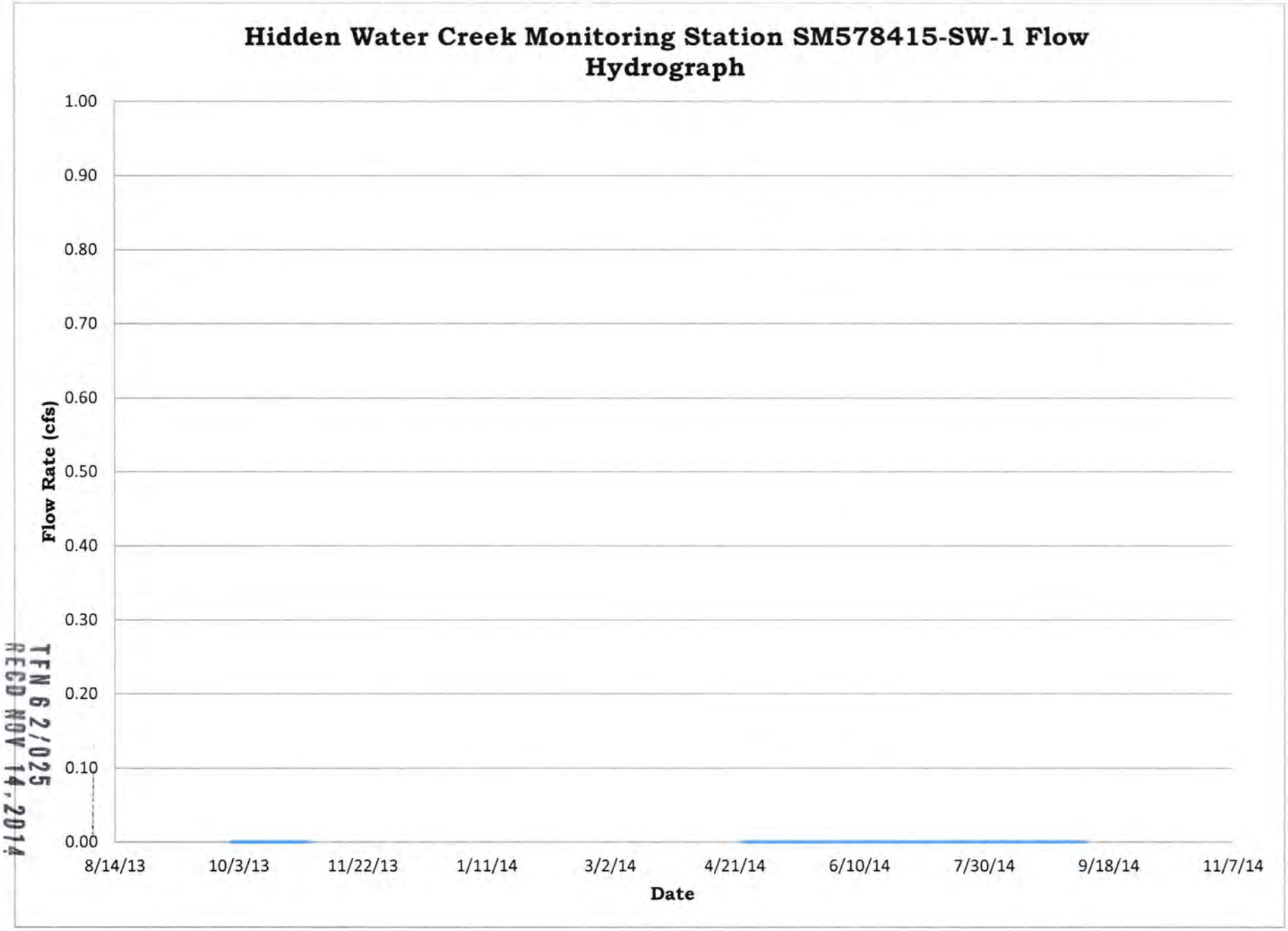

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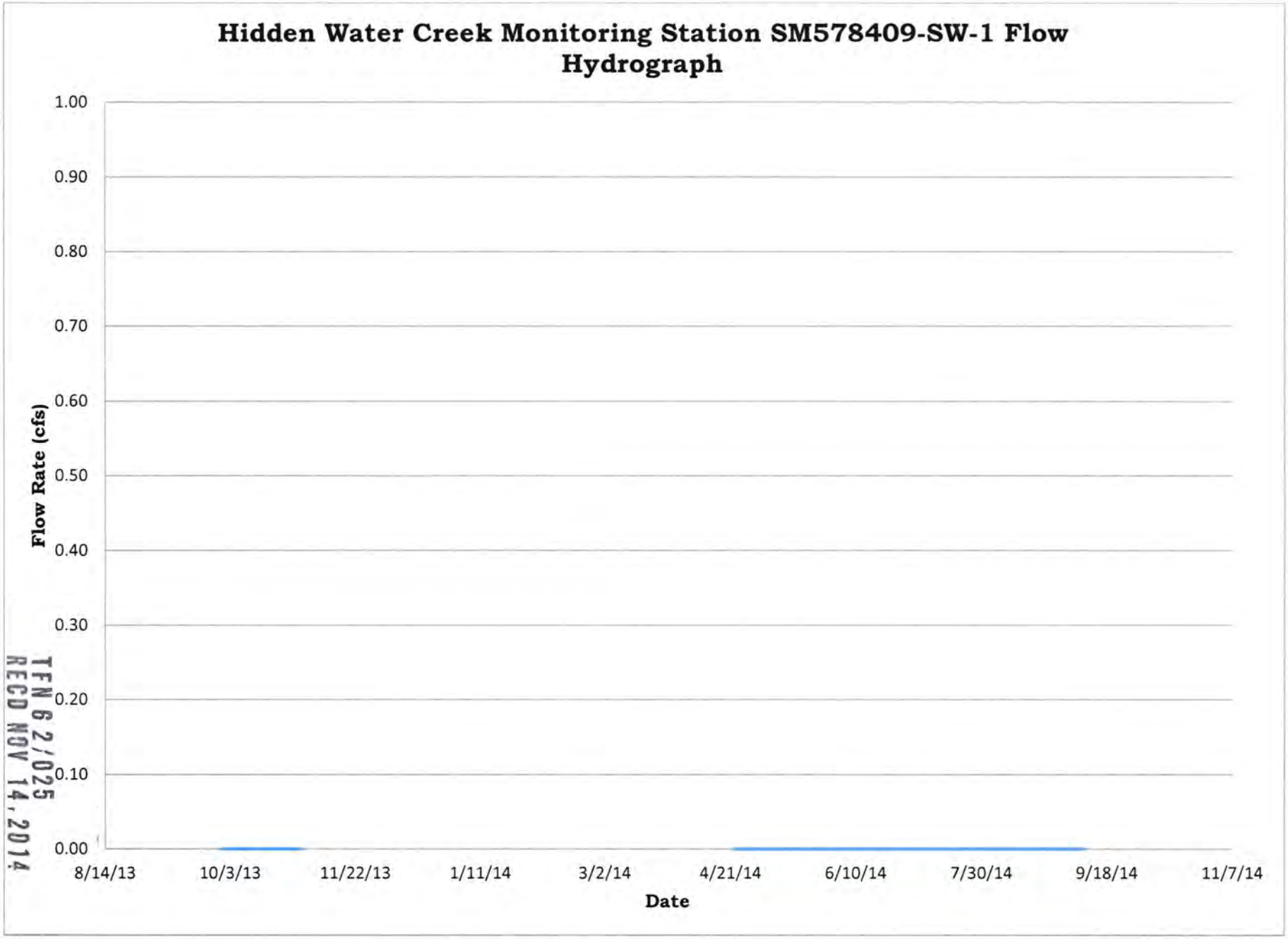

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ADDENDUM D6-5

Rating Curves

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LIST OF ATTACHMENTS

Attachment D6-5-A Rating Tables Stream Monitoring Stations
Attachment D6-5-B Rating Curves Stream Monitoring Stations

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D6-5 RATING CURVE DEVELOPMENT FOR STREAM MONITORING STATIONS

D6-5.1 Background

To measure streamflow occurring within the proposed Brook Mine permit boundary four continuous stage recorders were installed along Slater Creek and Hidden Water Creek and have been designated SM578418-SW-1, SM578512-SW-1, SM578409-SW-1 and SM578415-SW-1 (Figures D6-1 through D6-4). The monitoring stations are part of the baseline monitoring network for the mine permit application.

In an effort to depict flow conditions experienced at Slater Creek and Hidden Water Creek monitoring stations, rating curves were developed. Surveys of the channel thalweg and cross section at each monitoring station locations were completed by Prestfeldt Surveying in September 2013. WWC Engineering (WWC) developed rating curves for each monitoring site based on the surveyed stream cross sections and profiles.

D6-5.2 Approach

Uniform flow calculations were performed to determine flow rates within the Slater Creek and Hidden Water Creek channels. The Manning equation was used to calculate the flow. The Manning equation is:

$$Q = \frac{1.486}{n} AR^{0.67} S^{0.5}$$

where:

Q = flow (cfs)
n = Manning's roughness coefficient
A = area of flow (sq ft)
R = A/Wp = hydraulic radius (Wp = wetted perimeter in ft)
S = channel bottom slope (ft/ft)

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The Manning's roughness coefficient (n) was selected based on the vegetation growth within channel. Table D6-1 provides the roughness coefficients used for each location.

The channel thalweg at each monitoring station was surveyed upstream and downstream of each site. Figures D6-1 through D6-4 show the channel profiles. An average slope was determined from the surveyed information. Table D6-2 provides the slope used for each location.

Based on the survey data, a cross section was developed at the location of each monitoring station. Figures D6-1 through D6-4 show the cross sections and profiles for each monitor site.

Flows were calculated using Manning's equation for each channel cross section at 0.1-foot increments (Attachment D6-5-A). The minimum elevation chosen for calculations was the lowest point of each channel cross section. The maximum elevation chosen for calculations was based on judgment of appropriate flow rates anticipated for the channel.

D6-6.3 Results

Complete results of this uniform flow analysis are provided in Attachment D6-5-A (Rating Tables) and Attachment D6-5-B (Rating Curves). Table D6-3 provides a summary of minimum and maximum calculated flow rates for each cross section. Additionally, an equation was fit to each flow rate versus stage curve. Table D6-4 provides the equation for each curve at each station, as well as the R^2-value to demonstrate wellness of fit. Each equation calculates flow (Q) as a function of water stage (s).

D6-6.4 References

FlowMaster v8i. (2009). Bentley Systems, Inc.

Sturm, T. W. (2001). *Open Channel Hydraulics*. Singapore: McGraw-Hill Higher Education.

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Table D6-1. Manning's Roughness Coefficients for Individual Monitoring Station Locations

Monitoring Station	**Channel (n)**
SM578418-SW-1	0.030
SM578512-SW-1	0.030
SM578415-SW-1	0.030
SM578409-SW-1	0.030

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Table D6-2. Average Channel Slope for the Proximity of Each Monitoring Station Location

Monitoring Station	Average Slope (ft/ft)
SM578418-SW-1	0.00758
SM578512-SW-1	0.01427
SM578415-SW-1	0.01502
SM578409-SW-1	0.01459

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Table D6-3. Summary of Minimum and Maximum Flow Rates for Each Monitoring Station

Monitoring Station	Elevation (ft amsl)	Stage (ft)	Flow Rate (cfs)
SM578418-SW-1	3663.8	0.1	0.3
	3670.8	7.1	3,580
SM578512-SW-1	3743.2	0.1	0.1
	3750.3	7.2	4,460
SM578409-SW-1	3769.5	0.1	0.2
	3774.7	5.3	1,660
SM578415-SW-1	3656.0	0.1	0.2
	3661.0	5.1	1,730

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Table D6-4. Equations Fit to Rating Curves

Monitoring Station	Equation	R^2
SM578418-SW-1	$Q = 74.745s^2 - 5477178s + 1E+09$	0.9999
SM578512-SW-1	$Q = 102.15s^2 - 764877s + 1E+09$	0.9983
SM578409-SW-1	$Q = 54.658s^2 - 412028s + 8E+08$	0.9998
SM578415-SW-1	$Q = 69.329s^2 - 506949s + 9E+08$	0.9995

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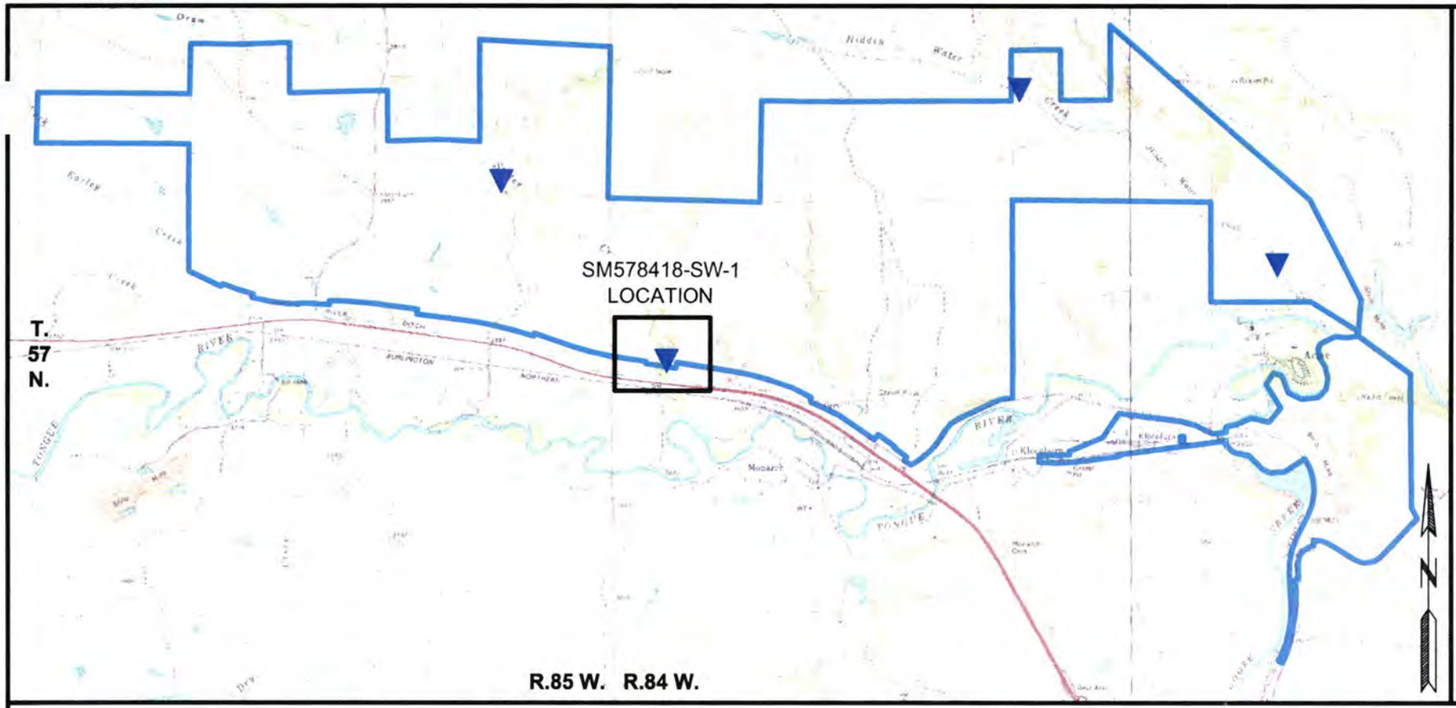

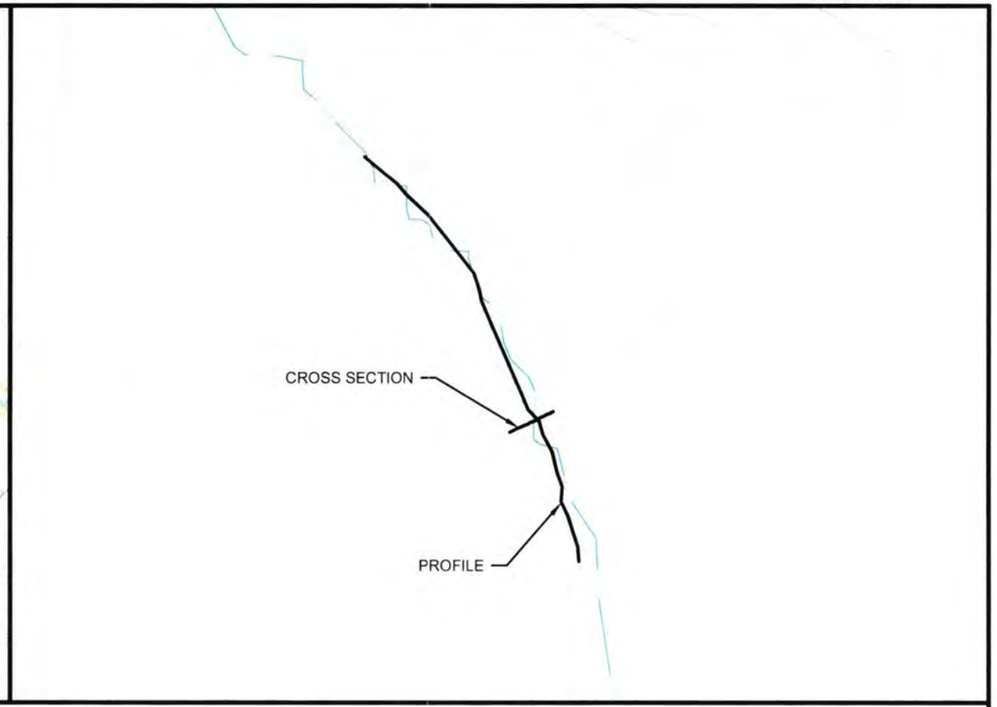

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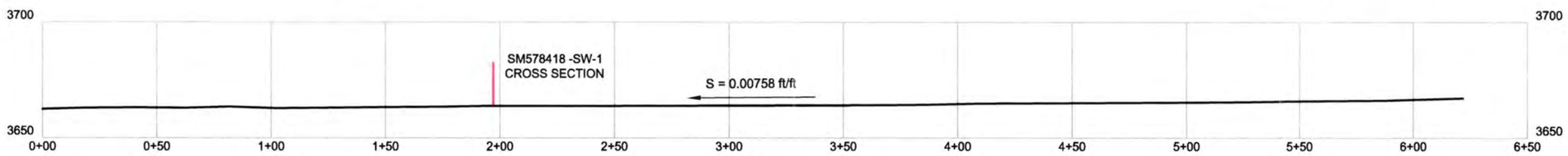

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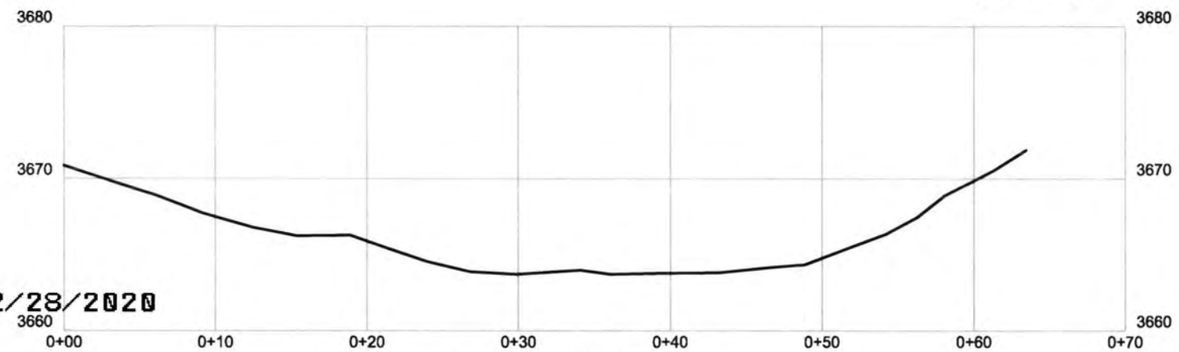

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RAMACO

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SHERIDAN COUNTY, WY

1101 SUGARVIEW DR STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description

ADDENDUM D6-5
FIGURE D6-1

SM578418-SW-1
MONITOR STATION PLAN VIEW, PROFILE AND CROSS SECTION

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Checked By:
Date:

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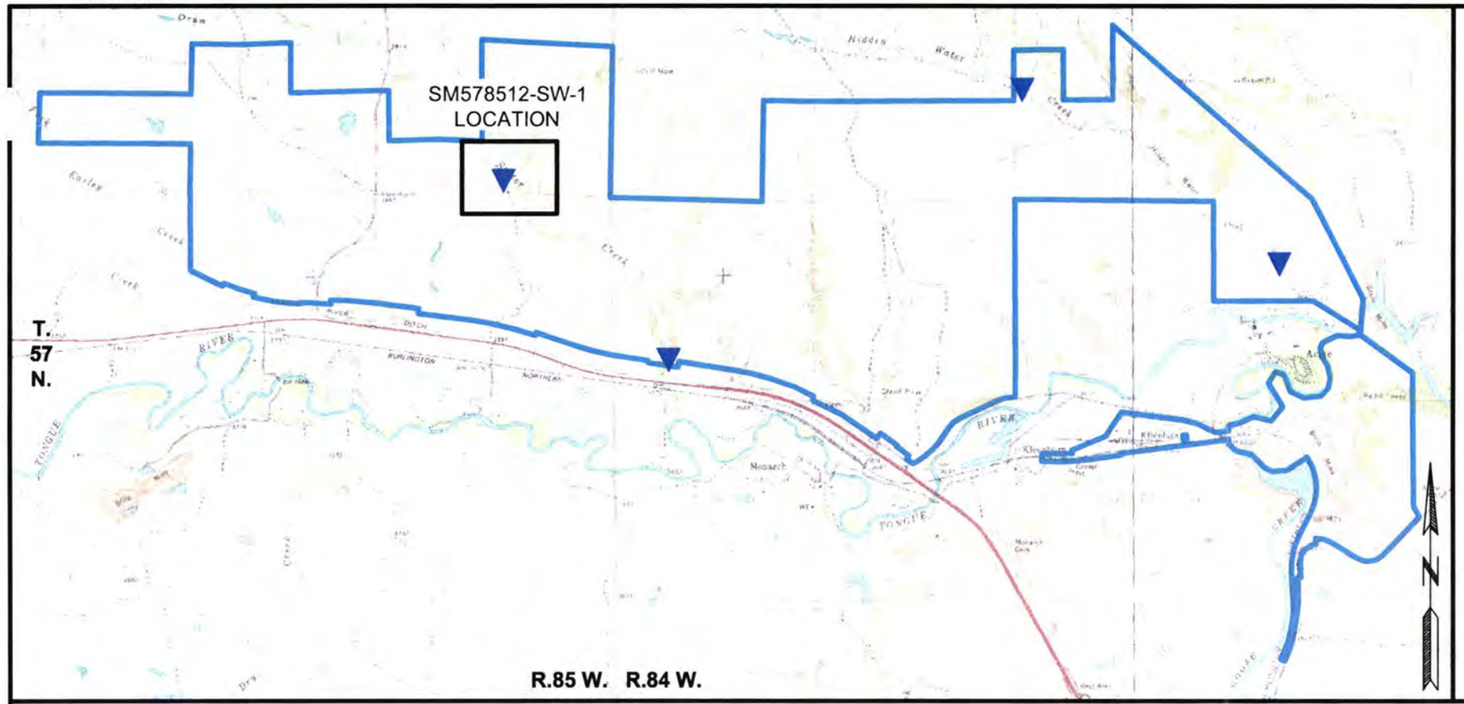

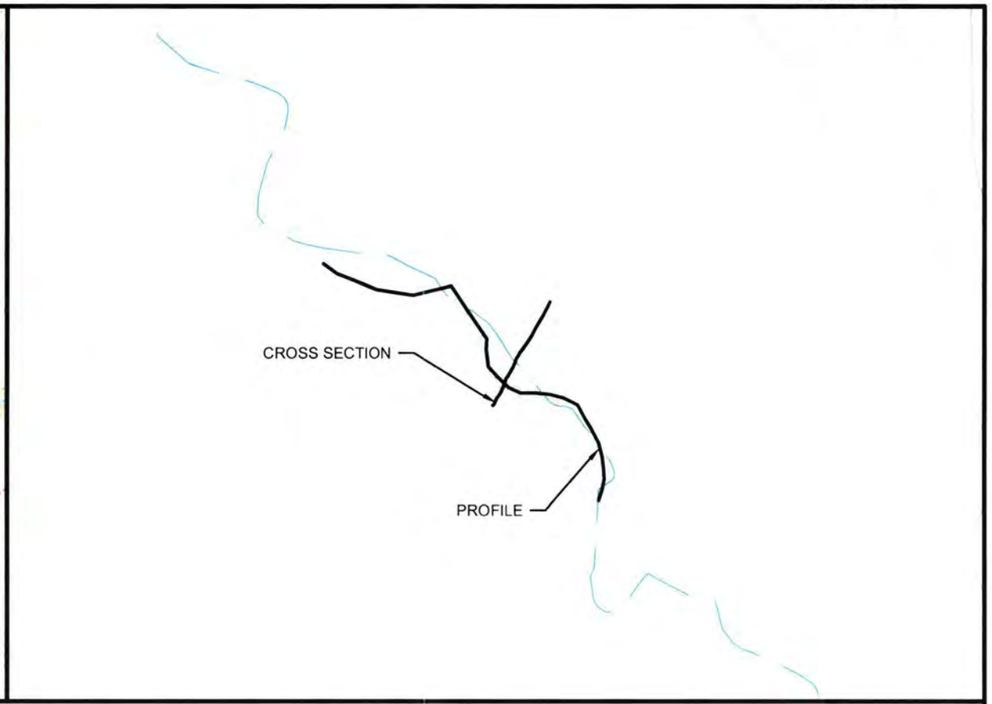

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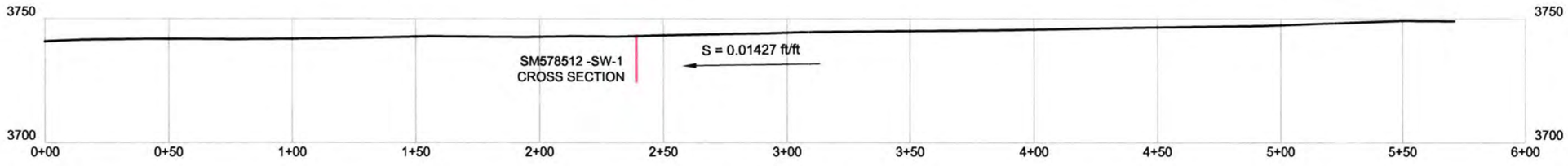

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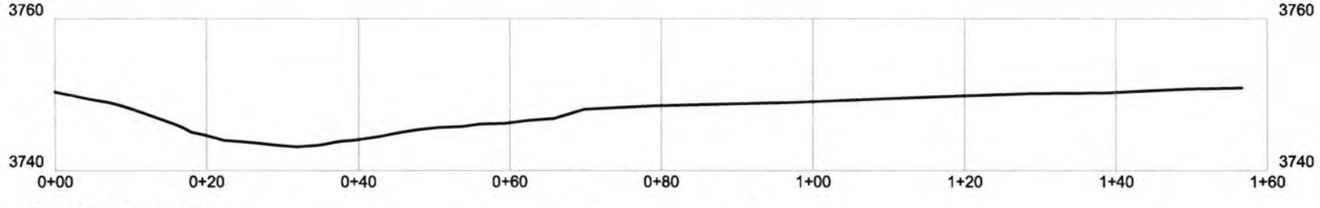

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SHERIDAN COUNTY, WY

1101 SUGARVIEW DR, STE. 201
SHERIDAN, WY 82801

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ADDENDUM D6-5
FIGURE D6-2

SM578512 -SW-1
MONITOR STATION PLAN VIEW, PROFILE AND CROSS SECTION

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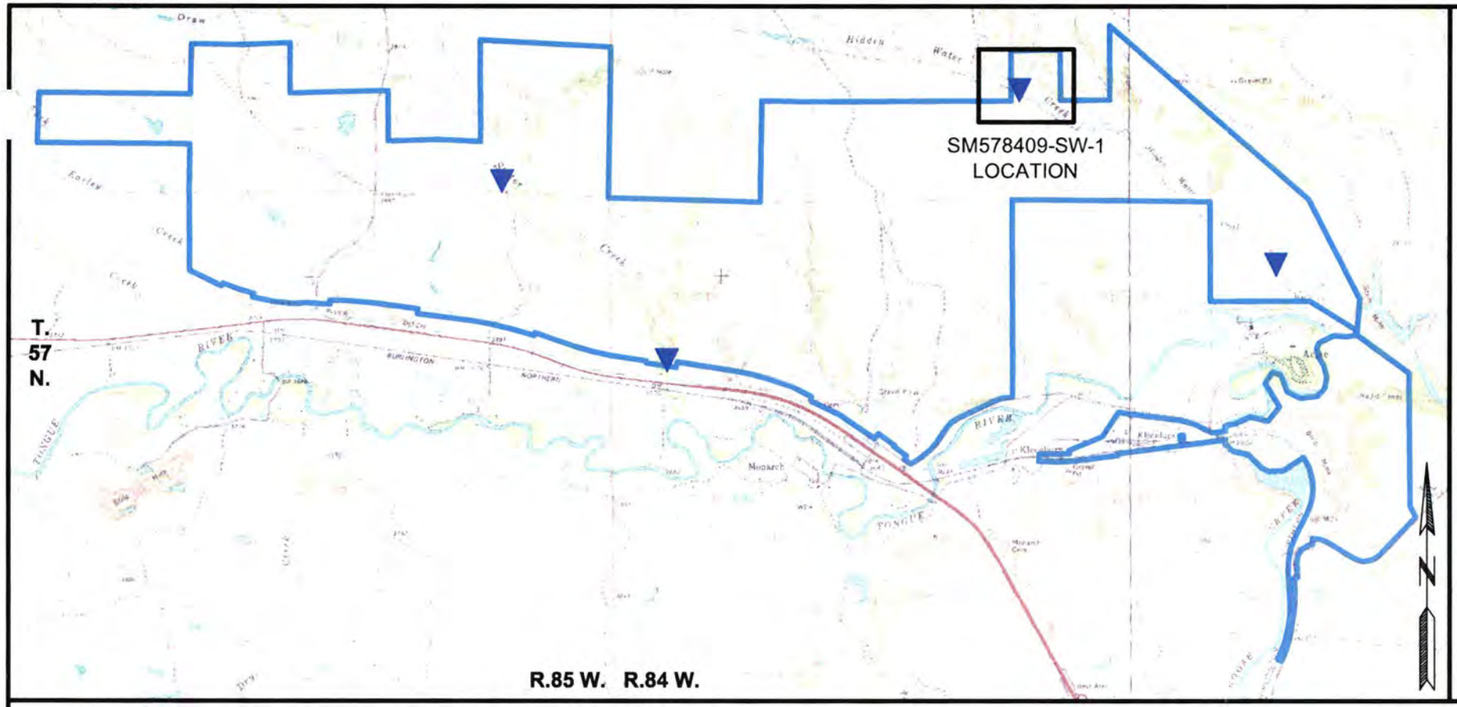

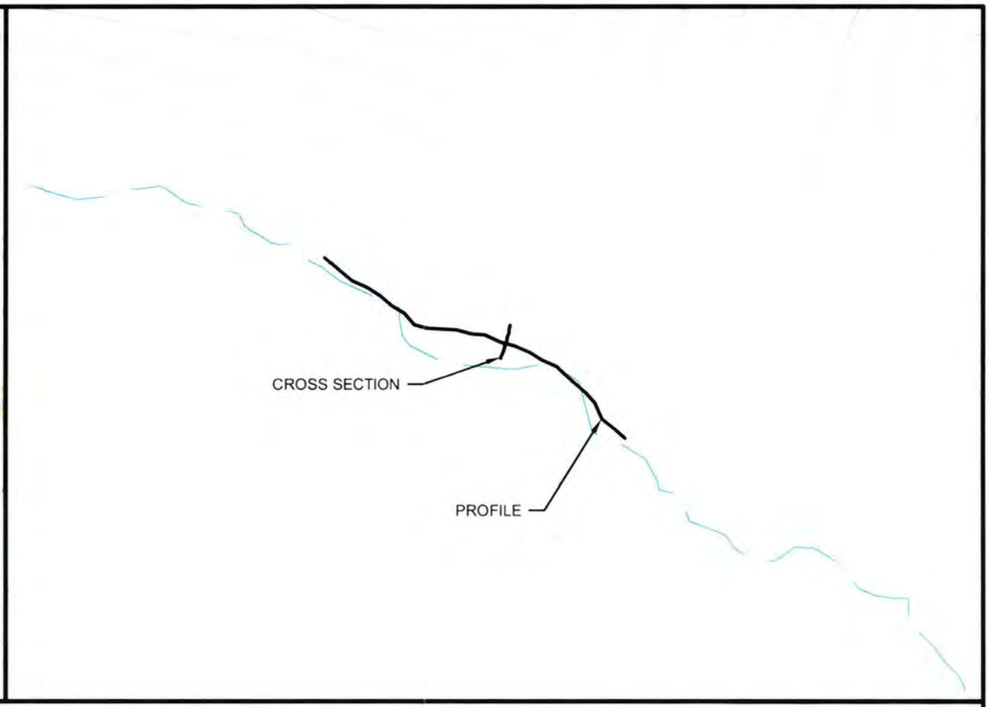

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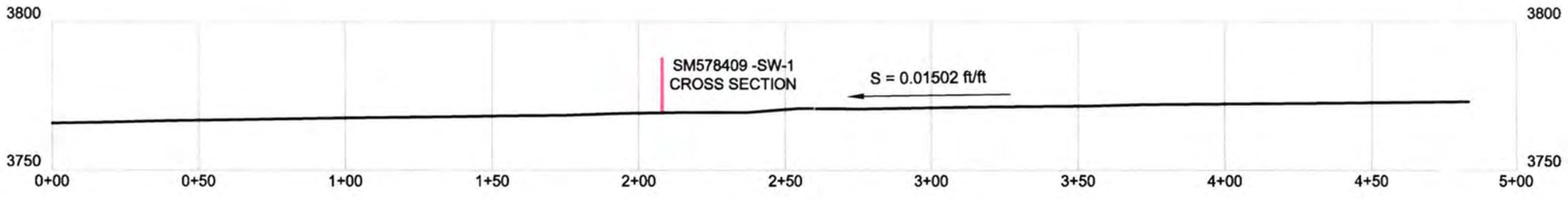

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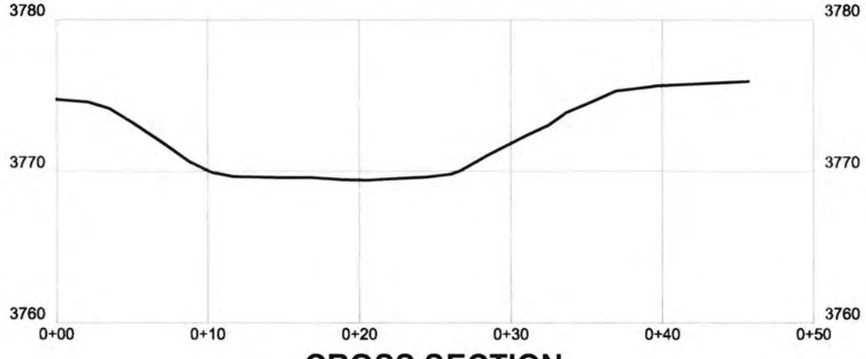

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RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description

ADDENDUM D6-5
FIGURE D6-3

SM578409-SW-1
MONITOR STATION PLAN VIEW, PROFILE AND CROSS SECTION

TFN 6 2/025
RECD NOV 14, 2014

Drawn By:
Checked By:
Date:

FILE: ADD_D6-5_MON_STA.dwg

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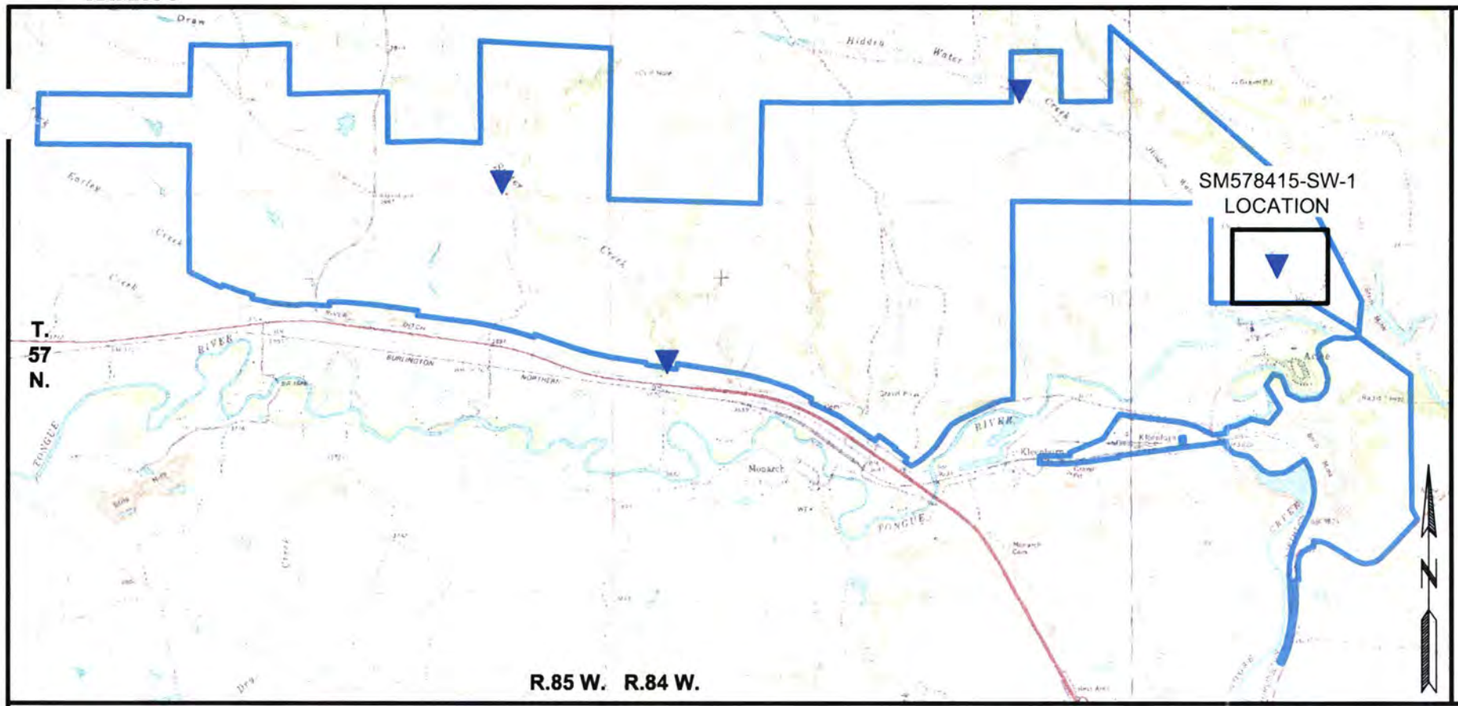
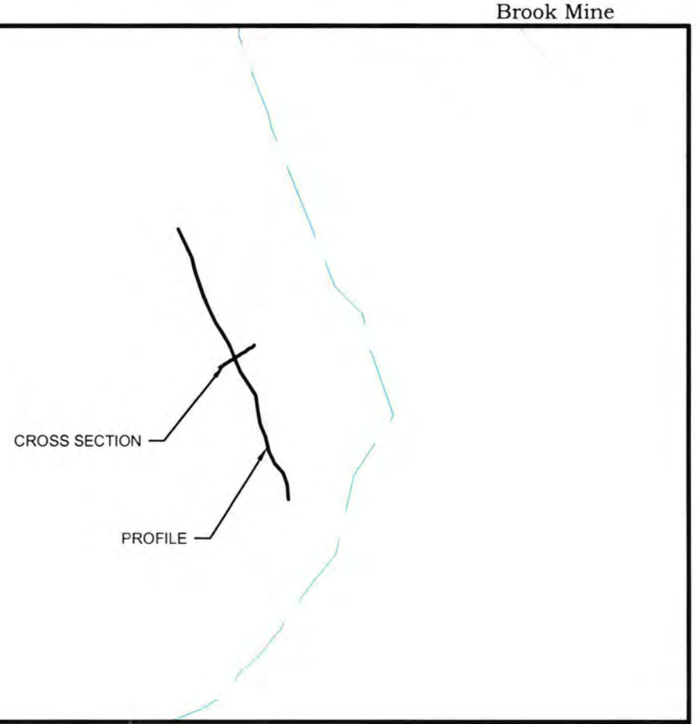
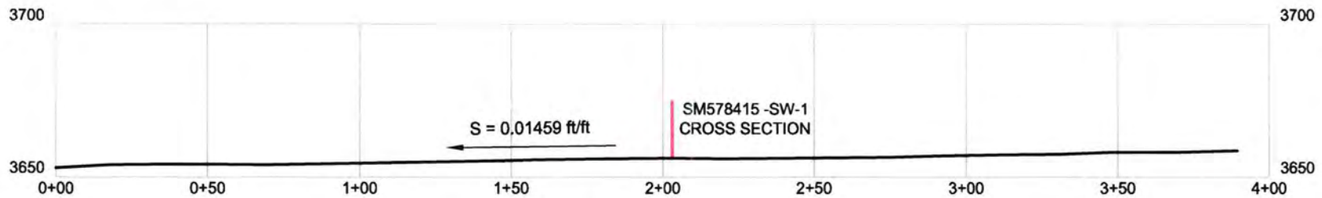


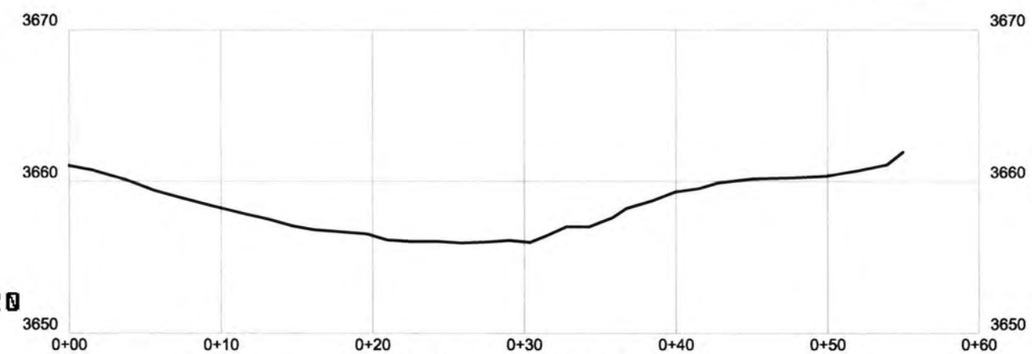


PLAN VIEW
SCALE: 1" = 4000'

SECTION/PROFILE VIEW
SCALE: 1" = 200'



PROFILE
SCALE: 1" = 50'



CROSS SECTION
SCALE: 1" = 10'

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RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description

ADDENDUM D6-5
FIGURE D6-4

TFN 6 2/025
RECD NOV 14, 2014

SM578415-SW-1
MONITOR STATION PLAN VIEW, PROFILE AND CROSS SECTION

Drawn By:
Checked By:
Date:

FILE: ADD_D6-5_MON_STA.dwg

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ATTACHMENT D6-5-A

Rating Tables
Stream Monitoring Stations

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Slater Creek Monitoring Station SM578418-SW-1 Rating Table			
Water Surface Elevation (ft)	Water Height (ft)	Wtd. Mannings Coefficient	Discharge (cfs)
3663.7	0	0.03	0
3663.8	0.1	0.03	0.29
3663.9	0.2	0.03	2.01
3664	0.3	0.03	5.43
3664.1	0.4	0.03	10.5
3664.2	0.5	0.03	16.96
3664.3	0.6	0.03	24.75
3664.4	0.7	0.03	34.34
3664.5	0.8	0.03	45.59
3664.6	0.9	0.03	58.3
3664.7	1	0.03	72.35
3664.8	1.1	0.03	87.68
3664.9	1.2	0.03	104.27
3665	1.3	0.03	122.1
3665.1	1.4	0.03	141.17
3665.2	1.5	0.03	161.45
3665.3	1.6	0.03	182.95
3665.4	1.7	0.03	205.66
3665.5	1.8	0.03	229.63
3665.6	1.9	0.03	254.77
3665.7	2	0.03	281.12
3665.8	2.1	0.03	308.68
3665.9	2.2	0.03	337.45
3666	2.3	0.03	367.42
3666.1	2.4	0.03	398.62
3666.2	2.5	0.03	431.03
3666.3	2.6	0.03	436.7
3666.4	2.7	0.03	472.39
3666.5	2.8	0.03	509.69
3666.6	2.9	0.03	548.44
3666.7	3	0.03	588.64
3666.8	3.1	0.03	630.3
3666.9	3.2	0.03	675.34
3667	3.3	0.03	721.83
3667.1	3.4	0.03	769.76
3667.2	3.5	0.03	819.15
3667.3	3.6	0.03	869.98
3667.4	3.7	0.03	922.27
3667.5	3.8	0.03	976.51
3667.6	3.9	0.03	1032.39
3667.7	4	0.03	1089.71
3667.8	4.1	0.03	1149.05
3667.9	4.2	0.03	1210.4
3668	4.3	0.03	1273.18

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Slater Creek Monitoring Station SM578418-SW-1 Rating Table cont.			
Water Surface Elevation (ft)	Water Height (ft)	Wtd. Mannings Coefficient	Discharge (cfs)
3668.1	4.4	0.03	1337.38
3668.2	4.5	0.03	1403.01
3668.3	4.6	0.03	1470.06
3668.4	4.7	0.03	1538.54
3668.5	4.8	0.03	1608.44
3668.6	4.9	0.03	1679.75
3668.7	5	0.03	1752.49
3668.8	5.1	0.03	1826.66
3668.9	5.2	0.03	1901.72
3669	5.3	0.03	1976.21
3669.1	5.4	0.03	2052.19
3669.2	5.5	0.03	2129.64
3669.3	5.6	0.03	2208.6
3669.4	5.7	0.03	2289.05
3669.5	5.8	0.03	2371.01
3669.6	5.9	0.03	2454.49
3669.7	6	0.03	2539.49
3669.8	6.1	0.03	2626.23
3669.9	6.2	0.03	2714.81
3670	6.3	0.03	2804.93
3670.1	6.4	0.03	2896.59
3670.2	6.5	0.03	2989.79
3670.3	6.6	0.03	3084.55
3670.4	6.7	0.03	3180.87
3670.5	6.8	0.03	3278.75
3670.6	6.9	0.03	3378.88
3670.7	7	0.03	3480.85
3670.8	7.1	0.03	3584.38

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Slater Creek Monitoring Station SM578512-SW-1 Rating Table			
Water Surface Elevation (ft)	Water Height (ft)	Wtd. Mannings Coefficient	Discharge (cfs)
3743.1	0	0.03	0
3743.2	0.1	0.03	0.09
3743.3	0.2	0.03	0.59
3743.4	0.3	0.03	1.79
3743.5	0.4	0.03	3.78
3743.6	0.5	0.03	6.59
3743.7	0.6	0.03	10.32
3743.8	0.7	0.03	15.07
3743.9	0.8	0.03	20.5
3744.0	0.9	0.03	27.2
3744.1	1	0.03	36.81
3744.2	1.1	0.03	47.83
3744.3	1.2	0.03	60.28
3744.4	1.3	0.03	74.18
3744.5	1.4	0.03	89.75
3744.6	1.5	0.03	106.93
3744.7	1.6	0.03	125.56
3744.8	1.7	0.03	145.75
3744.9	1.8	0.03	167.52
3745.0	1.9	0.03	190.84
3745.1	2	0.03	216.09
3745.2	2.1	0.03	243.22
3745.3	2.2	0.03	272.01
3745.4	2.3	0.03	302.06
3745.5	2.4	0.03	332.84
3745.6	2.5	0.03	365.47
3745.7	2.6	0.03	395.53
3745.8	2.7	0.03	423.93
3745.9	2.8	0.03	463.88
3746.0	2.9	0.03	505.94
3746.1	3	0.03	544.06
3746.2	3.1	0.03	577.38
3746.3	3.2	0.03	628.6
3746.4	3.3	0.03	721.83
3746.5	3.4	0.03	738.21
3746.6	3.5	0.03	795.02
3746.7	3.6	0.03	852.77
3746.8	3.7	0.03	913.21
3746.9	3.8	0.03	979.08
3747.0	3.9	0.03	1054.01
3747.1	4	0.03	1131.55
3747.2	4.1	0.03	1211.61
3747.3	4.2	0.03	1294.18
3668.0	4.3	0.03	1273.18

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Slater Creek Monitoring Station SM578512-SW-1 Rating Table cont.			
Water Surface Elevation (ft)	Water Height (ft)	Wtd. Mannings Coefficient	Discharge (cfs)
3747.5	4.4	0.03	1466.88
3747.6	4.5	0.03	1556.99
3747.7	4.6	0.03	1649.63
3747.8	4.7	0.03	1538.54
3747.9	4.8	0.03	1842.47
3748.0	4.9	0.03	1942.68
3748.1	5	0.03	2026.83
3748.2	5.1	0.03	2105.64
3748.3	5.2	0.03	2183.58
3748.4	5.3	0.03	2259.16
3748.5	5.4	0.03	2339.41
3748.6	5.5	0.03	2378.84
3748.7	5.6	0.03	2424.09
3748.8	5.7	0.03	2498.57
3748.9	5.8	0.03	2580.75
3749.0	5.9	0.03	2673.34
3749.1	6	0.03	2789.7
3749.2	6.1	0.03	2911.65
3749.3	6.2	0.03	3039.28
3749.4	6.3	0.03	3171.1
3749.5	6.4	0.03	3306.56
3749.6	6.5	0.03	3448.67
3749.7	6.6	0.03	3596.97
3749.8	6.7	0.03	3748.79
3749.9	6.8	0.03	3900.96
3750.0	6.9	0.03	4060.34
3750.1	7	0.03	4226.99
3750.2	7.1	0.03	4332.03
3750.3	7.2	0.03	4463.66

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Hidden Water Creek Monitoring Station SM578409-SW-1 Rating Table			
Water Surface Elevation (ft)	Water Height (ft)	Wtd. Mannings Coefficient	Discharge (cfs)
3769.4	0	0.03	0
3769.5	0.1	0.03	0.22
3769.6	0.2	0.03	1.22
3769.7	0.3	0.03	4.16
3769.8	0.4	0.03	8.87
3769.9	0.5	0.03	15.34
3770.0	0.6	0.03	23.5
3770.1	0.7	0.03	33.1
3770.2	0.8	0.03	44.03
3770.3	0.9	0.03	56.22
3770.4	1	0.03	69.65
3770.5	1.1	0.03	84.29
3770.6	1.2	0.03	100.1
3770.7	1.3	0.03	117.22
3770.8	1.4	0.03	135.56
3770.9	1.5	0.03	155.03
3771.0	1.6	0.03	175.61
3771.1	1.7	0.03	197.22
3771.2	1.8	0.03	219.86
3771.3	1.9	0.03	243.59
3771.4	2	0.03	268.41
3771.5	2.1	0.03	294.31
3771.6	2.2	0.03	321.3
3771.7	2.3	0.03	349.36
3771.8	2.4	0.03	378.51
3771.9	2.5	0.03	408.69
3772.0	2.6	0.03	439.92
3772.1	2.7	0.03	472.25
3772.2	2.8	0.03	505.67
3772.3	2.9	0.03	540.19
3772.4	3	0.03	575.66
3772.5	3.1	0.03	612.13
3772.6	3.2	0.03	649.73
3772.7	3.3	0.03	721.83
3772.8	3.4	0.03	728.34
3772.9	3.5	0.03	769.36
3773.0	3.6	0.03	811.54
3773.1	3.7	0.03	855.93
3773.2	3.8	0.03	901.62
3773.3	3.9	0.03	948.32
3773.4	4	0.03	996.15
3773.5	4.1	0.03	1045.13
3773.6	4.2	0.03	1095.24
3668.0	4.3	0.03	1273.18

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Hidden Water Creek Monitoring Station SM578409-SW-1 Rating Table cont.			
Water Surface Elevation (ft)	Water Height (ft)	Wtd. Mannings Coefficient	Discharge (cfs)
3773.8	4.4	0.03	1198.9
3773.9	4.5	0.03	1251.6
3774.0	4.6	0.03	1304.23
3774.1	4.7	0.03	1538.54
3774.2	4.8	0.03	1409.96
3774.3	4.9	0.03	1462.43
3774.4	5	0.03	1516.35
3774.5	5.1	0.03	1571.74
3774.6	5.2	0.03	1619.11
3774.7	5.3	0.03	1655.01

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Hidden Water Creek Monitoring Station SM578415-SW-1 Rating Table			
Water Surface Elevation (ft)	Water Height (ft)	Wtd. Mannings Coefficient	Discharge (cfs)
3655.9	0	0.03	0
3656.0	0.1	0.03	0.15
3656.1	0.2	0.03	1.29
3656.2	0.3	0.03	3.96
3656.3	0.4	0.03	7.78
3656.4	0.5	0.03	12.65
3656.5	0.6	0.03	18.53
3656.6	0.7	0.03	24.63
3656.7	0.8	0.03	31.68
3656.8	0.9	0.03	40.11
3656.9	1	0.03	50.65
3657.0	1.1	0.03	59.53
3657.1	1.2	0.03	73.62
3657.2	1.3	0.03	89.18
3657.3	1.4	0.03	106.1
3657.4	1.5	0.03	124.36
3657.5	1.6	0.03	143.86
3657.6	1.7	0.03	164.72
3657.7	1.8	0.03	187.19
3657.8	1.9	0.03	211.01
3657.9	2	0.03	236.26
3658.0	2.1	0.03	263.02
3658.1	2.2	0.03	291.15
3658.2	2.3	0.03	320.38
3658.3	2.4	0.03	349.86
3658.4	2.5	0.03	381.01
3658.5	2.6	0.03	413.78
3658.6	2.7	0.03	448.08
3658.7	2.8	0.03	484.29
3658.8	2.9	0.03	522.57
3658.9	3	0.03	562.42
3659.0	3.1	0.03	603.85
3659.1	3.2	0.03	646.86
3659.2	3.3	0.03	721.83
3659.3	3.4	0.03	735.84
3659.4	3.5	0.03	779.44
3659.5	3.6	0.03	825.93
3659.6	3.7	0.03	877.24
3659.7	3.8	0.03	931.03
3659.8	3.9	0.03	986.56
3659.9	4	0.03	1041.58
3660.0	4.1	0.03	1093.27
3660.1	4.2	0.03	1147.13
3668.0	4.3	0.03	1273.18

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Hidden Water Creek Monitoring Station SM578415-SW-1 Rating Table cont.			
Water Surface Elevation (ft)	Water Height (ft)	Wtd. Mannings Coefficient	Discharge (cfs)
3660.3	4.4	0.03	1206.84
3660.4	4.5	0.03	1273.44
3660.5	4.6	0.03	1344.3
3660.6	4.7	0.03	1538.54
3660.7	4.8	0.03	1492.95
3660.8	4.9	0.03	1569.45
3660.9	5	0.03	1646.94
3661.0	5.1	0.03	1726.96

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ATTACHMENT D6-5-B

Rating Curves
Stream Monitoring Stations

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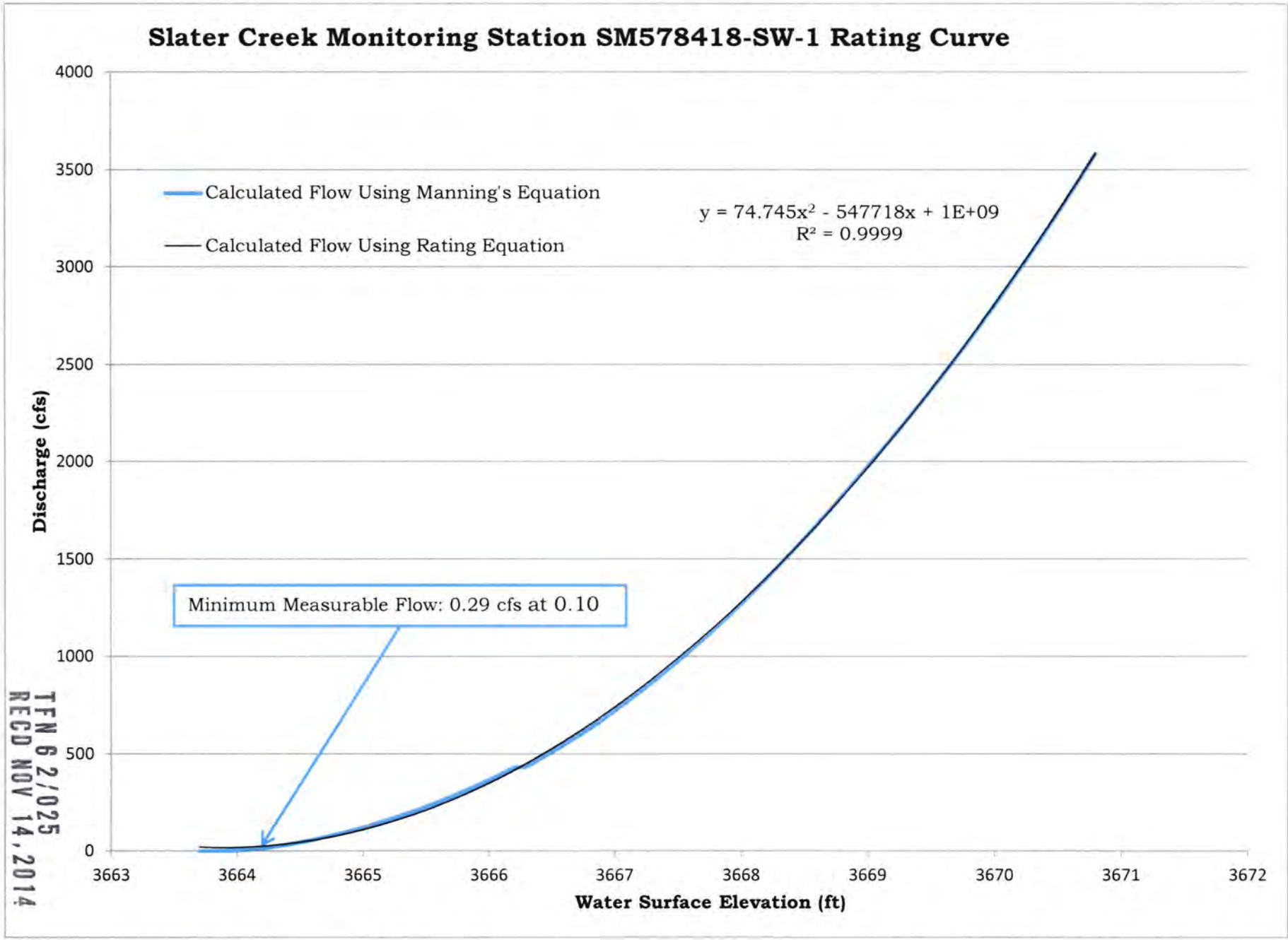

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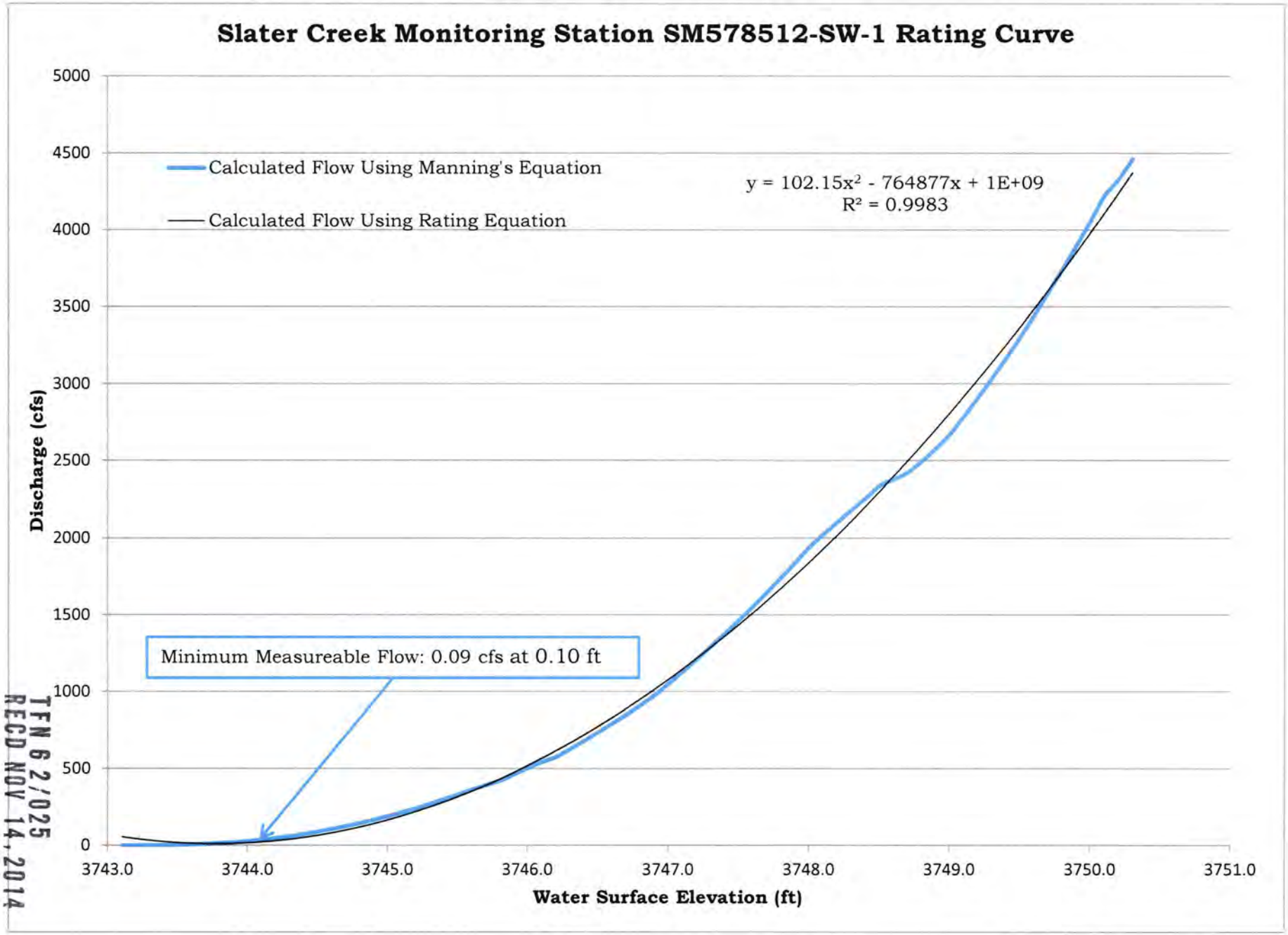

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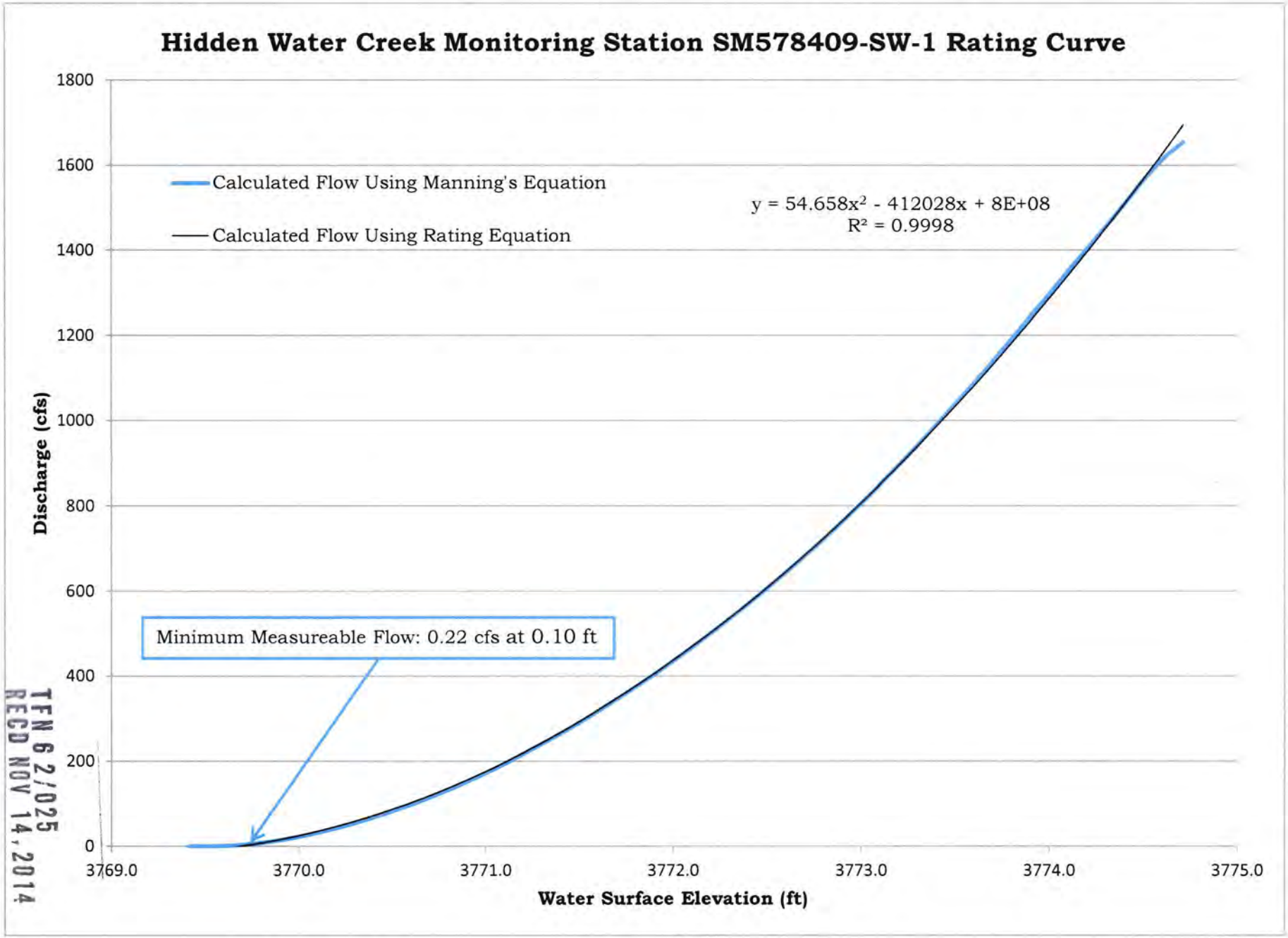

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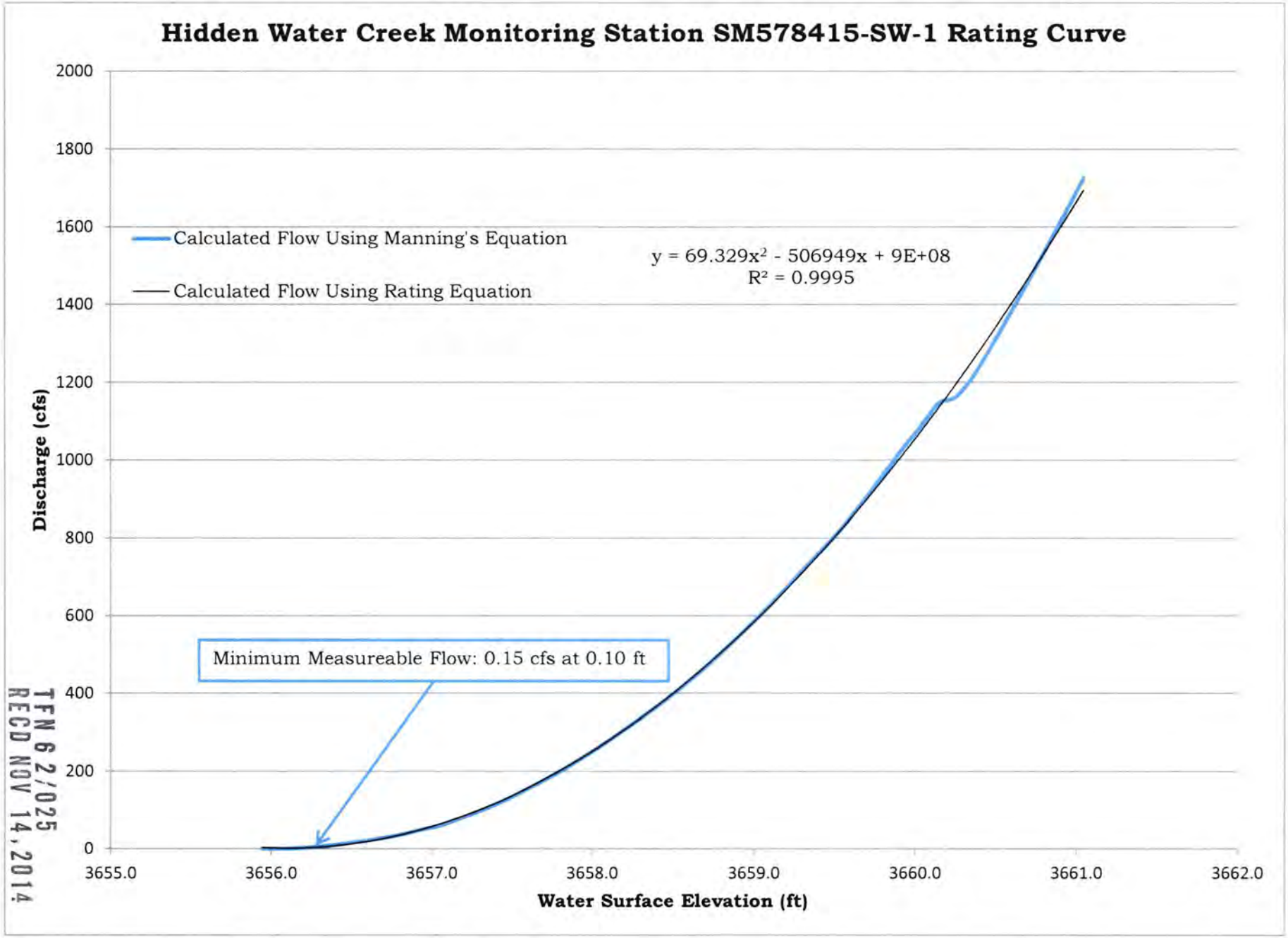

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ADDENDUM D6-6

Surface Water Quality

TFN 6 2/025
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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578409-SW-1 (Hidden Water Creek - US)

Date 9/10/13 @ 1300

Technician/Engineer Jeff Barron / Rod Fuller

Devices

Flow/Automatic sampler Device Site investigation

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

note: Investigation for suitable surface water site.

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

TFN 6 2/025
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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578409-SW-1 (Hidden Water Creek - US)

Date 9/13/13

Technician/Engineer Joe Crump / Rod Fuller

Devices

Flow/Automatic sampler Device Not installed yet (ISCO Flowmeter)

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

*Note: Installed instrument Shelter, Solar panel battery, 1" pipe for tubing. Waiting for shipment of instrument

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

TFN 6 2/025
RECD NOV 14, 2014

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578415-SW-1 (Hidden Water Creek - DS)

Date 9/10/13 @ 1400

Technician/Engineer Jeff Barron / Rod Fuller

Devices

Flow/Automatic sampler Device Site investigation

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

Note: Investigated for suitable surface water site.

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

TFN 6 2/025
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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578415-SW-1 (Hidden Water Creek - DS)

Date 9/13/13

Technician/Engineer Joe Crump / Rod Fuller

Devices

Flow/Automatic sampler Device Not installed yet (Flowmeter)

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

ıstantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

TFN 6 2/025
RECD NOV 14, 2014

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM 578418-SW-1 (Slatter Creek - DS)

Date 9/10/13 @ 1000

Technician/Engineer Jeff Barron / Rod Fuller

Devices

Flow/Automatic sampler Device Site investigation

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* note: Investigated for suitable surface water site.

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

Date Samples to Lab —

TFN 6 2/025
RECD NOV 14, 2014

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Surface Water Field Sheet

Project/Client RAMACO

Site Name. SM578418-SW-1 (Slatter Creek - DS)

Date 9/12/13 @ 0900

Technician/Engineer Joe Crump, Rod Fuller

Devices

Flow/Automatic sampler Device Not installed yet. (Sampler/Flowmeter)

Device Flow or Stage Reading 0.00 CFS/FT Dry

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Note: Installed instrument shelter, solar panel battery, 1" pipe for tubing. Waiting for shipment of instrument

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate Dry CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578418-SW-1 (Slatter Creek - DS)

Date 9/17/13 @ 1430

Technician/Engineer Q. Fuller

Devices

Flow/Automatic sampler Device ISCO 6712 Sampler/Flowmeter

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Note: Installed ISCO 6712 S/F instrument on this day.

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
—							

Lab Information

Lab COC # —

ate Samples to Lab —

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578512-SW-1 (Slatter Creek - US)

Date 9/10/13 @ 1130

Technician/Engineer Jeff Barron / Rod Fuller

Devices

Flow/Automatic sampler Device Site investigation

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

Note: Investigated for suitable surface water site.

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578512-SW-1 (Slatter Creek - US)

Date 9/12/13 @ 1400

Technician/Engineer Joe Crump, Rod Fuller

Devices

Flow/Automatic sampler Device Not installed yet (ISCO flowmeter)

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

Note: Installed instrument shelter, solar panel/battery, 1" PVC pipe for tubing. Waiting for shipment of instrument.

stantaneous Flow

Measured Flow Yes or (No) Dry

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ite Samples to Lab —

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM5T8409-SW-1

Date 9/30/13 @ 1320

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO flowmeter - Installed on this date

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed ____ Ft

Crest gage readings if installed ____ Ft

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device ____

Flow Rate ____ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # ____

ate Samples to Lab ____

TFN 6 2/025
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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578415-SW-1 (D.S. Hidden Water Crk)

Date 9/30/13 @ 1415

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device Isco flowmeter (Installed on this date)

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed _____ Ft

Crest gage readings if installed _____ Ft

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device _____

Flow Rate _____ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

Date Samples to Lab _____

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578418-SW-1 (D.S. Slatten Crk.)

Date 9/30/13 @ 1115

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO 6712

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No;)

Staff gage reading if installed ~ Ft

Crest gage readings if installed ~ Ft

ıstantaneous Flow

Measured Flow Yes or (No)

Measurement Device ~

Flow Rate ~ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
~							

Lab Information

Lab COC # ~

ate Samples to Lab ~

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578512-SW-1 (U.S. Slatter Crk)

Date 9-30-13 @ 1200

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device Installed Flowmeter (ISCO)

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

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Surface Water Field Sheet

Project/Client ~~SM578409~~ Ramaco

Site Name. SM578409-SW-1

Date 10/31/13 @ 1340

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device Isco flowmeter

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Took down site for Winter

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578415 -SW-1

Date 10/31/13

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device Isco Flowmeter

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Took site down for winter

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

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RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578418-SW-1

Date 10/31/13 @ 1040

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device Esco 6712

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Took down site for winter

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

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Surface Water Field Sheet

Project/Client Ramaco

Site Name. ~~[illegible]~~ SM578512-SW-1 (U.S. Slatter Crk)

Date 10/31/13 @ 1000

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device Isco flowmeter

Device Flow or Stage Reading 0.00/0.00 CFS/FT Dry

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Took down site for winter.

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

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RAMACO

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Brook Mine

Surface Water Field Sheet

Project/Client Ramaco / 2013139-07

Site Name. TM 9780409-SW-1

Date 4/22/14 @ 1600

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device Isco Signature flowmeter

Device Flow or Stage Reading 0.0/0.0 CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Installed instrument for season. Slight flow - not enough to measure, Increase solar pannel size to increase charging to battery.

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

ate Samples to Lab _____

TFN 6 2/025
RECD NOV 14, 2014

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RAMACO

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Brook Mine

Surface Water Field Sheet

Project/Client Ramaco / 2013139-07

Site Name. SM578415-SW-1

Date 4/24/14

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device Isco Flowmeter (Signature)

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Set up instrument for season. Increased size of solar panel for increase charging to battery. Put up some fence around instrument/solar panel.

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

ate Samples to Lab —

TFN 6 2/025
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Surface Water Field Sheet

Project/Client Ramaco - 2013137-07

Site Name. SM578418-SW-1

Date 4/22/14 @ 1100

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device Isco 6712 sampler/flowmeter

Device Flow or Stage Reading 0.84 / 0.14 CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed ___ Ft

Crest gage readings if installed ___ Ft

Installed instrument for reason. Installed bigger solar panel for increased charging to battery.

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device ___

Flow Rate ___ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # ___

ate Samples to Lab ___

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RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco / 2013139-07

Site Name. SM578418-SW-1

Date 4/24/14

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device ISCO 6712 Sampler / Flowmeter

Device Flow or Stage Reading 2.19 / 0.21 CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1440	8.48	1851	12.1	16.92	—	—	—

HCF

Lab Information

Lab COC # 151522

ate Samples to Lab 4/24/14

TFN 6 2/025
RECD NOV 14, 2014

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Surface Water Field Sheet

Project/Client Ramaco / 2013139-07

Site Name. SM978512-SW-1

Date 4-22-14 @ 1300

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device Isco Signature flow meter

Device Flow or Stage Reading 0.0/0.0 CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Set up site for season. No flow on device due to tubing not in thalwag. Need to add tubing to get to thalwag. Increase solar pannel size to increase solar pannel charging to battery.

Instantaneous Flow

Measured Flow (Yes) or No

Measurement Device Estimated

Flow Rate 3.0 CFS CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

ate Samples to Lab _____

TFN 6 2/025
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RAMACO

2017 QW Sample

Brook Mine

WWC ENGINEERING

Surface Water Field Sheet

Project/Client Ramaco / 2013139-07

Site Name. SM 578512 - SW-1

Date 4/24/14

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device Isco Signature flowmeter

Device Flow or Stage Reading 1.53/0.28 CFS/FT

Device Battery Charge Good Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1400	8.58	1504	13.8	17.84	—	—	—

HCF

Lab Information

Lab COC # 151522

ate Samples to Lab 4/24/14

TFN 6 2/025
RECD NOV 14, 2014

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RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/1/2014
Report ID: S1404416001

Project: Ramaco-2013139-07
Lab ID: S1404416-002
Client Sample ID: SM578418-SW-1
COC: 151522

Work Order: S1404416
Collection Date: 4/24/2014 2:40:00 PM
Date Received: 4/24/2014 3:47:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.48			s.u.	04/24/2014 1440	Field
Conductivity	1851			µmhos/cm	04/24/2014 1440	Field
Turbidity	16.92			NTU	04/24/2014 1440	Field
Temperature	12.1			°C	04/24/2014 1440	Field
General Parameters						
pH	8.4	0.1		s.u.	04/28/2014 1558 KV	SM 4500 H B
Electrical Conductivity	1890	5		µmhos/cm	04/28/2014 1558 KV	SM 2510B
Total Dissolved Solids (180)	1560	10		mg/L	04/25/2014 1506 BT	SM 2540
Solids, Total Dissolved (Calc)	1350	10		mg/L	04/30/2014 0813 JJ	SM 1030E
Total Suspended Solids	9	5		mg/L	04/28/2014 1006 BT	SM 2540
Alkalinity, Total (As CaCO3)	340	5		mg/L	04/28/2014 1558 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	816	1		mg/L	04/30/2014 0813 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	04/28/2014 1144 RH	EPA 350.1
gen, Dissolved	10	1		mg/L	04/24/2014 1553 KB	SM 4500-O G
idity	13.9	0.1		NTU	04/25/2014 1454 KB	SM 2130
Sodium Adsorption Ratio	2.2	0.1			04/30/2014 0813 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	395	5		mg/L	04/28/2014 1558 KV	SM 2320B
Alkalinity, Carbonate as CO3	10	5		mg/L	04/28/2014 1558 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/28/2014 1558 KV	SM 2320B
Chloride	8	1		mg/L	04/27/2014 0300 AMB	EPA 300.0
Fluoride	0.6	0.1		mg/L	04/28/2014 1558 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/28/2014 1422 RH	EPA 353.2
Sulfate	732	1		mg/L	04/27/2014 0300 AMB	EPA 300.0
Cations						
Calcium	104	1		mg/L	04/25/2014 1730 DG	EPA 200.7
Magnesium	136	1		mg/L	04/25/2014 1730 DG	EPA 200.7
Potassium	16	1		mg/L	04/25/2014 1730 DG	EPA 200.7
Sodium	147	1		mg/L	04/25/2014 1730 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-289

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/1/2014
Report ID: S1404416001

Project: Ramaco-2013139-07
Lab ID: S1404416-002
Client Sample ID: SM578418-SW-1
COC: 151522

Work Order: S1404416
Collection Date: 4/24/2014 2:40:00 PM
Date Received: 4/24/2014 3:47:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	6.47	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Carbonate as CO3	0.31	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Chloride	0.21	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Sulfate	15.24	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Calcium	5.17	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Magnesium	11.15	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Potassium	0.40	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Sodium	6.37	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	23.11	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
n Sum	22.27	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
on-Anion Balance	1.84	0.01		%	04/30/2014 0813 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.6	0.1		mg/L	04/25/2014 1730 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/25/2014 1459 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/25/2014 1459 MS	EPA 200.8
Boron	0.2	0.1		mg/L	04/25/2014 1730 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/25/2014 1459 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/25/2014 1730 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/25/2014 1459 MS	EPA 200.8
Iron	0.35	0.05		mg/L	04/25/2014 1730 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/25/2014 1459 MS	EPA 200.8
Manganese	0.12	0.02		mg/L	04/25/2014 1730 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/30/2014 1130 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/25/2014 1459 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/25/2014 1730 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/25/2014 1459 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/25/2014 1730 DG	EPA 200.7
Total Metals						
Iron	0.39	0.05		mg/L	04/28/2014 2154 DG	EPA 200.7
Manganese	0.13	0.02		mg/L	04/28/2014 2154 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

DEQ Ex. 3-290

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/1/2014
Report ID: S1404416001

Project: Ramaco-2013139-07
Lab ID: S1404416-001
Client Sample ID: SM578512-SW-1
COC: 151522

Work Order: S1404416
Collection Date: 4/24/2014 2:00:00 PM
Date Received: 4/24/2014 3:47:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.58			s.u.	04/24/2014 1400	Field
Conductivity	1504			µmhos/cm	04/24/2014 1400	Field
Turbidity	17.84			NTU	04/24/2014 1400	Field
Temperature	13.8			°C	04/24/2014 1400	Field
General Parameters						
pH	8.4	0.1		s.u.	04/28/2014 1547 KV	SM 4500 H B
Electrical Conductivity	1540	5		µmhos/cm	04/28/2014 1547 KV	SM 2510B
Total Dissolved Solids (180)	1220	10		mg/L	04/25/2014 1505 BT	SM 2540
Solids, Total Dissolved (Calc)	1050	10		mg/L	04/30/2014 0813 JJ	SM 1030E
Total Suspended Solids	8	5		mg/L	04/28/2014 1005 BT	SM 2540
Alkalinity, Total (As CaCO3)	303	5		mg/L	04/28/2014 1547 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	653	1		mg/L	04/30/2014 0813 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	04/28/2014 1143 RH	EPA 350.1
gen, Dissolved	10	1		mg/L	04/24/2014 1553 KB	SM 4500-O G
bidity	13.4	0.1		NTU	04/25/2014 1452 KB	SM 2130
Sodium Adsorption Ratio	1.9	0.1			04/30/2014 0813 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	347	5		mg/L	04/28/2014 1547 KV	SM 2320B
Alkalinity, Carbonate as CO3	11	5		mg/L	04/28/2014 1547 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/28/2014 1547 KV	SM 2320B
Chloride	5	1		mg/L	04/27/2014 0245 AMB	EPA 300.0
Fluoride	0.5	0.1		mg/L	04/28/2014 1547 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/28/2014 1421 RH	EPA 353.2
Sulfate	550	1		mg/L	04/27/2014 0245 AMB	EPA 300.0
Cations						
Calcium	87	1		mg/L	04/25/2014 1728 DG	EPA 200.7
Magnesium	106	1		mg/L	04/25/2014 1728 DG	EPA 200.7
Potassium	11	1		mg/L	04/25/2014 1728 DG	EPA 200.7
Sodium	112	1		mg/L	04/25/2014 1728 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-291

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/1/2014
Report ID: S1404416001

Project: Ramaco-2013139-07
Lab ID: S1404416-001
Client Sample ID: SM578512-SW-1
COC: 151522

Work Order: S1404416
Collection Date: 4/24/2014 2:00:00 PM
Date Received: 4/24/2014 3:47:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	5.69	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Carbonate as CO3	0.36	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Chloride	0.14	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Sulfate	11.45	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Calcium	4.34	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Magnesium	8.71	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Potassium	0.28	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Sodium	4.89	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	18.23	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
n Sum	17.68	0.01		meq/L	04/30/2014 0813 JJ	SM 1030E
on-Anion Balance	1.53	0.01		%	04/30/2014 0813 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/25/2014 1728 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/25/2014 1426 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/25/2014 1426 MS	EPA 200.8
Boron	0.1	0.1		mg/L	04/25/2014 1728 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/25/2014 1426 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/25/2014 1728 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/25/2014 1426 MS	EPA 200.8
Iron	ND	0.05		mg/L	04/25/2014 1728 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/25/2014 1426 MS	EPA 200.8
Manganese	0.08	0.02		mg/L	04/25/2014 1728 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/30/2014 1124 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/25/2014 1426 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/25/2014 1728 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/25/2014 1426 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/25/2014 1728 DG	EPA 200.7
Total Metals						
Iron	0.35	0.05		mg/L	04/28/2014 2150 DG	EPA 200.7
Manganese	0.09	0.02		mg/L	04/28/2014 2150 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

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Inter-Mountain Labs
Sheridan, WY and Gillette, WY

- CHAIN OF CUSTODY RECORD -

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All shaded fields must be completed.
This is a legal document: any misrepresentation may be construed as fraud.

151522

October 2014

RAMACO

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC/Ramaco	Ramaco - 2013139-07	Rod Fuller	

Report Address	Contact Name	Email	Phone
WWC	Jeff Barron - WWC		

Invoice Address	Purchase Order #	Quote #
WWC		440

ANALYSES / PARAMETERS

Quote #440

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME SAMPLED	SAMPLE IDENTIFICATION	Matrix	# of Containers	REMARKS
1	31404 4/6-001	4/24/14	1400	SM578572-SW-1	WT	4	✓
2				pH = 8.58, EC = 1504, T = 13.8, TUR = 17.84			
3							
4	002	4/24/14	1440	SM578418-SW-1	WT	4	✓
5				pH = 8.48, EC = 1851, T = 12.1, TUR = 16.92			
6							
7							
8							
9							
10							
11							
12							
13							
14							

TFN 6 2/025
RECD NOV 14, 2014

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
R01	Rod Fuller	4/24/14	1547	Kathy Fox	4.24.14	15:47

Addendum D6-6-29

Brook Mine

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
☐ UPS	Water	(WT)	Check desired service	Compliance Monitoring? Y / N	
☐ Fed Express	Soil	SL	☒ Standard turnaround	Program (SDWA, NPDES,...)	
☐ US Mail	Solid	SD	☐ RUSH - 5 Working Days	PWSID / Permit #	
☐ Hand Carried	Filter	FT	☐ URGENT - < 2 Working Days	Chlorinated? Y / N	
☐ Other _____	Other	OT	*Rush & Urgent Surcharges will be applied*	Sample Disposal: Lab / Client	

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Surface Water Field Sheet

Project/Client Ramaco / 2013139-07

Site Name. SM578409-SW-1

Date 5/20/14 @ 1430

Technician/Engineer Q. Fuller

Devices

Flow/Automatic sampler Device Isco Signature flow meter

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge 13.15 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device _____

Flow Rate _____ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

ate Samples to Lab _____

TFN 6 2/025
RECD NOV 14, 2014

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Surface Water Field Sheet

Project/Client Ramaco / 2013139-07

Site Name. SM578415-SW-1

Date 5/20/14

Technician/Engineer Q. Fuller

Devices

Flow/Automatic sampler Device ISCO - Signature flow meter

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge Good - 13.06 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No;)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

ıstantaneous Flow

Measured Flow Yes or (No)

Measurement Device _____

Flow Rate _____ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

Date Samples to Lab _____

TFN 6 2/025
RECD NOV 14, 2014

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Surface Water Field Sheet

Project/Client Ramaco - 2013139-07

Site Name. SM578418-SW-1

Date 5/22/14

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device Isco Signature flowmeter

Device Flow or Stage Reading 0.50/0.12 CFS/FT

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

stantaneous Flow

Measured Flow Yes or (No)

Measurement Device _____

Flow Rate _____ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

te Samples to Lab _____

TFN 6 2/025
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Surface Water Field Sheet

Project/Client Ramaco / 2013139-07

Site Name. SM578512-SW-1

Date 5/22/13 @ 1405

Technician/Engineer B. Fuller

Devices

Flow/Automatic sampler Device Isco Signature flowmeter

Device Flow or Stage Reading 1.41/0.26 CFS/FT

Device Battery Charge 12.91 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed ——— Ft

Crest gage readings if installed ——— Ft

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device _____

Flow Rate _____ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

ate Samples to Lab _____

TFN 6 2/025
RECD NOV 14, 2014

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578420-TR-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578420-TR-1 Date Sampled 6 / 20 / 18 Time 1545 am (pm)

Describe Sampling Point SW monitoring site for Pump test

Well Depth — ft below MP Depth to Water (below MP) — ft Casing Diameter — in

Date — / — / — Time — am pm Casing Volume — gal

At least _____ bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap Bailer (Grab)

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1545	8.16	292	15.5	11.6	—	—

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water slightly turbid - no odor

TFN 6 2/025
RECD 10-25-18

HCF
COC# 171834

Form completed by: Witnessed by: _____

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/5/2018
Report ID: S1806353001

Project: Ramaco-2014163-98
Lab ID: S1806353-001
Client Sample ID: 578420-TR-1

Work Order: S1806353
Collection Date: 6/20/2018 3:45:00 PM
Date Received: 6/20/2018 4:26:00 PM
Sampler: RF
Matrix: Water
COC: 171834

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.16			s.u.	06/20/2018 1545	Field
Conductivity	292			µmhos/cm	06/20/2018 1545	Field
Turbidity	11.6			NTU	06/20/2018 1545	Field
Temperature	15.5			°C	06/20/2018 1545	Field
General Parameters						
pH	8.4	0.1		s.u.	06/21/2018 1716 IBS	SM 4500 H B
Electrical Conductivity	292	5		µmhos/cm	06/21/2018 1716 IBS	SM 2510B
Total Dissolved Solids (180)	170	10		mg/L	06/21/2018 1600 NLG	SM 2540
Solids, Total Dissolved (Calc)	160	10		mg/L	07/05/2018 1351 JJ	SM 1030E
Total Suspended Solids	18	5		mg/L	06/25/2018 1401 NLG	SM 2540
Alkalinity, Total (As CaCO3)	128	5		mg/L	06/21/2018 1716 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	136	1		mg/L	07/05/2018 1351 JJ	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	06/27/2018 1245 AMB	EPA 350.1
rbidity	9.9	0.1		NTU	06/22/2018 1542 KB	SM 2130
odium Adsorption Ratio	0.25	0.01			07/05/2018 1351 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	152	5		mg/L	06/21/2018 1716 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	06/21/2018 1716 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/21/2018 1716 IBS	SM 2320B
Chloride	1	1		mg/L	06/21/2018 1930 AB	EPA 300.0
Fluoride	0.1	0.1		mg/L	06/21/2018 1716 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	06/27/2018 1349 AMB	EPA 353.2
Sulfate	26	1		mg/L	06/21/2018 1930 AB	EPA 300.0
Cations						
Calcium	34	1		mg/L	06/26/2018 1731 DG	EPA 200.7
Magnesium	12	1		mg/L	06/26/2018 1731 DG	EPA 200.7
Potassium	1	1		mg/L	06/26/2018 1731 DG	EPA 200.7
Sodium	7	1		mg/L	06/26/2018 1731 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager
October 2018

RECD 10-25-18

DEQ Ex. 3-299

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RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/5/2018
Report ID: S1806353001

Work Order: S1806353
Collection Date: 6/20/2018 3:45:00 PM
Date Received: 6/20/2018 4:26:00 PM
Sampler: RF
Matrix: Water
COC: 171834

Project: Ramaco-2014163-98
Lab ID: S1806353-001
Client Sample ID: 578420-TR-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	2.49	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Chloride	0.03	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Fluoride	ND	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Sulfate	0.53	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Calcium	1.71	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Magnesium	0.99	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Potassium	0.03	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Sodium	0.29	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	3.03	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
ion Sum	3.13	0.01		meq/L	07/05/2018 1351 JJ	SM 1030E
tion-Anion Balance	1.48	0.01		%	07/05/2018 1351 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	06/26/2018 1731 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	06/22/2018 1849 MS	EPA 200.8
Barium	ND	0.1		mg/L	06/22/2018 1849 MS	EPA 200.8
Boron	ND	0.1		mg/L	06/26/2018 1731 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	06/22/2018 1849 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/26/2018 1731 DG	EPA 200.7
Copper	ND	0.01		mg/L	06/22/2018 1849 MS	EPA 200.8
Iron	ND	0.05		mg/L	06/26/2018 1731 DG	EPA 200.7
Lead	ND	0.02		mg/L	06/22/2018 1849 MS	EPA 200.8
Manganese	ND	0.02		mg/L	06/26/2018 1731 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/27/2018 1035 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	06/22/2018 1849 MS	EPA 200.8
Nickel	ND	0.01		mg/L	06/26/2018 1731 DG	EPA 200.7
Selenium	ND	0.005		mg/L	06/22/2018 1849 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/26/2018 1731 DG	EPA 200.7
Total Metals						
Iron	0.35	0.05		mg/L	06/27/2018 0240 DG	EPA 200.7
Manganese	0.02	0.02		mg/L	06/27/2018 0240 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-300

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578420-TR-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578420-TR-1 Date Sampled 7/12/18 Time 0810 (am) pm

Describe Sampling Point Surface water monitoring site

Well Depth — ft below MP Depth to Water (below MP) — ft Casing Diameter — in

Date — / — / — Time — am pm Casing Volume — gal

At least _____ bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap Bailer (Grab)

Pump intake or bailer set at _____ ft below MP

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0810	8.45	329	20.7	9.09		

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF
COC # 177725

TEN 0 2/025
RECD 10-25-18

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/26/2018
Report ID: S1807202001

Work Order: S1807202
Collection Date: 7/12/2018 8:10:00 AM
Date Received: 7/12/2018 12:08:00 PM
Sampler: RF
Matrix: Water
COC: 177725

Project: Ramaco-2014163-98
Lab ID: S1807202-001
Client Sample ID: 578420-TR-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.45			s.u.	07/12/2018 0810	Field
Conductivity	329			µmhos/cm	07/12/2018 0810	Field
Turbidity	9.09			NTU	07/12/2018 0810	Field
Temperature	20.7			°C	07/12/2018 0810	Field
General Parameters						
pH	8.6	0.1		s.u.	07/13/2018 0601 IBS	SM 4500 H B
Electrical Conductivity	356	5		µmhos/cm	07/13/2018 0601 IBS	SM 2510B
Total Dissolved Solids (180)	210	10		mg/L	07/13/2018 0847 NLG	SM 2540
Solids, Total Dissolved (Calc)	190	10		mg/L	07/26/2018 1014 JJ	SM 1030E
Total Suspended Solids	13	5		mg/L	07/17/2018 1452 NLG	SM 2540
Alkalinity, Total (As CaCO3)	157	5		mg/L	07/13/2018 0601 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	163	1		mg/L	07/26/2018 1014 JJ	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	07/17/2018 1120 AMB	EPA 350.1
rbidity	7.7	0.1		NTU	07/13/2018 0716 KB	SM 2130
odium Adsorption Ratio	0.31	0.01			07/26/2018 1014 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	179	5		mg/L	07/13/2018 0601 IBS	SM 2320B
Alkalinity, Carbonate as CO3	6	5		mg/L	07/13/2018 0601 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/13/2018 0601 IBS	SM 2320B
Chloride	1	1		mg/L	07/13/2018 1600 AB	EPA 300.0
Fluoride	0.1	0.1		mg/L	07/13/2018 0601 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/13/2018 1535 AMB	EPA 353.2
Sulfate	28	1		mg/L	07/13/2018 1600 AB	EPA 300.0
Cations						
Calcium	40	1		mg/L	07/16/2018 1944 DG	EPA 200.7
Magnesium	16	1		mg/L	07/16/2018 1944 DG	EPA 200.7
Potassium	1	1		mg/L	07/16/2018 1944 DG	EPA 200.7
Sodium	9	1		mg/L	07/16/2018 1944 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

REC'D 2/2025
DEQ 10-25-18

DEQ Ex. 3-302

Addendum D6-6-38

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/26/2018
Report ID: S1807202001

Project: Ramaco-2014163-98
Lab ID: S1807202-001
Client Sample ID: 578420-TR-1

Work Order: S1807202
Collection Date: 7/12/2018 8:10:00 AM
Date Received: 7/12/2018 12:08:00 PM
Sampler: RF
Matrix: Water
COC: 177725

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	2.93	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Carbonate as CO3	0.20	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Chloride	0.03	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Fluoride	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Sulfate	0.58	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Calcium	1.97	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Magnesium	1.28	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Potassium	0.03	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Sodium	0.40	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	3.70	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
ion Sum	3.76	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
tion-Anion Balance	0.76	0.01		%	07/26/2018 1014 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/18/2018 1311 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/14/2018 0544 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/14/2018 0544 MS	EPA 200.8
Boron	ND	0.1		mg/L	07/18/2018 1311 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/14/2018 0544 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/18/2018 1311 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/14/2018 0544 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/18/2018 1311 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/14/2018 0544 MS	EPA 200.8
Manganese	ND	0.02		mg/L	07/18/2018 1311 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 1156 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/14/2018 0544 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/18/2018 1311 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/14/2018 0544 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/18/2018 1311 DG	EPA 200.7
Total Metals						
Iron	0.25	0.05		mg/L	07/18/2018 2138 DG	EPA 200.7
Manganese	ND	0.02		mg/L	07/18/2018 2138 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578513-IRR-DITCH Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578513-IRR Date Sampled 6/6/18 Time 1610 am (pm)

Describe Sampling Point Irrigation ditch

Well Depth — ft below MP Depth to Water (below MP) — ft Casing Diameter — in

Date — / / Time — am pm Casing Volume — gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap Bailer (Grab)

Pump intake or bailer set at — ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1610	8.89	241	23.7	27.5	—	—

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water slightly turbid - no odor - sampled ditch prior to Coal/alluvial pump test

HCF

COC# 171833

Form completed by: Rod Fuller Witnessed by: _____

IRR 6 2025
RECD 10-25-18

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/21/2018
Report ID: S1806097001

Work Order: S1806097
Collection Date: 6/6/2018 4:10:00 PM
Date Received: 6/6/2018 4:39:00 PM
Sampler: RF
Matrix: Water
COC: 171833

Project: Ramaco-2014163-98
Lab ID: S1806097-002
Client Sample ID: 578524-IRR

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.89			s.u.	06/06/2018 1610	Field
Conductivity	241			µmhos/cm	06/06/2018 1610	Field
Turbidity	27.5			NTU	06/06/2018 1610	Field
Temperature	23.7			°C	06/06/2018 1610	Field
General Parameters						
pH	8.8	0.1		s.u.	06/07/2018 1827 IBS	SM 4500 H B
Electrical Conductivity	248	5		µmhos/cm	06/07/2018 1827 IBS	SM 2510B
Total Dissolved Solids (180)	150	10		mg/L	06/07/2018 1214 NLG	SM 2540
Solids, Total Dissolved (Calc)	140	10		mg/L	06/21/2018 0949 JJ	SM 1030E
Total Suspended Solids	38	5		mg/L	06/08/2018 1457 NLG	SM 2540
Alkalinity, Total (As CaCO3)	107	5		mg/L	06/07/2018 1827 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	116	1		mg/L	06/21/2018 0949 JJ	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	06/14/2018 1507 AMB	EPA 350.1
rbidity	22.8	0.1		NTU	06/07/2018 1456 IBS	SM 2130
odium Adsorption Ratio	0.26	0.01			06/21/2018 0949 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	118	5		mg/L	06/07/2018 1827 IBS	SM 2320B
Alkalinity, Carbonate as CO3	6	5		mg/L	06/07/2018 1827 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/07/2018 1827 IBS	SM 2320B
Chloride	1	1		mg/L	06/07/2018 1929 AB	EPA 300.0
Fluoride	0.1	0.1		mg/L	06/07/2018 1827 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	06/08/2018 1355 AMB	EPA 353.2
Sulfate	22	1		mg/L	06/07/2018 1929 AB	EPA 300.0
Cations						
Calcium	29	1		mg/L	06/07/2018 1801 DG	EPA 200.7
Magnesium	10	1		mg/L	06/07/2018 1801 DG	EPA 200.7
Potassium	1	1		mg/L	06/07/2018 1801 DG	EPA 200.7
Sodium	7	1		mg/L	06/07/2018 1801 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-305

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/21/2018
Report ID: S1806097001

Work Order: S1806097
Collection Date: 6/6/2018 4:10:00 PM
Date Received: 6/6/2018 4:39:00 PM
Sampler: RF
Matrix: Water
COC: 171833

Project: Ramaco-2014163-98
Lab ID: S1806097-002
Client Sample ID: 578524-IRR

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	1.93	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Carbonate as CO3	0.20	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Chloride	0.02	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Fluoride	ND	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Sulfate	0.46	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Calcium	1.46	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Magnesium	0.84	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Potassium	0.03	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Sodium	0.28	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	2.63	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
ion Sum	2.63	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
tion-Anion Balance	0.04	0.01		%	06/21/2018 0949 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	06/07/2018 1801 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	06/07/2018 1748 MS	EPA 200.8
Barium	ND	0.1		mg/L	06/07/2018 1748 MS	EPA 200.8
Boron	ND	0.1		mg/L	06/07/2018 1801 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	06/07/2018 1748 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/07/2018 1801 DG	EPA 200.7
Copper	ND	0.01		mg/L	06/07/2018 1748 MS	EPA 200.8
Iron	ND	0.05		mg/L	06/07/2018 1801 DG	EPA 200.7
Lead	ND	0.02		mg/L	06/07/2018 1748 MS	EPA 200.8
Manganese	ND	0.02		mg/L	06/07/2018 1801 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/08/2018 1053 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	06/07/2018 1748 MS	EPA 200.8
Nickel	ND	0.01		mg/L	06/07/2018 1801 DG	EPA 200.7
Selenium	ND	0.005		mg/L	06/07/2018 1748 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/07/2018 1801 DG	EPA 200.7
Total Metals						
Iron	0.70	0.05		mg/L	06/08/2018 2210 DG	EPA 200.7
Manganese	0.03	0.02		mg/L	06/08/2018 2210 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

MAR 0 2 2025
RECD 10-25-18

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578513-IRR-DITCH Project

Location W.O.#

Sample ID# 578513-IRR-DITCH Date Sampled 7 / 12 / 18 Time 1200 (am) pm

Describe Sampling Point Surface water sampling site

Well Depth ft below MP Depth to Water (below MP) ft Casing Diameter in

Date / / Time am pm Casing Volume gal

At least bore volumes have been evacuated before sampling

DISCHARGE RATE

gpm

x 0.00223

cfs

Sampling method : Submersible pump Bladder

Tap Bailer Grab

Pump intake or bailer set at ft below MP.

Tubing (type:). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1100	8.69	326	22.5	33.2		

Pumping Start Time WL Pumping End Time WL

Comments:

HCF

COC # 177725

Form completed by: Witnessed by:

TFN 0 2/025

RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/26/2018
Report ID: S1807202001

Work Order: S1807202
Collection Date: 7/12/2018 11:00:00 AM
Date Received: 7/12/2018 12:08:00 PM
Sampler: RF
Matrix: Water
COC: 177725

Project: Ramaco-2014163-98
Lab ID: S1807202-003
Client Sample ID: 578513-IRR-DITCH

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.69			s.u.	07/12/2018 1100	Field
Conductivity	326			µmhos/cm	07/12/2018 1100	Field
Turbidity	33.2			NTU	07/12/2018 1100	Field
Temperature	22.6			°C	07/12/2018 1100	Field
General Parameters						
pH	8.6	0.1		s.u.	07/13/2018 0624 IBS	SM 4500 H B
Electrical Conductivity	335	5		µmhos/cm	07/13/2018 0624 IBS	SM 2510B
Total Dissolved Solids (180)	210	10		mg/L	07/13/2018 0850 NLG	SM 2540
Solids, Total Dissolved (Calc)	180	10		mg/L	07/26/2018 1014 JJ	SM 1030E
Total Suspended Solids	103	5		mg/L	07/17/2018 1454 NLG	SM 2540
Alkalinity, Total (As CaCO3)	148	5		mg/L	07/13/2018 0624 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	156	1		mg/L	07/26/2018 1014 JJ	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	07/17/2018 1123 AMB	EPA 350.1
rbidity	24.1	0.1		NTU	07/13/2018 0720 KB	SM 2130
odium Adsorption Ratio	0.28	0.01			07/26/2018 1014 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	171	5		mg/L	07/13/2018 0624 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/13/2018 0624 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/13/2018 0624 IBS	SM 2320B
Chloride	1	1		mg/L	07/13/2018 1622 AB	EPA 300.0
Fluoride	0.1	0.1		mg/L	07/13/2018 0624 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/13/2018 1538 AMB	EPA 353.2
Sulfate	27	1		mg/L	07/13/2018 1622 AB	EPA 300.0
Cations						
Calcium	38	1		mg/L	07/16/2018 1948 DG	EPA 200.7
Magnesium	15	1		mg/L	07/16/2018 1948 DG	EPA 200.7
Potassium	1	1		mg/L	07/16/2018 1948 DG	EPA 200.7
Sodium	8	1		mg/L	07/16/2018 1948 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TEN D 2020
RECD 10-25-18

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/26/2018
Report ID: S1807202001

Work Order: S1807202
Collection Date: 7/12/2018 11:00:00 AM
Date Received: 7/12/2018 12:08:00 PM
Sampler: RF
Matrix: Water
COC: 177725

Project: Ramaco-2014163-98
Lab ID: S1807202-003
Client Sample ID: 578513-IRR-DITCH

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	2.80	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Chloride	0.02	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Fluoride	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Sulfate	0.56	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Calcium	1.89	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Magnesium	1.21	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Potassium	0.03	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Sodium	0.35	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	3.50	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
ion Sum	3.55	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
tion-Anion Balance	0.73	0.01		%	07/26/2018 1014 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/18/2018 1316 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/14/2018 0555 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/14/2018 0555 MS	EPA 200.8
Boron	ND	0.1		mg/L	07/18/2018 1316 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/14/2018 0555 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/18/2018 1316 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/14/2018 0555 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/18/2018 1316 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/14/2018 0555 MS	EPA 200.8
Manganese	ND	0.02		mg/L	07/18/2018 1316 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 1200 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/14/2018 0555 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/18/2018 1316 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/14/2018 0555 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/18/2018 1316 DG	EPA 200.7
Total Metals						
Iron	0.70	0.05		mg/L	07/18/2018 2143 DG	EPA 200.7
Manganese	0.03	0.02		mg/L	07/18/2018 2143 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TFR G 2/020
RECD 10-25-18

DEQ Ex. 3-309

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578524-TR Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578524-TR Date Sampled 4 / 19 / 18 Time 1230 am (pm)

Describe Sampling Point Surface water site - Tounge River

Well Depth NA ft below MP Depth to Water (below MP) NA ft Casing Diameter _____ in

Date / / Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap Bailer Grab Sample

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1230	8.69	588	9.4	10.7		

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water Clear - no odor

HCF

COC# 171831

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-310
DEN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Brook Mine
Your Environmental Monitoring Partner

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/30/2018
Report ID: S1804246001

Work Order: S1804246
Collection Date: 4/19/2018 12:30:00 PM
Date Received: 4/19/2018 3:12:00 PM
Sampler: RF
Matrix: Water
COC: 171831

Project: Ramaco-2014163-98
Lab ID: S1804246-001
Client Sample ID: 578524-TR

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.69			s.u.	04/19/2018 1230	Field
Conductivity	588			µmhos/cm	04/19/2018 1230	Field
Turbidity	10.7			NTU	04/19/2018 1230	Field
Temperature	9.4			°C	04/19/2018 1230	Field
General Parameters						
pH	8.6	0.1		s.u.	04/20/2018 1633 IBS	SM 4500 H B
Electrical Conductivity	598	5		µmhos/cm	04/20/2018 1633 IBS	SM 2510B
Total Dissolved Solids (180)	380	10		mg/L	04/20/2018 1402 NLG	SM 2540
Solids, Total Dissolved (Calc)	360	10		mg/L	04/30/2018 1039 BC	SM 1030E
Total Suspended Solids	12	5		mg/L	04/20/2018 1603 NLG	SM 2540
Alkalinity, Total (As CaCO3)	204	5		mg/L	04/20/2018 1633 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	257	1		mg/L	04/30/2018 1039 BC	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	04/27/2018 1017 AMB	EPA 350.1
bidity	8.8	0.1		NTU	04/20/2018 0755 KB	SM 2130
lium Adsorption Ratio	0.76	0.01			04/30/2018 1039 BC	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	232	5		mg/L	04/20/2018 1633 IBS	SM 2320B
Alkalinity, Carbonate as CO3	8	5		mg/L	04/20/2018 1633 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/20/2018 1633 IBS	SM 2320B
Chloride	4	1		mg/L	04/20/2018 1407 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	04/20/2018 1633 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/24/2018 1454 AMB	EPA 353.2
Sulfate	115	1		mg/L	04/20/2018 1407 AB	EPA 300.0
Cations						
Calcium	58	1		mg/L	04/24/2018 1307 DG	EPA 200.7
Magnesium	28	1		mg/L	04/20/2018 1357 DG	EPA 200.7
Potassium	3	1		mg/L	04/24/2018 1307 DG	EPA 200.7
Sodium	28	1		mg/L	04/20/2018 1357 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN D 8/025

DEQ Ex. 3-311

10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/30/2018
Report ID: S1804246001

Work Order: S1804246
Collection Date: 4/19/2018 12:30:00 PM
Date Received: 4/19/2018 3:12:00 PM
Sampler: RF
Matrix: Water
COC: 171831

Project: Ramaco-2014163-98
Lab ID: S1804246-001
Client Sample ID: 578524-TR

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	3.80	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Carbonate as CO3	0.27	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Chloride	0.11	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Fluoride	ND	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Sulfate	2.38	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Calcium	2.88	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Magnesium	2.26	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Potassium	0.06	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Sodium	1.22	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	6.43	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
ion Sum	6.59	0.01		meq/L	04/30/2018 1039 BC	SM 1030E
tion-Anion Balance	1.19	0.01		%	04/30/2018 1039 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/20/2018 1357 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/20/2018 1542 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/20/2018 1542 MS	EPA 200.8
Boron	ND	0.1		mg/L	04/20/2018 1357 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/20/2018 1542 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/20/2018 1357 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/20/2018 1542 MS	EPA 200.8
Iron	ND	0.05		mg/L	04/20/2018 1357 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/20/2018 1542 MS	EPA 200.8
Manganese	0.03	0.02		mg/L	04/20/2018 1357 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/24/2018 0857 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/20/2018 1542 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/20/2018 1357 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/20/2018 1542 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/20/2018 1357 DG	EPA 200.7
Total Metals						
Iron	0.22	0.05		mg/L	04/23/2018 1547 DG	EPA 200.7
Manganese	0.04	0.02		mg/L	04/23/2018 1547 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/323

RECD 10-25-18

Scanned, 02/28/2020

Surface water

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578524-TR Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578524-TR Date Sampled 6 / 6 / 18 Time 1540 am (pm)

Describe Sampling Point Tongue River water quality site - surface water site

Well Depth — ft below MP Depth to Water (below MP) — ft Casing Diameter — in

Date — / — / — Time — am pm Casing Volume — gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap Bailer Grab

Pump intake or bailer set at NA ft below MP.

tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1540	7.97	232	18.8	19.2		

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water level high - slightly turbid - no odor - sampled prior to coal/alluvial pump test.

HCF

COC # 171833

Form completed by: Todd Fuller Witnessed by: _____

October 2018

TEN 6 2/025

RECD 10-25-18

Addendum D6-6-49

C:\Fuller Files\Monitor Well Sample Form-RF.doc

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/21/2018
Report ID: S1806097001

Work Order: S1806097
Collection Date: 6/6/2018 3:40:00 PM
Date Received: 6/6/2018 4:39:00 PM
Sampler: RF
Matrix: Water
COC: 171833

Project: Ramaco-2014163-98
Lab ID: S1806097-001
Client Sample ID: 578524-TR

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.97			s.u.	06/06/2018 1540	Field
Conductivity	232			µmhos/cm	06/06/2018 1540	Field
Turbidity	19.2			NTU	06/06/2018 1540	Field
Temperature	18.8			°C	06/06/2018 1540	Field
General Parameters						
pH	8.4	0.1		s.u.	06/07/2018 1814 IBS	SM 4500 H B
Electrical Conductivity	242	5		µmhos/cm	06/07/2018 1814 IBS	SM 2510B
Total Dissolved Solids (180)	140	10		mg/L	06/07/2018 1213 NLG	SM 2540
Solids, Total Dissolved (Calc)	130	10		mg/L	06/21/2018 0949 JJ	SM 1030E
Total Suspended Solids	29	5		mg/L	06/08/2018 1456 NLG	SM 2540
Alkalinity, Total (As CaCO3)	109	5		mg/L	06/07/2018 1814 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	113	1		mg/L	06/21/2018 0949 JJ	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	06/14/2018 1506 AMB	EPA 350.1
rbidity	15.1	0.1		NTU	06/07/2018 1454 IBS	SM 2130
dium Adsorption Ratio	0.20	0.01			06/21/2018 0949 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	130	5		mg/L	06/07/2018 1814 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	06/07/2018 1814 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/07/2018 1814 IBS	SM 2320B
Chloride	ND	1		mg/L	06/07/2018 1915 AB	EPA 300.0
Fluoride	ND	0.1		mg/L	06/07/2018 1814 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	06/08/2018 1353 AMB	EPA 353.2
Sulfate	15	1		mg/L	06/07/2018 1915 AB	EPA 300.0
Cations						
Calcium	30	1		mg/L	06/07/2018 1755 DG	EPA 200.7
Magnesium	10	1		mg/L	06/07/2018 1755 DG	EPA 200.7
Potassium	2	1		mg/L	06/07/2018 1755 DG	EPA 200.7
Sodium	5	1		mg/L	06/07/2018 1755 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TFR 6 2/025
RECD 10-25-18

Addendum D6-6-50

DEQ Ex. 3-314

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/21/2018
Report ID: S1806097001

Work Order: S1806097
Collection Date: 6/6/2018 3:40:00 PM
Date Received: 6/6/2018 4:39:00 PM
Sampler: RF
Matrix: Water
COC: 171833

Project: Ramaco-2014163-98
Lab ID: S1806097-001
Client Sample ID: 578524-TR

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	2.12	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Chloride	ND	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Fluoride	ND	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Sulfate	0.31	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Calcium	1.47	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Magnesium	0.79	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Potassium	0.04	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Sodium	0.22	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	2.52	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
ion Sum	2.50	0.01		meq/L	06/21/2018 0949 JJ	SM 1030E
tion-Anion Balance	0.49	0.01		%	06/21/2018 0949 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	06/07/2018 1755 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	06/07/2018 1725 MS	EPA 200.8
Barium	ND	0.1		mg/L	06/07/2018 1725 MS	EPA 200.8
Boron	ND	0.1		mg/L	06/07/2018 1755 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	06/07/2018 1725 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/07/2018 1755 DG	EPA 200.7
Copper	ND	0.01		mg/L	06/07/2018 1725 MS	EPA 200.8
Iron	ND	0.05		mg/L	06/07/2018 1755 DG	EPA 200.7
Lead	ND	0.02		mg/L	06/07/2018 1725 MS	EPA 200.8
Manganese	ND	0.02		mg/L	06/07/2018 1755 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/08/2018 1051 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	06/07/2018 1725 MS	EPA 200.8
Nickel	ND	0.01		mg/L	06/07/2018 1755 DG	EPA 200.7
Selenium	ND	0.005		mg/L	06/07/2018 1725 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/07/2018 1755 DG	EPA 200.7
Total Metals						
Iron	0.64	0.05		mg/L	06/08/2018 2208 DG	EPA 200.7
Manganese	0.03	0.02		mg/L	06/08/2018 2208 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-315

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578524-TR-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578524-TR-1 Date Sampled 7/12/18 Time 1040 (am) pm

Describe Sampling Point Surface water sampling site

Well Depth _____ ft below MP Depth to Water (below MP) _____ ft Casing Diameter _____ in

Date / / Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap Bailer (Grab)

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1040	8.64	335	21.8	6.17		

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: water clear - no odor

LCF
COC# 177725

Form completed by: Rod Fuller Witnessed by: _____

TEN G 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/26/2018
Report ID: S1807202001

Work Order: S1807202
Collection Date: 7/12/2018 10:40:00 AM
Date Received: 7/12/2018 12:08:00 PM
Sampler: RF
Matrix: Water
COC: 177725

Project: Ramaco-2014163-98
Lab ID: S1807202-002
Client Sample ID: 578524-TR-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.64			s.u.	07/12/2018 1040	Field
Conductivity	335			µmhos/cm	07/12/2018 1040	Field
Turbidity	6.17			NTU	07/12/2018 1040	Field
Temperature	21.8			°C	07/12/2018 1040	Field
General Parameters						
pH	8.6	0.1		s.u.	07/13/2018 0613 IBS	SM 4500 H B
Electrical Conductivity	343	5		µmhos/cm	07/13/2018 0613 IBS	SM 2510B
Total Dissolved Solids (180)	190	10		mg/L	07/13/2018 0848 NLG	SM 2540
Solids, Total Dissolved (Calc)	180	10		mg/L	07/26/2018 1014 JJ	SM 1030E
Total Suspended Solids	8	5		mg/L	07/17/2018 1453 NLG	SM 2540
Alkalinity, Total (As CaCO3)	156	5		mg/L	07/13/2018 0613 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	160	1		mg/L	07/26/2018 1014 JJ	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	07/17/2018 1123 AMB	EPA 350.1
rbidity	6.9	0.1		NTU	07/13/2018 0718 KB	SM 2130
odium Adsorption Ratio	0.28	0.01			07/26/2018 1014 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	179	5		mg/L	07/13/2018 0613 IBS	SM 2320B
Alkalinity, Carbonate as CO3	6	5		mg/L	07/13/2018 0613 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/13/2018 0613 IBS	SM 2320B
Chloride	1	1		mg/L	07/13/2018 1611 AB	EPA 300.0
Fluoride	0.1	0.1		mg/L	07/13/2018 0613 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/13/2018 1536 AMB	EPA 353.2
Sulfate	24	1		mg/L	07/13/2018 1611 AB	EPA 300.0
Cations						
Calcium	39	1		mg/L	07/16/2018 1946 DG	EPA 200.7
Magnesium	15	1		mg/L	07/16/2018 1946 DG	EPA 200.7
Potassium	1	1		mg/L	07/16/2018 1946 DG	EPA 200.7
Sodium	8	1		mg/L	07/16/2018 1946 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect
C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/023
DEQ 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/26/2018
Report ID: S1807202001

Work Order: S1807202
Collection Date: 7/12/2018 10:40:00 AM
Date Received: 7/12/2018 12:08:00 PM
Sampler: RF
Matrix: Water
COC: 177725

Project: Ramaco-2014163-98
Lab ID: S1807202-002
Client Sample ID: 578524-TR-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	2.93	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Carbonate as CO3	0.18	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Chloride	0.03	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Fluoride	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Sulfate	0.50	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Calcium	1.96	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Magnesium	1.23	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Potassium	0.03	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Sodium	0.36	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	3.59	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
ion Sum	3.66	0.01		meq/L	07/26/2018 1014 JJ	SM 1030E
tion-Anion Balance	0.92	0.01		%	07/26/2018 1014 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/18/2018 1314 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/14/2018 0549 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/14/2018 0549 MS	EPA 200.8
Boron	ND	0.1		mg/L	07/18/2018 1314 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/14/2018 0549 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/18/2018 1314 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/14/2018 0549 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/18/2018 1314 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/14/2018 0549 MS	EPA 200.8
Manganese	ND	0.02		mg/L	07/18/2018 1314 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 1158 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/14/2018 0549 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/18/2018 1314 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/14/2018 0549 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/18/2018 1314 DG	EPA 200.7
Total Metals						
Iron	0.20	0.05		mg/L	07/18/2018 2141 DG	EPA 200.7
Manganese	ND	0.02		mg/L	07/18/2018 2141 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TFN 6 2/025
RECD 10-29-18

DEQ Ex. 3-318

Scanned, 02/28/2020

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name 578434 - GC-1

Date 4/14/15

Technician/Engineer R. Fuehr

Devices

Flow/Automatic sampler Device NA

Device Flow or Stage Reading NA CFS/FT

Device Battery Charge NA Volts

Device Data Download Yes or No

Sample Collected by Device Yes or No;

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

Instantaneous Flow

Measured Flow Yes or No

Measurement Device

Flow Rate CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1720	8.97	502	14.1	5.83	—	—	—

Lab Information

Lab COC # 137350

Date Samples to Lab 4/15/15

TFN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Project: Ramaco
Lab ID: S1504190-004
Client Sample ID: 578434-GC-1

Date Reported: 4/21/2015
Report ID: S1504190001

Work Order: S1504190
Collection Date: 4/14/2015 5:20:00 PM
Date Received: 4/15/2015 8:39:00 AM
Sampler: RF
Matrix: Water
COC: 137350

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.97			s.u.	04/14/2015 1720	Field
Conductivity	502			µmhos/cm	04/14/2015 1720	Field
Turbidity	5.83			NTU	04/14/2015 1720	Field
Temperature	14.1			°C	04/14/2015 1720	Field
General Parameters						
pH	9.0	0.1		s.u.	04/15/2015 1936 BT	SM 4500 H B
Electrical Conductivity	517	5		µmhos/cm	04/15/2015 1936 BT	SM 2510B
Total Dissolved Solids (180)	320	10		mg/L	04/15/2015 1409 IR	SM 2540
Solids, Total Dissolved (Calc)	290	10		mg/L	04/21/2015 1005 JJ	SM 1030E
Total Suspended Solids	11	5		mg/L	04/15/2015 1619 IR	SM 2540
Alkalinity, Total (As CaCO3)	185	5		mg/L	04/15/2015 1936 BT	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	238	1		mg/L	04/21/2015 1005 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	04/16/2015 1459 AMB	EPA 350.1
ɔidity	3.4	0.1		NTU	04/15/2015 1405 JJ	SM 2130
..dium Adsorption Ratio	0.4	0.1			04/21/2015 1005 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	183	5		mg/L	04/15/2015 1936 BT	SM 2320B
Alkalinity, Carbonate as CO3	21	5		mg/L	04/15/2015 1936 BT	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/15/2015 1936 BT	SM 2320B
Chloride	7	1		mg/L	04/15/2015 2046 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	04/15/2015 1936 BT	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/20/2015 1017 AMB	EPA 353.2
Sulfate	83	1		mg/L	04/15/2015 2046 AB	EPA 300.0
Cations						
Calcium	46	1		mg/L	04/15/2015 2013 DG	EPA 200.7
Magnesium	30	1		mg/L	04/15/2015 2013 DG	EPA 200.7
Potassium	2	1		mg/L	04/15/2015 2013 DG	EPA 200.7
Sodium	16	1		mg/L	04/15/2015 2013 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

TFN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Project: Ramaco
Lab ID: S1504190-004
Client Sample ID: 578434-GC-1

Date Reported: 4/21/2015
Report ID: S1504190001

Work Order: S1504190
Collection Date: 4/14/2015 5:20:00 PM
Date Received: 4/15/2015 8:39:00 AM
Sampler: RF
Matrix: Water
COC: 137350

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	2.99	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Carbonate as CO3	0.70	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Chloride	0.19	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Sulfate	1.71	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Calcium	2.30	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Magnesium	2.45	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Potassium	0.05	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Sodium	0.67	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	5.50	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
ion Sum	5.61	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
tion-Anion Balance	1.06	0.01		%	04/21/2015 1005 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/15/2015 2013 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/15/2015 1717 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/15/2015 1717 MS	EPA 200.8
Boron	ND	0.1		mg/L	04/15/2015 2013 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/15/2015 1717 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/15/2015 2013 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/15/2015 1717 MS	EPA 200.8
Iron	ND	0.05		mg/L	04/15/2015 2013 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/15/2015 1717 MS	EPA 200.8
Manganese	0.02	0.02		mg/L	04/15/2015 2013 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/16/2015 0945 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/15/2015 1717 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/15/2015 2013 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/15/2015 1717 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/15/2015 2013 DG	EPA 200.7
Total Metals						
Iron	0.27	0.05		mg/L	04/16/2015 1717 DG	EPA 200.7
Manganese	0.04	0.02		mg/L	04/16/2015 1717 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

RCVD 2/025

RECD 10-25-18

DEQ Ex. 3-321

Scanned, 02/28/2020

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name 578434-GC-1

Date 9/17/15

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device NA

Device Flow or Stage Reading NA CFS/FT

Device Battery Charge NA Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1200	8.45	712	15.1	3.93	—	—	—

Lab Information

Lab COC # 161910

Date Samples to Lab 9/17/15

REC'D 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Brook Mine
Your Environmental Monitoring Partner

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/29/2015
Report ID: S1509325001

Work Order: S1509325
Collection Date: 9/17/2015 12:00:00 PM
Date Received: 9/17/2015 3:10:00 PM
Sampler: RF
Matrix: Water
COC: 161910

Project: Ramaco-2014163-07
Lab ID: S1509325-001 **Client**
Sample ID: 578434-GC-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.45			s.u.	09/17/2015 1200	Field
Conductivity	712			µmhos/cm	09/17/2015 1200	Field
Turbidity	3.93			NTU	09/17/2015 1200	Field
Temperature	15.1			°C	09/17/2015 1200	Field
General Parameters						
pH	8.6	0.1		s.u.	09/19/2015 2110 LJK	SM 4500 H B
Electrical Conductivity	759	5		µmhos/cm	09/19/2015 2110 LJK	SM 2510B
Total Dissolved Solids (180)	480	10		mg/L	09/18/2015 0950 LJK	SM 2540
Solids, Total Dissolved (Calc)	440	10		mg/L	09/29/2015 0847 JJ	SM 1030E
Total Suspended Solids	ND	5		mg/L	09/18/2015 1729 LJK	SM 2540
Alkalinity, Total (As CaCO3)	289	5		mg/L	09/19/2015 2110 LJK	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	351	1		mg/L	09/29/2015 0847 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	09/23/2015 1253 AMB	EPA 350.1
bidity	2.9	0.1		NTU	09/18/2015 1003 NLG	SM 2130
odium Adsorption Ratio	0.6	0.1			09/29/2015 0847 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	314	5		mg/L	09/19/2015 2110 LJK	SM 2320B
Alkalinity, Carbonate as CO3	19	5		mg/L	09/19/2015 2110 LJK	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	09/19/2015 2110 LJK	SM 2320B
Chloride	9	1		mg/L	09/25/2015 1649 AB	EPA 300.0
Fluoride	0.4	0.1		mg/L	09/20/2015 2302 MRL	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.5	0.1		mg/L	09/22/2015 1553 AMB	EPA 353.2
Sulfate	117	1		mg/L	09/25/2015 1649 AB	EPA 300.0
Cations						
Calcium	64	1		mg/L	09/21/2015 1631 DG	EPA 200.7
Magnesium	46	1		mg/L	09/21/2015 1631 DG	EPA 200.7
Potassium	4	1		mg/L	09/21/2015 1631 DG	EPA 200.7
Sodium	28	1		mg/L	09/21/2015 1631 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TEN 6 2/025
RECD 10-25-18

October 2018

DEQ Ex. 3-323

Addendum D6-6-59

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/29/2015
Report ID: S1509325001

Work Order: S1509325
Collection Date: 9/17/2015 12:00:00 PM
Date Received: 9/17/2015 3:10:00 PM
Sampler: RF
Matrix: Water
COC: 161910

Project: Ramaco-2014163-07
Lab ID: S1509325-001 **Client**
Sample ID: 578434-GC-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	5.15	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Carbonate as CO3	0.63	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Chloride	0.25	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Nitrate + Nitrite as N	0.03	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Sulfate	2.42	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Calcium	3.20	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Magnesium	3.81	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Potassium	0.09	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Sodium	1.21	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	8.33	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
ion Sum	8.51	0.01		meq/L	09/29/2015 0847 JJ	SM 1030E
tion-Anion Balance	1.07	0.01		%	09/29/2015 0847 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	09/21/2015 1631 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	09/18/2015 2334 MS	EPA 200.8
Barium	ND	0.1		mg/L	09/18/2015 2334 MS	EPA 200.8
Boron	ND	0.1		mg/L	09/21/2015 1631 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	09/18/2015 2334 MS	EPA 200.8
Chromium	ND	0.01		mg/L	09/21/2015 1631 DG	EPA 200.7
Copper	ND	0.01		mg/L	09/18/2015 2334 MS	EPA 200.8
Iron	ND	0.05		mg/L	09/21/2015 1631 DG	EPA 200.7
Lead	ND	0.02		mg/L	09/18/2015 2334 MS	EPA 200.8
Manganese	0.02	0.02		mg/L	09/21/2015 1631 DG	EPA 200.7
Mercury	ND	0.001		mg/L	09/22/2015 1139 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	09/18/2015 2334 MS	EPA 200.8
Nickel	ND	0.01		mg/L	09/21/2015 1631 DG	EPA 200.7
Selenium	ND	0.005		mg/L	09/18/2015 2334 MS	EPA 200.8
Zinc	ND	0.01		mg/L	09/21/2015 1631 DG	EPA 200.7
Total Metals						
Iron	0.15	0.05		mg/L	09/21/2015 2149 DG	EPA 200.7
Manganese	0.03	0.02		mg/L	09/21/2015 2149 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

October 2018

RECD 10-25-18

Addendum D6-6-60

DEQ Ex. 3-324

Scanned, 02/28/2020

Surface Water Field Sheet

Project/Client Ramaco - 2014163

Site Name. 578434-GC-1

Date 12/1/15

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device —

Device Flow or Stage Reading — CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or No

Sample Collected by Device Yes or No;

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

ıstantaneous Flow

Measured Flow Yes or No

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1420	8.67	662	2.2	4.07	—	—	—

Lab Information

Lab COC # 162096

Date Samples to Lab 12/1/15

TFR 6 27625
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512027001

Project: Ramaco-2014163-07
Lab ID: S1512027-001
Client Sample ID: 578434-GC-1

Work Order: S1512027
Collection Date: 12/1/2015 2:20:00 PM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162096

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.67			s.u.	12/01/2015 1420	Field
Conductivity	662			µmhos/cm	12/01/2015 1420	Field
Turbidity	4.07			NTU	12/01/2015 1420	Field
Temperature	2.2			°C	12/01/2015 1420	Field
General Parameters						
pH	8.4	0.1		s.u.	12/03/2015 1529 SFF	SM 4500 H B
Electrical Conductivity	628	5		µmhos/cm	12/02/2015 1606 SFF	SM 2510B
Total Dissolved Solids (180)	390	10		mg/L	12/02/2015 1437 IR	SM 2540
Solids, Total Dissolved (Calc)	370	10		mg/L	12/08/2015 0820 JJ	SM 1030E
Total Suspended Solids	5	5		mg/L	12/02/2015 1252 IR	SM 2540
Alkalinity, Total (As CaCO3)	246	5		mg/L	12/03/2015 1529 SFF	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	306	1		mg/L	12/08/2015 0820 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	12/07/2015 0950 AMB	EPA 350.1
ɔidity	2.2	0.1		NTU	12/02/2015 1128 NLG	SM 2130
ɔodium Adsorption Ratio	0.5	0.1			12/08/2015 0820 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	294	5		mg/L	12/03/2015 1529 SFF	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/03/2015 1529 SFF	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/03/2015 1529 SFF	SM 2320B
Chloride	6	1		mg/L	12/02/2015 1820 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	12/02/2015 1606 SFF	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.5	0.1		mg/L	12/02/2015 1123 AMB	EPA 353.2
Sulfate	95	1		mg/L	12/05/2015 1432 AB	EPA 300.0
Cations						
Calcium	60	1		mg/L	12/04/2015 1354 DG	EPA 200.7
Magnesium	38	1		mg/L	12/04/2015 1354 DG	EPA 200.7
Potassium	3	1		mg/L	12/04/2015 1354 DG	EPA 200.7
Sodium	20	1		mg/L	12/04/2015 1354 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- A Check MSA specifications
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512027001

Work Order: S1512027
Collection Date: 12/1/2015 2:20:00 PM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162096

Project: Ramaco-2014163-07
Lab ID: S1512027-001
Client Sample ID: 578434-GC-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	4.81	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Chloride	0.15	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Nitrate + Nitrite as N	0.03	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Sulfate	1.97	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Calcium	3.01	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Magnesium	3.11	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Potassium	0.06	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Sodium	0.85	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	7.04	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
ion Sum	7.11	0.01		meq/L	12/08/2015 0820 JJ	SM 1030E
tion-Anion Balance	0.43	0.01		%	12/08/2015 0820 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/02/2015 1450 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/02/2015 2024 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/02/2015 2024 MS	EPA 200.8
Boron	ND	0.1		mg/L	12/02/2015 1450 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/02/2015 2024 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/02/2015 1450 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/02/2015 2024 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/02/2015 1450 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/02/2015 2024 MS	EPA 200.8
Manganese	0.02	0.02		mg/L	12/02/2015 1450 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/04/2015 1002 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/02/2015 2024 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/02/2015 1450 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/02/2015 2024 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/02/2015 1450 DG	EPA 200.7
Total Metals						
Iron	0.18	0.05		mg/L	12/03/2015 1610 DG	EPA 200.7
Manganese	0.03	0.02		mg/L	12/03/2015 1610 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- A Check MSA specifications
- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by another laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco 2014163-07

Site Name 578434-GC-1 (Goose Creek)

Date 3/1/16

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device NA

Device Flow or Stage Reading NA CFS/FT

Device Battery Charge NA Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

nstantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1410	8.89	665	7.1	6.57	—	—	—

Lab Information

Lab COC # 162114

Date Samples to Lab 3/1/16

VFN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/9/2016
Report ID: S1603019001

Work Order: S1603019
Collection Date: 3/1/2016 2:10:00 PM
Date Received: 3/1/2016 4:06:00 PM
Sampler: RF
Matrix: Water
COC: 162114

Project: Ramaco-2014163-07
Lab ID: S1603019-001
Client Sample ID: 578434-GC-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.89			s.u.	03/01/2016 1410	Field
Conductivity	665			µmhos/cm	03/01/2016 1410	Field
Turbidity	6.57			NTU	03/01/2016 1410	Field
Temperature	7.1			°C	03/01/2016 1410	Field
General Parameters						
pH	8.6	0.1		s.u.	03/02/2016 1753 LAB	SM 4500 H B
Electrical Conductivity	628	5		µmhos/cm	03/02/2016 1753 LAB	SM 2510B
Total Dissolved Solids (180)	410	10		mg/L	03/02/2016 0943 NLG	SM 2540
Solids, Total Dissolved (Calc)	370	10		mg/L	03/08/2016 1543 JJ	SM 1030E
Total Suspended Solids	ND	5		mg/L	03/02/2016 1324 AB	SM 2540
Alkalinity, Total (As CaCO3)	236	5		mg/L	03/02/2016 1753 LAB	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	298	1		mg/L	03/08/2016 1543 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.1	0.1		mg/L	03/04/2016 1452 AMB	EPA 350.1
rbidity	1.6	0.1		NTU	03/02/2016 0922 KB	SM 2130
odium Adsorption Ratio	0.5	0.1			03/08/2016 1543 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	260	5		mg/L	03/02/2016 1753 LAB	SM 2320B
Alkalinity, Carbonate as CO3	14	5		mg/L	03/02/2016 1753 LAB	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/02/2016 1753 LAB	SM 2320B
Chloride	7	1		mg/L	03/02/2016 1248 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	03/02/2016 1753 LAB	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.4	0.1		mg/L	03/03/2016 1304 AMB	EPA 353.2
Sulfate	98	1		mg/L	03/02/2016 1248 AB	EPA 300.0
Cations						
Calcium	57	1		mg/L	03/02/2016 1426 DG	EPA 200.7
Magnesium	38	1		mg/L	03/02/2016 1426 DG	EPA 200.7
Potassium	3	1		mg/L	03/02/2016 1426 DG	EPA 200.7
Sodium	21	1		mg/L	03/02/2016 1426 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD 10-25-18

October 2018

DEQ Ex. 3-329

Addendum D6-6-65

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/9/2016
Report ID: S1603019001

Work Order: S1603019
Collection Date: 3/1/2016 2:10:00 PM
Date Received: 3/1/2016 4:06:00 PM
Sampler: RF
Matrix: Water
COC: 162114

Project: Ramaco-2014163-07
Lab ID: S1603019-001
Client Sample ID: 578434-GC-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	4.26	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Carbonate as CO3	0.44	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Chloride	0.19	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Nitrate + Nitrite as N	0.02	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Sulfate	2.04	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Calcium	2.83	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Magnesium	3.12	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Potassium	0.06	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Sodium	0.90	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	6.94	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
ion Sum	6.99	0.01		meq/L	03/08/2016 1543 JJ	SM 1030E
tion-Anion Balance	0.38	0.01		%	03/08/2016 1543 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/02/2016 1426 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/02/2016 1643 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/02/2016 1643 MS	EPA 200.8
Boron	ND	0.1		mg/L	03/02/2016 1426 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/02/2016 1643 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/02/2016 1426 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/02/2016 1643 MS	EPA 200.8
Iron	ND	0.05		mg/L	03/02/2016 1426 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/02/2016 1643 MS	EPA 200.8
Manganese	0.04	0.02		mg/L	03/02/2016 1426 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/04/2016 0947 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/02/2016 1643 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/02/2016 1426 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/02/2016 1643 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/02/2016 1426 DG	EPA 200.7
Total Metals						
Iron	0.14	0.05		mg/L	03/04/2016 1617 DG	EPA 200.7
Manganese	0.04	0.02		mg/L	03/04/2016 1617 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

2/025

DEQ 10-25-18

October 2018

DEQ Ex. 3-330

Addendum D6-6-66

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco - 2014163

Site Name 578434-GC-1

Date 5/20/16

Technician/Engineer R. Fuller

Devices

Flow/Automatic sampler Device —

Device Flow or Stage Reading — CFS/FT

Device Battery Charge — Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

nstantaneous Flow

Measured Flow Yes or (No)

Measurement Device —

Flow Rate — CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1330	8.73	336	17.9	28.0	—	—	—

Lab Information

Lab COC # 165202

Date Samples to Lab 5/20/16

TFN 6 2/026
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/1/2016
Report ID: S1605397001

Work Order: S1605397
Collection Date: 5/20/2016 1:30:00 PM
Date Received: 5/20/2016 2:52:00 PM
Sampler: RF
Matrix: Water
COC: 165202

Project: Ramaco-2014163-07
Lab ID: S1605397-001
Client Sample ID: Big Goose Creek

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.73			s.u.	05/20/2016 1330	Field
Conductivity	336			µmhos/cm	05/20/2016 1330	Field
Turbidity	28.0			NTU	05/20/2016 1330	Field
Temperature	17.9			°C	05/20/2016 1330	Field
General Parameters						
pH	8.5	0.1		s.u.	05/24/2016 1805 IBS	SM 4500 H B
Electrical Conductivity	349	5		µmhos/cm	05/24/2016 1805 IBS	SM 2510B
Total Dissolved Solids (180)	210	10		mg/L	05/20/2016 1706 NLG	SM 2540
Solids, Total Dissolved (Calc)	180	10		mg/L	06/01/2016 0756 JJ	SM 1030E
Total Suspended Solids	30	5		mg/L	05/21/2016 1442 AB	SM 2540
Alkalinity, Total (As CaCO3)	129	5		mg/L	05/24/2016 1805 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	147	1		mg/L	06/01/2016 0756 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	05/27/2016 1618 AMB	EPA 350.1
bidity	14.3	0.1		NTU	05/20/2016 1609 IBS	SM 2130
odium Adsorption Ratio	0.4	0.1			06/01/2016 0756 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	150	5		mg/L	05/24/2016 1805 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/24/2016 1805 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/24/2016 1805 IBS	SM 2320B
Chloride	3	1		mg/L	05/25/2016 0037 AB	EPA 300.0
Fluoride	0.1	0.1		mg/L	05/24/2016 1805 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/25/2016 1327 AMB	EPA 353.2
Sulfate	43	1		mg/L	05/25/2016 0037 AB	EPA 300.0
Cations						
Calcium	31	1		mg/L	05/23/2016 1529 DG	EPA 200.7
Magnesium	17	1		mg/L	05/23/2016 1529 DG	EPA 200.7
Potassium	2	1		mg/L	05/23/2016 1529 DG	EPA 200.7
Sodium	12	1		mg/L	05/23/2016 1529 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-332

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/1/2016
Report ID: S1605397001

Work Order: S1605397
Collection Date: 5/20/2016 1:30:00 PM
Date Received: 5/20/2016 2:52:00 PM
Sampler: RF
Matrix: Water
COC: 165202

Project: Ramaco-2014163-07
Lab ID: S1605397-001
Client Sample ID: Big Goose Creek

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	2.45	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Chloride	0.08	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Fluoride	ND	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Sulfate	0.88	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Calcium	1.52	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Magnesium	1.42	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Potassium	0.03	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Sodium	0.49	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	3.48	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
ion Sum	3.55	0.01		meq/L	06/01/2016 0756 JJ	SM 1030E
tion-Anion Balance	0.96	0.01		%	06/01/2016 0756 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/23/2016 1529 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/23/2016 1759 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/23/2016 1759 MS	EPA 200.8
Boron	ND	0.1		mg/L	05/23/2016 1529 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/23/2016 1759 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/23/2016 1529 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/23/2016 1759 MS	EPA 200.8
Iron	ND	0.05		mg/L	05/23/2016 1529 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/23/2016 1759 MS	EPA 200.8
Manganese	ND	0.02		mg/L	05/23/2016 1529 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/26/2016 1416 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/23/2016 1759 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/23/2016 1529 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/23/2016 1759 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/23/2016 1529 DG	EPA 200.7
Total Metals						
Iron	0.67	0.05		mg/L	05/25/2016 1717 DG	EPA 200.7
Manganese	0.05	0.02		mg/L	05/25/2016 1717 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFR 6 2/025
RECD 10-25-18

DEQ Ex. 3-333

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RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name SM578409-SW-1

Date 4/14/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO - signature flowmeter

Device Flow or Stage Reading Dry CFS/FT

Device Battery Charge [redacted] 12.76 Volts

Device Data Download Yes or No NA

Sample Collected by Device Yes or No: NA

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Set up flowmeter for season

Instantaneous Flow

Measured Flow Yes or (No) Dry

Measurement Device

Flow Rate CFS

Include Stream Gaging Data

Grab Sample Collected Yes or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
			DRY				

Lab Information

Lab COC # —

Date Samples to Lab —

TFN 5 2/025
RECD MAY 23, 2019

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RAMACO

* no access

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name. SM578415-SW-1

Date 4/14/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device _____

Device Flow or Stage Reading _____ CFS/FT

Device Battery Charge _____ Volts

Device Data Download Yes or No

Sample Collected by Device Yes or No;

Staff gage reading if installed _____ Ft

Crest gage readings if installed _____ Ft

Instantaneous Flow

Measured Flow Yes or No

Measurement Device _____

Flow Rate _____ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

* No landowner access permission

Lab Information

Lab COC # _____

Date Samples to Lab _____

IFNS 2/025
RECD MAY 23, 2019

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RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco 2014163-07

Site Name. SM578418-SW-1

Date 4/14/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO - 6712 flowmeter/sampler

Device Flow or Stage Reading NA CFS/FT

Device Battery Charge 12.86 Volts

* Set up Flowmeter/ Sampler for season

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

Instantaneous Flow

Measured Flow Yes or (No) Estimated

Measurement Device NA

Flow Rate 0.20 CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1430	8.04	4200	13.9	9.14	—	—	—

Lab Information

Lab COC # 137350

Date Samples to Lab 4/14/15

TFNS 2/025

DEQ Ex. 3-336 RECD MAY 23, 2019

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/21/2015
Report ID: S1504190001

Work Order: S1504190
Collection Date: 4/14/2015 2:30:00 PM
Date Received: 4/15/2015 8:39:00 AM
Sampler: RF
Matrix: Water
COC: 137350

Project: Ramaco
Lab ID: S1504190-003
Client Sample ID: SM578418-SW-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.04			s.u.	04/14/2015 1430	Field
Conductivity	4200			µmhos/cm	04/14/2015 1430	Field
Turbidity	9.14			NTU	04/14/2015 1430	Field
Temperature	13.9			°C	04/14/2015 1430	Field
General Parameters						
pH	8.3	0.1		s.u.	04/15/2015 1924 BT	SM 4500 H B
Electrical Conductivity	4170	5		µmhos/cm	04/15/2015 1924 BT	SM 2510B
Total Dissolved Solids (180)	3990	10		mg/L	04/15/2015 1408 IR	SM 2540
Solids, Total Dissolved (Calc)	3530	10		mg/L	04/21/2015 1005 JJ	SM 1030E
Total Suspended Solids	10	5		mg/L	04/15/2015 1618 IR	SM 2540
Alkalinity, Total (As CaCO3)	558	5		mg/L	04/15/2015 1924 BT	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1940	1		mg/L	04/21/2015 1005 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.2	0.1		mg/L	04/16/2015 1458 AMB	EPA 350.1
Turbidity	4.9	0.1		NTU	04/15/2015 1405 JJ	SM 2130
Sodium Adsorption Ratio	3.5	0.1			04/21/2015 1005 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	663	5		mg/L	04/15/2015 1924 BT	SM 2320B
Alkalinity, Carbonate as CO3	9	5		mg/L	04/15/2015 1924 BT	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/15/2015 1924 BT	SM 2320B
Chloride	23	1		mg/L	04/15/2015 2033 AB	EPA 300.0
Fluoride	1.0	0.1		mg/L	04/15/2015 1924 BT	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/20/2015 1015 AMB	EPA 353.2
Sulfate	2230	1		mg/L	04/15/2015 2033 AB	EPA 300.0
Cations						
Calcium	234	1		mg/L	04/15/2015 2011 DG	EPA 200.7
Magnesium	329	1		mg/L	04/15/2015 2011 DG	EPA 200.7
Potassium	30	1		mg/L	04/15/2015 2011 DG	EPA 200.7
Sodium	353	1		mg/L	04/15/2015 2011 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNG 2/C25
RECD MAY 23, 2019

DEQ Ex. 3-337

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/21/2015
Report ID: S1504190001

Work Order: S1504190
Collection Date: 4/14/2015 2:30:00 PM
Date Received: 4/15/2015 8:39:00 AM
Sampler: RF
Matrix: Water
COC: 137350

Project: Ramaco
Lab ID: S1504190-003
Client Sample ID: SM578418-SW-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	10.86	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Carbonate as CO3	0.29	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Chloride	0.64	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Sulfate	46.46	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Calcium	11.68	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Magnesium	27.07	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Potassium	0.75	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Sodium	15.33	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	54.87	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Anion Sum	58.32	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Cation-Anion Balance	3.05	0.01		%	04/21/2015 1005 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/15/2015 2011 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/15/2015 1711 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/15/2015 1711 MS	EPA 200.8
Boron	0.3	0.1		mg/L	04/15/2015 2011 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/15/2015 1711 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/15/2015 2011 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/15/2015 1711 MS	EPA 200.8
Iron	ND	0.05		mg/L	04/15/2015 2011 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/15/2015 1711 MS	EPA 200.8
Manganese	0.31	0.02		mg/L	04/15/2015 2011 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/16/2015 0943 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/15/2015 1711 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/15/2015 2011 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/15/2015 1711 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/15/2015 2011 DG	EPA 200.7
Total Metals						
Iron	0.49	0.05		mg/L	04/16/2015 1715 DG	EPA 200.7
Manganese	0.33	0.02		mg/L	04/16/2015 1715 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by a contract laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/625
RECD MAY 23, 2019

DEQ Ex. 3-338

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RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client 2014163-07 Ramaco ~~2013139-07~~

Site Name. SM578512-SW-1 (SM578512-SW-1)

Date 4/14/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO Signature Flowmeter

Device Flow or Stage Reading NA CFS/FT

Device Battery Charge 12.60 Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No)

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

* Set up flowmeter for season

Instantaneous Flow

Measured Flow Yes or (No) Estimated - not enough water to measure

Measurement Device NA

Flow Rate 0.20 CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1230	8.04	5070	12.9	11.30	—	—	—

Lab Information

Lab COC # 137350

Date Samples to Lab 4/14/15

HCF

DEQ Ex. 3-339

TFN 5 2/625

RECD MAY 23, 2019

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/21/2015
Report ID: S1504190001

Work Order: S1504190
Collection Date: 4/14/2015 12:30:00 PM
Date Received: 4/15/2015 8:39:00 AM
Sampler: RF
Matrix: Water
COC: 137350

Project: Ramaco
Lab ID: S1504190-001
Client Sample ID: SM578512-SW-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.04			s.u.	04/14/2015 1230	Field
Conductivity	5070			µmhos/cm	04/14/2015 1230	Field
Turbidity	11.30			NTU	04/14/2015 1230	Field
Temperature	12.9			°C	04/14/2015 1230	Field
General Parameters						
pH	8.3	0.1		s.u.	04/15/2015 1859 BT	SM 4500 H B
Electrical Conductivity	5060	5		µmhos/cm	04/15/2015 1859 BT	SM 2510B
Total Dissolved Solids (180)	5200	10		mg/L	04/15/2015 1406 IR	SM 2540
Solids, Total Dissolved (Calc)	4350	10		mg/L	04/21/2015 1005 JJ	SM 1030E
Total Suspended Solids	10	5		mg/L	04/15/2015 1616 IR	SM 2540
Alkalinity, Total (As CaCO3)	658	5		mg/L	04/15/2015 1859 BT	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2320	1		mg/L	04/21/2015 1005 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.3	0.1		mg/L	04/16/2015 1455 AMB	EPA 350.1
Turbidity	8.3	0.1		NTU	04/15/2015 1405 JJ	SM 2130
Sodium Adsorption Ratio	4.1	0.1			04/21/2015 1005 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	793	5		mg/L	04/15/2015 1859 BT	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	04/15/2015 1859 BT	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/15/2015 1859 BT	SM 2320B
Chloride	29	1		mg/L	04/15/2015 2005 AB	EPA 300.0
Fluoride	1.0	0.1		mg/L	04/15/2015 1859 BT	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/20/2015 1003 AMB	EPA 353.2
Sulfate	2790	1		mg/L	04/15/2015 2005 AB	EPA 300.0
Cations						
Calcium	238	1		mg/L	04/15/2015 2006 DG	EPA 200.7
Magnesium	421	1		mg/L	04/15/2015 2006 DG	EPA 200.7
Potassium	22	1		mg/L	04/15/2015 2006 DG	EPA 200.7
Sodium	455	1		mg/L	04/15/2015 2006 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by a contract laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

April 2019

TFNS 2/025

Addendum D6-6-76

DEQ Ex. 3-340
DEQ MAY 23, 2019

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/21/2015
Report ID: S1504190001

Work Order: S1504190
Collection Date: 4/14/2015 12:30:00 PM
Date Received: 4/15/2015 8:39:00 AM
Sampler: RF
Matrix: Water
COC: 137350

Project: Ramaco
Lab ID: S1504190-001
Client Sample ID: SM578512-SW-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.99	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Chloride	0.82	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Sulfate	58.10	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Calcium	11.88	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Magnesium	34.61	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Potassium	0.55	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Sodium	19.77	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	66.84	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Anion Sum	72.14	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Cation-Anion Balance	3.81	0.01		%	04/21/2015 1005 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/15/2015 2006 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/15/2015 1649 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/15/2015 1649 MS	EPA 200.8
Boron	0.5	0.1		mg/L	04/15/2015 2006 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/15/2015 1649 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/15/2015 2006 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/15/2015 1649 MS	EPA 200.8
Iron	0.06	0.05		mg/L	04/15/2015 2006 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/15/2015 1649 MS	EPA 200.8
Manganese	0.94	0.02		mg/L	04/15/2015 2006 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/16/2015 0939 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/15/2015 1649 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/15/2015 2006 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/15/2015 1649 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/15/2015 2006 DG	EPA 200.7
Total Metals						
Iron	0.89	0.05		mg/L	04/16/2015 1711 DG	EPA 200.7
Manganese	1.20	0.02		mg/L	04/16/2015 1711 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/025
RECD MAY 23, 2019

DEQ Ex. 3-341

Scanned, 02/28/2020

RAMACO

* Field Duplicate

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco 2014163-07 ~~2013139-07~~

Site Name. SM578512-SW-1 Sample ID: FD-~~SM~~578512-SW-1

Date 4/14/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO Signature Flow meter

Device Flow or Stage Reading NA CFS/FT * Set up flowmeter for season

Device Battery Charge 12.60 Volts

Device Data Download Yes or (No)

Sample Collected by Device Yes or (No) NA

Staff gage reading if installed ——— Ft

Crest gage readings if installed ——— Ft

Instantaneous Flow

Measured Flow Yes or (No) - Estimate - not enough flow to measure

Measurement Device NA

Flow Rate 0.20 CFS

Include Stream Gaging Data

Grab Sample Collected Yes or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1240	8.04	5070	12.9	11.30	—	—	—

* Field Duplicate

Lab Information

Lab COC # 137350

Date Samples to Lab 4/14/15

TFNS 2/025
RECD MAY 23, 2019

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/21/2015
Report ID: S1504190001

Work Order: S1504190
Collection Date: 4/14/2015 12:40:00 PM
Date Received: 4/15/2015 8:39:00 AM
Sampler: RF
Matrix: Water
COC: 137350

Project: Ramaco
Lab ID: S1504190-002
Client Sample ID: FD-SM578512-SW-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.04			s.u.	04/14/2015 1240	Field
Conductivity	5070			µmhos/cm	04/14/2015 1240	Field
Turbidity	11.30			NTU	04/14/2015 1240	Field
Temperature	12.9			°C	04/14/2015 1240	Field
General Parameters						
pH	8.3	0.1		s.u.	04/15/2015 1912 BT	SM 4500 H B
Electrical Conductivity	5090	5		µmhos/cm	04/15/2015 1912 BT	SM 2510B
Total Dissolved Solids (180)	5060	10		mg/L	04/15/2015 1407 IR	SM 2540
Solids, Total Dissolved (Calc)	4340	10		mg/L	04/21/2015 1005 JJ	SM 1030E
Total Suspended Solids	10	5		mg/L	04/15/2015 1617 IR	SM 2540
Alkalinity, Total (As CaCO3)	641	5		mg/L	04/15/2015 1912 BT	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2360	1		mg/L	04/21/2015 1005 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.3	0.1		mg/L	04/16/2015 1457 AMB	EPA 350.1
Turbidity	8.2	0.1		NTU	04/15/2015 1405 JJ	SM 2130
Sodium Adsorption Ratio	4.0	0.1			04/21/2015 1005 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	774	5		mg/L	04/15/2015 1912 BT	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	04/15/2015 1912 BT	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/15/2015 1912 BT	SM 2320B
Chloride	28	1		mg/L	04/15/2015 2019 AB	EPA 300.0
Fluoride	0.9	0.1		mg/L	04/15/2015 1912 BT	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/20/2015 1014 AMB	EPA 353.2
Sulfate	2790	1		mg/L	04/15/2015 2019 AB	EPA 300.0
Cations						
Calcium	241	1		mg/L	04/15/2015 2008 DG	EPA 200.7
Magnesium	427	1		mg/L	04/15/2015 2008 DG	EPA 200.7
Potassium	20	1		mg/L	04/15/2015 2008 DG	EPA 200.7
Sodium	453	1		mg/L	04/15/2015 2008 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by a contract laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/025
RECD MAY 23, 2016

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Project: Ramaco
Lab ID: S1504190-002
Client Sample ID: FD-SM578512-SW-1

Date Reported: 4/21/2015
Report ID: S1504190001

Work Order: S1504190
Collection Date: 4/14/2015 12:40:00 PM
Date Received: 4/15/2015 8:39:00 AM
Sampler: RF
Matrix: Water
COC: 137350

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.68	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Chloride	0.78	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Sulfate	58.10	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Calcium	12.02	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Magnesium	35.14	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Potassium	0.52	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Sodium	19.68	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	67.39	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Anion Sum	71.74	0.01		meq/L	04/21/2015 1005 JJ	SM 1030E
Cation-Anion Balance	3.12	0.01		%	04/21/2015 1005 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/15/2015 2008 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/15/2015 1706 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/15/2015 1706 MS	EPA 200.8
Boron	0.4	0.1		mg/L	04/15/2015 2008 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/15/2015 1706 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/15/2015 2008 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/15/2015 1706 MS	EPA 200.8
Iron	ND	0.05		mg/L	04/15/2015 2008 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/15/2015 1706 MS	EPA 200.8
Manganese	0.96	0.02		mg/L	04/15/2015 2008 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/16/2015 0941 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/15/2015 1706 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/15/2015 2008 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/15/2015 1706 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/15/2015 2008 DG	EPA 200.7
Total Metals						
Iron	0.94	0.05		mg/L	04/16/2015 1713 DG	EPA 200.7
Manganese	1.31	0.02		mg/L	04/16/2015 1713 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/025
RECD MAY 23, 2016

Scanned, 02/28/2020

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name SM578409-SW-1

Date 6/26/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO - Signature Flow meter

Device Flow or Stage Reading DRY CFS/FT

Device Battery Charge 12.65 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

ıstantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
		DRY					

Lab Information

Lab COC #

Date Samples to Lab

DEQ Ex. 3-345

TFNS 2/C25
RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name. SM578418-SW-1

Date 6/26/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO 6712

Device Flow or Stage Reading 0.06/0.07 CFS/FT

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device (Yes) or No; Collected 3 samples - Collected water from bottle #1 for analysis

Staff gage reading if installed — Ft

Crest gage readings if installed — Ft

nstantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
Bot01 1300	8.23	3310	24.2	over limit			

Lab Information

Lab COC # 161900

Date Samples to Lab 6/26/15

DEQ Ex. 3-346 TFNS 2/025 RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name. SM5785 12 - SW-1

Date 6/26/15 @ 1130

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO Signature Flowmeter

Device Flow or Stage Reading 2.63 / 0.35 CFS/FT

Device Battery Charge 12.76 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

ıstantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected (Yes) or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP
1200	Sampled in April				—	—	—

Lab Information

Lab COC # NA

Date Samples to Lab NA

O:\Administration\SHERIDAN\ADM\FORMS\Surface_Water_Field_Sheet.doc

DEQ Ex. 3-347

TFNS 2/025
RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name. SM578409-SW-1

Date 9/17/15 @1400

Technician/Engineer Rod Fuller

Devices

Flow/Automatic sampler Device ISCO - Signature Flow Meter

Device Flow or Stage Reading 0.0/0.0 CFS/FT Dry

Device Battery Charge 12.94 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # NA

Date Samples to Lab NA

TFNS 2/C25
RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name. SM578415 - SW-1

Date 9/17/15

Technician/Engineer Rod Fuller

Devices

Flow/Automatic sampler Device _____

Device Flow or Stage Reading _____ CFS/FT

Device Battery Charge _____ Volts

Device Data Download Yes or No

Sample Collected by Device Yes or No;

Staff gage reading if installed _____ Ft

Crest gage readings if installed _____ Ft

* Could not visit site due to no landowner permission.

Instantaneous Flow

Measured Flow Yes or No

Measurement Device _____

Flow Rate _____ CFS

Include Stream Gaging Data

Grab Sample Collected Yes or No

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

Date Samples to Lab _____

TFNS 2/825

RECD MAY 23, 2019

DEQ Ex. 3-349

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco - 2014163-07

Site Name. SM578418-SW-1

Date 9/17/15

Technician/Engineer Rod Fuller

Devices

Flow/Automatic sampler Device ISCO 6712

Device Flow or Stage Reading 0.0/0.0 CFS/FT Very slight flow - almost dry

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

nstantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No) - Not enough to sample

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # NA

Date Samples to Lab NA

DEQ Ex. 3-350

TFNS 2/025
RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco 2014163-07

Site Name. SM578512 - SW-1

Date 9/17/15 @1240

Technician/Engineer Rod Fuller

Devices

Flow/Automatic sampler Device ISCO signature Flow meter

Device Flow or Stage Reading 0.0/0.0 CFS/FT All But Dry

Device Battery Charge 13.04 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No) Not enough to sample

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # —

Date Samples to Lab —

TENS 2/025
RECD MAY 23, 2018

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RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578409-SW-1

Date 10/26/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO Signature Flowmeter

Device Flow or Stage Reading 0.00/0.00 CFS/FT Dry

Device Battery Charge 12.40 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

Decommissioned site for winter.

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

Date Samples to Lab _____

TFNS 2/525

DEQ Ex. 3-352 RECD MAY 23, 2019

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RAMACO

WWC ENGINEERING

Brook Mine ✓

Surface Water Field Sheet

Project/Client Ramaco 2014163-07

Site Name SM578418-SW-1

Date 10/26/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO 6712

Device Flow or Stage Reading 0.00/0.00 CFS/FT Dry

Device Battery Charge Good Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

* Decommissioned site for Winter

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC #

Date Samples to Lab

TFNS 2/025
RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

Surface Water Field Sheet

Project/Client Ramaco

Site Name. SM578512-SW-1

Date 10/26/15

Technician/Engineer Fuller

Devices

Flow/Automatic sampler Device ISCO Signature Flowmeter

Device Flow or Stage Reading 0.00/0.00 CFS/FT

Device Battery Charge 13.42 Volts

Device Data Download (Yes) or No

Sample Collected by Device Yes or (No)

Staff gage reading if installed NA Ft

Crest gage readings if installed NA Ft

* Decommissioned site for winter.

Instantaneous Flow

Measured Flow Yes or (No)

Measurement Device NA

Flow Rate NA CFS

Include Stream Gaging Data

Grab Sample Collected Yes or (No)

Water Quality Field Parameters for Storm or Instantaneous Sample

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	DO mg/l	DO %	ORP

Lab Information

Lab COC # _____

Date Samples to Lab _____

TFNS 2/025
RECD MAY 23, 2019

Scanned, 02/28/2020

RAMCO
INTER-MOUNTAIN LABS
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/11/2015
Report ID: S1506643001

Work Order: S1506643
Collection Date: 6/26/2015 1:00:00 PM
Date Received: 6/26/2015 3:22:00 PM
Sampler: RF
Matrix: Water
COC: 161900

Project: Ramaco-2014163-07
Lab ID: S1506643-001
Client Sample ID: 578418-SW-1 BOTO1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.23			s.u.	06/26/2015 1300	Field
Conductivity	3310			µmhos/cm	06/26/2015 1300	Field
Turbidity	over limit			NTU	06/26/2015 1300	Field
Temperature	24.2			°C	06/26/2015 1300	Field
General Parameters						
pH	8.5	0.1		s.u.	06/30/2015 0407 MRL	SM 4500 H B
Electrical Conductivity	2860	5		µmhos/cm	06/30/2015 0407 MRL	SM 2510B
Total Dissolved Solids (180)	3160	10		mg/L	06/29/2015 1516 TS	SM 2540
Solids, Total Dissolved (Calc)	2800	10		mg/L	07/10/2015 1014 JJ	SM 1030E
Total Suspended Solids	4800	5		mg/L	06/29/2015 1555 TS	SM 2540
Alkalinity, Total (As CaCO3)	412	5		mg/L	06/30/2015 0407 MRL	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1490	1		mg/L	07/10/2015 1014 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.3	0.1		mg/L	07/09/2015 1618 AMB	EPA 350.1
Turbidity	3070	0.1		NTU	06/26/2015 1647 NLG	SM 2130
Sodium Adsorption Ratio	3.4	0.1			07/10/2015 1014 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	459	5		mg/L	06/30/2015 0407 MRL	SM 2320B
Alkalinity, Carbonate as CO3	22	5		mg/L	06/30/2015 0407 MRL	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/30/2015 0407 MRL	SM 2320B
Chloride	13	1		mg/L	07/08/2015 2040 LAB	EPA 300.0
Fluoride	0.8	0.1		mg/L	06/30/2015 0407 MRL	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.2	0.1		mg/L	07/07/2015 1344 AMB	EPA 353.2
Sulfate	1790	1		mg/L	07/08/2015 2040 LAB	EPA 300.0
Cations						
Calcium	147	1		mg/L	06/29/2015 2157 DG	EPA 200.7
Magnesium	272	1		mg/L	06/29/2015 2157 DG	EPA 200.7
Potassium	26	1		mg/L	06/29/2015 2157 DG	EPA 200.7
Sodium	298	1		mg/L	06/29/2015 2157 DG	EPA 200.7

TFN 6 2/025
RECD 09-20-19

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

September 2019

Addendum D6-6-91

DEQ Ex. 3-355

Scanned, 02/28/2020

RAMCO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/11/2015
Report ID: S1506643001

Work Order: S1506643
Collection Date: 6/26/2015 1:00:00 PM
Date Received: 6/26/2015 3:22:00 PM
Sampler: RF
Matrix: Water
COC: 161900

Project: Ramaco-2014163-07
Lab ID: S1506643-001
Client Sample ID: 578418-SW-1 BOTO1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	7.52	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Carbonate as CO3	0.72	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Chloride	0.36	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Nitrate + Nitrite as N	0.01	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Sulfate	37.33	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Calcium	7.35	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Magnesium	22.37	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Potassium	0.67	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Sodium	12.94	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	43.36	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Anion Sum	46.00	0.01		meq/L	07/10/2015 1014 JJ	SM 1030E
Cation-Anion Balance	2.95	0.01		%	07/10/2015 1014 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	06/29/2015 2157 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/01/2015 0512 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/01/2015 0512 MS	EPA 200.8
Boron	0.3	0.1		mg/L	06/29/2015 2157 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/01/2015 0512 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/29/2015 2157 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/01/2015 0512 MS	EPA 200.8
Iron	ND	0.05		mg/L	06/29/2015 2157 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/01/2015 0512 MS	EPA 200.8
Manganese	ND	0.02		mg/L	06/29/2015 2157 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/30/2015 1211 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/01/2015 0512 MS	EPA 200.8
Nickel	ND	0.01		mg/L	06/29/2015 2157 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/01/2015 0512 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/29/2015 2157 DG	EPA 200.7
Total Metals						
Iron	49.4	0.05		mg/L	07/01/2015 2050 DG	EPA 200.7
Manganese	3.32	0.02		mg/L	07/01/2015 2050 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD 09-20-19

September 2019

Addendum D6-6-92

DEQ Ex. 3-356

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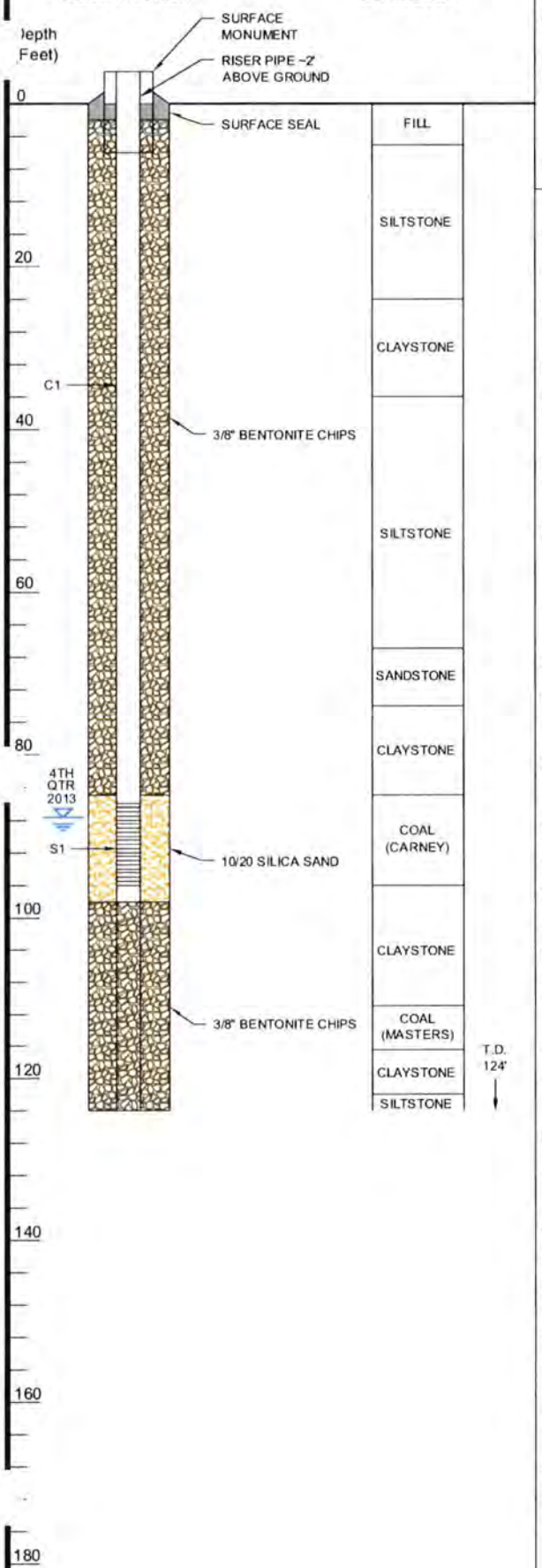
ADDENDUM D6-7

Monitor Well Completion Data

TFN 6 2/025
RECD JUL 30, 2015

Scanned, 02/28/2020



Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578408-CRN

Location: N 1,394,415.5 E 1,941,809.9 EL 3,887.7

NE /4, SE /4, Section 8 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 98'

Hole Dia.: 5-1/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 5-1/8" core barrel

Fluid: Water and foam

Casing: 2" SCH 40 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - 86 - +2 | S1 - 96 - 86

Monument or Surface Casing:
6" Locking Steel

Centralizer:
5 at 20' intervals

Casing C1:
2" SCH 40 flush thread PVC

Screen S1:
2" SCH 40 flush thread PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 98 - 85

Bentonite:
3/8" chips
Depth: 124 - 98
85 - 2.0

Cement:
Type 1
Depth: 2.0 - 0

Other:
44 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
8/30/13	1:00pm	3:00pm
9/3/13	7:00am	10:30am

Casing:	Start	End
9/3/13	11:15am	2:50pm

Well Development

Began development on 9/3/13 at 2:15pm.

Well produced very turbid mist.

Inject water, little spray then mist from well.

Cleaned up slightly.

Cease development at 2:40pm.

Remarks

Cored to bottom of Masters - 124'.

Chipped to bottom of Carney to install well - 98' (4 bags bentonite).

Wellbore wash-out occurred, evident by volume of annular sealant required.

TFN 6 2/025

RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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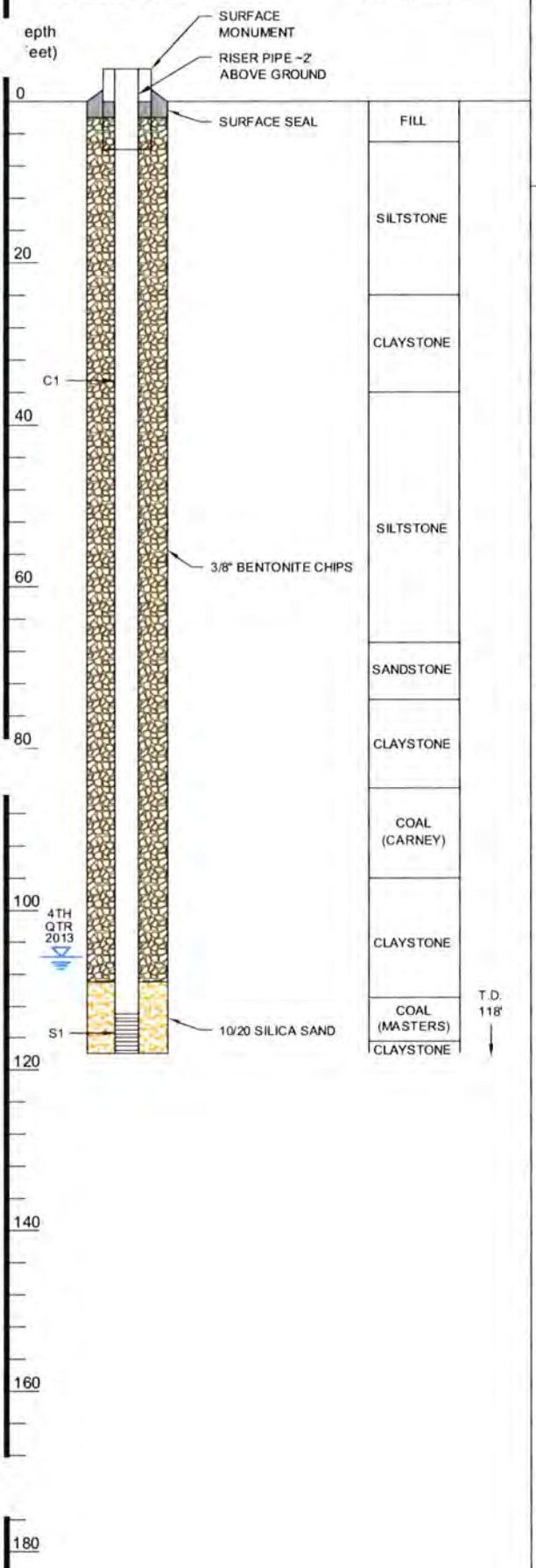

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578408-MST

Location: N 1,394,423.1 E 1,941,802.4 EL 3,887.9

NE /4, SE /4, Section 8 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 118'

Hole Dia.: 5-5/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 5-5/8" Spade

Fluid: Water and foam

Casing: 2" SCH 40 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - 113 - +2 | S1 - 113 - 118

Monument or Surface Casing:
6" Locking Steel

Centralizer:
5 at 25' intervals

Casing C1:
2" SCH 40 flush thread PVC

Screen S1:
2" SCH 40 flush thread PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 109 - 118

Bentonite:
3/8" chips
Depth: 109 - 2.0

Cement:
Type 1
Depth: 2.0 - 0

Other:
23 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
8/30/13	7:00am	8:00am

Casing:	Start	End
8/30/13	9:00am	11:30am

Well Development

Began development on 8/30/13 at 11:30am.

Residual drilling foam evident in produced water.

Flush well with water to remove foam.

Blow dry - little spray, then mist.

Cleaned up slightly.

Ceased development at 12:00pm.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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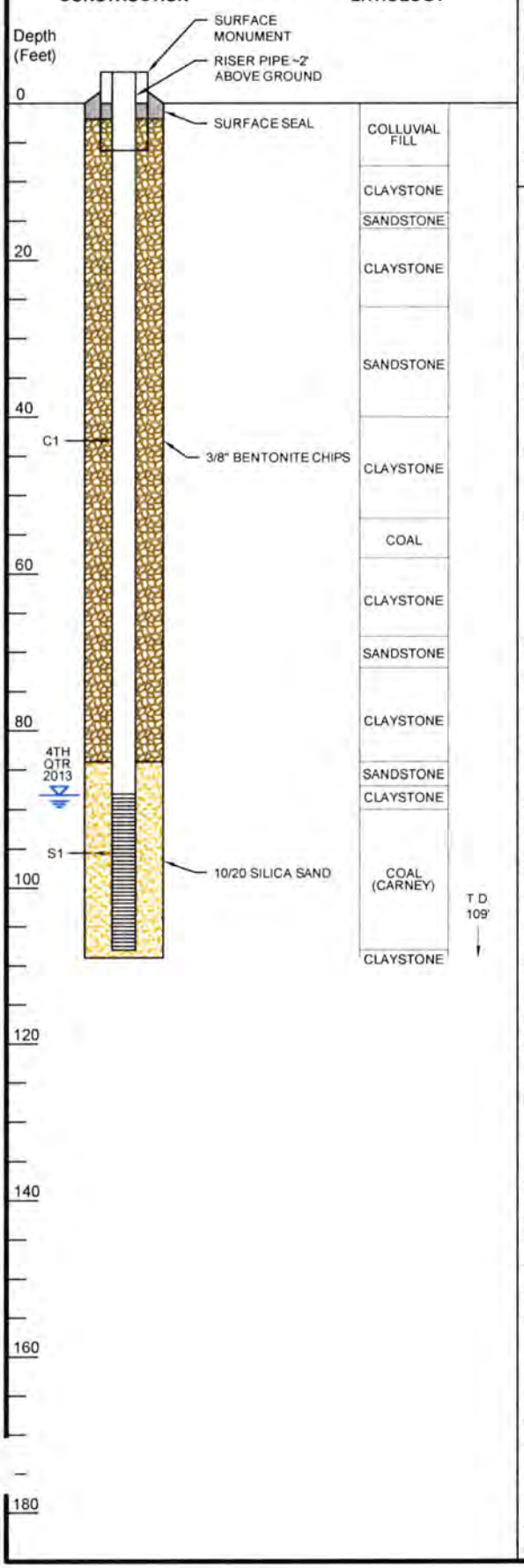

Well Construction Summary

Client: Ramaco
Project: Brook Mine Monitor Network Well: 578409-CRN
Location: N 1,940,097.5 E 1,399,549.2 EL 3,710.1
SE /4, SE /4, Section 9 T. 57 N. R. 84 W.
Geologist: Swayne Redinger

Drilling Summary

Total Depth: 109'
Hole Dia.: 9-7/8"
Driller: Shawn Ankney
Rig: Gardner Denver 1500
Bit(s): 14-3/4" roller (surface)
9-7/8" PDC
Fluid: Water, air, foam
Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 88 - +2 | S1 - 88 - 108

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 on screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 84 - 109

Bentonite:
3/8" chips
Depth: 84 - 1

Cement:
Type 1
Depth: 1 - +0.5

Other:
20 bags sand in annulus
42 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
10/1/13	3:00pm	3:30pm
10/2/13	6:00am	7:55am

Casing:	Start	End
10/2/13	7:55am	8:45am

Well Development

Began development on 10/2/13 at 8:45am.

Blow out drilling fluid and begin injecting water.

Blow out

Well making approximately 1gpm.

Sample at 9:00am:
Turb: 167NTU
Temp: 10.2°C
PH: 8.41
Conduct: 1157µS
(residual river water)

Let sit from 9:00am to 9:14am.

Sample at 9:20am:
Turb: 160NTU
Temp: 9.9°C
PH: 8.56
Conduct: 1303µS

Water from truck:
Temp: 9.6°C
PH: 8.83
Conduct: 388µS

Let sit from 9:22am to 9:33am.

Sample at 9:38am:
Turb: 96.4NTU
Temp: 9.4°C
PH: 8.64
Conduct: 1480µS

Cease development at 9:40am.

Produced approximately 20 gallons from well during development.

Remarks

Filter pack slightly higher tan intended sandstone above Carney may be in communication with the filter pack. Low air development rates suggest that communication is not an issue.

TFN 6 2/025
RECD OCT 23, 2015

Abandoned

Date:
Method:

WWC ENGINEERING

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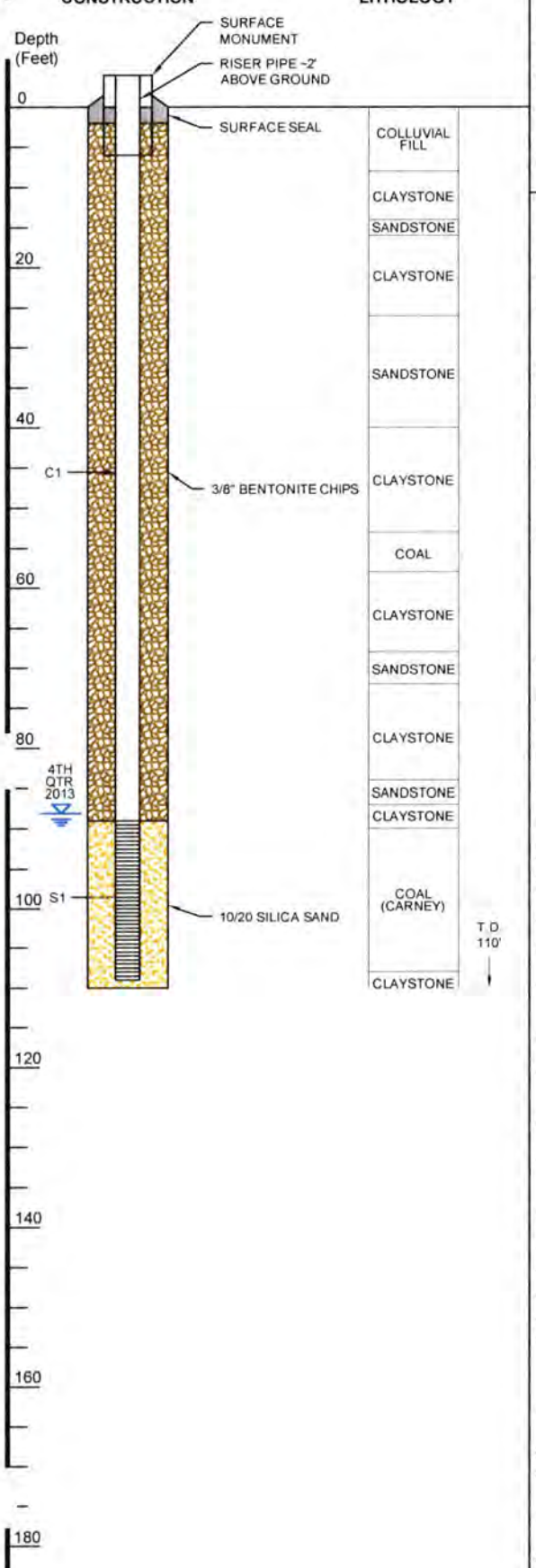

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578409-CRN-OB

Location: N 1,940,108.4 E 1,399,537.8 EL 3,710.3

SE /4, SE /4, Section 9 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 110'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 14-3/4" roller (surface)
9-7/8" PDC

Fluid: Water, air, foam, polymer

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 89 - +2 | S1 - 89 - 109

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 on screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 89 - 110

Bentonite:
3/8" chips
Depth: 89 - 1

Cement:
Type 1
Depth: 1 - +0.5

Other:
18 bags sand in annulus
49 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
10/2/13	10:00am	11:30am

Casing:	Start	End
10/2/13	11:30am	12:25pm

Well Development

Began development on 10/2/13 at 12:25pm.

Blow out drilling fluid and begin injecting water.

Blow out water.

Well making approximately 3gpm (estimate)

Sample at 12:45pm:
Turb: 491NTU
Temp: 11.9°C
PH: 8.37
Conduct: 3.23mS

Cannot feel any pressure at adjacent CRN wellhead during development.

Sample at 12:55pm:
Turb: 895NTU
Temp: 11.6°C
PH: 8.49
Conduct: 2.75mS

Let well sit from 12:55pm to 1:04pm.
Well surged when development restarted.

Sample at 1:08pm:
Turb: 671NTU
Temp: 11.7°C
PH: 8.52
Conduct: 2.63mS

Let sit from 1:11pm to 1:20pm.

Sample at 1:25pm:
Turb: 788NTU
Temp: 11.7°C
PH: 8.56
Conduct: 2.55mS

Sample at 1:30pm:
Turb: 963NTU
Temp: 11.8°C
PH: 8.61
Conduct: 2.51mS

Cease development at 1:32 pm
Well produced approximately 90 gallons during development.

Remarks

Driller notes that he followed a fracture that threw him off course at approximately 40'.

TFN 6 2/025
RECD OCT 23, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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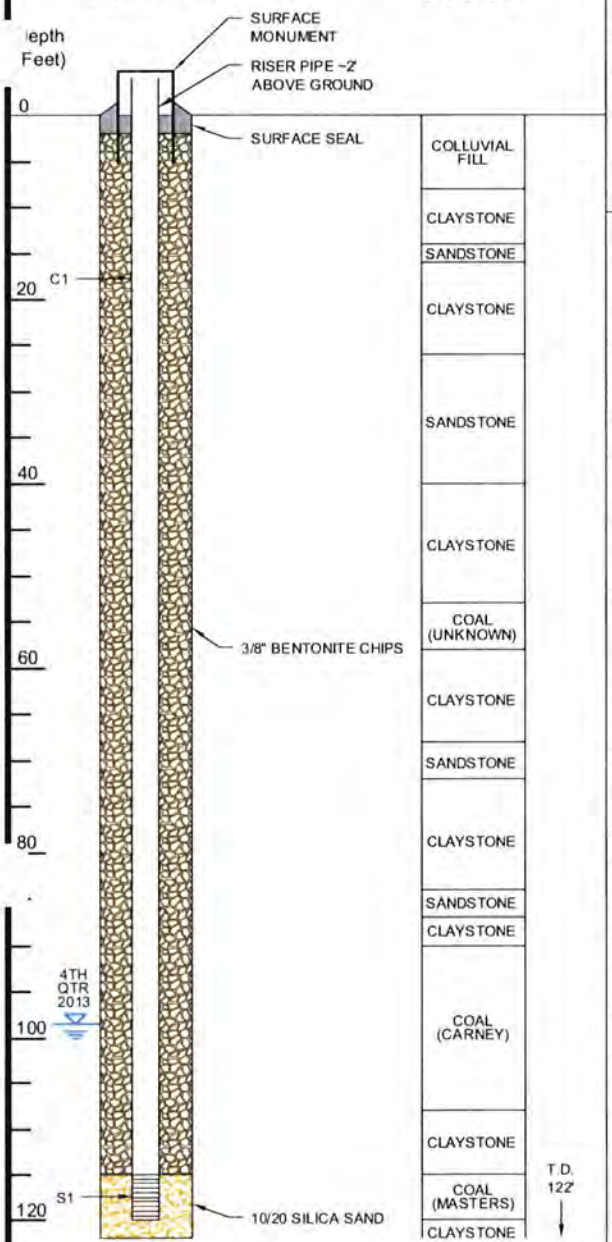

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578409-MST

Location: N 1,940,087.6 E 1,399,559.3 EL 3,709.8

SE /4, SE /4, Section 9 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 122'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 14-3/4" roller (surface)
9-7/8" PDC

Fluid: Water, foam, air

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 115 - +2 | S1 - 115 - 120

Monument or Surface Casing:
8" Locking Steel

Centralizer:
2

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 115 - 122

Bentonite:
3/8" chips
Depth: 115 - 1

Cement:
Type 1
Depth: 1 - +0.5

Other:
5 bags sand in annulus
57 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
10/1/13	11:20am	12:50am

Casing:	Start	End
10/1/13	12:50am	1:45pm

Well Development

Began development on 10/1/13 at 1:45pm.

Blow out drill fluid and inject water and blow out.

Well making approximately 1gpm or less (estimate).

Sample at 1:55pm:
Turb: 852NTU
Temp: 14.1°C
Conduct: 866µS
PH: 8.38

Sample at 2:05pm:
Turb: 910NTU
Temp: 13.5°C
Conduct: 1833µS
PH: 8.69

Sample at 2:25pm:
Turb: 851NTU
Temp: 14.0°C
Conduct: 1912µS
PH: 8.77

Sample at 2:35pm:
Turb: 573NTU
Temp: 14.0°C
Conduct: 1932µS
PH: 8.82

Cease development at 2:35pm.

Produced approximately 40 gallons from well.

Parameters began to stabilize, may require additional development when more time is available.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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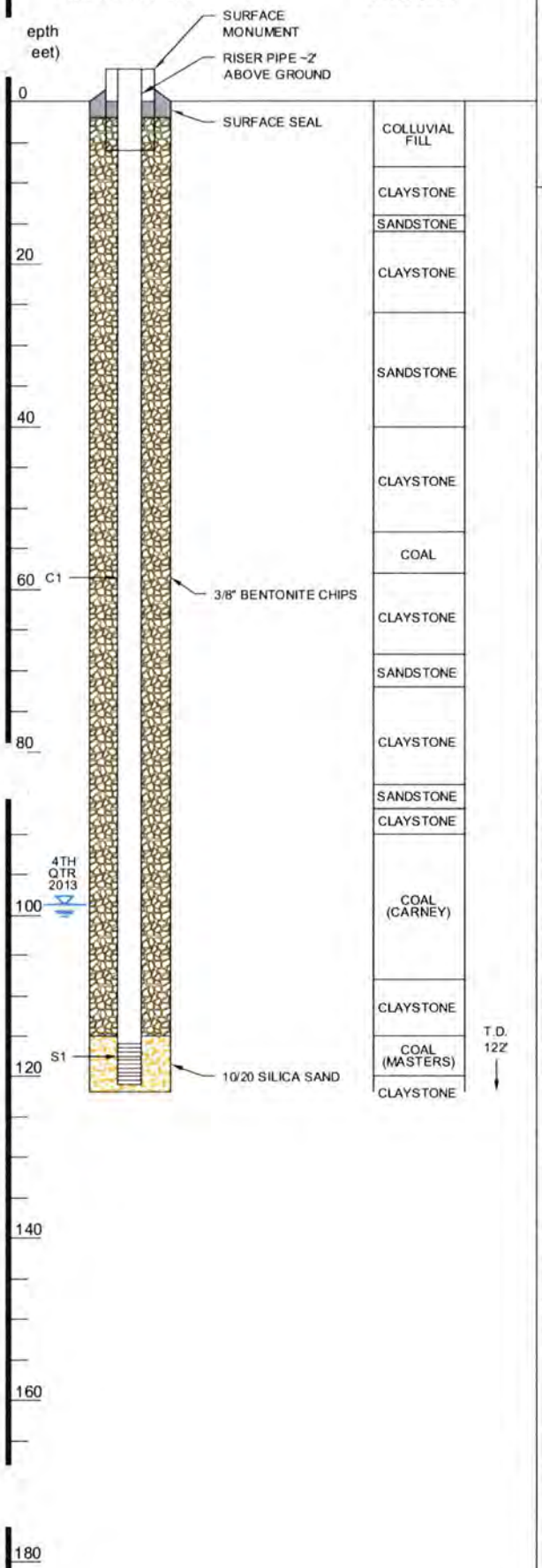

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578409-MST-OB

Location: N 1,940,084.5 E 1,399,546.6 EL 3,710.3

SE /4, SE /4, Section 9 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 122'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 14-3/4" roller (surface)
9-7/8" PDC

Fluid: Air, water, foam

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 116 - +2 | S1 - 116 - 121

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 on screen, 1 20' up

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 122 - 115

Bentonite:
3/8" chips
Depth: 115 - 1

Cement:
Type 1
Depth: 1 - +0.5

Other:
5 bags sand in annulus
70 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
10/2/13	1:55pm	3:30pm

Casing:	Start	End
10/2/13	3:30pm	4:30pm

Well Development

Began development on 10/2/13 at 4:30pm.

Blow out drilling fluid and inject water.

Blow dry.

Well making approximately 1-2gpm.

Cease development at 4:55pm due to time constraints (weather).

Produced approximately 10 gallons from well.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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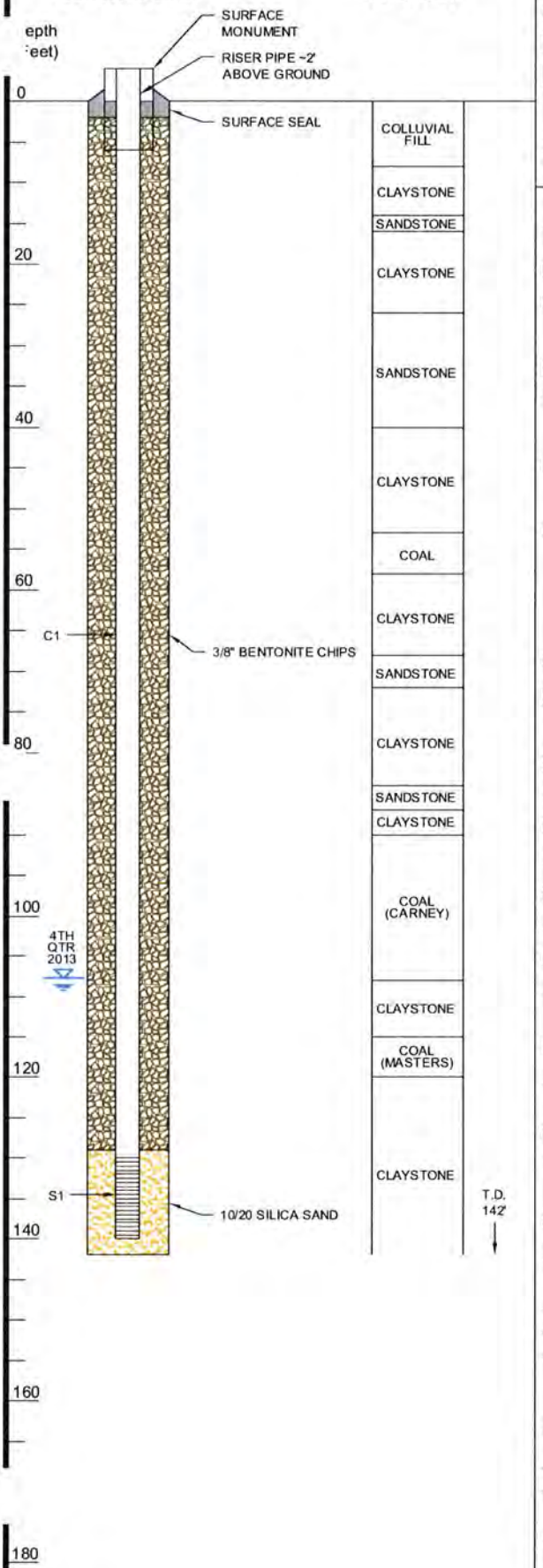

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578409-MST-UB

Location: N 1,940,076.6 E 1,399,568.3 EL 3,709.7

SE /4, SE /4, Section 9 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 142'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 14-3/4" roller (surface)
9-7/8" PDC

Fluid: Water, foam, polymer

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 130 - +2 | S1 - 130 - 140

Monument or Surface Casing:
8" Locking Steel

Centralizer:
3 at 20' intervals on bottom half of well

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 129 - 142

Bentonite:
3/8" chips
Depth: 129 - 1

Cement:
Type 1
Depth: 1 - +0.5

Other:
12 bags sand in annulus
60 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
10/1/13	6:30am	9:00am

Casing:	Start	End
10/1/13	9:00am	10:10am

Well Development

Began development on 10/1/13 at 10:15am.

Begin by blowing out excess drilling fluid and then adding water.

Blow until mist.

Well making approximately 1-2gpm (estimate)

Blow until 10:35am.

Still very turbid - adding more water.

Sample at 10:50am:
Turb: ~~17.72NTU~~ ERROR
Temp: 11.2°C
PH: 8.56
Conduct: 3.45mS

Cease development at 10:55am.

Produced approximately 60 gallons from well.

Additional development would be beneficial, however due to time constraints (weather) we ceased development at 10:55am.

Remarks

3 bags of chips from 119-129, may have small bridge in that interval.

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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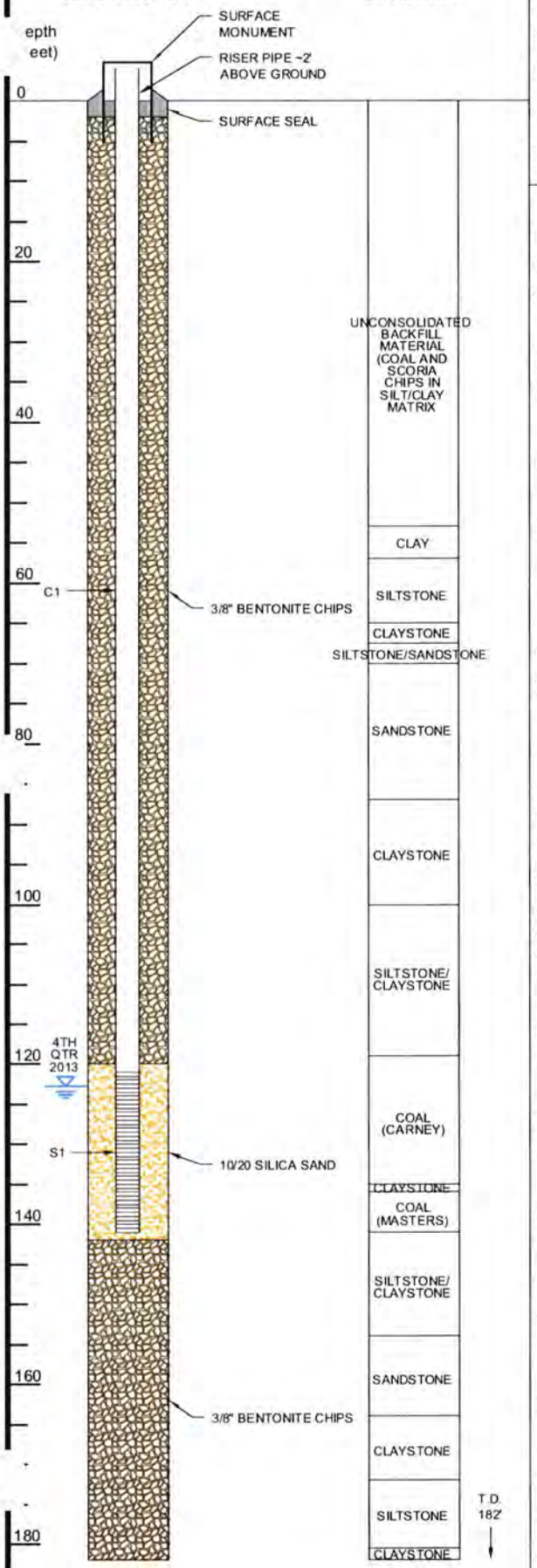

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578415-CRN/MST

Location: N 1,936,077.6 E 1,404,291.8 EL 3,611.4

NW /4, SE /4, Section 15 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 182'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 14-3/4" roller
9-7/8" roller and PDC

Fluid: Water, air, foam, gel

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 121 - +2 | S1 - 121 - 141

Monument or Surface Casing:
8" Locking Steel

Centralizer:
4 at 30' intervals

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 142 - 120

Bentonite:
3/8" chips
Depth: 120 - 1

Cement:
Type 1
Depth: 1 - +0.5

Other:
25 bags bentonite to plug back hole
21 bags sand in annulus
70 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
10/3/13	7:00am	
10/9/13		1:30pm

Casing:	Start	End
10/9/13	2:00pm	3:10pm

Well Development

Began development on 10/9/13 at 3:10pm.

Blow out drilling fluid and inject water from 3:24pm to 3:29pm.

Well making approximately 1-2gpm.

Sample at 3:42pm:
Turb: Error
Temp: 11.4°C
Conduct: 1398µS
PH: 8.17

Inject more water from 3:43pm to 3:54pm.

Sample at 4:00pm:
Turb: 319NTU
Temp: 10.7°C
Conduct: 1009µS
PH: 8.40

Sample at 4:15pm:
Turb: 144NTU
Temp: 11.4°C
Conduct: 1325µS
PH: 8.60

Cease development at 4:16pm.

Well produced approximately 50 gallons during development.

Remarks

Carney 119' - 135'.
Master 136' - 141'.
Completing together in one well.

Drilled to 182' but did not intersect any other coal bands.

Chipped back to 142' and complete well 121' HS - 141'.

Left 40' of 10" surface casing in hole as it separated from first joint.

TFN 6 2/025

RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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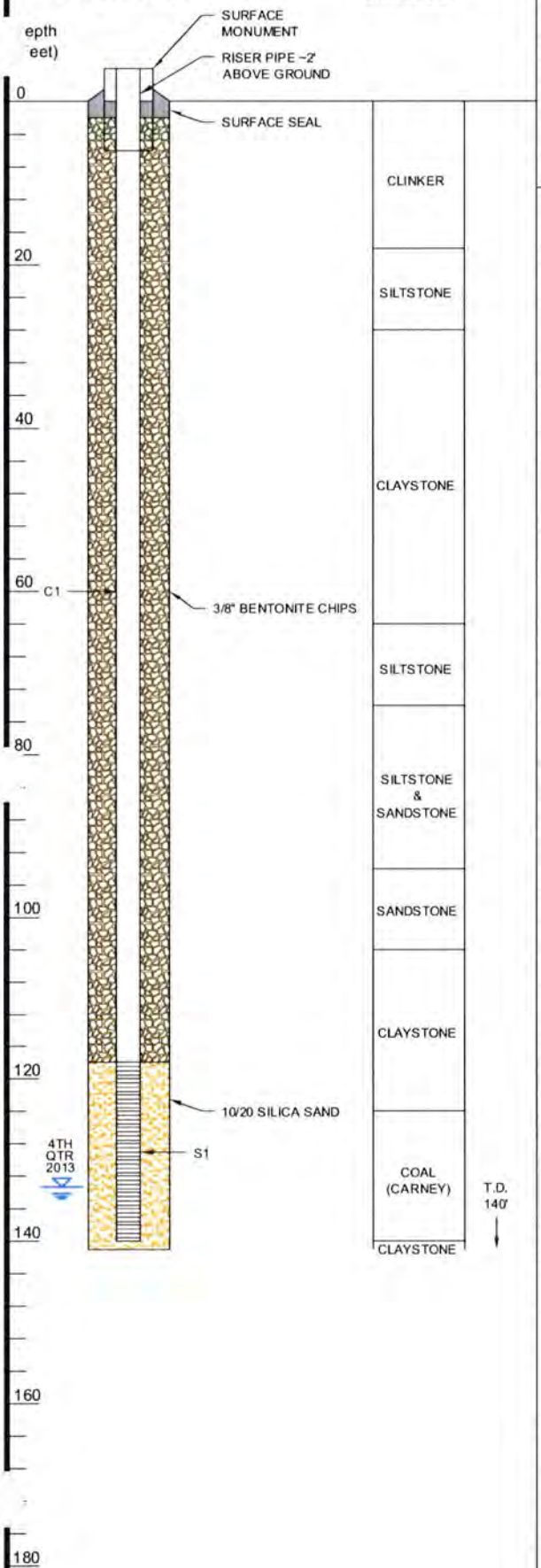

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578417-CRN

Location: N 1,391,364.2 E 1,939,152.3 EL 3,926.4

NW /4, NW /4, Section 17 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 141'

Hole Dia.: 5-5/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 5 5/8" spade

Fluid: Water and foam

Casing: 2" SCH 40 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - 120 - +2 | S1 - 118 - 140

Monument or Surface Casing:
6" Locking Steel

Centralizer:
5 at 25' intervals

Casing C1:
2" SCH 40 flush thread PVC

Screen S1:
2" SCH 40 flush thread PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 140 - 118

Bentonite:
3/8" chips
Depth: 118 - 2.0

Cement:
Type 1
Depth: 2.0 - 0

Other:
27 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
8/21/13	2:30pm	3:40pm

Casing:	Start	End
8/21/13	3:45pm	5:00pm

Well Development

Began development on 8/22 at 7:26am.

Well producing approximately 0.5 gpm.

Surged well in 15 minute increments.

Ceased air development at 8:27pm, well producing approximately 0.25 gpm.

Water very turbid.

Remarks

SWL = 131.67 on 8/26/13 at 8:00am.

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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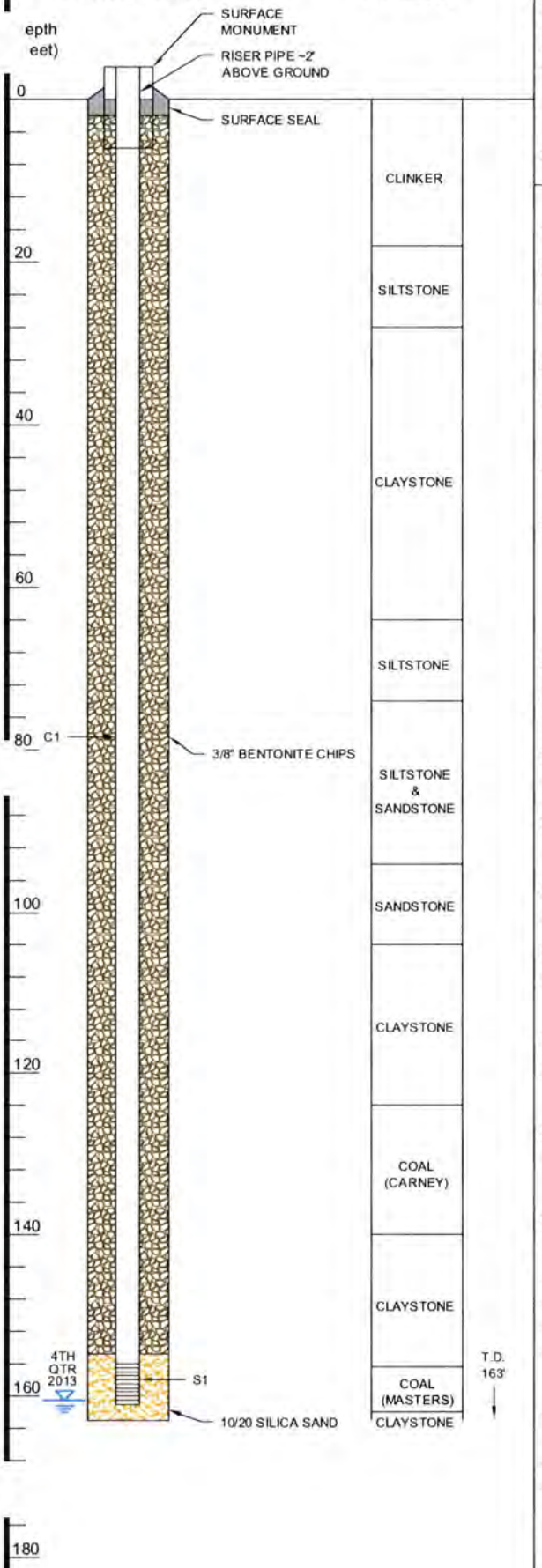

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578417-MST

Location: N 1,391,382.0 E 1,939,174.6 EL 3925.9

NW /4, NW /4, Section 17 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 163'

Hole Dia.: 5-1/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 5-1/8" core barrel

Fluid: Water, air

Casing: 2" SCH 40 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - 156 - +2 | S1 - 161 - 156

Monument or Surface Casing:
6" Locking Steel

Centralizer:
5 at 30' intervals

Casing C1:
2" SCH 40 flush thread PVC

Screen S1:
2" SCH 40 flush thread PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 163 - 155

Bentonite:
3/8" chips
Depth: 155 - 2.0

Cement:
Type 1
Depth: 2.0 - 0

Other:
22 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
8/21/13	6:30am	8:45am

Casing:	Start	End
8/21/13	9:00am	12:30pm

Well Development

Began development on 8/21/13 at 1:00pm.

Well producing approximately 0.25-0.5 gpm during airlift.

Added water and blew out.

Surged well in 15 minute increments.

Ceased development at 2:00pm.

Cleaned up slightly, still very turbid.

Remarks

Poured 4 bags very slow (10min/bag).

Bentonite at 90' after 4 bags, bridged. Cannot assume Masters sealed.

SWL comparisons between wells may demonstrate if communication exists between coals in this cluster.

SWL = 160.66 on 8/26/13 @ 8:00am.

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

K:\Sheridan\RAMACO\13139\ACAD_WY83EC\DWGS_D6_RESPONSE\MW_578417-MST_R1.dwg 5/20/2015 1:37:12 PM dave.johnson

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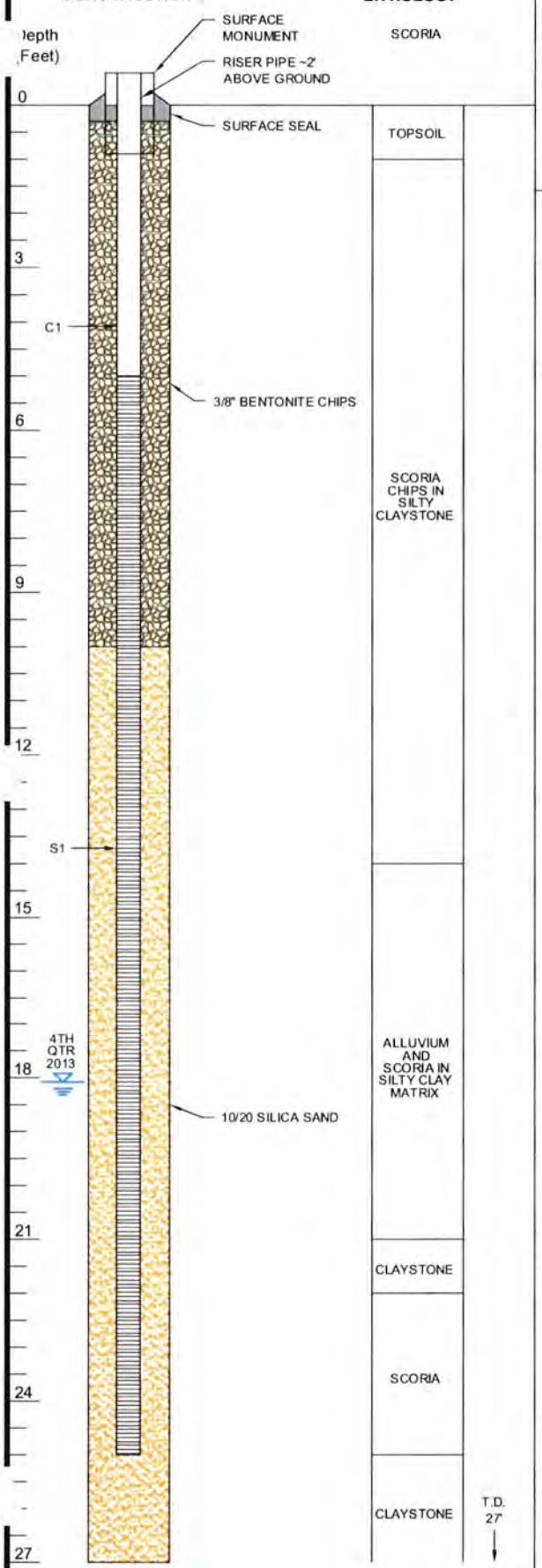

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578418-AL-1

Location: N 1,935,962.2 E 1,386,058.5 EL 3,687.5

NW /4, SW /4, Section 18 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 27'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" roller

Fluid: Gel

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 5 - +2 | S1 - 25 - 5

Monument or Surface Casing:
8" Locking Steel

Centralizer:
none

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 27 - 10

Bentonite:
3/8" chips
Depth: 10 - 2.0

Cement:
Type 1
Depth: 2.0 - 0.5

Other:
16 bags sand in annulus
3-1/2 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
9/30/13	10:30am	11:15am

Casing:	Start	End
9/30/13	11:15am	11:45am

Well Development

Begin development on 9/30/13 at 11:45am.
Blow out until 11:50.
Add water and blow out until mist.
Add more water and blow out until mist.
Well is making very little water.
Cease development at 12:30pm.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:
Method:

WWC ENGINEERING

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Well Construction Summary

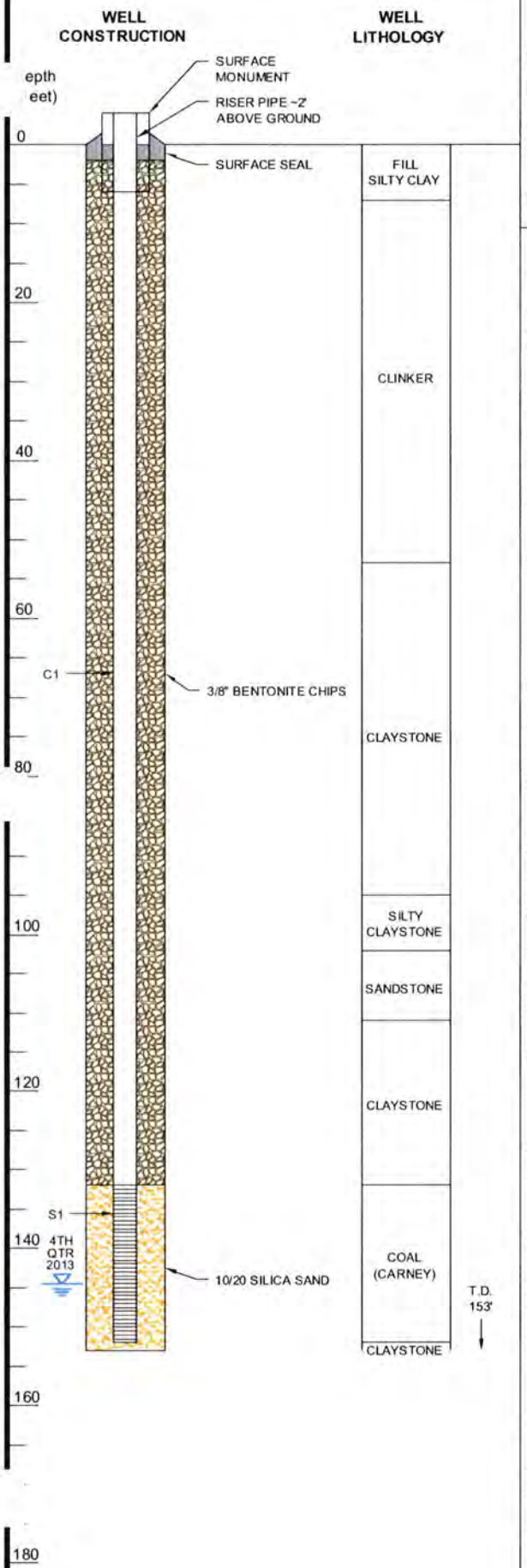
Client: Ramaco

Project: Brook Mine Monitor Network Well: 578418-CRN

Location: N 1,936,927.8 E 1,387,102.2 EL 3,882.4

NW /4, NW /4, Section 18 T. 57 N. R. 84 W.

Geologist: Swayne Redinger



Drilling Summary

Total Depth: 153'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 14-3/4" roller (surface)
9-7/8" PDC to ream

Fluid: Water, foam, bentonite gel, polymer

Casing: 5" SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 132 - +3 | S1 - 152 - 132

Monument or Surface Casing:
8" locking steel

Centralizer:
1 at top of screen

Casing C1:
5" SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 153 - 132

Bentonite:
3/8" chips
Depth: 132 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
71 bags bentonite in annulus
14 bags sand in filter pack

Construction Time Log

Drilling:	Start	End
9/17/13	4:00pm	5:00pm
9/19/13	6:30am	11:45am

Casing:	Start	End
9/19/13	11:45am	12:45pm

Well Development

Began development on 9/19/13 at 1:00pm.

Inject water and blow dry.

Well appears dry or close to dry.

Fine mist at end of development, not sufficient to collect field sample.

Cease development @ 1:25pm.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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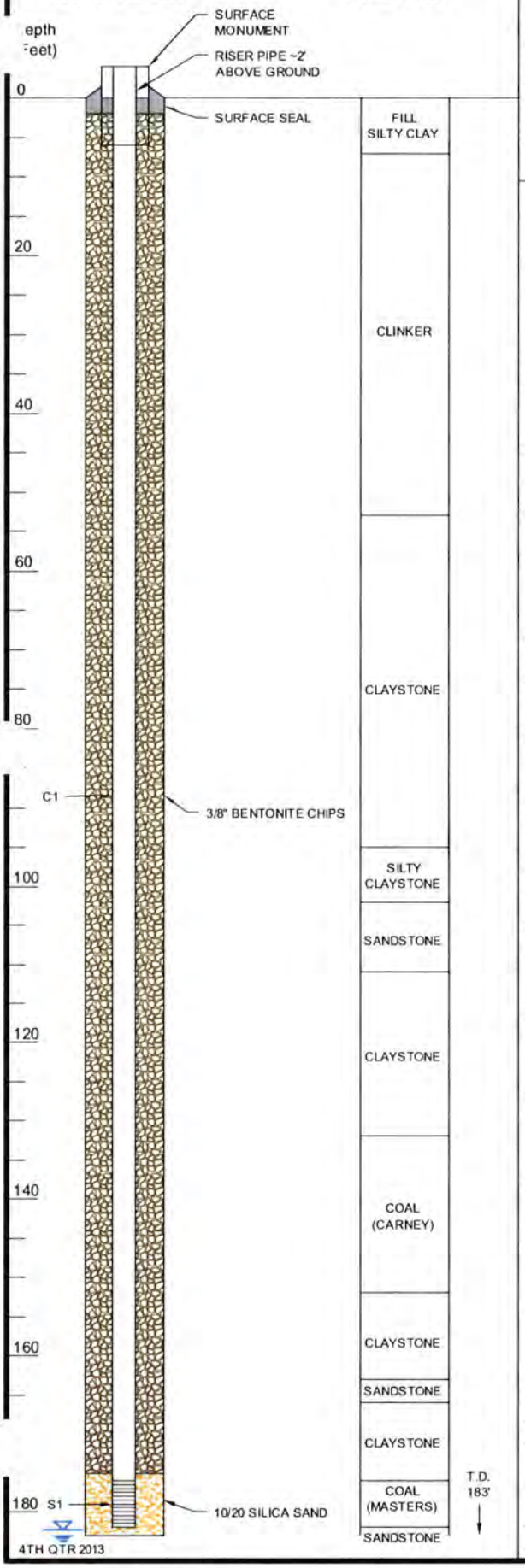

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578418-MST

Location: N 1,936,922.9 E 1,387,130.9 EL 3,883.6

NE /4, SW /4, Section 18 T. 57 N. R. 84 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 183'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 14-3/4" roller (surface)
9-7/8" PDC to ream

Fluid: Water, foam, polymer, bentonite mud

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 176 - +2 | S1 - 183 - 176

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 above screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 183 - 175

Bentonite:
3/8" chips
Depth: 175 - 7.0

Cement:
Type 1
Depth: 2.0 - 0

Other:

Construction Time Log

Drilling:	Start	End
9/16/13	9:00am	5:00pm
9/17/13	9:30am	11:15am

Casing:	Start	End
9/17/13	11:30am	1:15pm

Well Development

Began development on 9/17/13.

Blow 5 minutes - mist very black turbid.

Inject water for 5 minutes, cleaning up.

Blow dry, well appears dry.

Let sit from 1:36 to1:48, no surge.

Add water and blow dry, well dry or very close to it.

Ceased development at 2:00pm.

Remarks

SWL = 182.05' on 9/19/13 at 11:30am.

Appears dry as screen 176-182'.

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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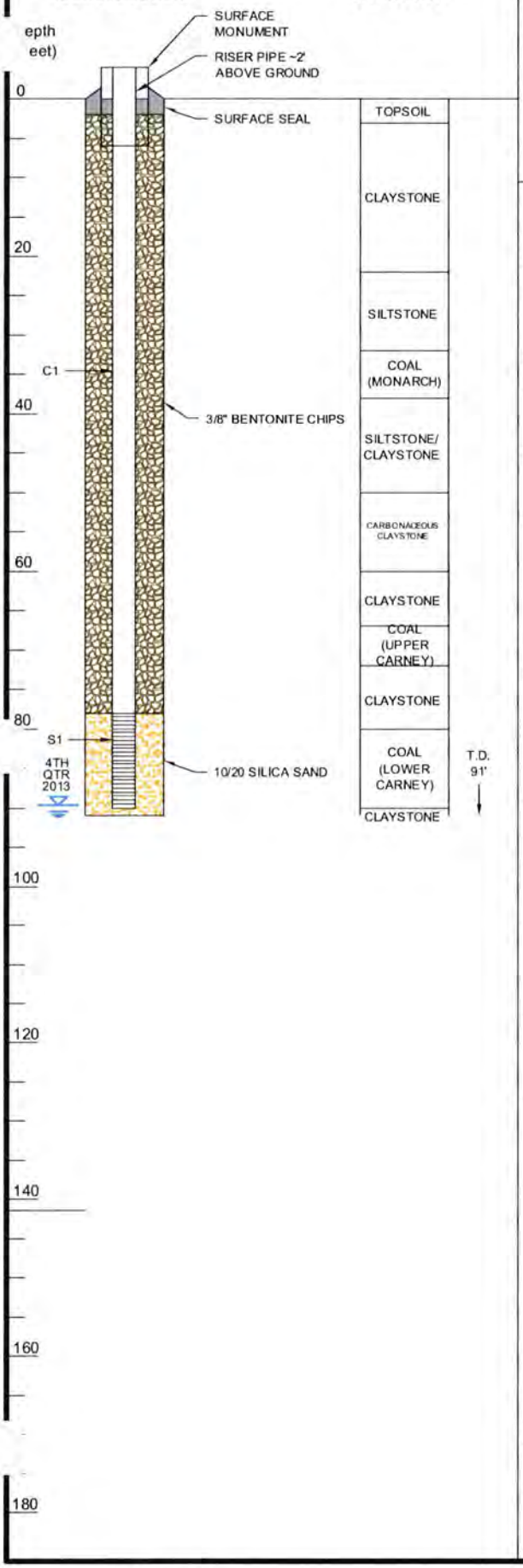

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578510-CRN

Location: N 1,941,542.1 E 1,371,807.2 EL 3,962.4

NE /4, SW /4, Section 10 T. 57 N. R. 85 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 91'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" PDC to ream

Fluid: Air and water

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 78 - +2 | S1 - 90 - 78

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 above screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 91 - 78

Bentonite:
3/8" chips
Depth: 78 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
43 bags bentonite in annulus
10 bags sand in filter pack

Construction Time Log

Drilling:	Start	End
9/24/13	1:15pm	2:00pm

Casing:	Start	End
9/24/13	2:00pm	2:30pm

Well Development

Began development on 9/24/13 at 2:35pm.

Added water and blew dry.

Well appears dry.

Cease Development at 3:00pm.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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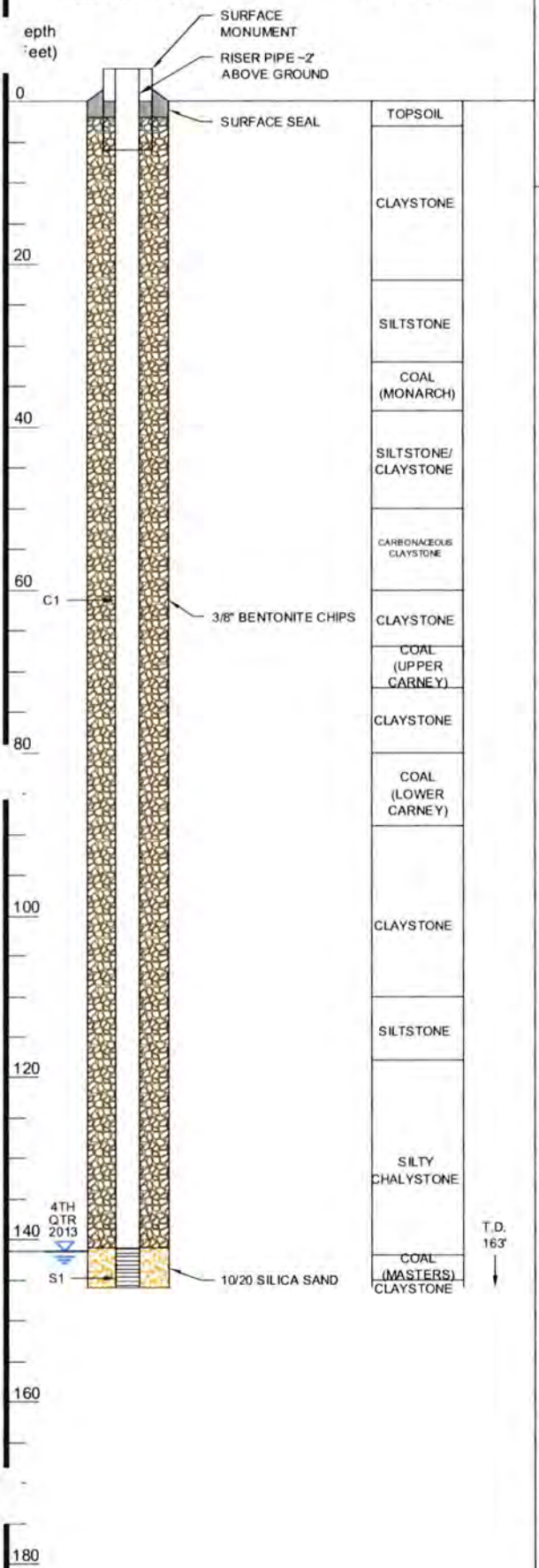

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578510-MST

Location: N 1,941,558.1 E 1,371,823.0 EL 3,962.4

NE /4, SW /4, Section 10 T. 57 N. R. 85 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 146'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" PDC to ream

Fluid: Air, water

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 141 - +2 | S1 - 146 - 141

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 above screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 146 - 141

Bentonite:
3/8" chips
Depth: 141 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
72 bags bentonite in annulus
4 bags sand in filter pack

Construction Time Log

Drilling:	Start	End
9/24/13	9:30am	10:45am

Casing:	Start	End
9/24/13	10:45am	12:00pm

Well Development

Began development on 9/24/13 at 12:00pm.
Add water and blow dry.
Let sit for 20 minutes, no surge.
Well dry.
Cease development at 12:45pm.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:
Method:

WWC ENGINEERING

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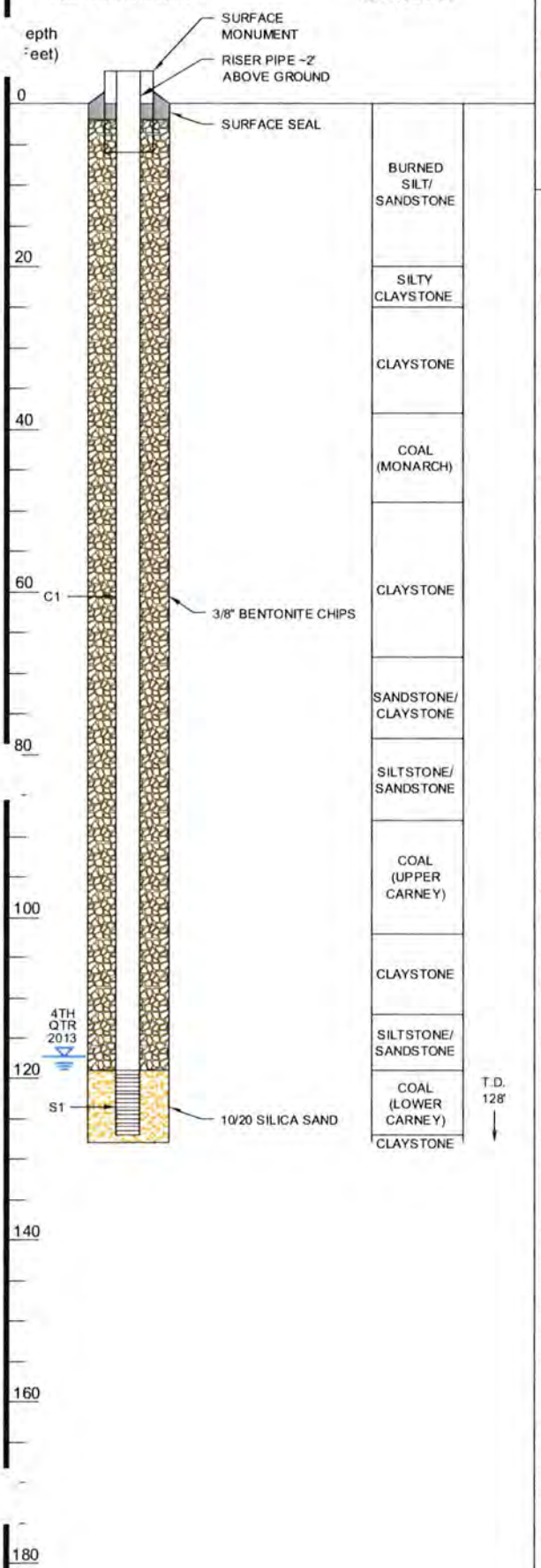

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578511-CRN

Location: N 1,940,246.5 E 1,377,926.5 EL 3,893.8

SW /4, SE /4, Section 11 T. 57 N. R. 85 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 128'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" PDC for ream
14-3/4" roller (surface)

Fluid: Water, air, some foam at surface

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 119 - +2 | S1 - 127 - 119

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 above screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 128 - 119

Bentonite:
3/8" chips
Depth: 119 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:

Construction Time Log

Drilling:	Start	End
9/23/13	12:45pm	2:30pm

Casing:	Start	End
9/23/13	2:30pm	3:30pm

Well Development

Began development on 9/23/13 at 3:30pm.

Add water and blow out.

Blow until 3:47pm.

Sample at 3:47pm:
Turb: 909NTU
Temp: 12.4°C
Conduct: 571µS
PH: 8.05

Let sit 15 minutes.

After letting well sit we attempted to blowout and there wasn't even a mist.

Well completely dry.

Cease development at 4:05pm.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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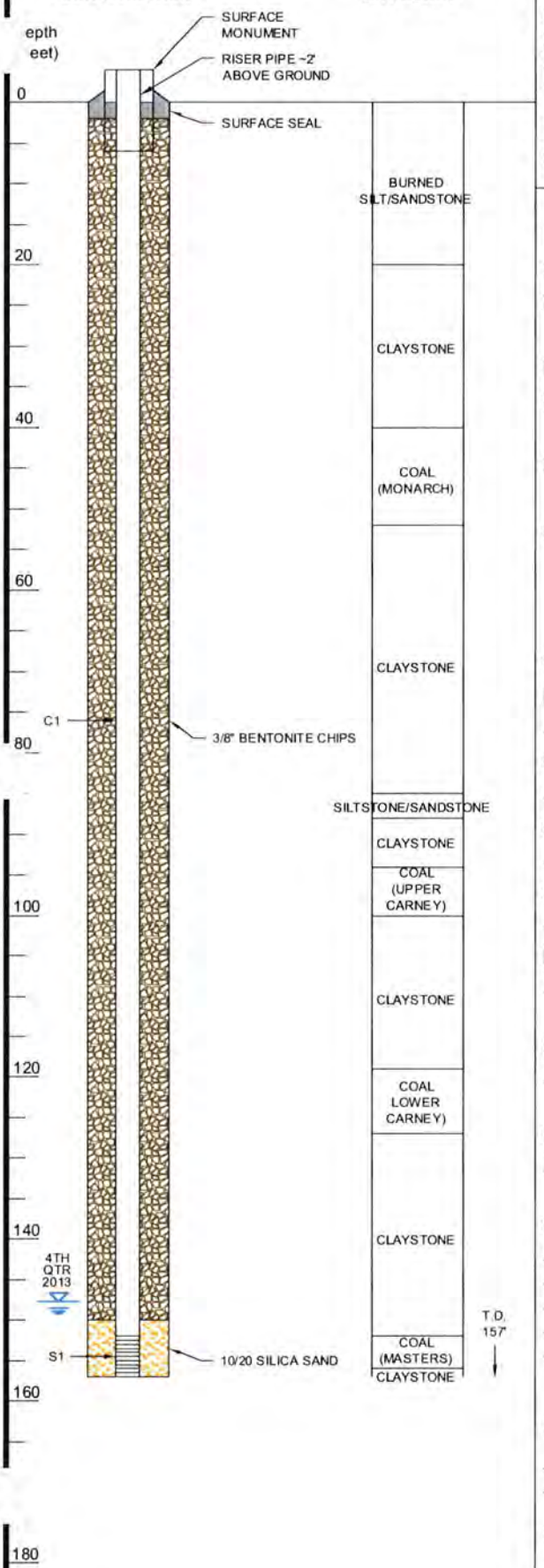

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578511-MST

Location: N 1,940,243.6 E 1,377,944.7 EL 3,894

SW /4, SE /4, Section 11 T. 57 N. R. 85 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 157'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" PDC to ream
14-3/4" roller (surface)

Fluid: Water, air, some foam at surface

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 152 - +2 | S1 - 157 - 152

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 on screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 157 - 150

Bentonite:
3/8" chips
Depth: 150 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
89 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
9/23/13	6:30am	10:15am

Casing:	Start	End
9/23/13	10:15am	11:30am

Well Development

Began development on 9/23/13 at 11:40am.

Blow, add water and blow till mist.

Well making less than 1 gpm.

Let sit 10 minutes and blow out, slight surge.

Sample at 12:05pm:
Turb: 761NTU
Temp: 14.1
Conduct: 656 µS
PH: 7.95

Cease development at 12:10pm.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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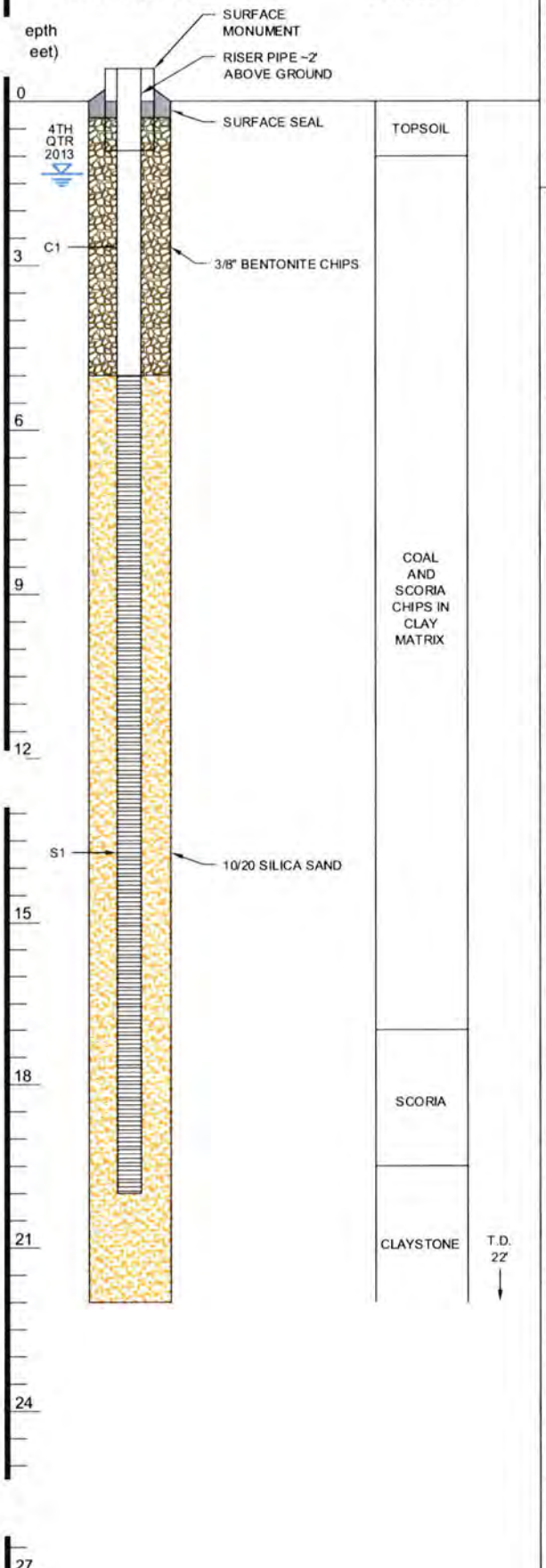

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578512-AL

Location: N 1,940,880.3 E 1,381,530.1 EL 3,758

SE /4, SW /4, Section 12 T. 57 N. R. 85 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 22'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" roller

Fluid: Gel

Casing: 5" SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 5 - +2 | S1 - 20 - 5

Monument or Surface Casing:
8" Locking Steel

Centralizer:
None

Casing C1:
5" SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 22 - 5

Bentonite:
3/8" chips
Depth: 5 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
2 bags bentonite in annulus
16 bags sand in filter pack

Construction Time Log

Drilling:	Start	End
9/25/13	2:30pm	3:00pm

Casing:	Start	End
9/25/13	3:10pm	3:45pm

Well Development

Began development on 9/25/13 at 3:45pm.

Well making 15-20gpm (estimated)

Sample at 4:16pm:
Turb: 249NTU
Temp: 11.3°C
Conduct: 4.25mS
PH: 8.09

Additional pumping may help clean well.

Air development is difficult this shallow.

Produced approximately 500 gallons.

Cease development at 4:18pm.

Sample from nearby surface water (pond):
Turb: 10.67NTU
Temp: 14.0°C
Conduct: 4.69mS
PH: 8.59

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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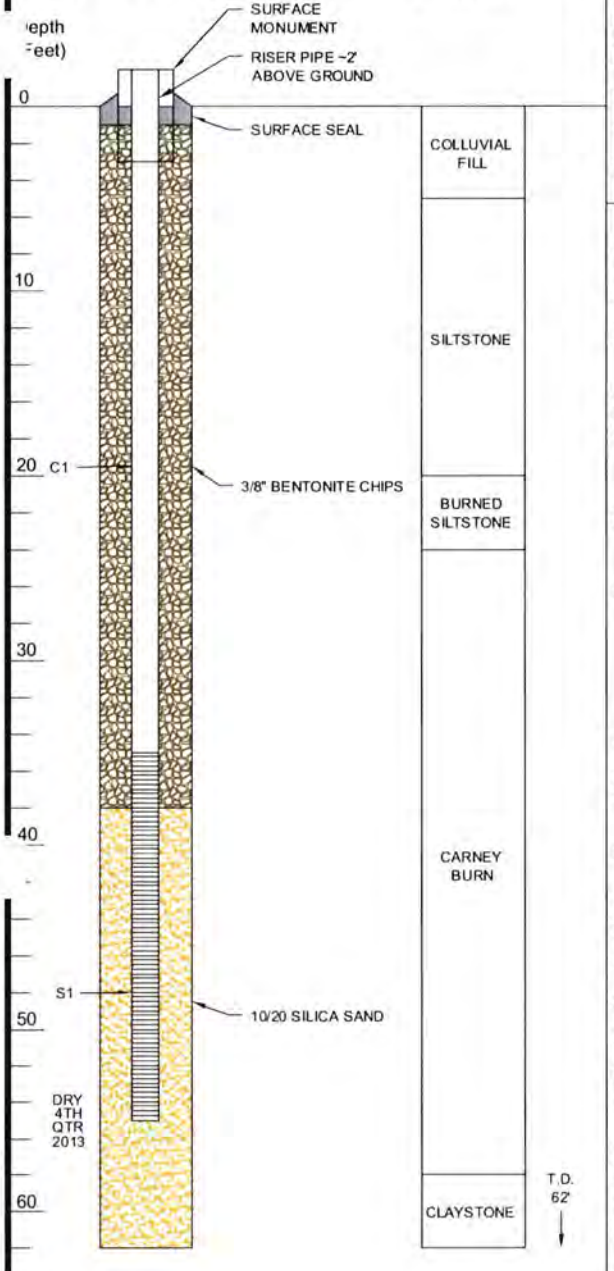

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578512 CRN

Location: N 1,943,160.0 E 1,382,757.0 EL 3,931.0

SW /4, NE /4, Section 12 T. 57 N. R. 85 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 62'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" roller

Fluid: Air, water, foam, polymer

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 35 - +2 | S1 - 55 - 35

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 in middle of screen

Casing C1:
105" SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 62 - 38

Bentonite:
3/8" chips
Depth: 38 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
35 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
9/20/13	2:05pm	3:30pm

Casing:	Start	End
9/20/13	3:30pm	3:50pm

Well Development

Began development on 9/20/13 at 4:00pm.

Blew out lots of drilling foam.

Added water.

No returns to surface, well takes every thing we inject.

Recommend cleaning in another way (bleach?) as polymer was not cleaned out of hole, unless well is dry and cannot be sampled.

Remarks

Air line stuck in hole after development and lifted screen 3' above intended completion interval. Would not push back down due to filter pack.

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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Scanned, 02/28/2020

Well Construction Summary

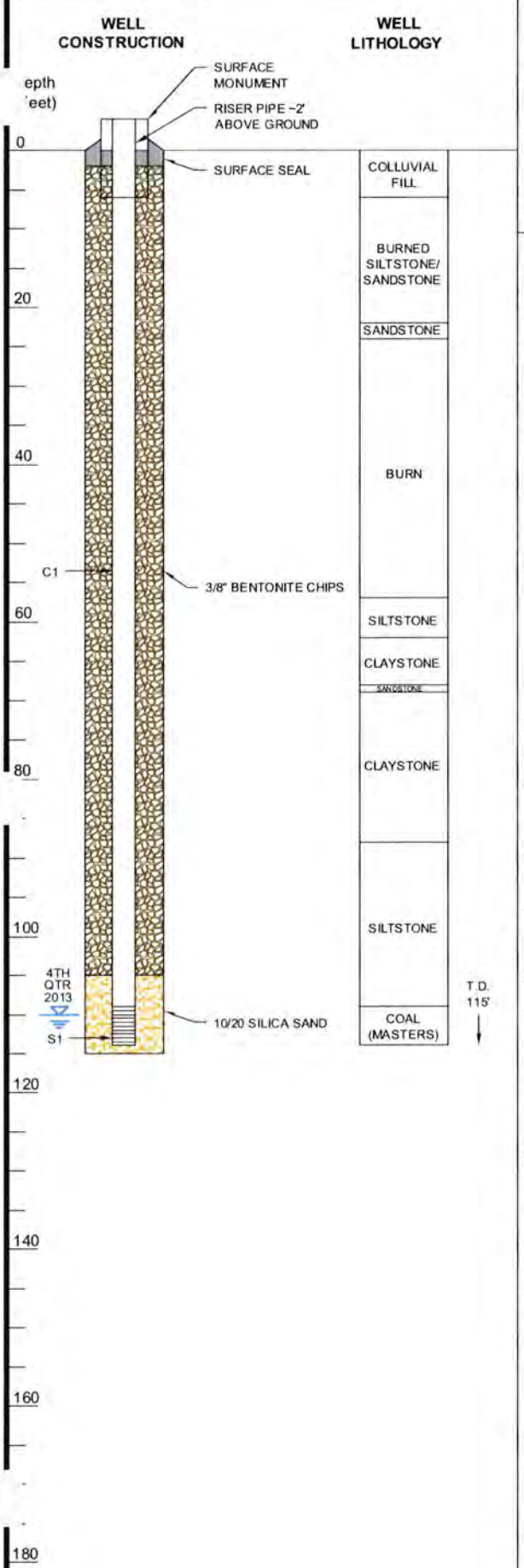
Client: Ramaco

Project: Brook Mine Monitor Network Well: 578512-MST

Location: N 1,943,171.6 E 1,382,742.6 EL 3,930.9

SW /4, NE /4, Section 12 T. 57 N. R. 85 W.

Geologist: Swayne Redinger



Drilling Summary

Total Depth: 115'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 14-3/4" roller (surface)
9-7/8" PDC to ream

Fluid: Air, water, foam, polymer

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 109 - +2 | S1 - 114 - 109

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 above screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 115 - 105

Bentonite:
3/8" chips
Depth: 105 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
65 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
9/20/13	7:00am	11:45am

Casing:	Start	End
9/20/13	11:55am	1:00pm

Well Development

Began development on 9/20/13 at 1:00pm.

Blow dry (Drilling fluid).

Add water and blow dry.

Let sit for 15 minutes and blow dry again.

No surge.

Well appears dry.

Cease development at 1:30pm.

Remarks

Much more burn than expected.

Exploration hole uphill from this location had approximately 10' less burn than this location.

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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Well Construction Summary

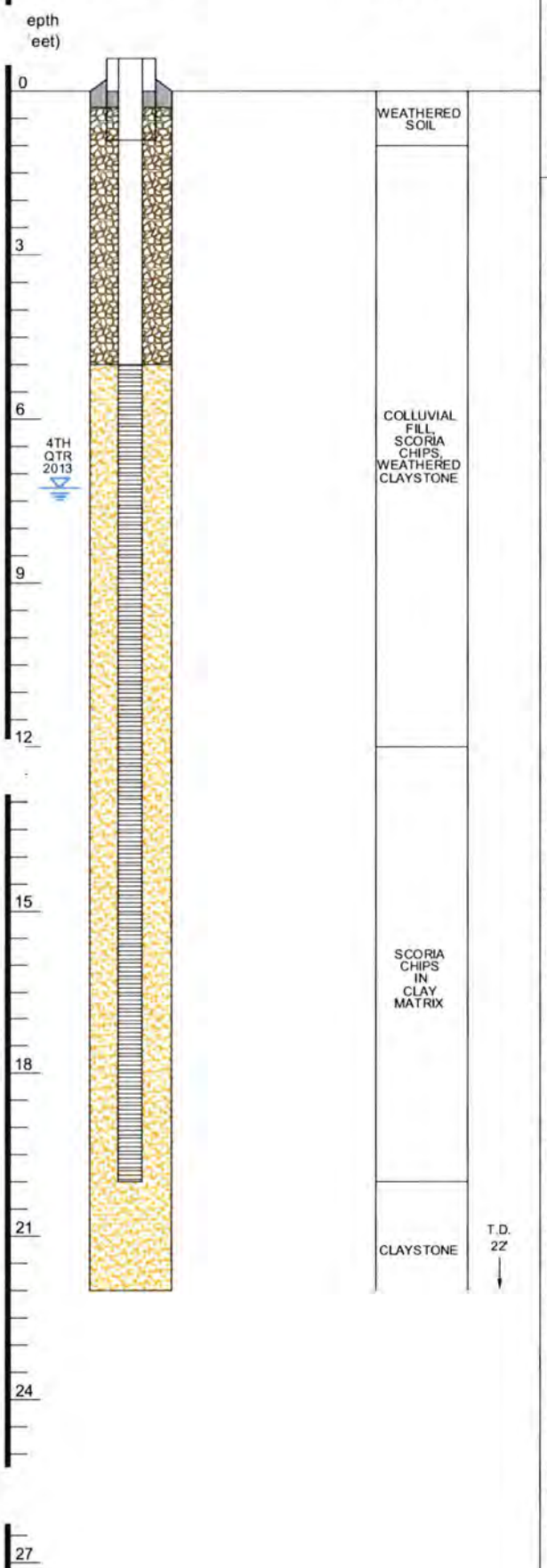
Client: Ramaco

Project: Brook Mine Monitor Network Well: 578513-AL-1

Location: N 1,938,633.9 E 1,383,970.4 EL 3,721.9

NE /4, NE /4, Section 13 T. 57 N. R. 85 W.

Geologist: Swayne Redinger



Drilling Summary

Total Depth: 22'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" roller

Fluid: Gel

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 5 - +2 | S1 - 20 - 5

Monument or Surface Casing:
8" Locking Steel

Centralizer:
none

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 22 - 5

Bentonite:
3/8" chips
Depth: 5 - 2
- -

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
17 bags sand in annulus
1 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
9/30/13	7:15am	7:55am

Casing:	Start	End
9/30/13	7:55am	8:30am

Well Development

Began development on 9/30/13 at 8:30am.

Blow out and then inject water to clean up.

Surge several times.

Well making approximately 20gpm (estimated).

Sample at 8:50am:
Turb: 655NTU
Temp: 10.3°C
Conduct: 3.58mS
PH: 8.12

Sample at 9:05am:
Turb: 865NTU
Temp: 10.2°C
Conduct: 3.81mS
PH: 8.19

Surge well 9:05am - 9:19am.

Sample at 9:25am:
Turb: 357NTU
Temp: 10.4°C
Conduct: 3.85mS
PH: 8.20

Sample at 9:30am:
Turb: 223NTU
Temp: 10.4°C
Conduct: 3.91mS
PH: 8.24

Cease development at 9:35am.

Approximately 450 gallons developed from well.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

K:\Sheridan\RAMACO\13139\ACAD_WY83EC\DWGS_D6_RESPONSE\MW_578513-AL-1_R1.dwg 5/20/2015 1:40:18 PM dave johnson

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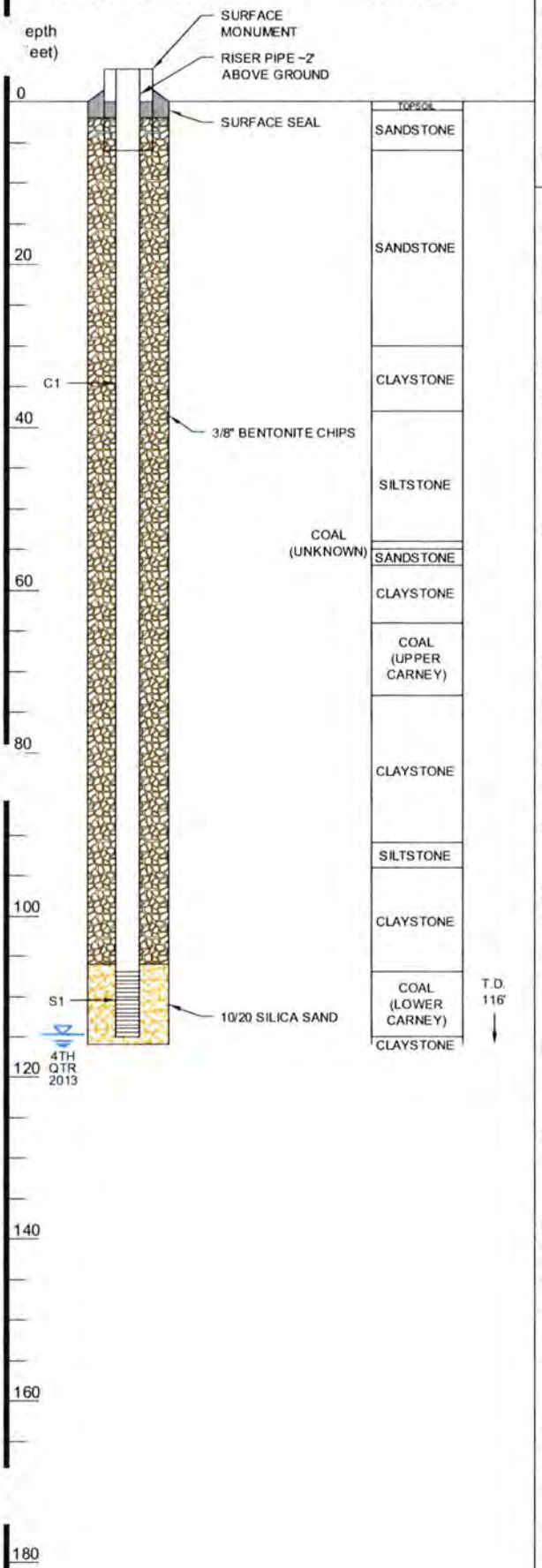

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578513-CRN

Location: N 1,938,329.3 E 1,381,665.6 EL 3,847.7

SE /4, NW /4, Section 13 T. 57 N. R. 85 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 116'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" PDC to ream

Fluid: Air and water

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 107 - +2 | S1 - 115 - 107

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 above screen

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 116 - 106

Bentonite:
3/8" chips
Depth: 106 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
55 bags bentonite in annulus
7 bags sand in filter pack

Construction Time Log

Drilling:	Start	End
9/25/13	10:45am	11:45m

Casing:	Start	End
9/25/13	11:45am	12:30pm

Well Development

Began development on 9/24/13 at 12:30pm.
Blow dry and then add water and blow out.
Goes to mist and then dry.
Hole appears dry.
Cease development at 1:00pm.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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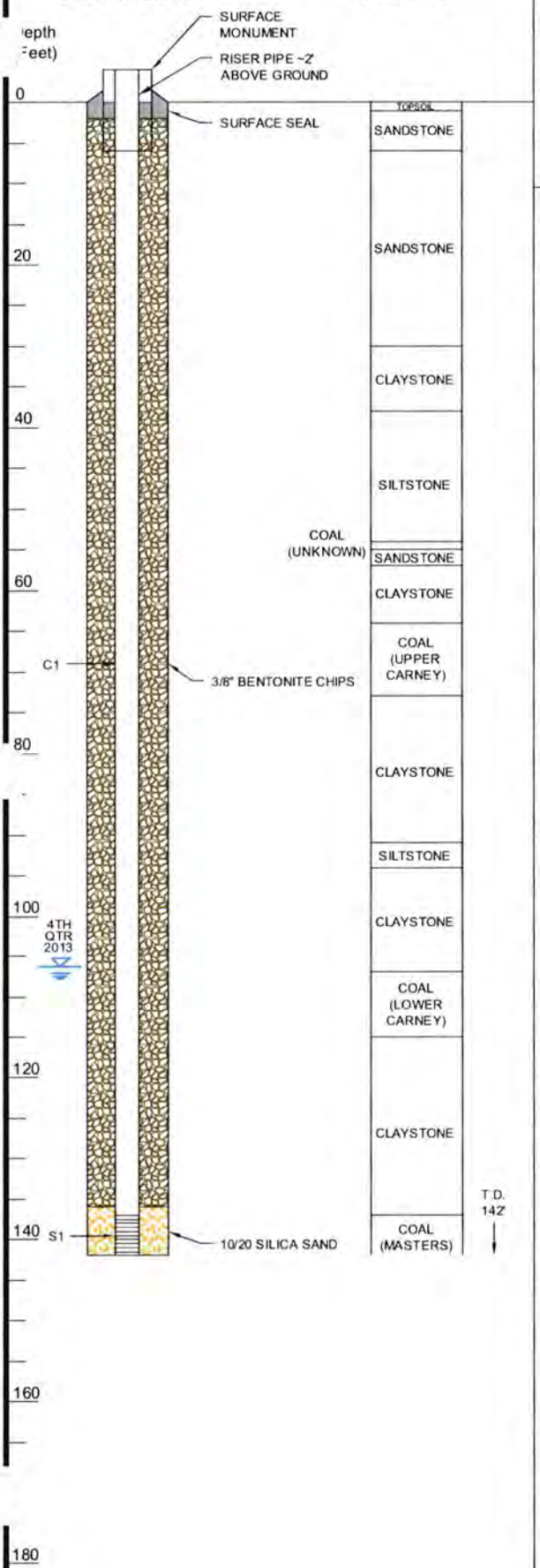

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578513-MST

Location: N 1,938,341.4 E 1,381,680.6 EL 3,848.4

SE /4, NW /4, Section 13 T. 57 N. R. 85 W.

Geologist: Swayne Redinger

Drilling Summary

Total Depth: 142'

Hole Dia.: 9-7/8"

Driller: Shawn Ankney

Rig: Gardner Denver 1500

Bit(s): 9-7/8" PDC to ream

Fluid: Air and water

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 137 - +2 | S1 - 142 - 137

Monument or Surface Casing:
8" Locking Steel

Centralizer:
1 above screen and one 40' up

Casing C1:
5" Certa-Lok SDR-17 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 142 - 136

Bentonite:
3/8" chips
Depth: 136 - 2.0

Cement:
Type 1
Depth: 2.0 - +0.5

Other:
65 bags bentonite in annulus

Construction Time Log

Drilling:	Start	End
9/25/13	7:30am	9:00am

Casing:	Start	End
9/25/13	9:00am	9:45am

Well Development

Began development on 9/25/13 at 9:50am.

Inject water and blow dry.

Sample at 9:55am:
Turb: 309NTU
Temp: 13.5°C
Conduct: 3.46mS
PH: 8.02

Driller injected water to help clean well out.

Well making approximately 7gpm.

Sample at 10:07am:
Turb: 304NTU
Temp: 11.6°C
Conduct: 3.50mS
PH: 8.18

Sample at 10:20am:
Turb: 59.2NTU
Temp: 11.2°C
Conduct: 3.49mS
PH: 8.34

Cease development at 10:17am.

Produced approximately 190 gallons.

Remarks

TFN 6 2/025
RECD JUL 30, 2015

Abandoned

Date:

Method:

WWC ENGINEERING

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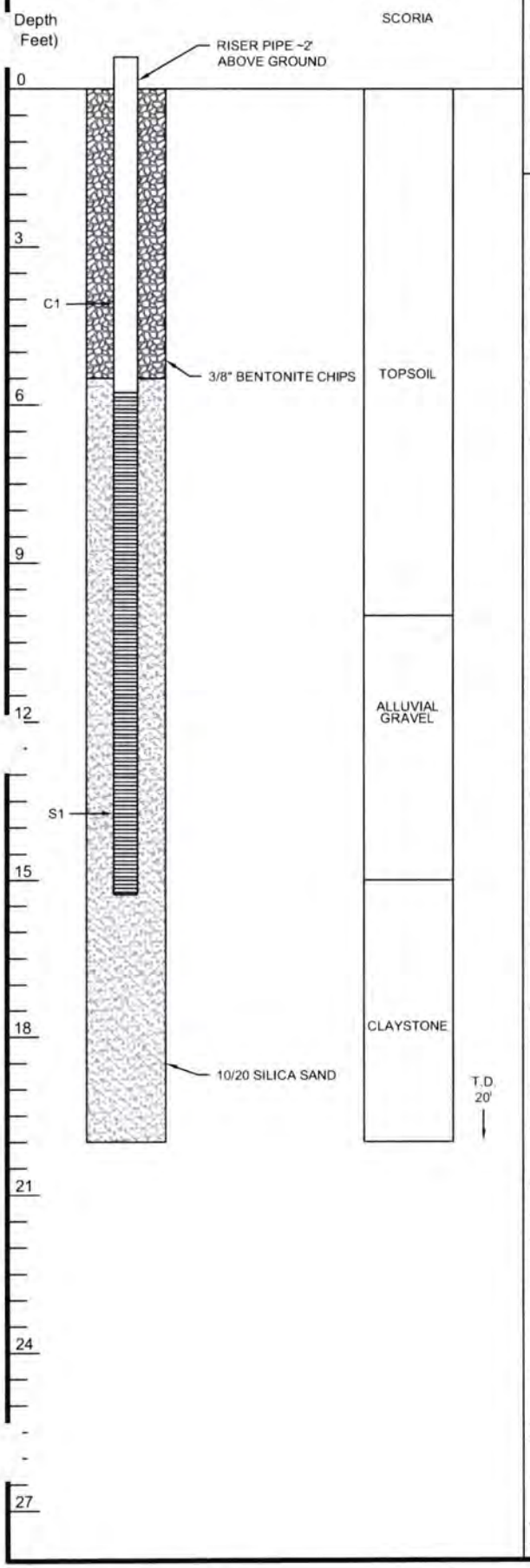

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578420-AL-1

Location: N 1,931,378.96 E 1,392,776.75 EL 3,634.4

NE /4, SW /4, Section 20 T. 57 N. R. 84 W.

Geologist: Chris McDowell

Drilling Summary

Total Depth: 20'

Hole Dia.: 5-1/2"

Driller: Kid Pronghorn

Rig: Gardner Denver 1500

Bit(s): 5-1/2" core barrel

Fluid: Air and foam

Casing: 2" SDR17 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2 - 5.6 | S1 - 5.6 - 15.6

Monument or Surface Casing:

-

Centralizer:

-

Casing C1:

2" SDR 17 flush thread PVC

Screen S1:

2" SDR17 flush thread PVC with 0.032" slots

Filter Pack:

10/20 Colorado Silica Sand

Depth: 5 - 20

Bentonite:

3/8" chips

Depth: 0 - 5

Cement:

Depth: - - -

Other:

-

Construction Time Log

Drilling:	Start	End
6/18/18	-	-

Casing:	Start	End
6/18/18	-	-

Well Development

Well developed on 6/19/18 - 6/20/18. on 6/19/18 well was bailed (3 casing volumes) water was turbid. on 6/20/18 well was airlifted for 4 hours turbid spray was produced and cleaned up slightly.

Remarks

TFN 6 2/028
RECD 10-25-18

Abandoned

Date:

Method:

WWC ENGINEERING

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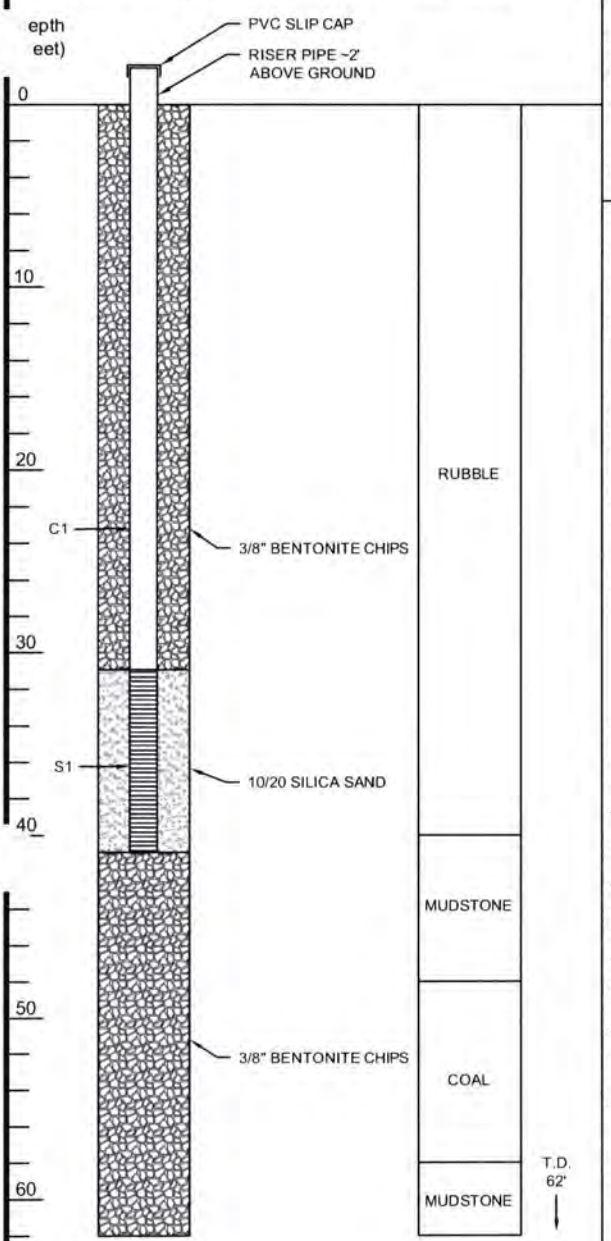

Well Construction Summary

Client: Ramaco
Project: Brook Mine Monitor Network Well: 578415-SPL-1
Location: N 1,934,126.6 E 1,404,656.3 EL 3,603.7
NE /4, NE /4, Section 22 T. 57 N. R. 84 W.
Geologist:

Drilling Summary

Total Depth: 62'
Hole Dia.: 5-1/2"
Driller: Kurt Taylor
Rig: Gardner Denver 1500
Bit(s): 5-1/2" roller
Fluid: Air, foam
Casing: 2" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2 - 31 | S1 - 31 - 41

Monument or Surface Casing:
-

Centralizer:
-

Casing C1:
2" SDR-17 PVC

Screen S1:
2" PVC with 0.032" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 31 - 41

Bentonite:
3/8" chips
Depth: 0 - 31

Cement:
Depth: - -

Other:
-

Construction Time Log

Drilling:	Start	End
-	-	-

Casing:	Start	End
-	-	-

Well Development

Remarks

TFN 6 2/025
RECD 10-25-18

Abandoned

Date:
Method:

WWC ENGINEERING

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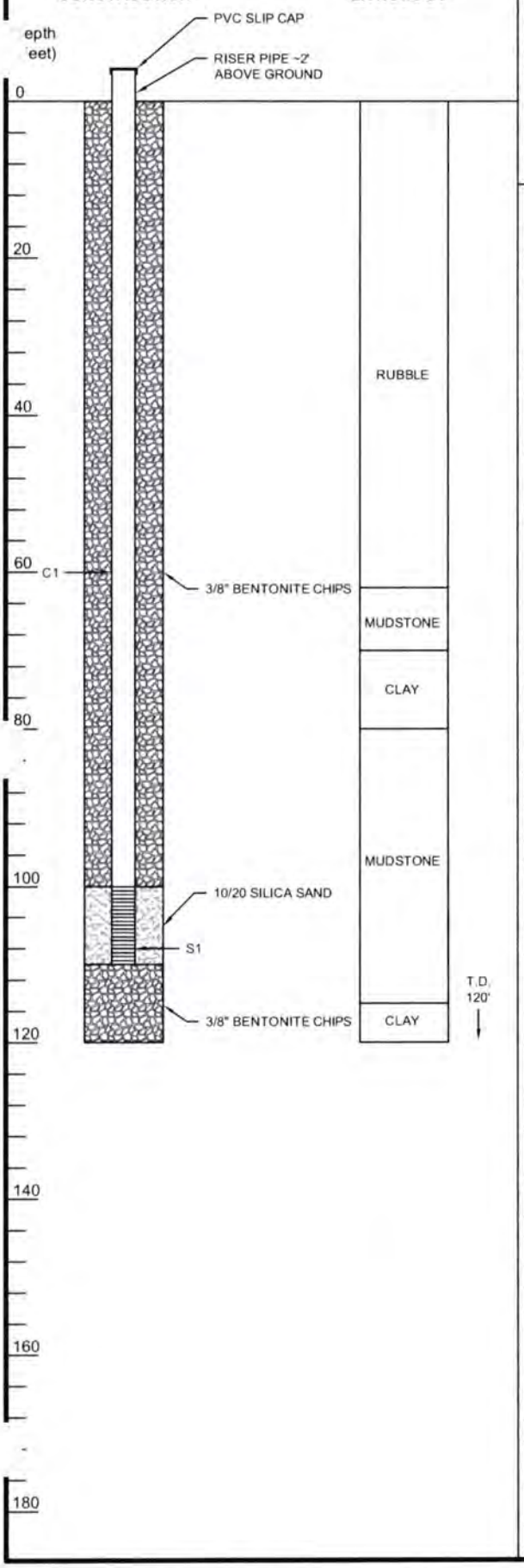

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578415-SPL-2

Location: N 1,935,618.5 E 1,404,635.8 EL 3,611.5

SE /4, SE /4, Section 15 T. 57 N. R. 84 W.

Geologist:

Drilling Summary

Total Depth: 120'

Hole Dia.: 5-5/8"

Driller: Kurt Taylor

Rig: Gardner Denver 1500

Bit(s): 5 5/8" roller

Fluid: Water and foam

Casing: 2" SCH 40 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2 - 100 | S1 - 100 - 110

Monument or Surface Casing:

Centralizer:

Casing C1:
2" SCH 40 flush thread PVC

Screen S1:
2" SCH 40 flush thread PVC with 0.032" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 100 - 110

Bentonite:
3/8" chips
Depth: 0 - 100

Cement:
Type 1
Depth: -

Other:

Construction Time Log

Drilling:	Start	End

Casing:	Start	End

Well Development

Remarks

TFN 6 2/025
RECD 10-25-18

Abandoned

Date:

Method:

WWC ENGINEERING

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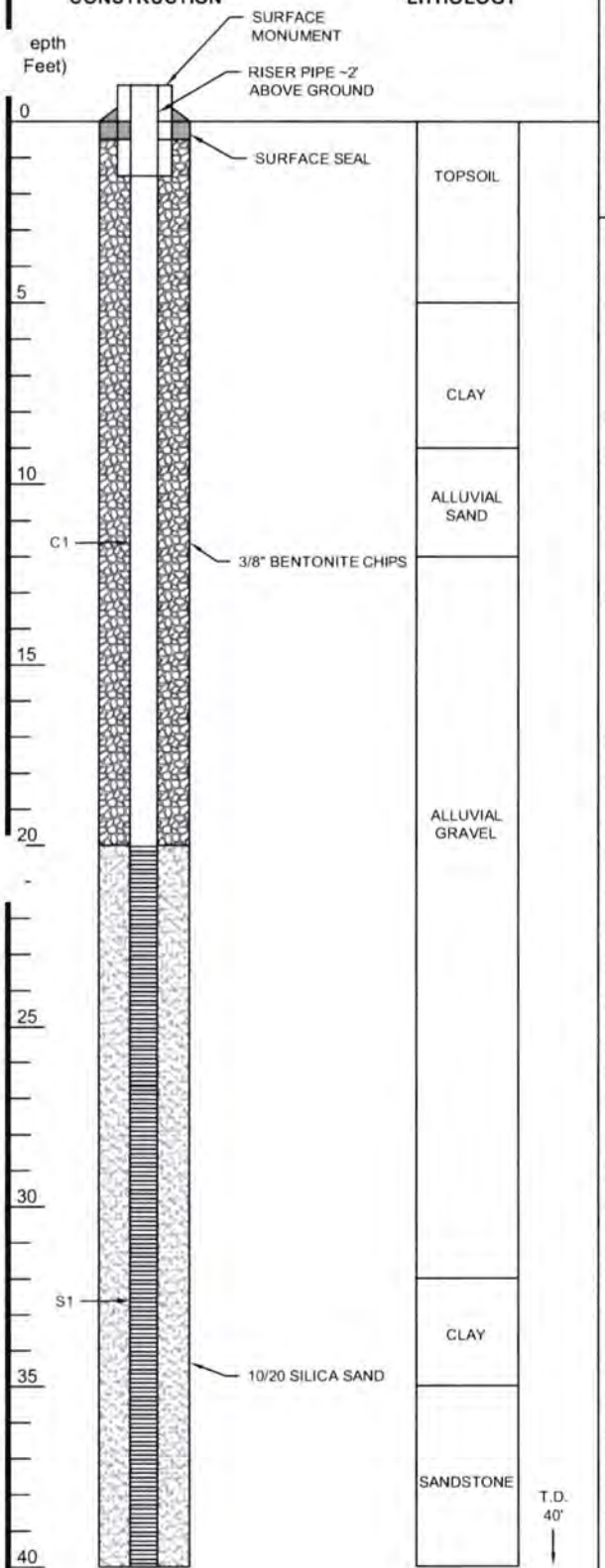

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578524-AL-1

Location: N 1,934,064.7 E 1,381,955.2 EL 3,673.9

NE /4, NW /4, Section 24 T. 57 N. R. 85 W.

Geologist:

Drilling Summary

Total Depth: 40'

Hole Dia.: 8-3/4"

Driller: Kurt Taylor

Rig: Gardner Denver 1500

Bit(s): 8-3/4" roller / 8-3/4" PDC

Fluid: Mud

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2 - 20 | S1 - 20 - 40

Monument or Surface Casing:
-

Centralizer:
-

Casing C1:
5" SDR-17 PVC

Screen S1:
5" PVC with 0.032" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 20 - 40

Bentonite:
3/8" chips
Depth: 5 - 20

Cement:
Type 1
Depth: 0 - 5

Other:
-

Construction Time Log

Drilling:	Start	End
-	-	-

Casing:	Start	End
-	-	-

Well Development

Remarks

TFR 6 2/025
RECD 10-25-18

Abandoned

Date:

Method:

WWC ENGINEERING

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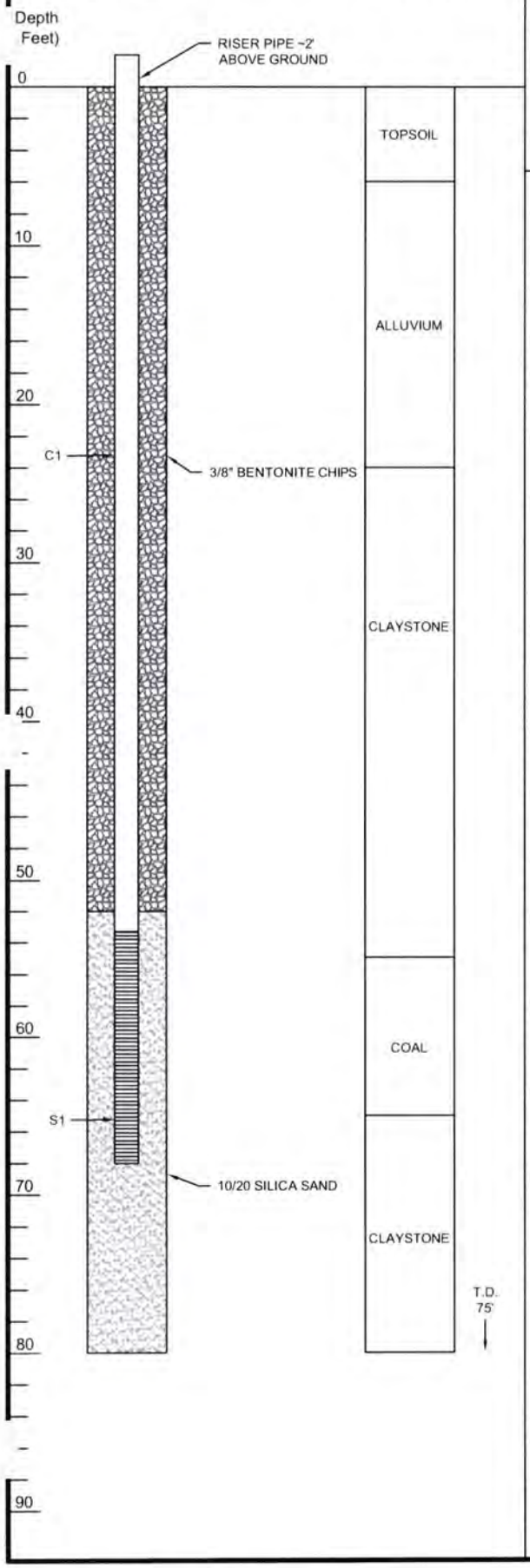

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578524-CRN-PUMP

Location: N 1,934,173.20 E 1,381,917.03 EL 3,672.9

NE /4, NW /4, Section 24 T. 57 N. R. 85 W.

Geologist: Chris McDowell

Drilling Summary

Total Depth: 80'

Hole Dia.: 8-3/4"

Driller: Kurt Taylor

Rig: Gardner Denver 1500

Bit(s): 8-3/4" roller / 8-3/4" PDC

Fluid: Mud

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2 - 53 | S1 - 53 - 68

Monument or Surface Casing:
-

Centralizer:
1 in middle of screen

Casing C1:
5" SDR-17 PVC

Screen S1:
5" PVC with 0.032" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 52 - 80

Bentonite:
3/8" chips
Depth: 0 - 52

Cement:
Type 1
Depth: - - -

Other:
-

Construction Time Log

Drilling:	Start	End
6/5/18	-	-
6/6/18		

Casing:	Start	End
6/6/18	-	-

Well Development

Began development on 6/6/18 at 1220. Air lifted for 1.3 hours until 1340.

Remarks

TFN 6 2/025
RECD 10-25-18

Abandoned

Date: 6/12/18

Method: removed casing and plugged with bentonite

WWC ENGINEERING

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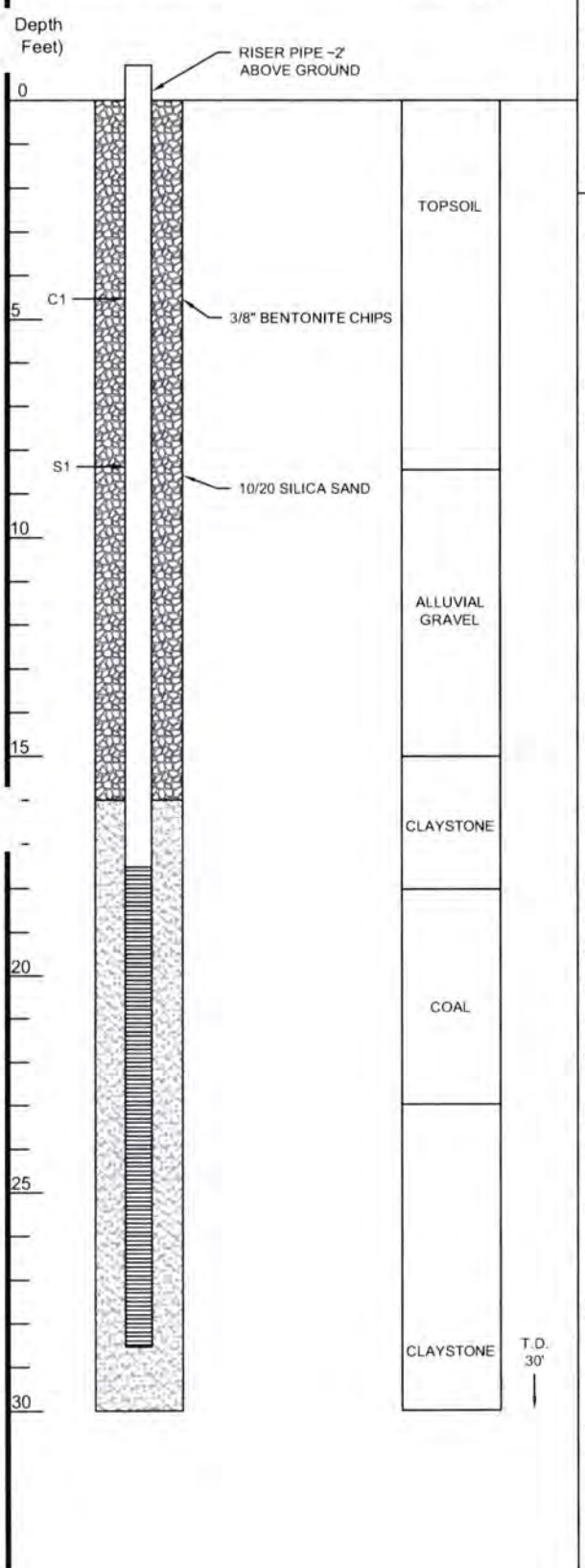

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578420-CRN-PUMP

Location: N 1,931,278.79 E 1,392,894.78 EL 3,633.5

NW /4, SE /4, Section 20 T. 57 N. R. 84 W.

Geologist: Chris McDowell

Drilling Summary

Total Depth: 30'

Hole Dia.: 8-3/4"

Driller: Kurt Taylor

Rig: Gardner Denver 1500

Bit(s): 8-3/4" roller

Fluid: Mud

Casing: 5" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2 - 17.5 | S1 - 17.5 - 28.5

Monument or Surface Casing:
-

Centralizer:
-

Casing C1:
5" SDR-17 PVC

Screen S1:
5" PVC with 0.032" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 16 - 30

Bentonite:
3/8" chips
Depth: 0 - 16

Cement:
Depth: - -

Other:

Construction Time Log

Drilling:	Start	End
6/18/18	-	-

Casing:	Start	End
6/19/18	-	-

Well Development

Began development on 6/20/18. Well blew dry very quickly and was not producing enough water to airlift continuously.

Remarks

Abandoned

Date:

Method:

WWC ENGINEERING

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RECD 10-25-18

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Well Construction Summary

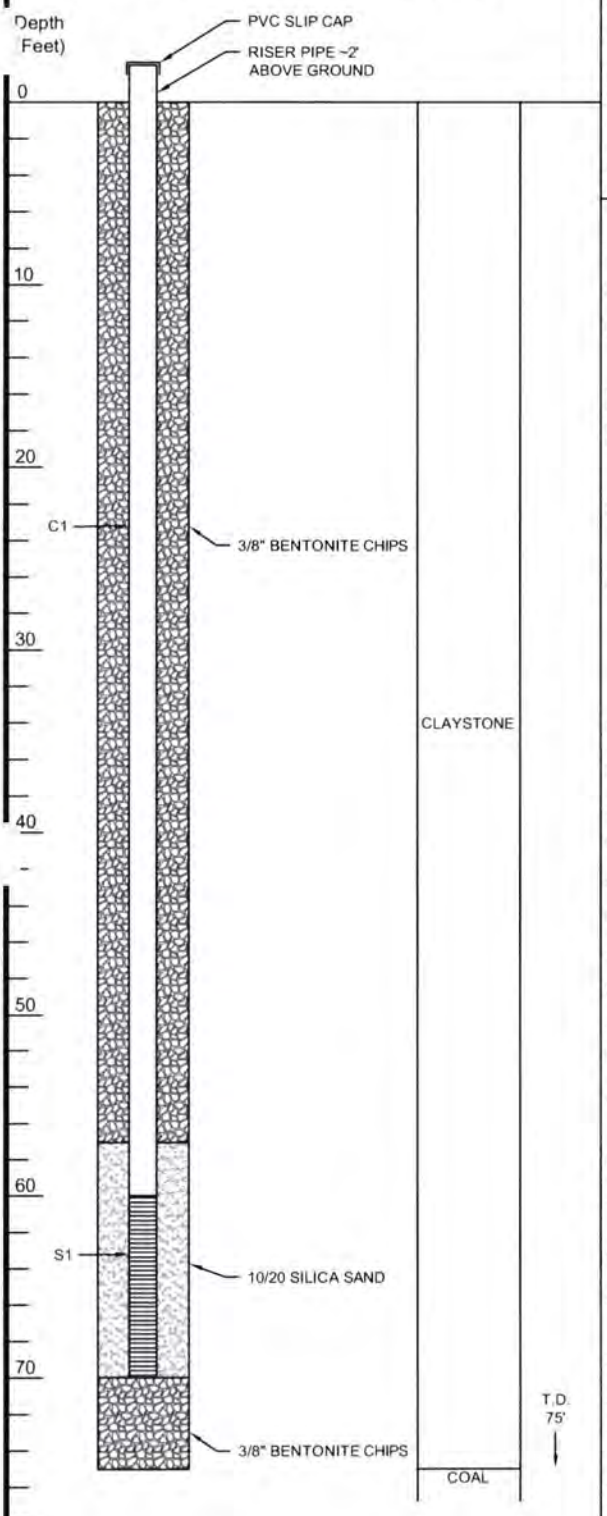
Client: Ramaco

Project: Brook Mine Monitor Network Well: 578513-OVB-1

Location: N 1,936,206.36 E 1,384,801.46 EL 3,753.2

NE /4, SE /4, Section 13 T. 57 N. R. 85 W.

Geologist: Chris McDowell



Drilling Summary

Total Depth: 70'

Hole Dia.: 5-1/2"

Driller: Kurt Taylor

Rig: Gardner Denver 1500

Bit(s): 5-1/2" roller

Fluid: Air, foam

Casing: 2" Certa-Lok SDR-17 PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2 - 60 | S1 - 60 - 70

Monument or Surface Casing: -

Centralizer: -

Casing C1: 2" SDR-17 PVC

Screen S1: 2" PVC with 0.032" slots

Filter Pack: 10/20 Colorado Silica Sand Depth: 57 - 70

Bentonite: 3/8" chips Depth: 0 - 57

Cement: Depth: - -

Other: -

Construction Time Log

Drilling:	Start	End
6/6/18	-	-

Casing:	Start	End
6/6/18	-	-

Well Development

Remarks

Well cuttings dry in sceened interval. Hit coal at 75'. Plugged back with 1 bag of bentonite then set screen.

Abandoned

Date:

Method:

WWC ENGINEERING

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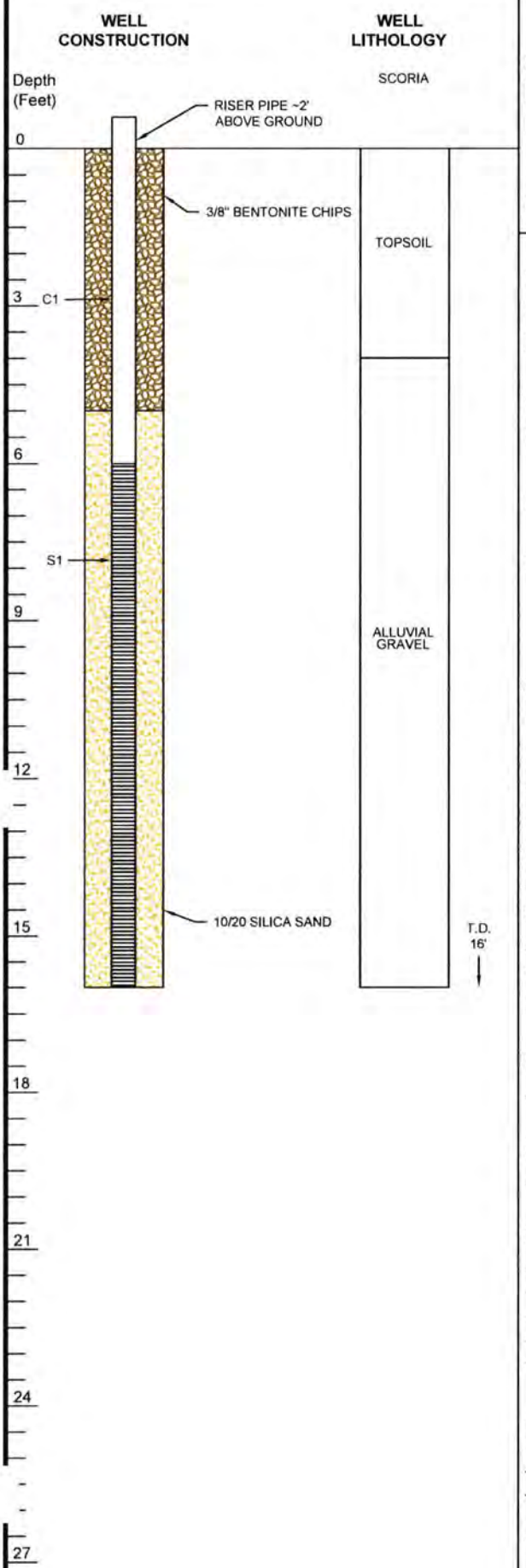

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578433-AL-1

Location: N 1,922,703.09 E 1,402,205.65 EL -

SE /4, NE /4, Section 33 T. 57 N. R. 84 W.

Geologist: J. Scyphers

Drilling Summary

Total Depth: 16'

Hole Dia.: 3-1/2"

Driller: Y-ENVIRONMENTAL

Rig: Geoprobe

Bit(s): 3-1/2" direct push drive shoe

Fluid:

Casing: 2" SDR17 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2.5 - 6 | S1 - 6 - 16

Monument or Surface Casing:
5" lockable steel

Centralizer:
-

Casing C1:
2" SDR 17 flush thread PVC

Screen S1:
2" SDR17 flush thread PVC with 0.032" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 5 - 16

Bentonite:
3/8" chips
Depth: 0 - 5

Cement:
Depth: - - -

Other:
-

Construction Time Log

Drilling:	Start	End
8/14/15	-	-

Casing:	Start	End
8/14/15	-	-

Well Development

Remarks

TFN 6 / 025
RECD MAY 23, 2019

Abandoned

Date:

Method:

WWC ENGINEERING

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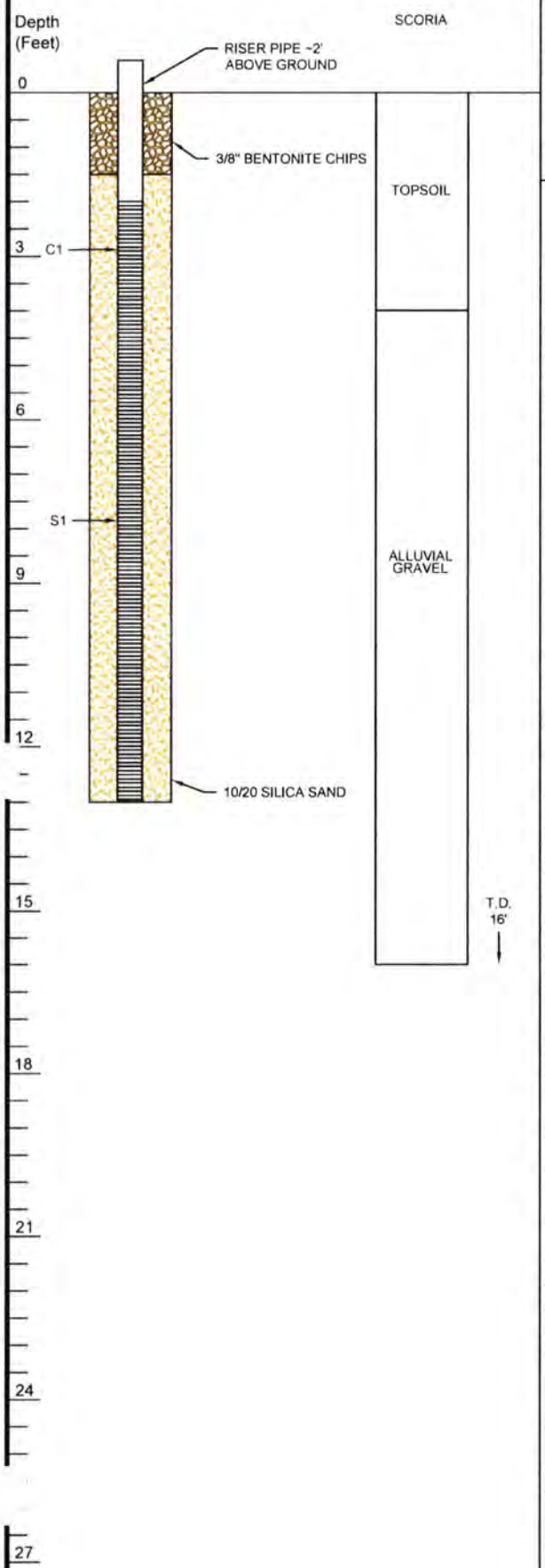

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578434-AL-1

Location: N 1,921,551.40 E 1,403,229.15 EL -

NW /4, SE /4, Section 34 T. 57 N. R. 84 W.

Geologist: J. Scyphers

Drilling Summary

Total Depth: 13'

Hole Dia.: 3-1/2"

Driller: Y-ENVIRONMENTAL

Rig: Geoprobe

Bit(s): 3-1/2" direct push drive shoe

Fluid:

Casing: 2" SDR17 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2.5 - 3.0 | S1 - 3.0 - 13.0

Monument or Surface Casing:
5" lockable steel

Centralizer:
-

Casing C1:
2" SDR 17 flush thread PVC

Screen S1:
2" SDR17 flush thread PVC with 0.032" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 1.5 - 13

Bentonite:
3/8" chips
Depth: 0 - 1.5

Cement:
Depth: - - -

Other:
-

Construction Time Log

Drilling:	Start	End
8/14/15	-	-

Casing:	Start	End
8/14/15	-	-

Well Development

Remarks

TFNS 2/625
RECD MAY 23, 2019

Abandoned

Date:

Method:

WWC ENGINEERING

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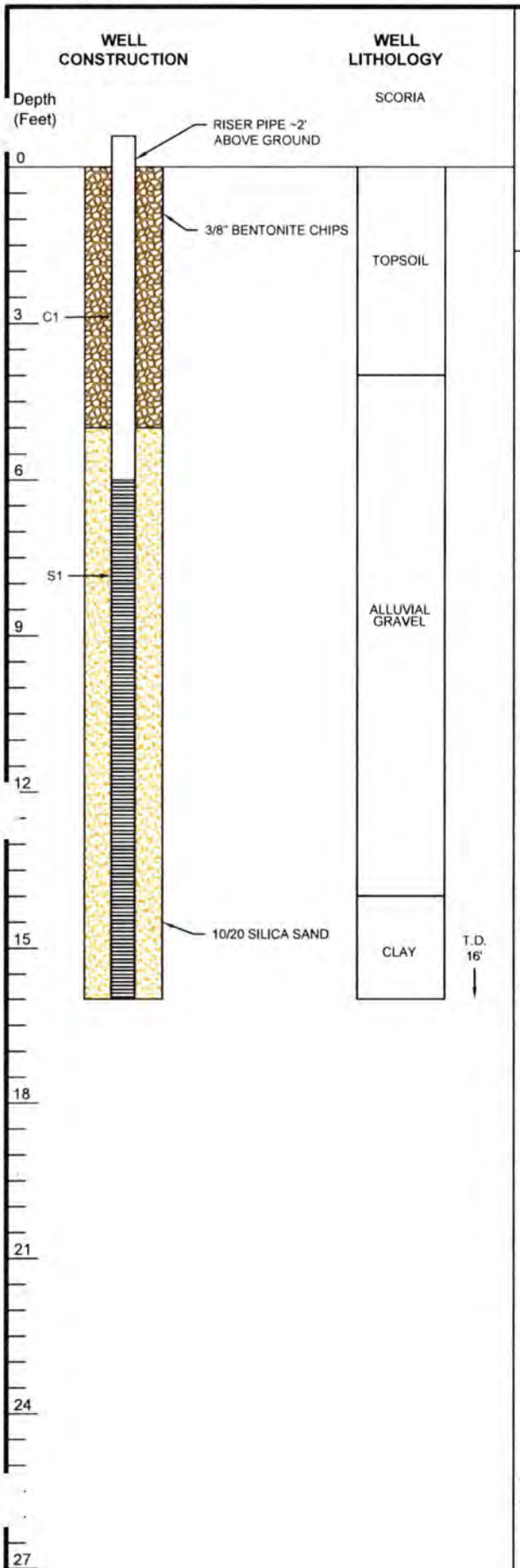

Well Construction Summary

Client: Ramaco

Project: Brook Mine Monitor Network Well: 578434-AL-2

Location: N 1,919,746.55 E 1,404,529.15 EL -

NW /4, SE /4, Section 34 T. 57 N. R. 84 W.

Geologist: J. Scyphers

Drilling Summary

Total Depth: 16'

Hole Dia.: 3-1/2"

Driller: Y-ENVIRONMENTAL

Rig: Geoprobe

Bit(s): 3-1/2" direct push drive shoe

Fluid: Air and foam

Casing: 2" SDR17 flush thread PVC

Well Data

Casing: C=Casing S=Screen

C1 - +2.5 - 6 | S1 - 6 - 16

Monument or Surface Casing:
5" lockable steel

Centralizer:
-

Casing C1:
2" SDR 17 flush thread PVC

Screen S1:
2" SDR17 flush thread PVC with 0.032" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 5 - 16

Bentonite:
3/8" chips
Depth: 0 - 5

Cement:
Depth: - - -

Other:
-

Construction Time Log

Drilling:	Start	End
8/14/15	-	-

Casing:	Start	End
8/14/15	-	-

Well Development

Remarks

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RECD MAY 23, 2019

Abandoned

Date:

Method:

WWC ENGINEERING

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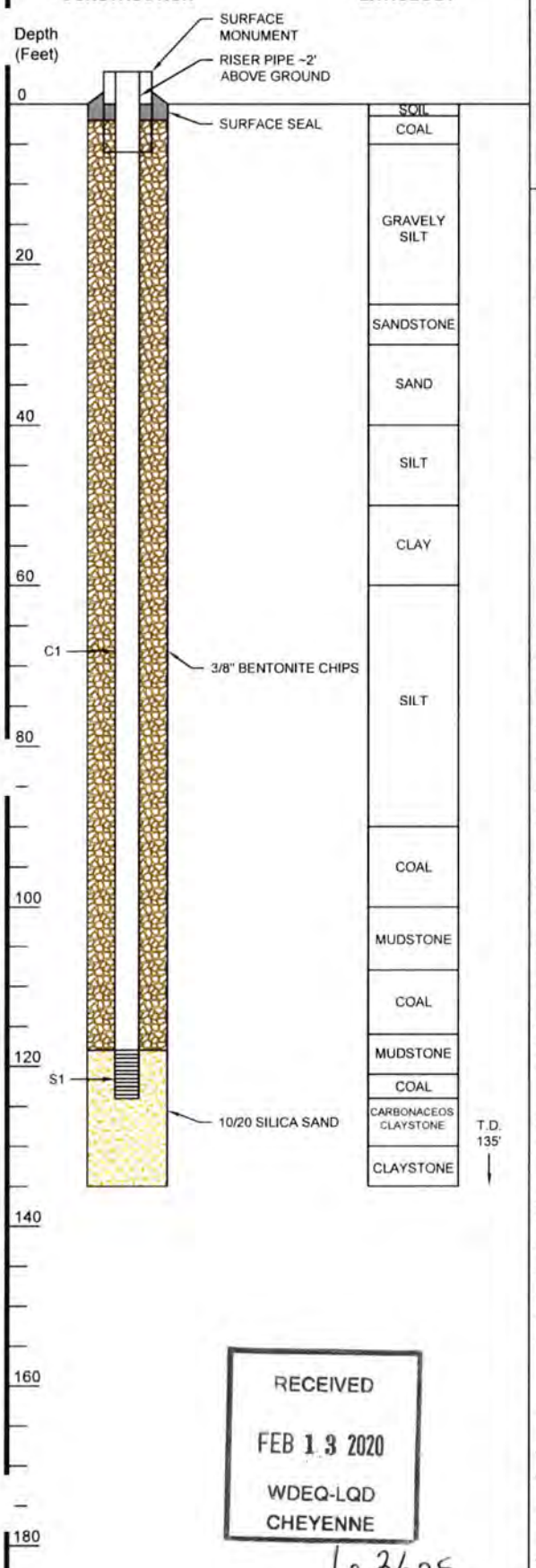

Well Construction Summary

Client: Ramaco
Project: Brook Mine Monitor Network Well: 578421-3-MAS
Location: N - E - EL -
- /4, - /4, Section 21 T. 57 N. R. 84 W.
Engineer: Loren Ruttinger

Drilling Summary

Total Depth: 135'
Hole Dia.: 8-3/4"
Driller: Kurt Taylor
Rig: Gardner Denver 1500
Bit(s): 14-3/4" roller (surface)
8-3/4" PDC to ream
Fluid: Water, foam, polymer, bentonite mud
Casing: 5" Certa-Lok SDR-21 PVC

Well Data

Casing: C=Casing S=Screen

C1 - 118 - +2 | S1 - 124 - 118

Monument or Surface Casing:
8" Locking Steel

Centralizer:
-

Casing C1:
5" Certa-Lok SDR-21 PVC

Screen S1:
5" PVC with 0.020" slots

Filter Pack:
10/20 Colorado Silica Sand
Depth: 118 - 135

Bentonite:
3/8" chips
Depth: 2 - 118

Cement:
Type 1
Depth: 0 - 2

Other:

Construction Time Log

Drilling:	Start	End
12/2/14		

Casing:	Start	End
12/5/14		

Well Development

DEVELOPED WITH AIR LIFT FOR APPROXIMATELY 1.75 HOURS WITH THE AIR LINE AT 120'

Remarks

BENTONITE CHIPS SWELLED IN ANNULUS AND BRIDGED. COULD NOT GET FULL ANNULAR VOLUME OF BENTONITE IN HOLE.

RECEIVED FEB 18 2020 WDEQ/LQD

Abandoned

Date:
Method:

WWC ENGINEERING

RECEIVED FEB 13 2020 WDEQ-LQD CHEYENNE

6/2/25

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AMERICAN ENGINEERING TESTING, INC.

BORING LOG

PROJECT NUMBER	19-20119	**BORING/WELL NUMBER**	578415-AL-1
PROJECT NAME	WWC Monitoring Well	**DATE DRILLED**	7/19/19
LOCATION	Acme, Wyoming	**CASING TYPE/DIAMETER**	Flush Threaded 2" Sch. 40 PVC
DRILLING METHOD	4.25" HSA	**SCREEN TYPE**	Flush Threaded 2" PVC Screen
SAMPLING METHOD	Continuous	**PACKING TYPE**	10-20 Silica Sand
GROUND ELEVATION	3,573.08 feet	**GROUT TYPE**	Bentonite
TOP OF CASING	3,576.00 feet	**DEPTH TO WATER**	29.80 feet from TOC @ 1300 on 7/19/19
LOGGED BY	J. Huot	**GROUND WATER ELEVATION**	3,546.20 feet
REMARKS	Latitude: 44.912803; Longitude: -106.978316	Depth to bottom of well from TOC = 36.90 feet	

HNU (ppm)	Blow Count	RECOVERY (inches)	SAMPLER TYPE	DEPTH (ft. BGL)	U.S.C.S.	MATERIAL DESCRIPTION
NA	NA	60	HSA 1	0–5	CL / CLG	**Lean Clay** with gravel and organics, brown, moist (Fill) **Gravelly Lean Clay** with sand and trace organics, brown, moist (Fill)
NA	NA	60	HSA 2	5–10	CLM CLS	**Silty-Sandy Lean Clay** tan-brown, moist (Fill)
NA	NA	60	HSA 3	10–25	CLM	**Silty Lean Clay** with sand, gravel, and cobbles, interbedded with coal and weathered shale fragments, brown-gray-black, moist (Fill)
NA	NA	60	HSA 4			
NA	NA	60	HSA 5			**Note:** Increased moisture content
NA	NA	60	HSA 6	25–30	SS	**Weathered Fine Grained Sandstone** interbedded with weathered shale and silty lean clay lenses, gray-tan, wet (Tongue River Member of the Fort Union Formation)
NA	NA	49.2	HSA 7	30–34		End of Boring

GW LEVEL ▽

4"x4"Steel Protective

Concrete Seal

2" PVC Riser

Bentonite Seal

2" PVC 0.010" Slot Screen

10-20 Silica Sand

AET_ENVI 19-_GPJ AET_ENVI.GDT 7/22/19

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ADDENDUM D6-8

Pumping Test Report

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Attachment D6-8-B	Example Field Form
Attachment D6-8-C	Masters Pumping Test November 12, 2013, Discharge Rate Data
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Attachment D6-8-E	Masters Wells Groundwater Level Hydrographs
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Attachment D6-8-G	Section 9 Aquifer Pumping Test, Observation Well 578409-MST-OB, Plots of Time-Drawdown and Analyses
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D6-8 PUMPING TEST

D6-8.1 Introduction

This report presents the results of the pumping test program conducted in support of the Brook Mine Permit Application. The program was conducted at the Section 9 baseline characterization well cluster located in the SESE quarter/quarter of Section 9, Township 57 north, Range 84 west. After discussion with WDEQ and analysis of historic well data surrounding the permit area, a cluster of wells in the eastern portion of permit was chosen because the coal seam aquifers in the western portion of the permit area were dry, or exhibited very little saturation. The Section 9 well cluster is depicted on Figure D6-1.

The Section 9 cluster consists of five separate monitor wells. Two monitor wells are completed in the Carney Coal, two are completed in the Masters Coal, and one monitor well is completed in the underburden beneath the Masters Coal. Wells were not completed in the overburden and interburden because these units were dry. No alluvial material is present within the immediate vicinity of the cluster so alluvial monitor wells were not completed as part of the cluster. Separate pumping tests were conducted on wells completed in the Masters and the Carney Coal seams. Only one underburden well was used for the testing as the underburden was typically unsaturated. Figure D6-2 depicts the relative location of each of the wells in the cluster.

D6-8.1.1 Purpose and Scope

This report describes the methods and techniques used to measure the aquifer characteristics of hydraulic conductivity (K), transmissivity (T), and storativity (S) of the aquifers of interest and provides the test results.

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D6-8.2 Pumping Test Procedures

Prior to performing the pumping tests, WWC Engineering (WWC) developed a pumping test plan to serve as an operational guide for field

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personnel during the pumping test. The pumping tests were performed in accordance with this plan. This plan is included in Attachment D6-8-A.

D6-8.2.1 Pumping Test Equipment/Discharge Management

The pumped wells were equipped with a Grundfos Redi-Flo2 0.5 horsepower submersible pump powered by a portable generator. The pump setting depth was approximately 119 feet below ground level (bgl) in the Masters well (MST-1), and 105 feet bgl in the Carney well (CRN-1). During each test the discharge rate was controlled with a ball valve, a pressure gage, and a 0.5 gpm Dole valve. The flow was manually controlled using the ball valve to maintain a constant pressure reading, which ensured a constant discharge rate. Flow rates were measured using a bucket and stop watch. A blank example field form is included in Attachment D6-8-B. Discharge measurement field data sheets for the Masters and Carney pumping test areas are provided in Attachments D6-8-C and D6-8-D, respectively. The flow rate was maintained at approximately 0.33 gpm during both pumping tests. Pumped water was contained onsite within excavated pits. No water was discharged to any drainages during the tests.

D6-8.2.2 Background Monitoring

Background monitoring for each test was conducted using a combination of transducers and manual depth measurements. Three transducers were used during each test. All three transducers were manufactured by In-Situ Inc. Two of the transducers had a full scale reading range of 15 psi and the other one had a 50 psi range. All the transducers were set to record water level on one minute increments prior to and during the pumping tests.

D6-8.2.2.1 MST-1 Pumping Test Background Monitoring

For the MST-1 pumping test, the 15 psi transducers were installed in the MST-1 and the Masters Observation well (MST-OB) approximately 19 hours before the start of the pumping test. The 50 psi transducer was

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installed in the Masters underburden well (MST-UB) at the same time the Master's wells were instrumented. Manual groundwater level measurements were used to verify the transducer data prior to and during the pumping tests. Prior to the pumping test there had been no drilling, sampling, or pumping activities near the site for 35 days. Water levels measured over the 19 hour pre-test monitoring period demonstrated that the aquifer was stable prior to the pumping tests since no measurable changes in the water levels were observed.

D6-8.2.2.2 CRN-1 Pumping Test Background Monitoring

For the CRN-1 pumping test, the 15 psi transducers were installed in the CRN-1 and the Carney Observation well (CRN-OB) approximately 16 hours before the start of the pumping test. The 50 psi transducer was installed in MST-1 at the same time the Carney wells were instrumented. Manual groundwater level measurements were used to verify the transducer data prior to and during the pumping tests. The Carney Coal seam pumping test was conducted two days after the pumping test conducted in the Masters Coal seam; however, prior to, during, and after the Masters pumping test manual water level measurements were taken in the Carney wells. Water level data collected from the Carney wells demonstrated that water levels in the Carney Coal did not deviate during the Masters pumping test and were stable prior to the pumping test.

D6-8.2.3 Test Procedures and Methods of Analysis

Prior to conducting the pumping tests, discharge rates and resulting time-drawdown data were recorded at the designated pumping wells during routine water quality sample collection. Based on the drawdown response at each pumped well, a pumping rate that would effectively stress the aquifer for an appropriate test duration was determined, thus eliminating the need to conduct a step-drawdown analysis on the pumping wells to select the optimum pumping rates.

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The raw pressure transducer data were downloaded in the field and then converted into Microsoft Excel files. As applicable, manual water level measurements were added to transducer data in order to extend the data set. The time-drawdown data, along with the pumping rates and well completion information, were then imported into the Aquifer^{Win32} program (ESI 2003) for analysis and presentation.

D6-8.3 Pumping Tests

D6-8.3.1 Well Locations and Completion Intervals

The Cluster 9 wells are located within the same general vicinity (within a 50 foot radius as shown on Figure D6-2). Completion information for each well is provided in Table D6-1.

D6-8.3.2 Pumping Rate and Duration

D6-8.3.2.1 Masters Pumping Rate and Duration

Within the Masters Coal seam, the pumping test commenced in MST-1 at 11:12AM on November 12, 2013 and ended at 9:52PM on November 12, 2013 for a total duration of 640 minutes. MST-1 was pumped at an average discharge rate of 0.33 gpm. Discharge measurement field data sheets are included in Attachment D6-8-C. After the pumping period, the transducers remained in MST-1 and MST-OB until 4:30PM on November 13, 2013. Manual water level observations continued until 8:00AM on November 16, 2013.

D6-8.3.2.2 Carney Pumping Rate and Duration

Within the Carney Coal seam the pumping test commenced in CRN-1 at 8:41AM on November 14, 2013. After approximately 12 minutes the pump overloaded, and shut down. The pump was immediately restarted and then it shut down again at approximately 9:00AM (7 minutes). Believing that the pump may have been set in the mud at the bottom of the well the pump was raised four feet and restarted at 9:03AM. After raising the pump in the well, no further problems were encountered and the pump continued to pump at a

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steady rate with no shut-downs until the test was terminated at 7:35PM. The total duration of the test was 632 minutes. CRN-1 was pumped at an average rate of 0.33 gpm. Discharge measurement field data sheets are included in Attachment D6-8-D. After the pumping period, the transducers remained in CRN-1 and CRN-OB until 8:00AM on November 16, 2013.

D6-8.3.2.3 Well Responses

Groundwater level hydrographs for the pumped well and the observation wells for the Masters and the Carney pumping tests are presented in Attachments D6-8-E and D6-8-F, respectively. Tables D6-2 and D6-3 summarize the maximum amount of drawdown observed in each well during the pumping tests.

The pumping test results demonstrate that the observation and pumped wells within each respective coal seam are in hydraulic communication with each other. When the Masters well (MST-1) was pumped, there was no response due to pumping in the Carney wells, and conversely when the Carney well (CRN-1) was pumped no response was observed in the Masters wells. In both cases no response due to pumping was recorded in the underburden well (MST-UB) which demonstrates that the Masters and Carney wells are not in hydraulic communication with each other nor are they in communication with the underburden.

It is unlikely that a longer pumping period would have resulted in communication across the interburden between the coals because there are significant differences between the static water levels in the Carney coal and the Masters coal. As shown on Table D6-2, the initial water level in the Carney Coal was approximately 11.5 feet higher than the water level in the Masters Coal and the initial water level in the Masters Coal was approximately 9 feet higher than the initial water level in the underburden well. If there were a hydrologic connection between the aquifers, it is likely that the water levels in the aquifers would have come into equilibrium.

As noted on Tables D6-2 and D6-3, increased water levels were noted in the Carney Coal wells during the Masters Coal pumping test that are attributed to changes in barometric pressure. A similar rise in water levels due to the barometric pressure was noted in the Masters Coal wells during the Carney Coal pumping test although the rising water level may also be attributed to recovery from the previous pumping test in the Masters coal. Field water level measurements as compared to barometric pressure measurements collected at the Sheridan County Airport (approximately 10 miles south of the wells) is included as Attachment D6-8-K.

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Only very minor water level variations in the Masters underburden well (MST-UB) were noted during both pumping tests. As shown on the well completion form in Addendum D6-7, MST-UB was completed in an interval that was predominately claystone with an estimated yield less than 2 gpm. Essentially, the strata in which MST-UB is completed is more of an aquitard than an aquifer. As a result, it takes a lot longer for the water levels in the well to adjust to changing atmospheric pressure because water does not enter or discharge from the formation very fast. The lack of barometric responses in the MST-UB are attributed to the fact that the low yielding aquitard in which the well is completed has a lower barometric efficiency than the wells completed in the coal aquifers.

D6-8.4 Determination of Aquifer Parameters

Drawdown data from pumping tests completed in each respective coal seam were used to determine the hydraulic coefficients of the Carney and Masters Coal. The Aquifer^{Win32}, Version 3, software was used to analyze the drawdown and recovery data for the pumped wells and the observation wells.

At the Section 9 cluster, the Masters Coal seam is approximately six feet thick and the Carney Coal seam is approximately 18 feet thick. As shown on Table D6-1 the screened interval in the Masters Coal wells is five feet. The screened interval in the Carney Coal wells is 20 feet. In a confined aquifer, the optimum screen length should be 80 to 90 percent of the aquifer's thickness (Driscoll 1986). Therefore, all the wells are considered to be fully penetrating wells.

The aquifer coefficients of transmissivity (T) and storativity (S) for the pumped well and the observation well were calculated using the Cooper-Jacob (1946) and Theis (1935) methods. The results are summarized in Table D6-4 and plots of the time-drawdown data and analyses are included in Attachments D6-8-G through D6-8-J. The transmissivity estimates resulting from the various analysis methods were consistent and for the Carney Coal range from 5.1 to 5.6 ft^2/day, and for the Masters Coal the transmissivity ranged from 2.9 to 3.6 ft^2/day. The drawdown data for all four wells closely follow the Theis curve. No hydrologic boundary conditions were encountered and the hydraulic conductivity values presented in Table D6-4 are considered valid. No responses were observed across the interburden, therefore the vertical hydraulic conductivity of the interburden is too low to measure and no analysis were performed to assess the aquifer parameters in the interburden. Additionally, the differing static water levels in the Carney and Masters coal seams demonstrate that the vertical hydraulic conductivity of the interburden is very low. Storativity values were determined using the Theis drawdown analysis on the observation wells. The storativity estimated at the Carney

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observation well (CRN-OB) is 3.6 x 10^{-4} and at the Masters Observation well (MST-OB) is 2.5 x 10^{-4}. These storativity values suggest confined aquifer conditions.

There are several faults identified within the region, however no hydrologic boundary conditions were observed in the data, therefore it can be surmised that the faults did not have an impact on the results of the aquifer tests. As can be seen on Exhibit D6.2-2, the 578409 well cluster is located approximately 2,100 feet south and east of the nearest mapped fault. Since neither the Carney nor the Masters coal seams are very robust aquifers and have low transmissivity values, it is not surprising that the nearest fault would not influence the pumping test results. For example, using Theis drawdown equations and the aquifer characteristics measured in the Masters coal (transmissivity of 3.2 ft^2/day, storativity of 2.5 x 10^{-4}, and a pumping rate of 0.5 gpm), it is estimated that it would take over 70 days of continuous pumping for a water level response greater than 0.5 feet to be observed 2,000 feet away. Therefore the likelihood that the faults would have influenced the pumping test results is very low.

D6-8.5 Summary and Conclusions

The goals of the aquifer pumping test program were 1) to evaluate the aquifer hydraulic characteristics of the coals and develop baseline data to be used for modeling and permitting purposes, 2) to evaluate the level of hydraulic communication between the coals and the underburden beneath the Masters Coal. The pumping test program successfully met both goals. As shown in Table D6-4, data from the pumping test was able to be successfully used to estimate the hydraulic conductivity and the storativity of the coal aquifers. The test also demonstrated the lack of hydraulic communication between the coal seams and the underburden at the test site.

D6-8.6 References

Cooper, H.H., Jr., and C.E. Jacob, 1946, A generalized graphical method for evaluating formation constants and summarizing well field history, Trans. Amer. Geophysical Union, Vol. 27 pp. 526-534.

Driscoll, F.G., 1986, Groundwater and Wells, Second Edition, Johnson Division, St. Paul, Minnesota

Environmental Simulation Inc. (ESI), 2003, AquiferWin32Version 3, (aquifer test analysis software). Available online at: <http://www.groundwatermodels.com/ESI_Software.php>

Theis, C.V., 1935, The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Trans. Amer. Geophys. Union, Vol. 16, pp. 519-524.

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D6-8.7 Certification

I, Michael J. Evers, hereby certify that this report was prepared by myself or under my direct supervision and that it correctly represents the conditions described in the accompanying addendum which is provided to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

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Table D6-1. Well Completion Information

Well ID	Geologic Unit Monitored	Well Type	Depth to Top of Screen (ft bgs)	Depth to Bottom of Screen (ft bgs)	Total Depth (ft)
CRN-1	Carney Coal	Pumped Well	88	108	109
CRN-OB	Carney Coal	Observation	89	109	110
MST-1	Masters Coal	Pumped Well	115	120	122
MST-OB	Masters Coal	Observation	116	121	122
MST-UB	Masters Coal Underburden	Observation	130	140	142

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Table D6-2. Pumping Test Drawdown and Response Summary for Masters Coal Pumping Test

Well ID	Well Type	Initial Depth to Water (ft)	Initial Water Level Elevation (ft amsl)	Maximum Drawdown (ft)	Time After Pump On for First Drawdown Response (min)	Radial Distance from Pumped Well (ft)
CRN-1	Observation	91.2	3621.5	+0.23 ft*	No Response	14.1
CRN-OB	Observation	91.1	3621.9	+0.23 ft*	No Response	29.8
MST-1	Pumped	101.7	3610.7	10.4	0	0
MST-OB	Observation	102.3	3611.0	6.3	2	13.1
MST-UB	Observation	110.1	3602.0	0	No Response	14.1

* Rising water levels during the test were attributed to changes in barometric pressure over the course of the test. Over the course of the test the barometric pressure measured at the Sheridan County Airport decreased by 0.31 feet. Assuming a similar change in barometric pressure occurred at the site, the water level in the observation wells would be expected to rise as a result.

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Table D6-3. Pumping Test Drawdown and Response Summary for Carney Coal Pumping Test

Well ID	Well Type	Initial Depth to Water (ft)	Initial Water Level Elevation (ft amsl)	Maximum Drawdown (ft)	Time After Pump On for First Drawdown Response (min)	Radial Distance from Pumped Well (ft)
CRN-1	Pumped Well	90.9	3621.8	6.1	0	0
CRN-OB	Observation	90.9	3622.1	2.9	2	15.7
MST-1	Observation	101.8	3610.6	0	No Response	14.1
MST-OB	Observation	102.5	3610.8	+0.27*	No Response	13.3
MST-UB	Observation	110.1	3602.0	+0.29*	No Response	28.2

* The rise in water level recorded in the MST-OB and MST-UB wells is attributed to the combined effects of continued water level recovery and barometric pressure changes, over the course of the test. The barometric pressure is estimated to have decreased by 0.19 feet which would result in a rise in the water levels in the well. In addition, the Masters Coal wells were still recovering from the pumping test two days earlier which may also explain the water level recovery observed in the wells.

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Table D6-4. Masters and Carney Pumping Tests Summary of Hydraulic Characteristics

Well ID	Well Type	Interpretation Method	Transmissivity (ft^2/day)	Aquifer Thickness (ft)	Hydraulic Conductivity (ft/day)	Storativity (unitless)
Carney Coal Hydraulic Characteristics						
578409-CRN-1	Pumped	Cooper Jacob Straight Line Drawdown	5.7	18	0.32	-
		Theis Drawdown (Confined)	5.1	18	0.28	-
		Theis Recovery	5.2	18	0.29	-
578409-CRN-OB	Observation	Cooper Jacob Straight Line Drawdown	6.0	18	0.33	0.000343
		Theis Drawdown (Confined)	5.9	18	0.33	0.000384
		Theis Recovery	5.6	18	0.31	-
		Minimum	**5.1**		**0.28**	**0.000343**
		Maximum	**6.0**		**0.33**	**0.000384**
		Average	**5.6**		**0.31**	**0.000364**
Masters Coal Hydraulic Characteristics.						
578409-MST-1	Pumped	Cooper Jacob Straight Line Drawdown	3.2	6	0.53	-
		Theis Drawdown (Confined)	3.2	6	0.53	-
		Theis Recovery	2.9	6	0.48	-
578409-MST-OB	Observation	Cooper Jacob Straight Line Drawdown	3.6	6	0.6	0.000203
		Theis Drawdown (Confined)	3.3	6	0.55	0.000294
		Theis Recovery	3.1	6	0.52	-
		Minimum	**2.9**		**0.48**	**0.000203**
		Maximum	**3.6**		**0.60**	**0.000294**
		Average	**3.2**		**0.54**	**0.000249**

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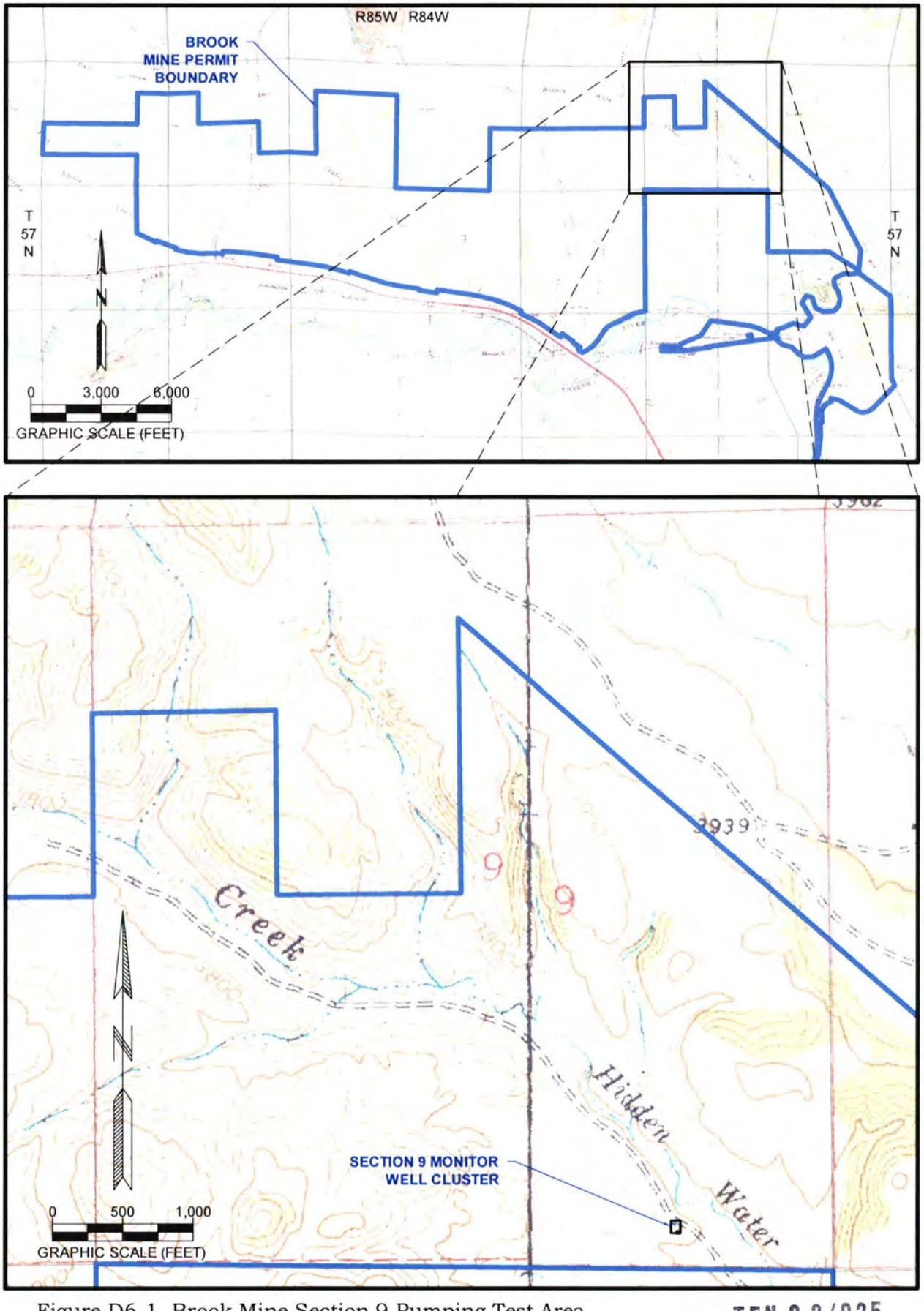

Figure D6-1. Brook Mine Section 9 Pumping Test Area

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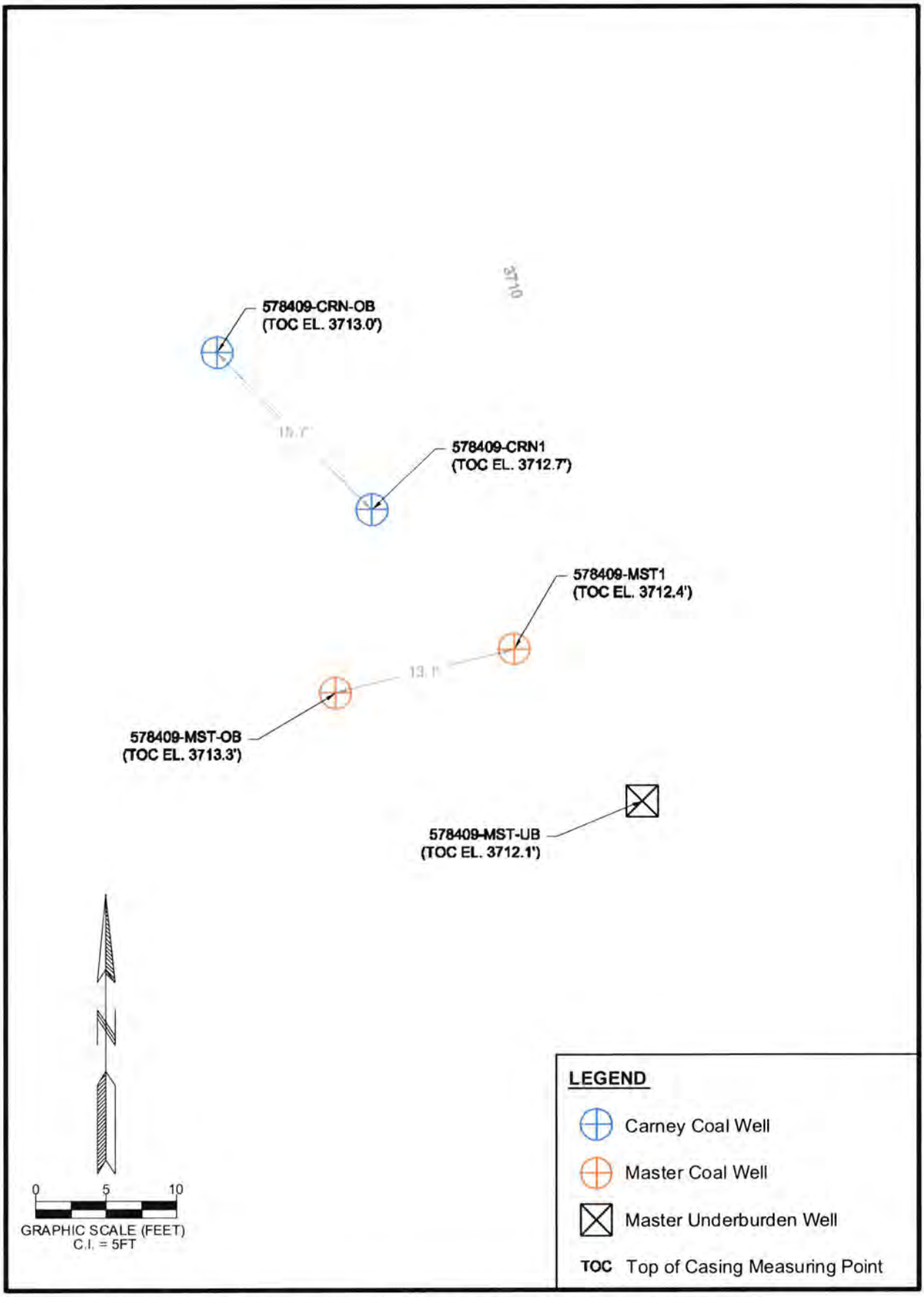

Figure D6-2. Brook Mine Section 9 Pumping Test Well Layout Details

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ATTACHMENT D6-8-A

RAMACO Proposed Brook Mine
Pumping Test Plan

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RAMACO Proposed Brook Mine Pumping Test Plan
November 4, 2013

INTRODUCTION

This work plan details procedures to complete a pumping test on baseline monitor wells constructed as part of RAMACO's proposed Brook mine. The goal of the pumping test is to determine aquifer hydraulic properties for the Carney and Masters coal seams within the project area.

PUMPING TEST PROGRAM

Wells

RAMACO has completed 2 wells in both the Carney and the Masters coal seams. In each coal seam one well will serve as a pumping well and the other will serve as an observation well. In both coal seams the observation well is located approximately 15 feet from the proposed pumping well.

Antecedent Conditions

The pumped well and the observation well will each be equipped with recording pressure transducers. These transducers will collect water level data continuously. The pressure transducers will be vented, which eliminates the barometric effects on the sensor.

After the pressure transducers are installed in each well, water level data will be collected prior to the pumping test to establish antecedent conditions. Water level data will be collected for up to 24 hours prior to the test to demonstrate that aquifer conditions are stable. In order to evaluate aquifer stability, the pre-test hydrograph will be evaluated to determine if the observed water level changes are beyond what can be attributed to naturally occurring barometric effects. If water level changes are greater than barometric effects, the pre-test monitoring period will continue until background water level trends can be determined to properly evaluate test data.

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Test Discharge Rate and Duration

Anticipated pumping test constant discharge rates will range from 0.25 to 5 gpm. The duration of the test may range from 12 to 24 hours as field conditions merit. Ultimate test duration will be determined in the field with the test duration adjusted as necessary to ensure a drawdown response is observed in the observation well. Typically, the minimum acceptable response in an observation will be one foot. Field data will be collected and analyzed in real time to determine if boundary or equilibrium conditions are encountered. Example field forms are included in Attachment D6-8-B.

Discharge Management

Water will be collected in a stock tank and used for livestock or wildlife water or used for irrigation in those instances that it meets WQD rules and regulations, Chapter 8, Table 1, Class I, II or III. Water will not be directly discharged in a manner that allows it reach waters of the state.

TEST PROCEDURES AND METHODS OF ANALYSIS

Two separate pumping tests are planned, one of which will occur in the Carney Coal seam and the other will occur in the Masters Coal seam. The procedures for each test are described in detail below.

Water Level Measurement

During each pumping test water levels within the pumped well and the observation well completed in the same coal seam will be measured with recording pressure transducers. The pressure transducers will be installed in the observation wells prior to the pumping test and aquifer stabilization will be evaluated before the test commences. Table 1 provides proposed pressure transducer specifications. Prior to the test, water levels will be measured to the nearest hundredth foot with an electronic water level probe and pressure transducers will be set to record head changes once per minute. After pumping

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has ceased, water level measurement will continue through recovery of the pumped well. Typically, recovery will be defined as the point at which water levels in the pumping well reach 90 percent of the pre-pumping test levels. Depending on the specific aquifer conditions and the location of the well, recovery levels may be adjusted as necessary. All well response and discharge data will be recorded on the field form, an example of which is provided in Attachment D6-8-B.

Table 1. Monitor Well Transducer Specifications

Well Type	Transducer	Parameters Measured	Accuracy
Pumping Well	50 psi	Pressure level	Press. ± 0.01%
Production Observation Wells	15 psi	Pressure level	Press. ± 0.01%

In order to determine the degree of hydrologic continuity between each coal seam, periodic manual water level measurements will be taken throughout each pumping test in the observation well completed in the adjacent coal seam. In order to determine whether the pumping test is actually influencing water levels in the adjacent coal seam, manual water levels will be collected during each stage of the pumping test which includes the pre-pumping stabilization stage, pumping stage, and aquifer recovery stage.

Discharge Measurement

Dole Valves will be used to maintain constant flow rates during the pumping tests. For the first eight hours of the test the flow will also be manually recorded using a stop watch and container of known volume by field personnel on intervals not exceeding two hours. Depending on the performance of the pumping well during the initial pumping period, the frequency of the manual flow verification may be reduced for the remainder of the pumping test.

Field Measurement and Samples

Field parameters (pH) will also be measured in conjunction with flow measurements.

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Field Operations and Schedule

The pumping test will be conducted using a portable generator to provide power to a pump installed within the pumping well. A typical pumping test could take up to six days. The exact test schedule may vary depending on actual aquifer conditions encountered at the pumping test location. Table 2 summarizes a typical pumping test schedule.

Table 2. Typical Pumping Test Schedule

Transducer Installation	Stability Monitoring	Pump Test	Recovery
1 Day	1 Day	12-24 Hours	Up to 3 Days

Flow Management

A dole valve will be used to maintain a constant flow rate. Pressure upstream of the dole valve will be measured throughout the pumping test to ensure the pressure is appropriate for accurate flow regulation through the dole valve. A manual valve installed upstream of the both the dole valve and the pressure gauge will allow for adjustment of the pressure and ultimately flow through the dole valve to ensure flow is maintained at a constant rate. Manual flow measurements using a bucket and stopwatch will be used to verify flow rates.

METHODS OF ANALYSIS

Pumping test results will be analyzed using the Cooper and Jacob (1946) method for the drawdown portion of the test and the Theis (1935) for the recovery portion of the test.

Data will also be evaluated using the method(s) appropriate to the observed well responses. Depending upon the response recorded in the observation and pumping wells (i.e. confined, unconfined, leaky confined, and partial penetration). One or more of the following techniques will be used:

- Non-leaky confined, Theis (1935); Cooper and Jacob (1946)
- Leaky confined, Hantush and Jacob (1955)

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- Leaky confined with storage in confining layer, Hantush (1960)
- Partial penetration, Hantush (1964)
- Unconfined, Neuman (1972, 1975)

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ATTACHMENT D6-8-B

Example Field Form

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WWC ENGINEERING

AQUIFER TEST FIELD DATA

Project/Client _____

Pumped Well No. _____ Observation Well No. _____

Type of Pump Test: ☐ Constant Discharge ☐ Step-Drawdown

Pumped Well Casing ID _____ inches

Distance Between Pumped and Observation Wells _____ feet

Water Level Measurements by: ☐ electric tape ☐ pressure transducer

Discharge Measurements by: ☐ bucket/stopwatch ☐ flow meter ☐ flume/weir

Screen/Perforation Interval(s) (below land surface) _____

Depth of Pump Intake (below land surface) _____feet

Depth of Static Water Level (from measurement point) _____feet

Height of Measurement Point (above land surface) _____feet

Elevation of Measurement Point _____feet a.m.s.l.

Pump On Date _____/_____/_____ Time _____ AM/PM

Pump Off Date _____/_____/_____ Time _____ AM/PM

Weather Conditions _____

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Test Performed by _____

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WWC ENGINEERING

AQUIFER TEST FIELD DATA

Project/Client _____ Well No. _____

TIME			WATER LEVEL DATA				
Date	Clock Time	(**t**) Elapsed Time Since Pump ON or OFF (min)	Depth to Water Below M.P. (ft)	(**s**) Drawdown/ Recovery (ft)	(**Q**) Discharge (gpm)	Discharge Pipe Pressure (PSI)	COMMENTS

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ATTACHMENT D6-8-C

Masters Pumping Test
November 12, 2013
Discharge Rate Data

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WWC ENGINEERING

AQUIFER TEST FIELD DATA

Project/Client : RAMACO

Pumped Well No. MST-1 Observation Well No. MST-OB AND MST-UB

Type of Pump Test: ☒ Constant Discharge ☐ Step-Drawdown

Pumped Well Casing ID 4" inches

Distance Between Pumped and Observation Wells 12.8' TO MST-OB AND 14' TO MST-UB feet

Water Level Measurements by: ☒ electric tape ☒ pressure transducer

Discharge Measurements by: ☒ bucket/stopwatch ☐ flow meter ☐ flume/weir

0.5 gpm dole valve with constant pressure of 10 psi on valve.

Screen/Perforation Interval(s) (below land surface) _____

Depth of Pump Intake (below land surface) 119' feet

Depth of Static Water Level (from measurement point) 101.68' feet

Height of Measurement Point (above land surface) 2.64' feet

Elevation of Measurement Point _____ feet a.m.s.l.

Pump On Date 11 / 12 / 13 Time 11:11 (AM)/PM

Pump Off Date 11 / 12 / 13 Time 9:57 AM/(PM)

Weather Conditions Cool and foggy early then sunny.

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Test Performed by Ray Moores and Rod Fuller

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Starting WL = 101.68

Pump On @ 11:12

WWC ENGINEERING

AQUIFER TEST FIELD DATA

Project/Client RAMACO Well No. MST-1

TIME			WATER LEVEL DATA				
Date	Clock Time	(t) Elapsed Time Since Pump ON or OFF (min)	Depth to Water Below M.P. (ft)	(s) Drawdown/ Recovery (ft)	(Q) Discharge (gpm)	Discharge Pipe Pressure (PSI)	BUCKET TESTS COMMENTS
11-12-13	11:19	7 MINUTES	104.67	2.99	0.32	10 PSI	3:05 FOR ONE GALLON
11-12-13	11:25	13 MINUTES	105.10	3.42			
11-12-13	11:30	18 MINUTES			0.33	10 PSI	3:01 FOR ONE GALLON
11-12-13	11:31	19 MINUTES	105.88	4.2			
11-12-13	11:38	26 MINUTES	106.63	4.95			
11-12-13	11:50	38 MINUTES	107.40	5.72			
11-12-13	11:56	44 MINUTES	107.73	6.05	0.33	10 PSI	3:02 FOR ONE GALLON
11-12-13	12:15	63 MINUTES	108.46	6.78			
11-12-13	12:22	71 MINUTES	108.71	7.03			
11-12-13	12:42	80 MINUTES	109.19	7.51	0.32	10 PSI	3:05 FOR ONE GALLON
11-12-13	13:09	117 MINUTES	109.66	7.98			
11-12-13	13:23	131 MINUTES	109.87	8.19			
11-12-13	13:41	149 MINUTES	110.07	8.39	0.33	10 PSI	3:02 FOR ONE GALLON. INCREASED PRESSURE SLIGHTLY TO GET 10 PSI
11-12-13	14:24	192 MINUTES	110.58	8.9	0.34	10 PSI	2:56 FOR ONE GALLON
11-12-13	15:10	238 MINUTES	110.93	9.25		10 PSI	
11-12-13	15:24	252 MINUTES	111.02	9.34		10 PSI	
11-12-13	15:42	270 MINUTES	111.08	9.4	0.32	10 PSI	3:06 FOR ONE GALLON
11-12-13	16:06	294 MINUTES	111.20	9.52		10 PSI	

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WWC ENGINEERING

AQUIFER TEST FIELD DATA

Project/Client RAMACO Well No. MST-1

TIME			WATER LEVEL DATA				
Date	Clock Time	(t) Elapsed Time Since Pump ON or OFF (min)	Depth to Water Below M.P. (ft)	(s) Drawdown/ Recovery (ft)	(Q) Discharge (gpm)	Discharge Pipe Pressure (PSI)	BUCKET TESTS COMMENTS
11-12-13	16:50	338 MINUTES	111.31	9.63		10 PSI	
11-12-13	17:07	355 MINUTES	111.36	9.68	0.32	10 PSI	3:06 FOR ONE GALLON
11-12-13	21:47	635 MINUTES	112.00	10.32	0.32	10 PSI	3:10 FOR ONE GALLON
11-12-13	21:54	642 MINUTES	112.06	10.38		10 PSI	
		Pulled pump out of well at approximately 21:57. When we pulled the pump it was leaking water back into the well from the discharge line so there is a chance that until 21:59, there could have been rapid increases in water levels from pulling the pump.					

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ATTACHMENT D6-8-D

Carney Pumping Test
November 14, 2013
Discharge Rate Data

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WWC ENGINEERING

AQUIFER TEST FIELD DATA

Project/Client : RAMACO

Pumped Well No. CRN-1 Observation Well No. CRN-OB

Type of Pump Test: ☒ Constant Discharge ☐ Step-Drawdown

Pumped Well Casing ID 5" (nominal) inches

Distance Between Pumped and Observation Wells 15.4' feet

Water Level Measurements by: ☒ electric tape ☒ pressure transducer

Discharge Measurements by: ☒ bucket/stopwatch ☐ flow meter ☐ flume/weir

0.5 gpm dole valve continuously maintaining 10 psi ahead of dole valve.

Screen/Perforation Interval(s) (below land surface) _____

Depth of Pump Intake (below land surface) estimated at 105' (no actual measurement) feet

Depth of Static Water Level (from measurement point) 90.94' feet

Height of Measurement Point (above land surface) 2.55' feet

Elevation of Measurement Point _____ feet a.m.s.l.

Pump On Date 11 / 14 / 13 Time 8:41 (AM)/PM

Pump Off Date 11 / 14 / 13 Time 7:35 AM/(PM)

Weather Conditions Chilly in morning then partly cloudy, sunny warming into the 50's.

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RECD NOV 14, 2014

Test Performed by Ray Moores and Rod Fuller

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Starting WL = 90.94

Pump On @ 8:41

WWC ENGINEERING

AQUIFER TEST FIELD DATA

Project/Client RAMACO Well No. CRN-1

TIME			WATER LEVEL DATA				
Date	Clock Time	(t) Elapsed Time Since Pump ON or OFF (min)	Depth to Water Below M.P. (ft)	(s) Drawdown/ Recovery (ft)	(Q) Discharge (gpm)	Discharge Pipe Pressure (PSI)	BUCKET TESTS COMMENTS
11-14-13	08:41	0	90.94		~0.33		
11-14-13	08:50	9 MINUTES			0.32	10 PSI	ONE GALLON FOR 3:10
11-14-13	08:52	PUMP SHUT OFF					
11-14-13		RESTARTED					
11-14-13	09:00	PUMP SHUT OFF	PULLED PUMP OUT APPROX 4' TO GET OUT OF MUD				
11-14-13	09:03	RESTARTED					
11-14-13	09:08	27 MINUTES	93.56	2.62	0.33	10 PSI	
11-14-13	09:14	33 MINUTES	94.02		0.35	12 PSI	2:50 FOR ONE GALLON REDUCED PRESSURE
11-14-13	09:27	46 MINUTES	94.31	3.37	0.31	9 PSI	3:14 FOR ONE GALLON ADJUSTED TO 10 PSI
11-14-13	09:39	58 MINUTES	94.70	3.76	0.33		3:00 FOR ONE GALLON
11-14-13	10:01	80 MINUTES	95.47	4.53		10 PSI	
11-14-13	10:13	92 MINUTES	95.69	4.75		10 PSI	
11-14-13	10:27	106 MINUTES	95.87	4.93			
11-14-13	11:09	148 MINUTES	95.96	5.02	0.32	10 PSI	3:06 FOR ONE GALLON
11-14-13	11:23	162 MINUTES	96.07	5.13		10 PSI	
11-14-13	11:36	175 MINUTES	96.18	5.24		10 PSI	
11-14-13	11:50	189 MINUTES	96.26	5.32		10 PSI	
11-14-13	12:22	221 MINUTES	96.40	5.1	0.32		3:05 FOR ONE GALLON

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WWC ENGINEERING

AQUIFER TEST FIELD DATA

Project/Client RAMACO Well No. CRN-1

TIME			WATER LEVEL DATA				
Date	Clock Time	(t) Elapsed Time Since Pump ON or OFF (min)	Depth to Water Below M.P. (ft)	(s) Drawdown/ Recovery (ft)	(Q) Discharge (gpm)	Discharge Pipe Pressure (PSI)	BUCKET TESTS COMMENTS
11-14-13	12:33	232	96.44	5.5	0.32	10 PSI	
11-14-13	16:40	479	96.95	6.1		10 PSI	
11-14-13	16:57	496	96.95		0.31	10 PSI	3:11 FOR ONE GALLON SLIGHTLY INCREASED FLOW
11-14-13	17:55	554	97.15	6.21		10 PSI	
11-14-13	19:18	577	97.27			10 PSI	
11-14-13	19:33	592	97.26		0.33	10 PSI	3:00 FOR ONE GALLON
		Shut off pump at 19:35, 5.25 psi above transducer at the end.					

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ATTACHMENT D6-8-E

Masters Wells Groundwater Level Hydrographs

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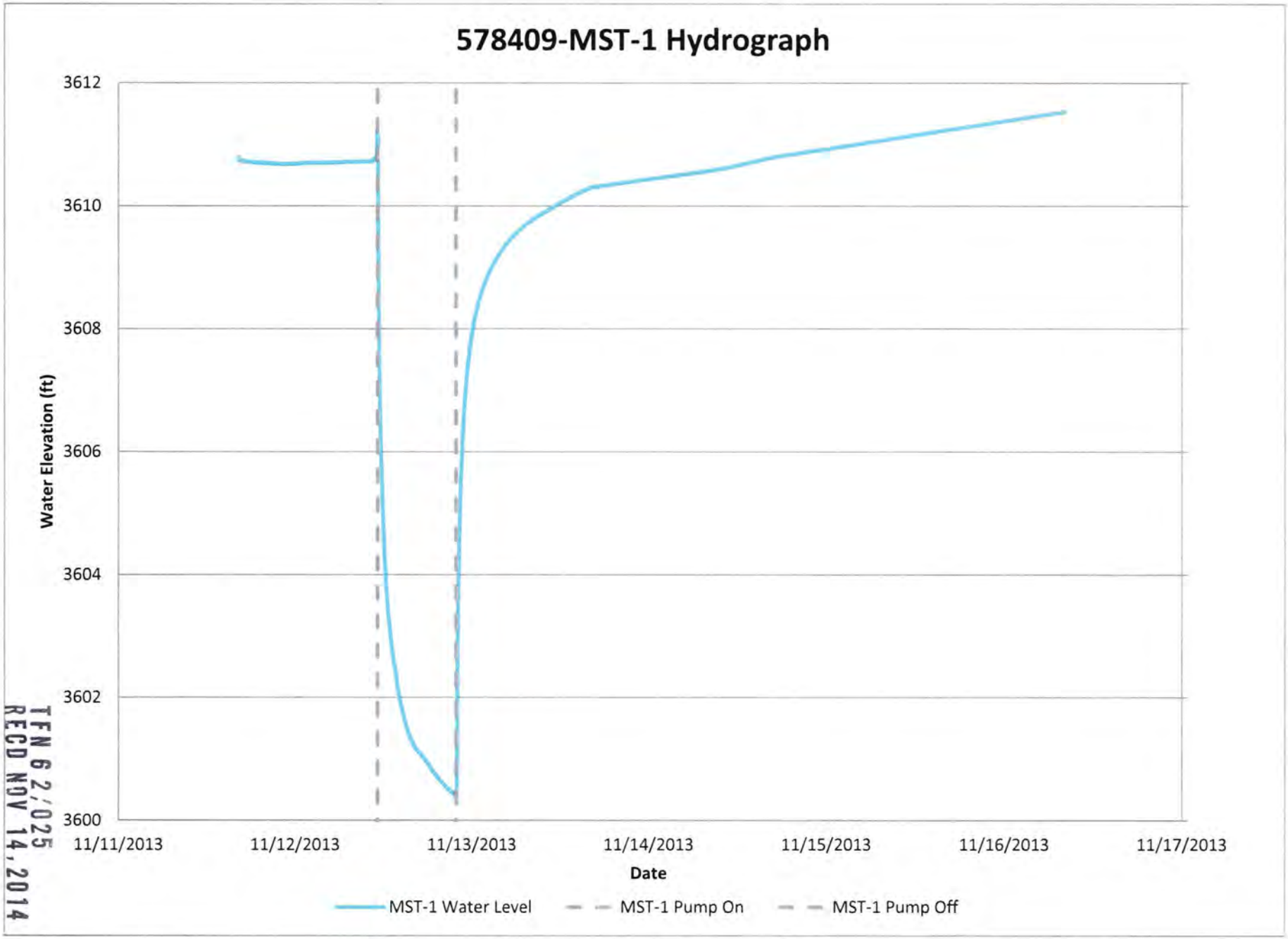

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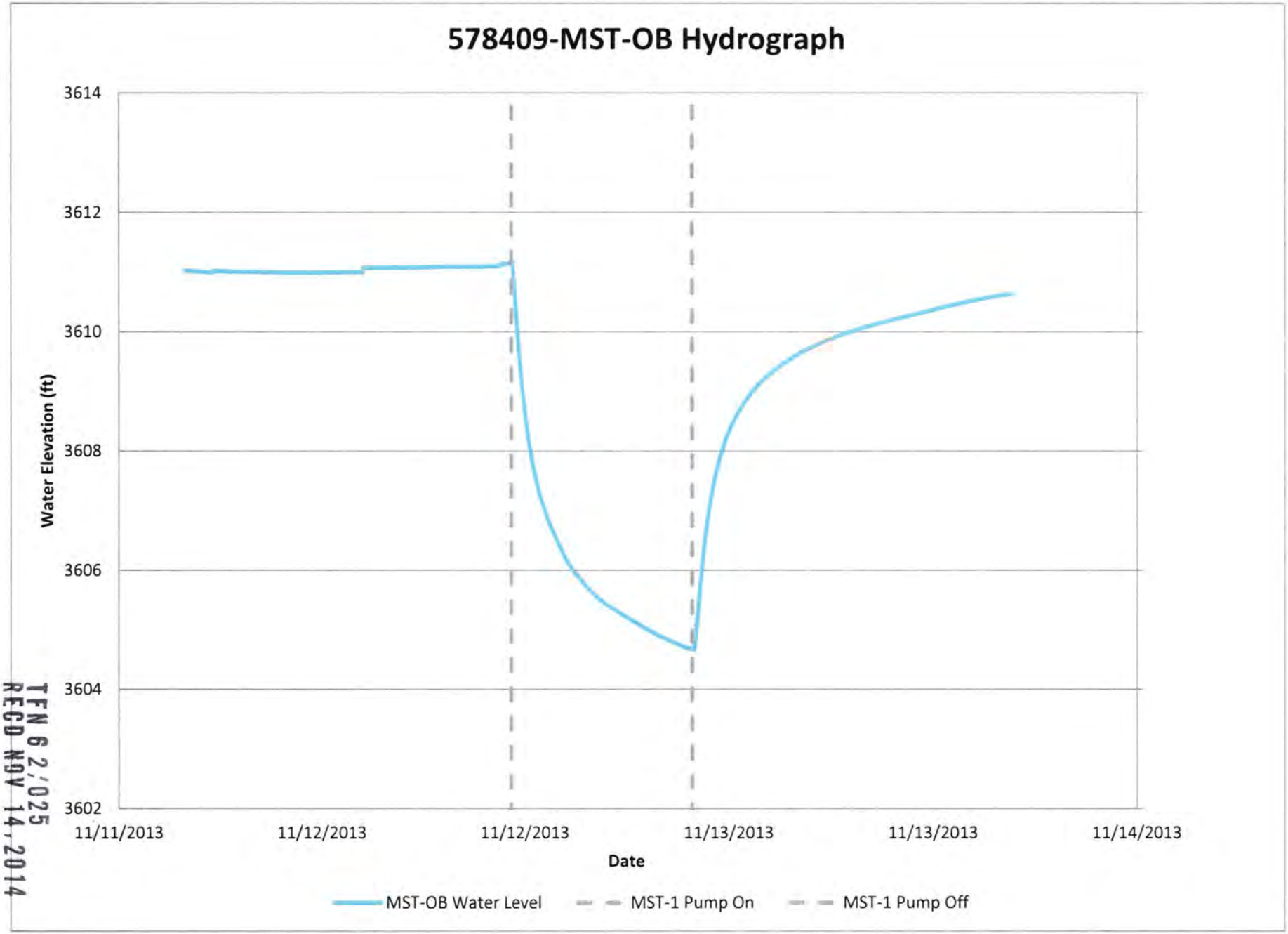

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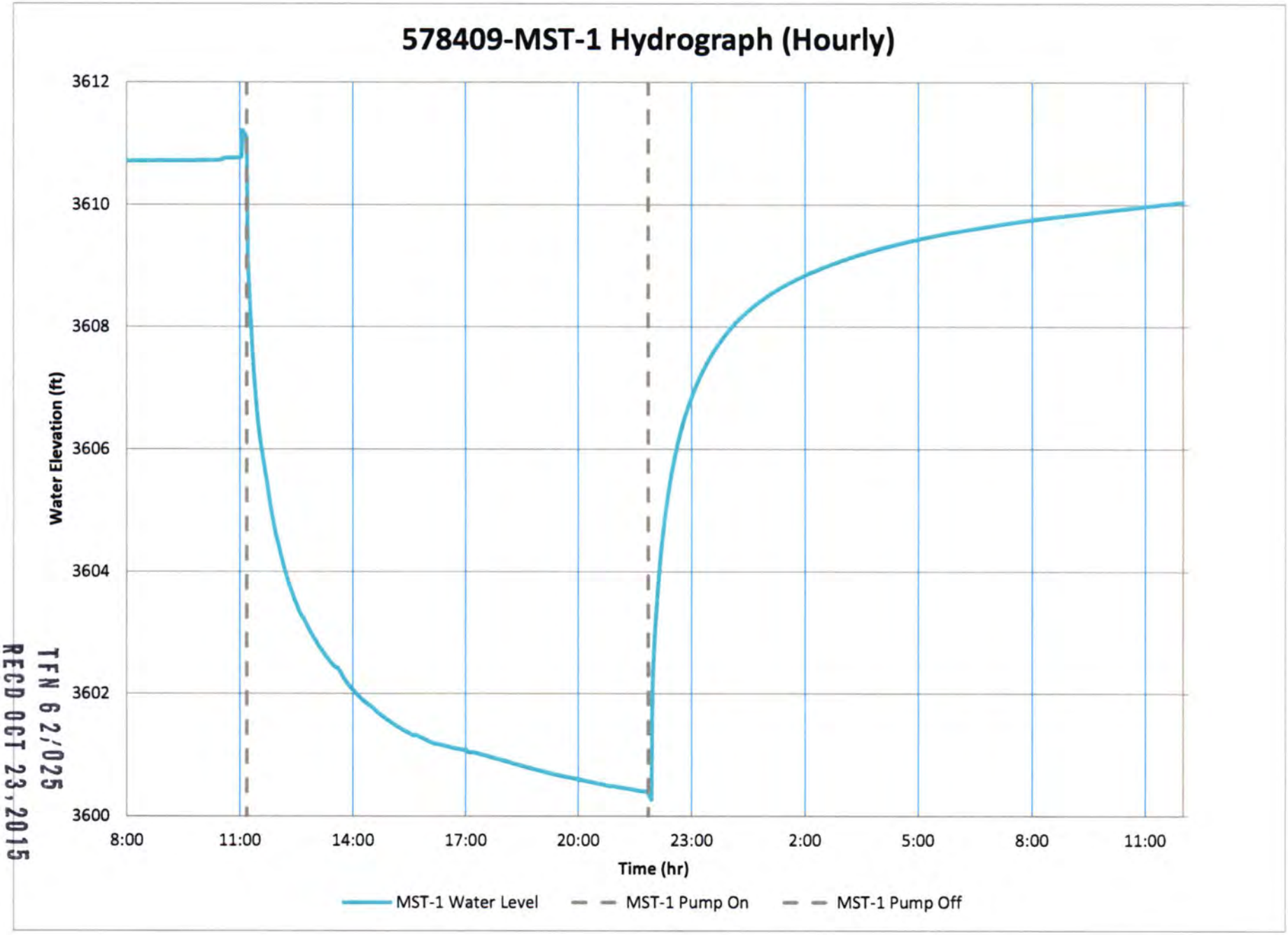

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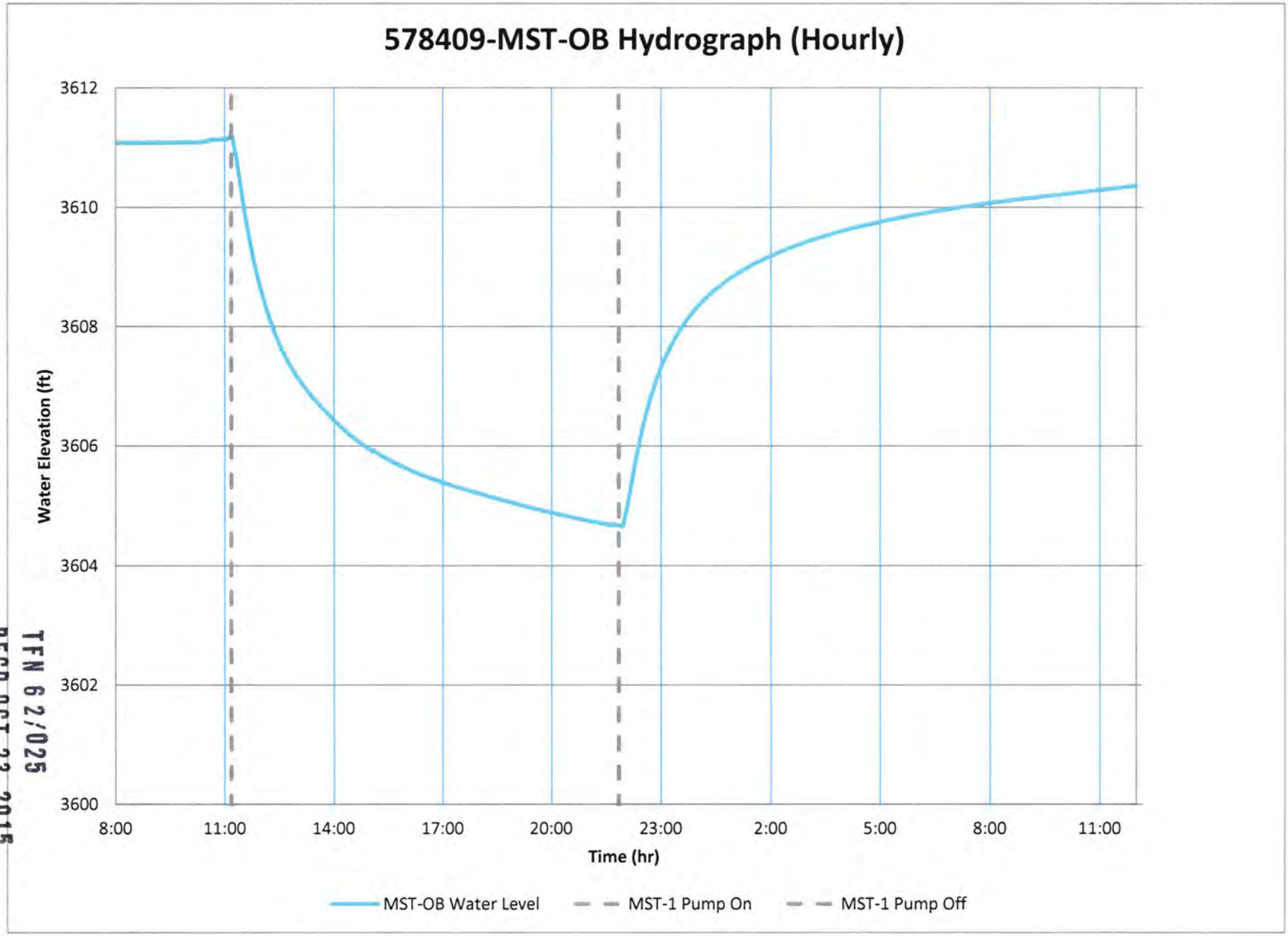

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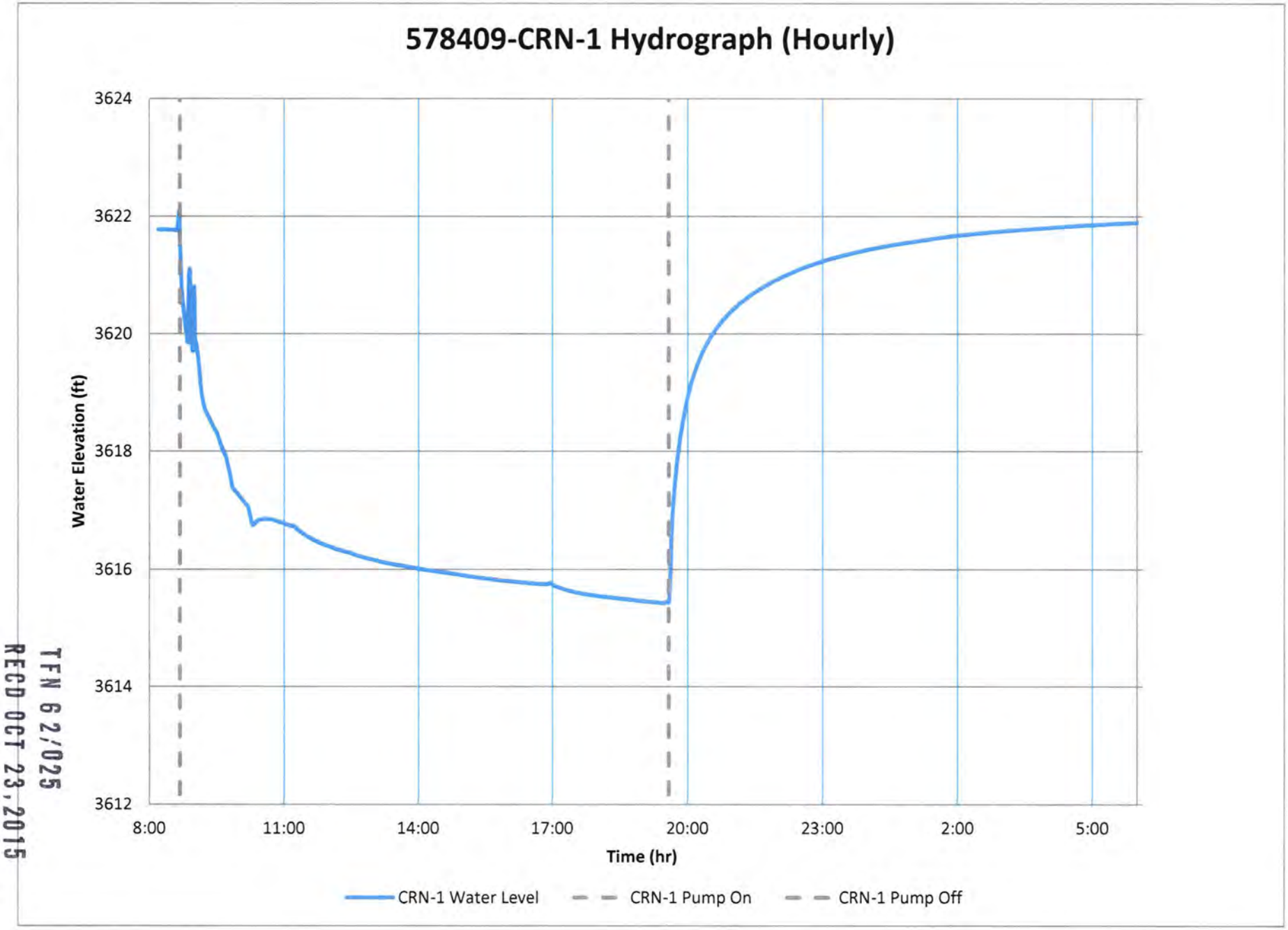

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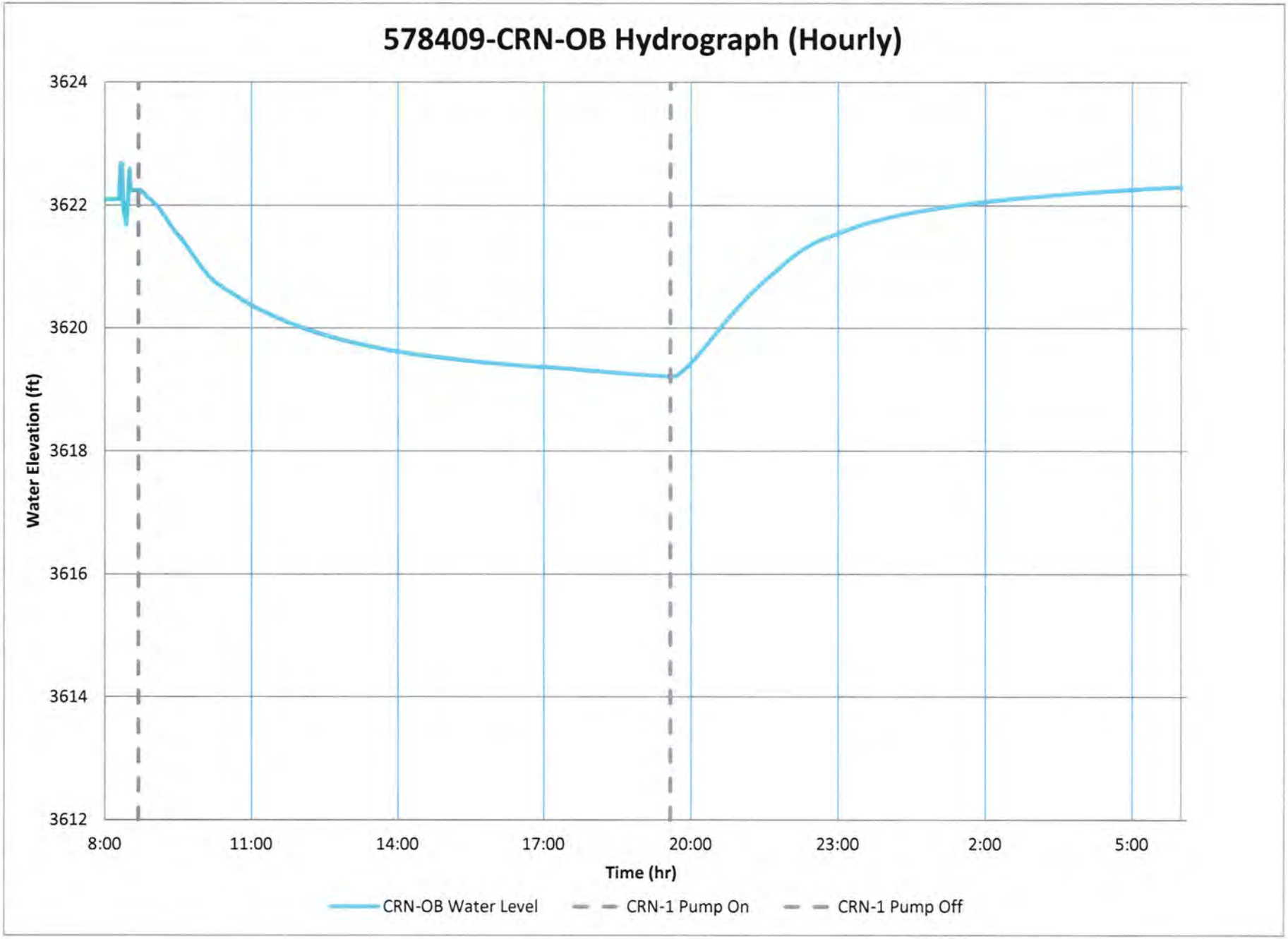

TFN 6 2/025
RECD OCT 23, 2015

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ATTACHMENT D6-8-F

Carney Wells Groundwater Level Hydrographs

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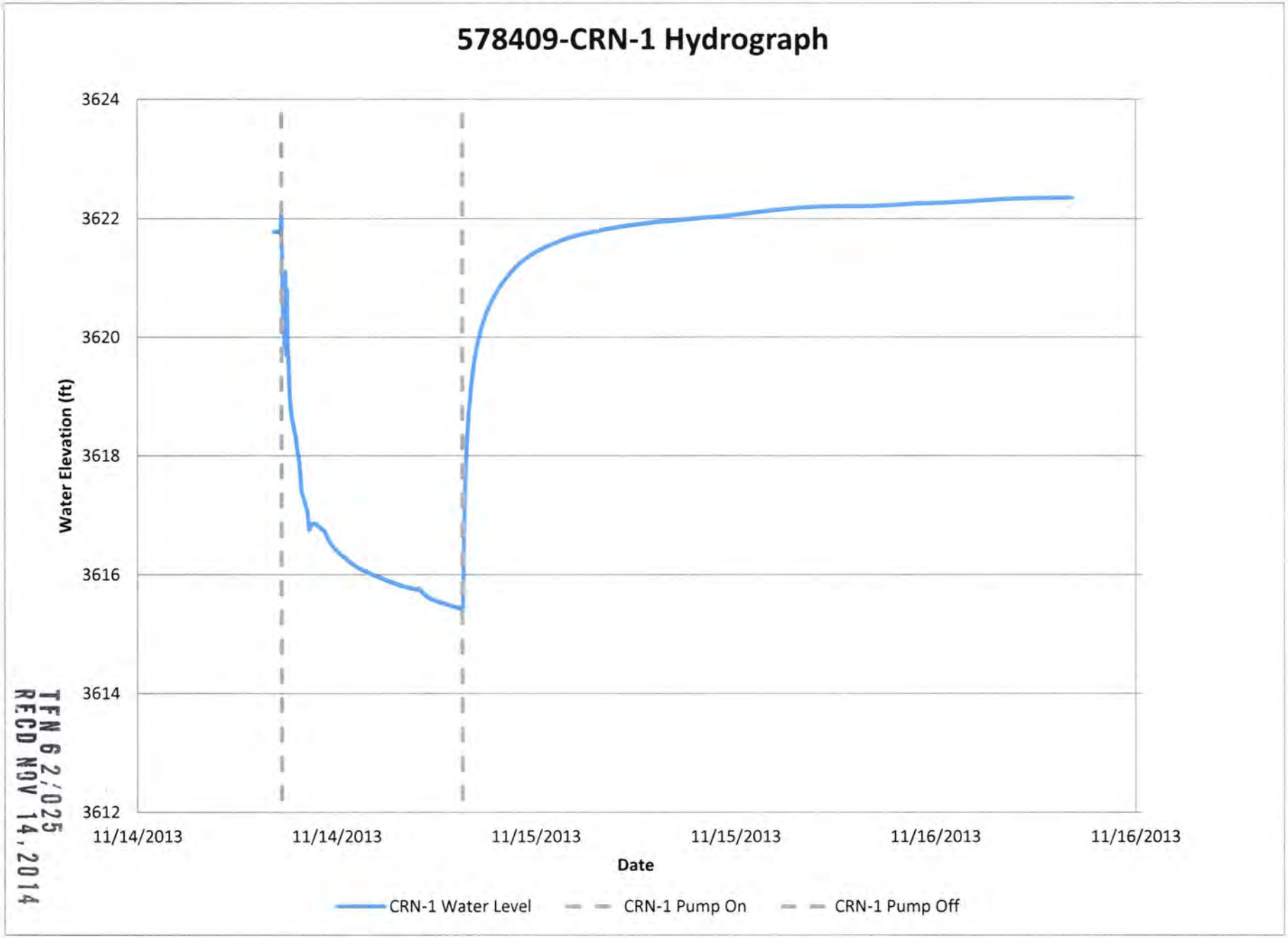

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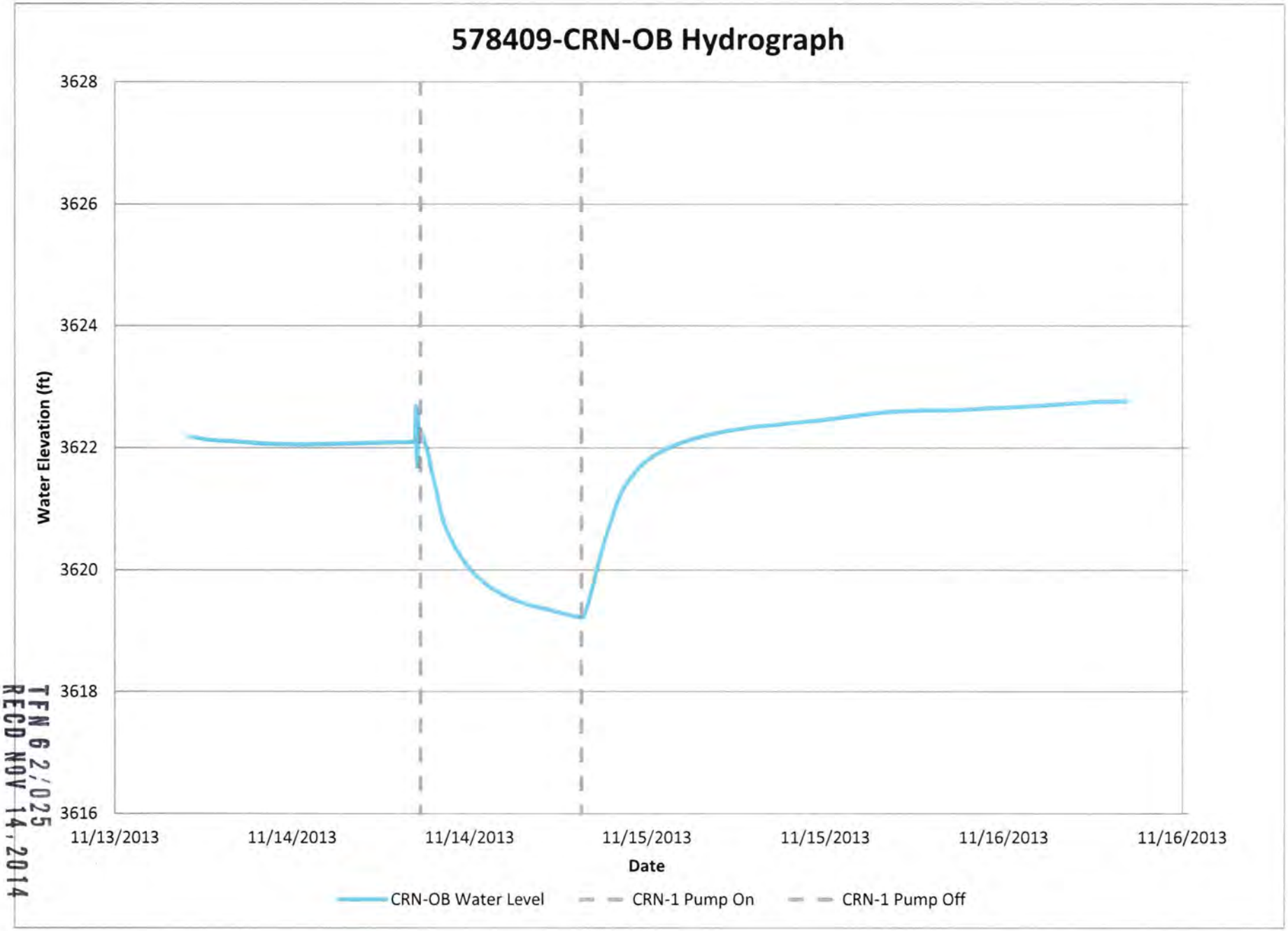

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ATTACHMENT D6-8-G

Section 9 Aquifer Pumping Test
Observation Well 578409-MST-OB
Plots of Time-Drawdown and Analyses

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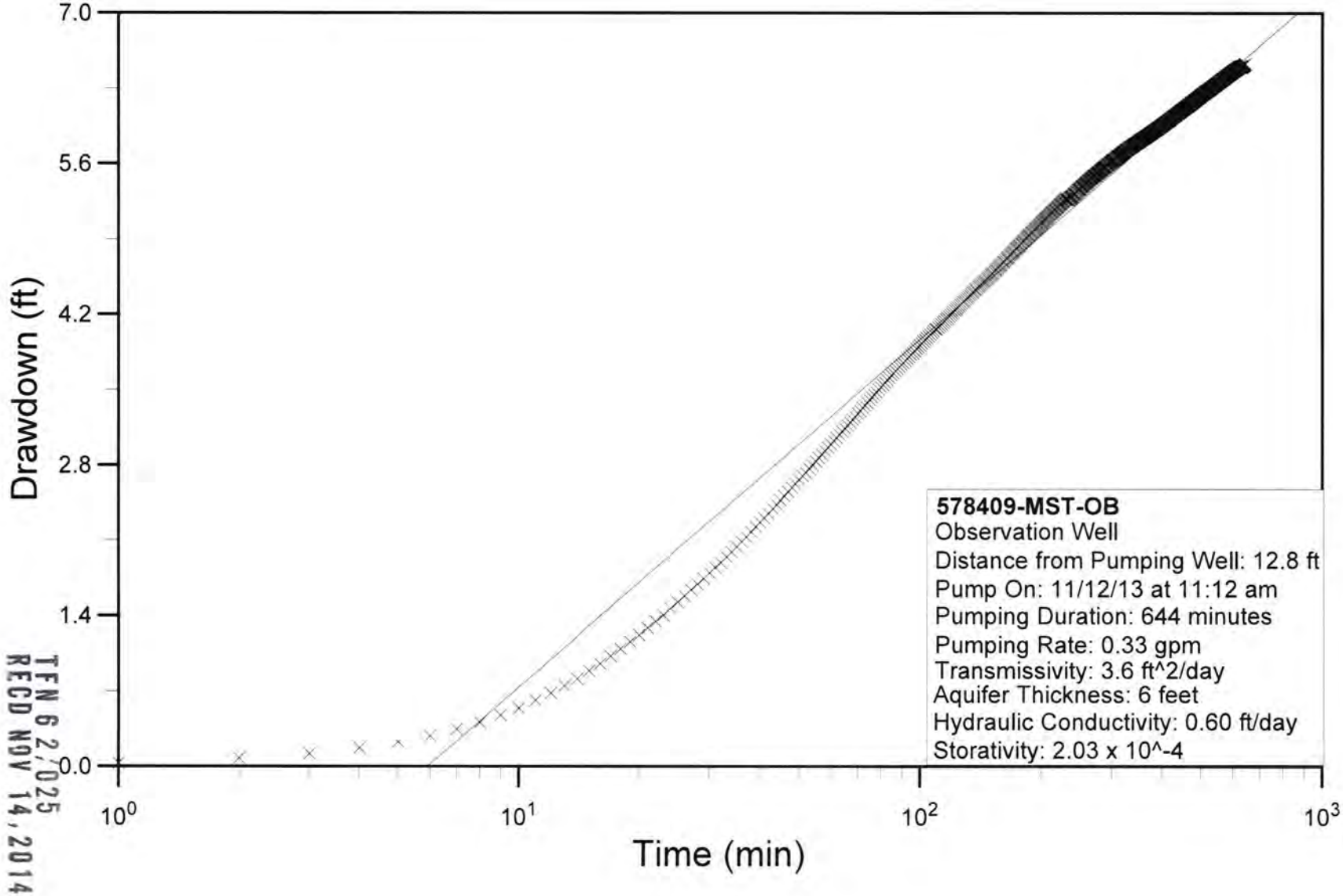
Cooper and Jacob - 578409-MST-OB



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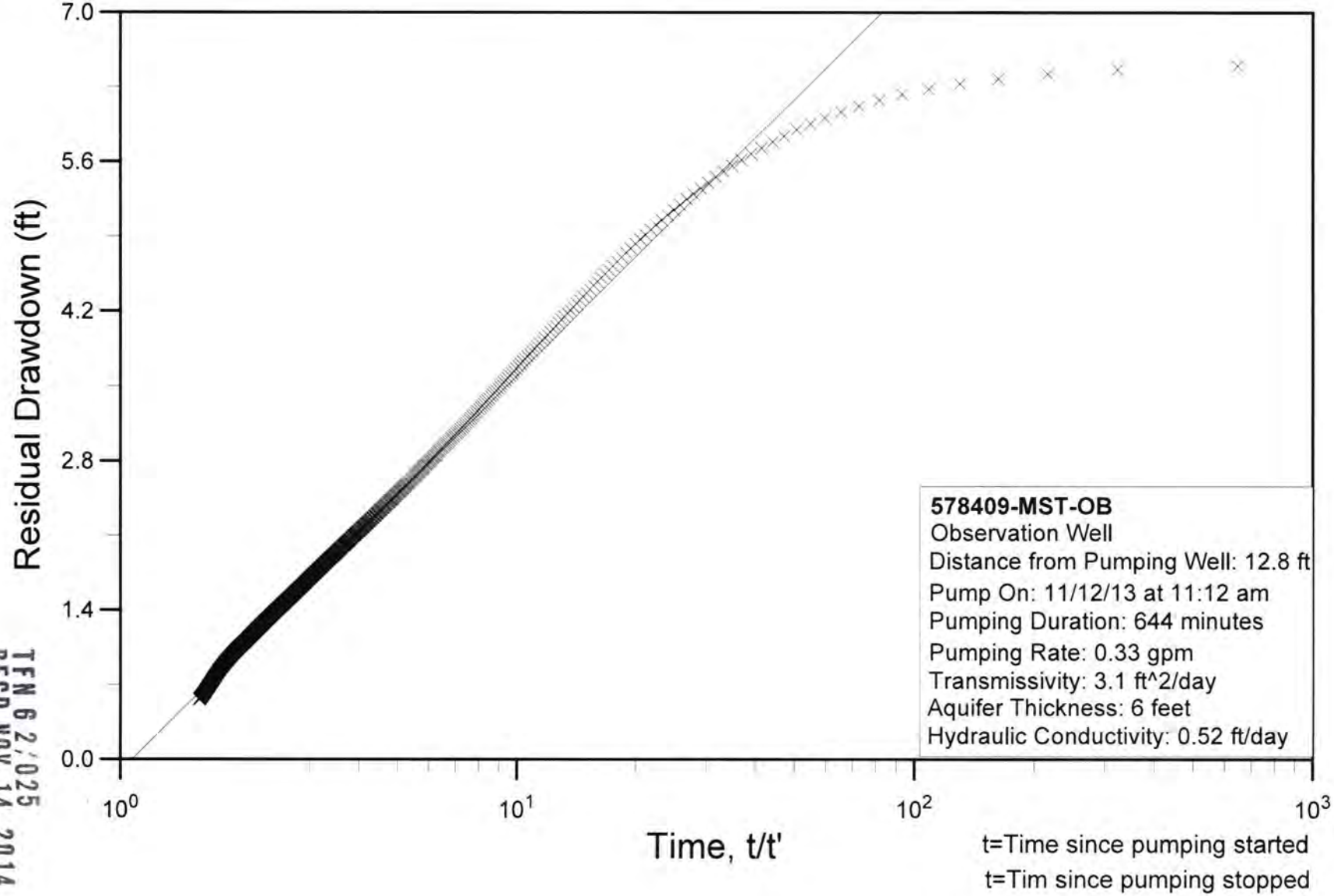
Theis Recovery - 578409-MST-OB



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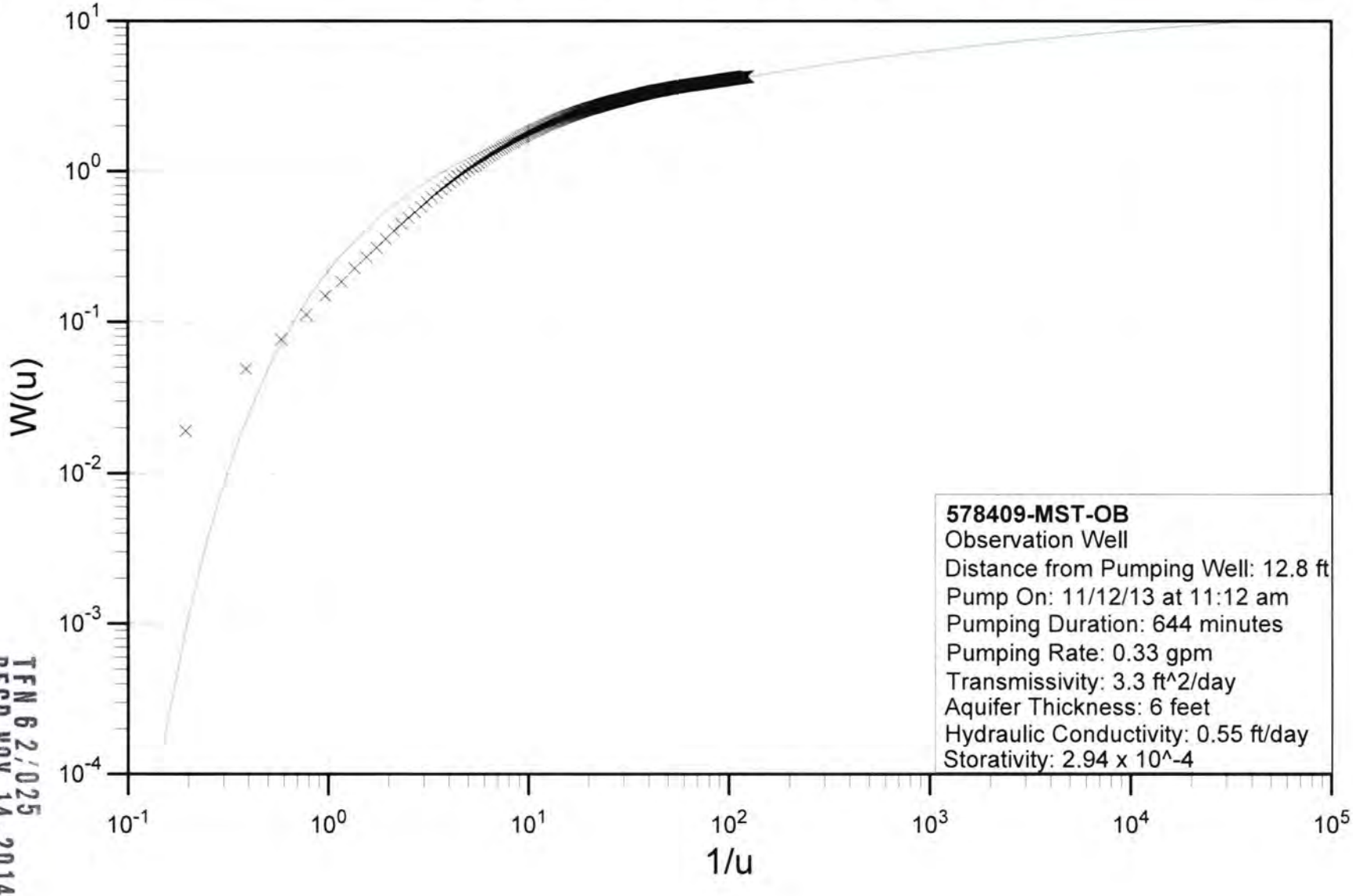
Theis - 578409-MST-OB



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ATTACHMENT D6-8-H

Section 9 Aquifer Pumping Test
Pumped Well 578409-MST-1
Plots of Time-Drawdown and Analyses

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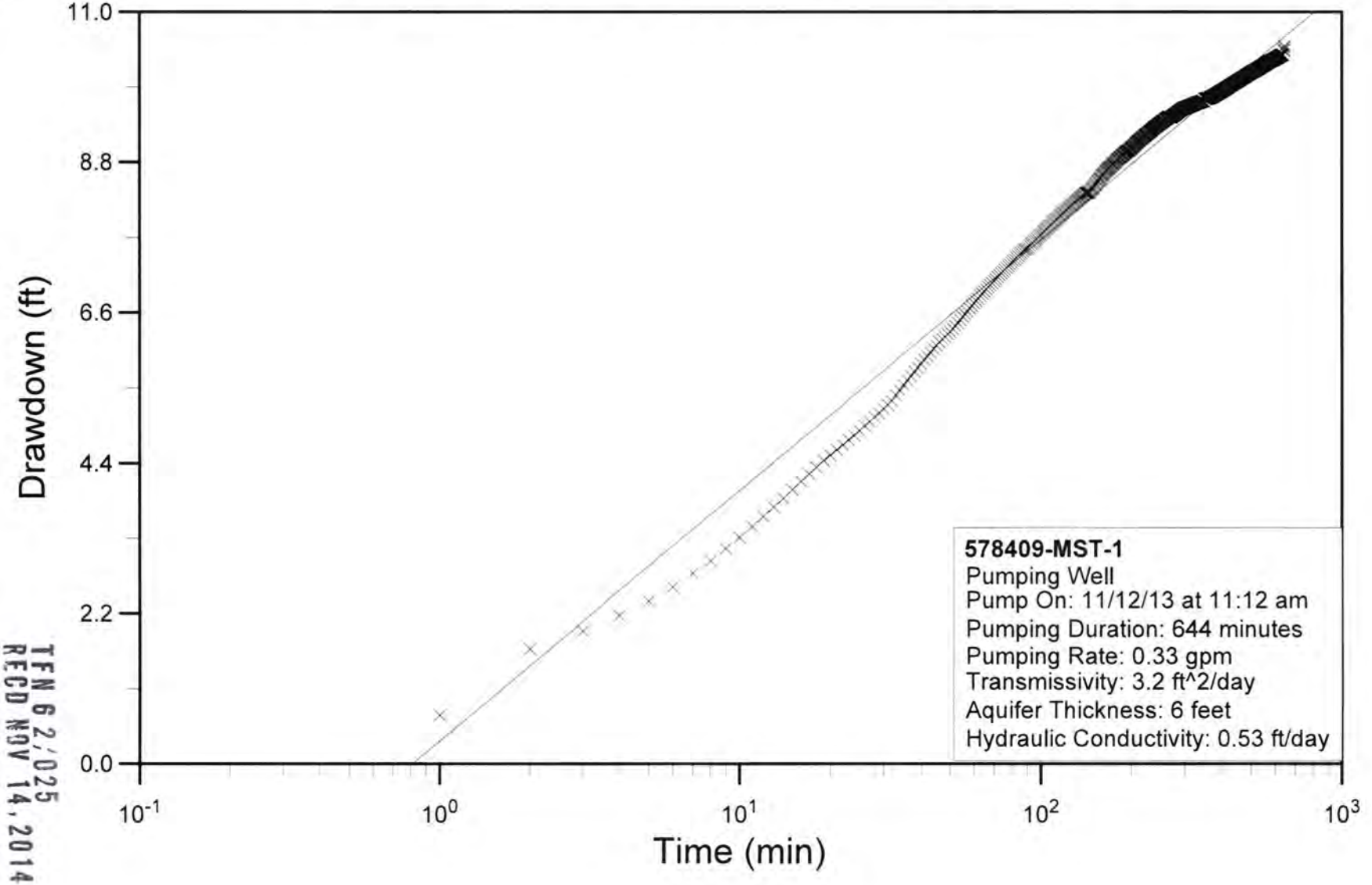
Cooper and Jacob - 578409-MST-1



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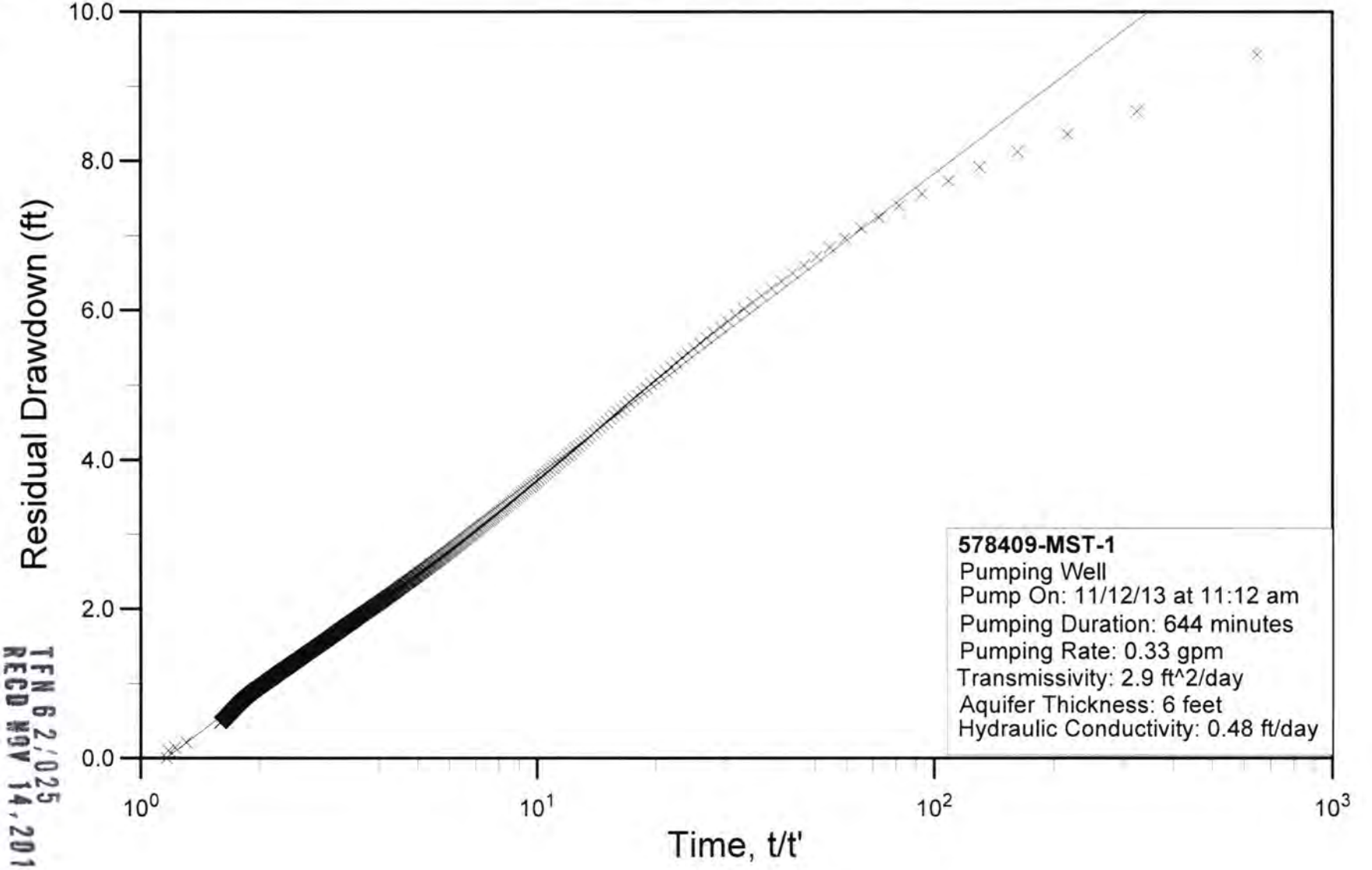
Theis Recovery - 578409-MST-1



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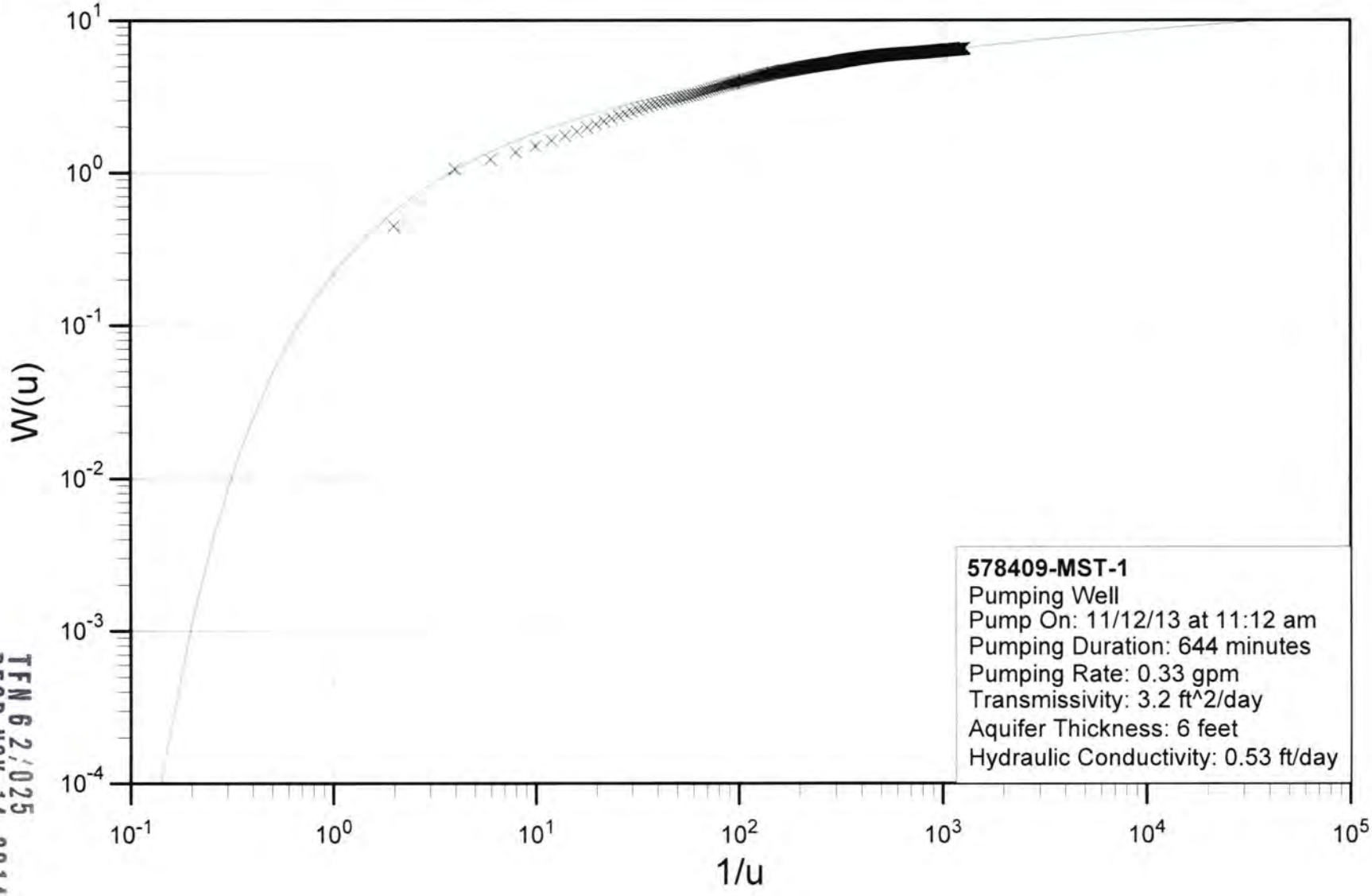
Theis - 578409-MST-1



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ATTACHMENT D6-8-I

Section 9 Aquifer Pumping Test
Observation Well 578409-CRN-OB
Plots of Time-Drawdown and Analyses

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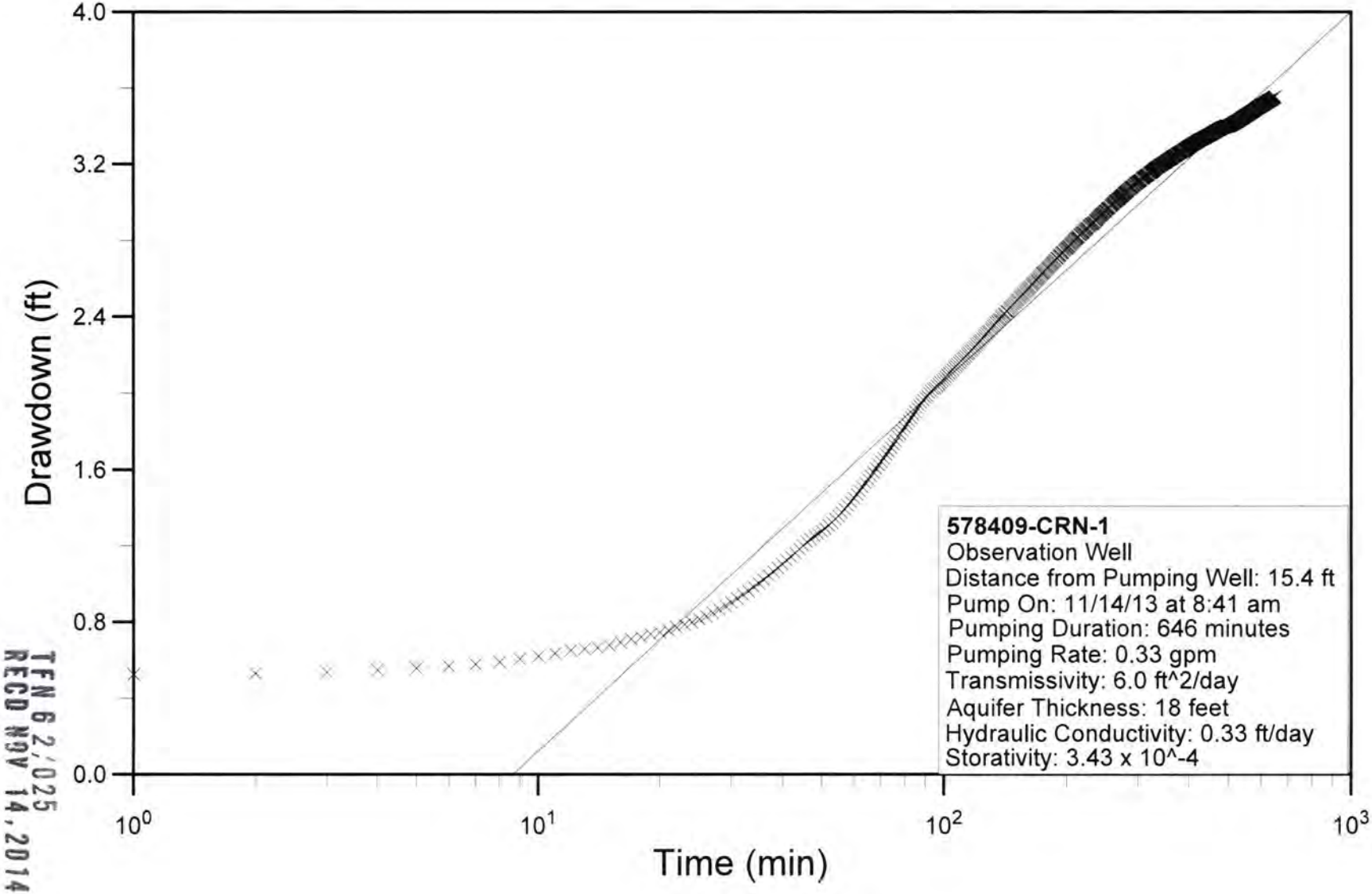
Cooper and Jacob - 578409-CRN-OB



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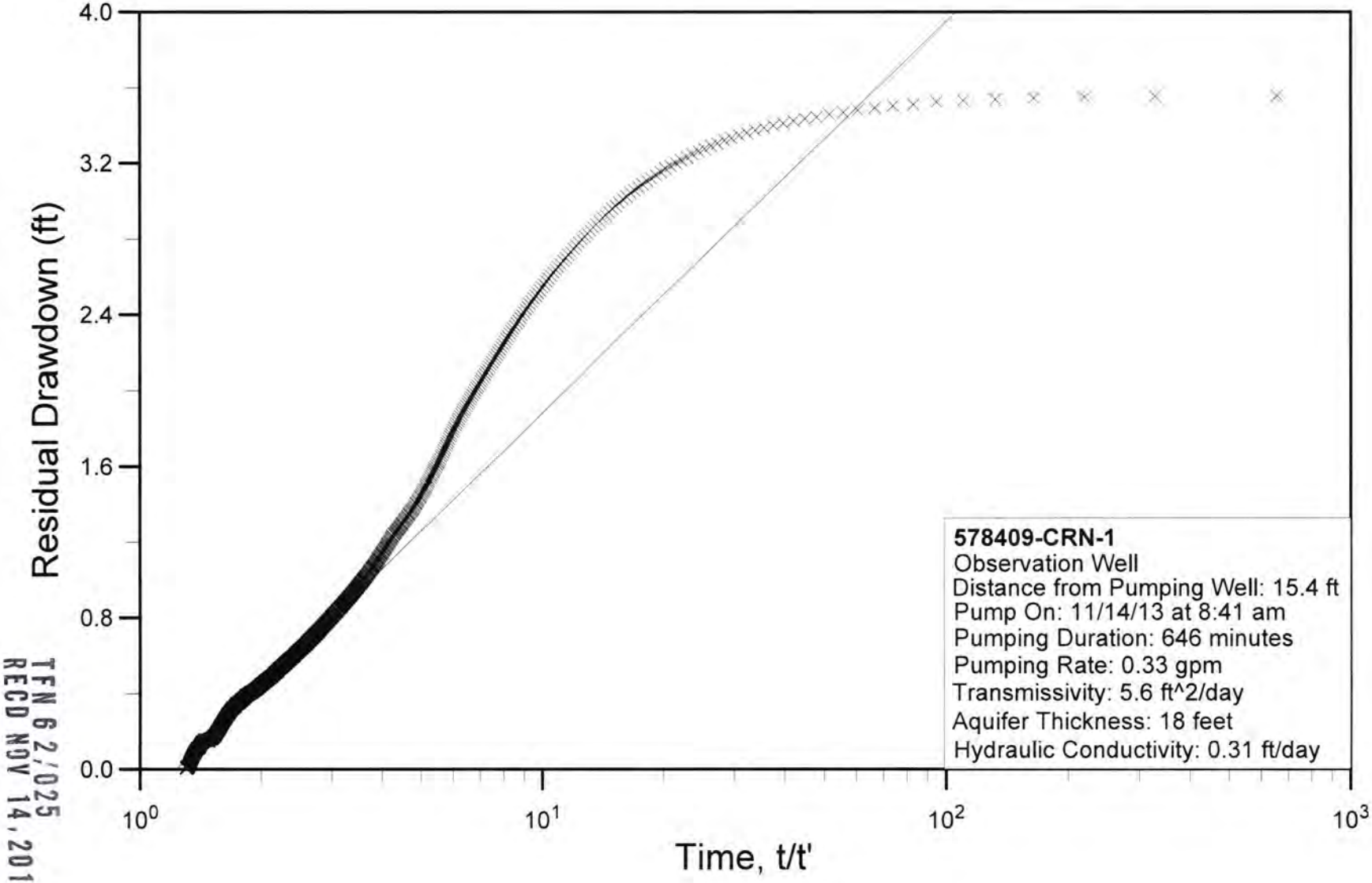
Theis Recovery - 578409-CRN-OB



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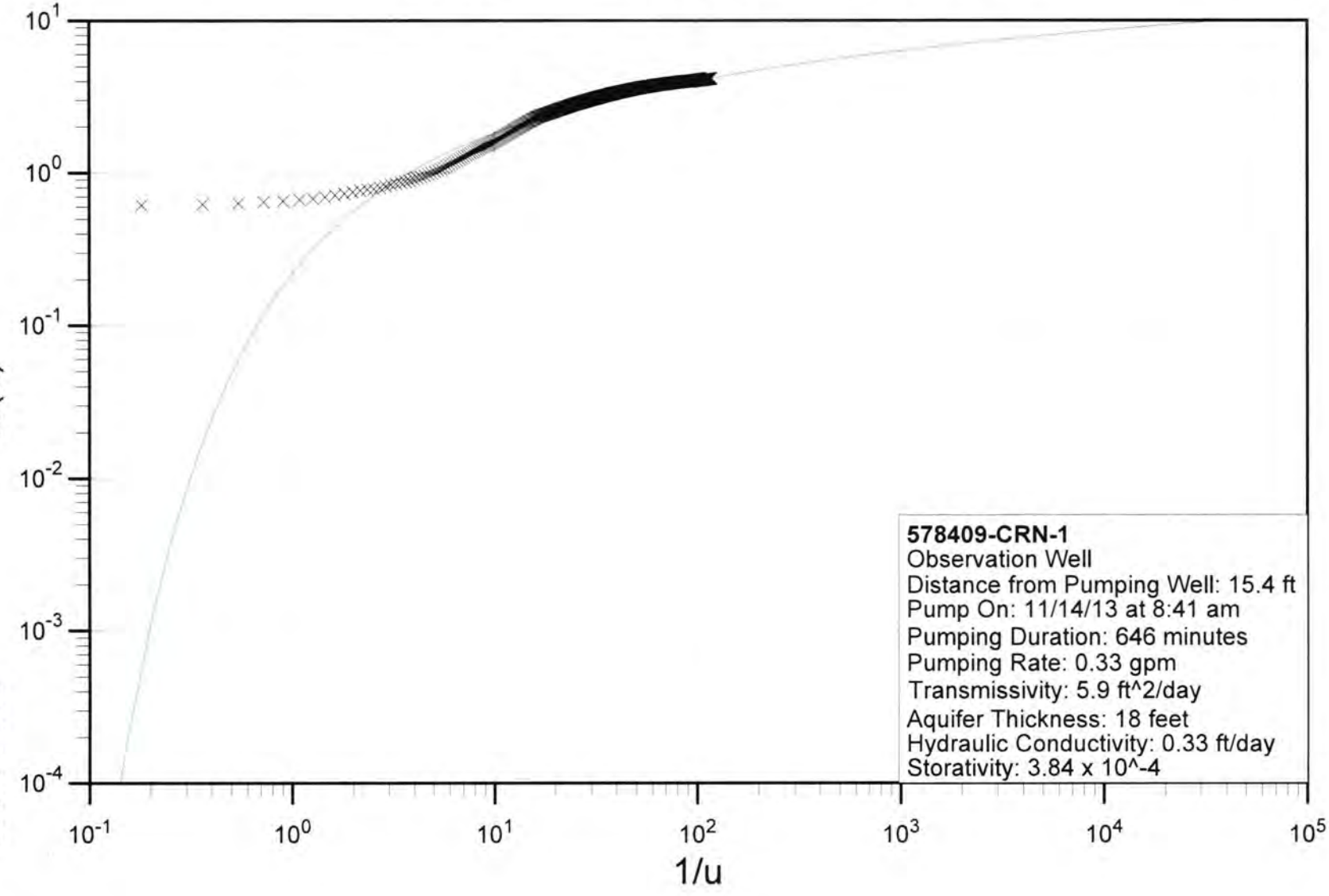

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ATTACHMENT D6-8-J

Section 9 Aquifer Pumping Test
Pumped Well 578409-CRN-1
Plots of Time-Drawdown and Analyses

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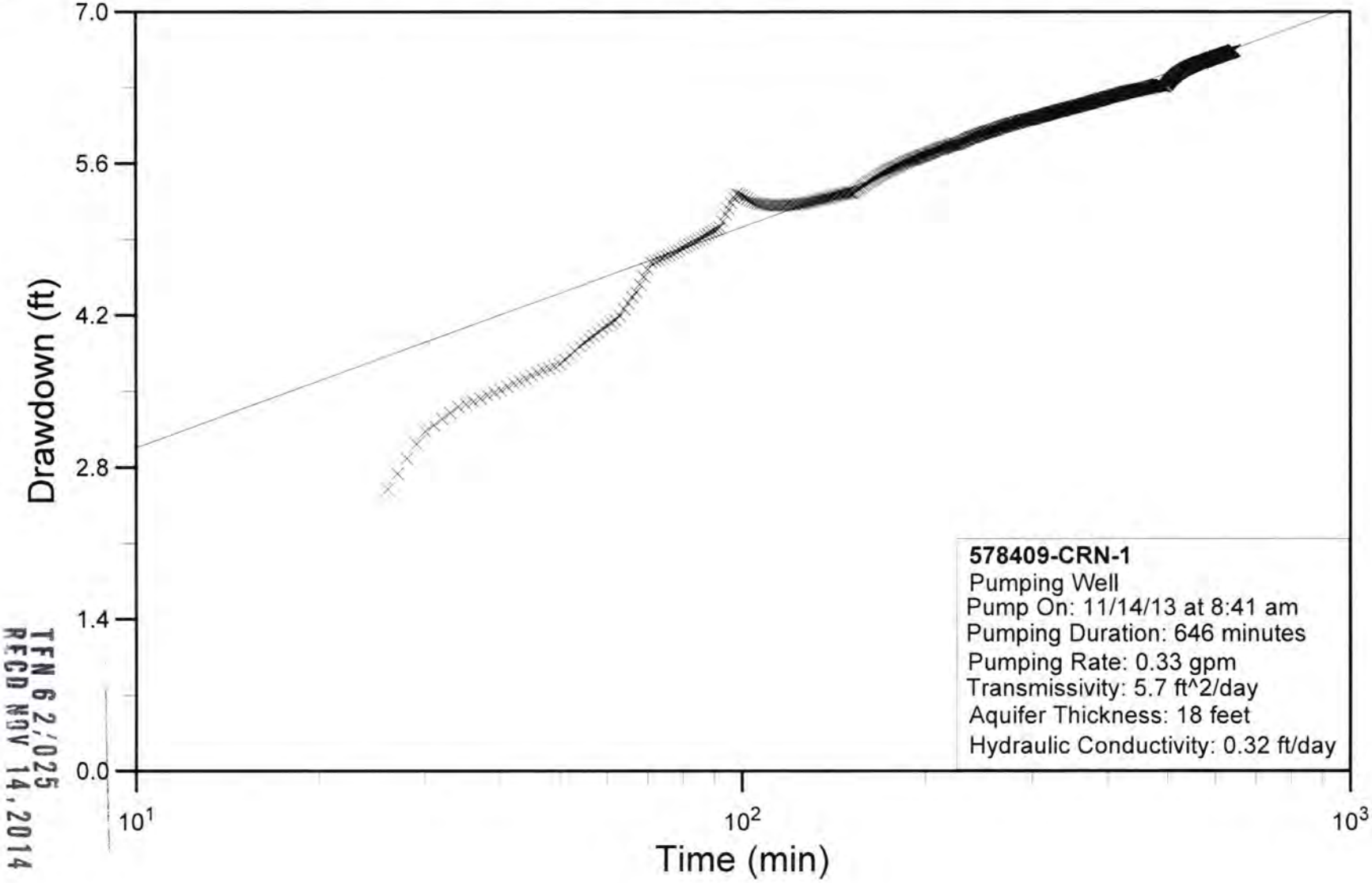
Cooper and Jacob - 578409-CRN-1



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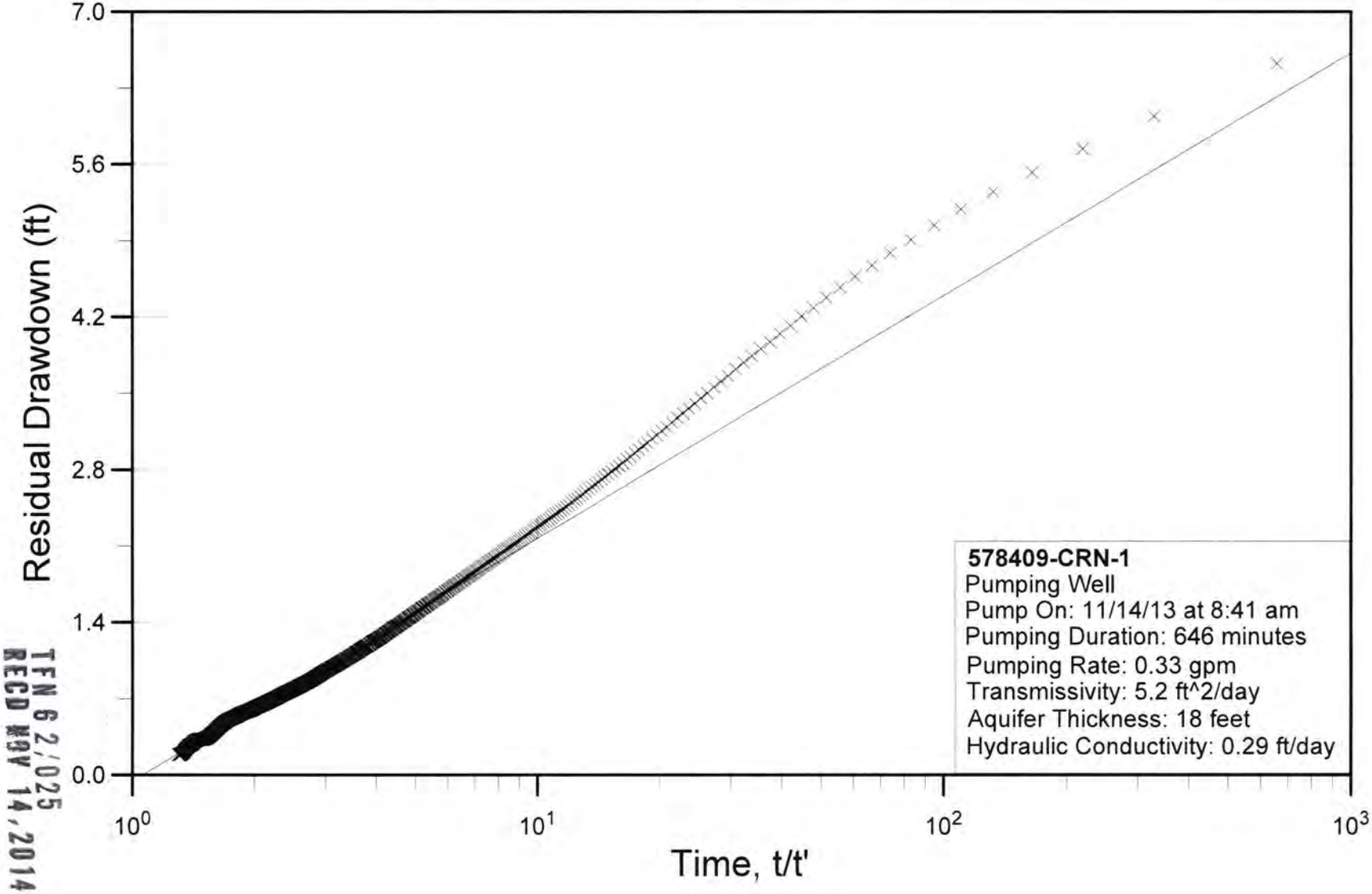
Theis Recovery - 578409-CRN-1



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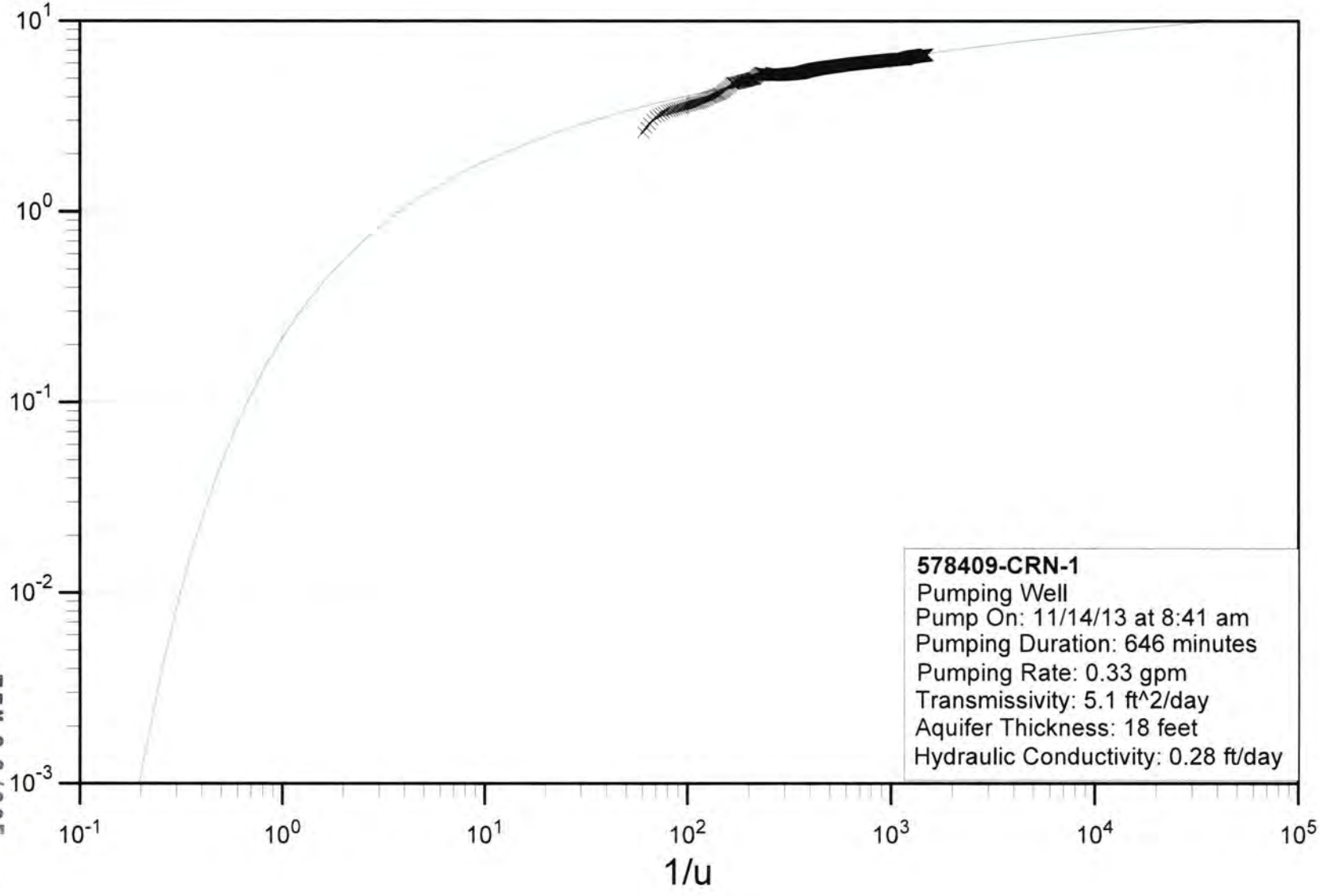
Theis - 578409-CRN-1



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Attachment D6-8-K Field Water Level Measurements vs. Barometric Pressure

Water Levels Measured in During the Masters Coal Pumping Test Compared to Barometric Pressure

Measurement[1]		1a (ft)	1b	1c	1d	1e	1f	1g	Difference (1g-1a)
Date		11/11/2013	11/12/2013	11/12/2013	11/12/13	11/12/2013	11/12/2013	11/13/2013	
Time		3:00	10:30	13:00	15:05	17:00	21:30	16:20	
Depth to Water From Well TOC (ft)	MST UB	110.08	110.07	110.05	110.07	110.09	110.08	110.08	0
	MST-1	101.67	101.68					102.26	-0.59
	MST-OB	102.3	102.33	106.33	107.58	108.1	108.83	102.9	-0.6
	CRN	91.17	91.16	91.12	91.09	91.08	91.05	90.94	0.23
	CRN-OB	91.1	91.1	91.07	91.04	91	91	90.87	0.23
Barometric Pressure (ft) H2O[3]		34.44	34.50	34.45	34.45	34.40	34.27	34.13	-0.31
Pressure change (ft)		0.00	0.07	0.01	0.01	-0.03	-0.17	-0.31	-0.31

Water Levels Measured During the Carney Coal Pumping Test Compared to Barometric Pressure

Measurement[1]		2a	2b	2c	2d	2e	2f	2g	Difference (2g-2a)
Date		11/14/13	11/14/13	11/14/13	11/14/13	11/14/13	11/14/13	11/16/13	
Time		7:55	9:50	11:16	12:26	17:00	19:22	8:09	
Depth to Water From TOC (ft)	MST UB	110.13	110.15	110.15	110.14	110.15	110.14	110.07	0.06
	MST-1[2]	101.83	101.8	101.76	101.72	101.6	101.56	100.87	0.96
	MST-OB[2]	102.48	102.45	102.4	103.35	102.24	102.19	101.55	0.93
	CRN	90.94	95.37					90.37	0.57
	CRN-OB	90.88	92.09	92.98	93.31	93.83	93.97	90.42	0.46
Barometric Pressure (ft) H2O[3]		34.09	34.09	34.04	34.02	33.96	33.89	33.24	-0.85
Pressure change (ft)		0.00	0.00	-0.05	-0.07	-0.12	-0.19	-0.85	-0.85

1 All measurements were taken with a hand operated electronic depth meter.
2 Water levels in the MST -1 and MST-OB wells were still recovering from the pumping test performed on 11/12/13.
3 Barometric pressure recorded at the Sheridan County airport AWOS (approximately 10 miles south of the well cluster). Data downloaded from NOAA. http://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/automated-weather-observing-system-awos

Note: The underbuden well (MST UB) did not respond to barometric changes to the same degree that the other wells did. Since the underburden water bearing unit has a very low yield, the well would not be able to respond to barometric pressure affects as quickly. Thus, the lack of barometric response in the underburden is attributed to the decreased barometric efficiency of the underburdern water bearing unit. Also, in between the Masters and Carney pumping tests, equipment was removed from the underburden well. The removal of the equipment and slow recovery rate in the well was attributed to the slight drop in water level in the MST UB well between tests.

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ADDENDUM D6-9

Groundwater Hydrographs

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Table D6-1. Collected Groundwater Elevations

StationName	Measuring Point Elevation (ft)	Drill Hole TD Elevation (ft)	Ground Coordinates		Water Elevation (ft MSL)			
			Easting	Northing	3Q13	4Q13	1Q14	2Q14
578408-CRN	3,890.0	3,791.7	1,394,416	1,941,810	3,802.3	3,802.3	3,802.3	3,802.3
578408-MST	3,890.5	3,770.3	1,394,423	1,941,802	3,786.0	3,784.6	3,787.6	3,790.7
578409-CRN	3,712.7	3,602.2	1,399,549	1,940,097	3,622.9	3,622.0	3,622.0	3,622.8
578409-CRN-OB	3,713.0	3,601.7	1,399,538	1,940,108	3,627.0	3,622.2	3,622.2	3,623.1
578409-MST-OB	3,713.3	3,589.5	1,399,547	1,940,085	3,611.5	3,611.6	3,611.2	3,611.8
578409-MST	3,712.4	3,589.6	1,399,559	1,940,088	3,611.2	3,611.3	3,611.2	3,611.5
578409-UBN	3,712.1	3,570.9	1,399,568	1,940,077	3,603.7	3,601.9	3,601.9	3,601.7
578415-CRN-MST	3,614.3	3,470.6	1,404,292	1,936,078	3,491.5	3,491.6	3,492.3	3,493.1
578417-CRN	3,929.1	3,786.7	1,391,364	1,939,152	3,796.0	3,795.8	3,796.0	3,795.6
578417-MST	3,928.7	3,764.9	1,391,382	1,939,175	3,767.9	3,768.2	3,768.5	3,768.2
578418-AL	3,690.2	3,665.7	1,386,058	1,935,962	3,669.6	3,669.4	3,669.6	3,670.1
578418-CRN	3,884.5	3,730.7	1,387,102	1,936,928	3,737.8	3,738.0	3,737.9	3,737.9
578418-MST	3,885.8	3,700.1	1,387,131	1,936,923	3,701.5	3,701.4	3,701.4	3,701.3
578510-CRN	3,965.4	3,872.7	1,371,807	1,941,542	3,873.2	Dry	Dry	Dry
578510-MST	3,964.4	3,817.2	1,371,823	1,941,558	3,821.0	3,818.3	3,818.1	3,818.1
578511-CRN	3,896.1	3,767.2	1,377,926	1,940,246	3,776.6	3,776.5	3,776.5	3,776.5
578511-MST	3,896.4	3,738.4	1,377,945	1,940,244	3,746.3	3,746.3	Dry	3,746.5
578512-AL	3,760.5	3,739.3	1,381,530	1,940,880	3,756.5	3,756.7	3,756.8	3,756.9
578512-CRN	3,932.5	3,882.7	1,382,758	1,943,160	Dry	Dry	Dry	Dry
578512-MST	3,932.7	3,817.7	1,382,743	1,943,172	3,820.8	3,820.8	3,820.8	3,820.8
578513-AL	3,724.0	3,703.2	1,383,970	1,938,634	3,714.5	3,714.6	3,716.3	3,717.8
578513-MST	3,850.6	3,706.6	1,381,680	1,938,341	3,742.4	3,742.1	3,741.8	3,742.7
578513-CRN	3,850.0	3,732.7	1,381,665	1,938,329	3,733.5	3,733.0	3,733.1	3,733.2

StationName	Measuring Point Elevation (ft)	Drill Hole TD Elevation (ft)	Ground Coordinates		Water Elevation (ft MSL)			
			Easting	Northing	3Q15	4Q15	1Q16	2Q16
578418-AL	3,690.2	3,665.7	1,386,058	1,935,962			3669.38	3669.70
578512-AL	3,760.5	3,739.3	1,381,530	1,940,880			3756.59	3756.75
578513-AL	3,724.0	3,703.2	1,383,970	1,938,634			3716.37	3717.20
578433-AL-1	3,645.0	3,628.4	1,402,206	1,922,703	3637.80	3638.11	3637.85	3638.71
578434-AL-1	3,650.0	3,636.1	1,403,229	1,921,551	3644.64	3644.96	3644.80	3645.41
578434-AL-2	3,654.5	3,637.3	1,404,529	1,919,747	3648.66	3648.87	3648.81	3649.74

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Table D6-1. Collected Groundwater Elevations

StationName	Measuring Point Elevation (ft)	Drill Hole TD Elevation (ft)	Ground Coordinates		Water Elevation (ft MSL)			
			Easting	Northing	3Q13	4Q13	1Q14	2Q14
578408-CRN	3,890.0	3,791.7	1,394,416	1,941,810	3,802.3	3,802.3	3,802.3	3,802.3
578408-MST	3,890.5	3,770.3	1,394,423	1,941,802	3,786.0	3,784.6	3,787.6	3,790.7
578409-CRN	3,712.7	3,602.2	1,399,549	1,940,097	3,622.9	3,622.0	3,622.0	3,622.8
578409-CRN-OB	3,713.0	3,601.7	1,399,538	1,940,108	3,627.0	3,622.2	3,622.2	3,623.1
578409-MST-OB	3,713.3	3,589.5	1,399,547	1,940,085	3,611.5	3,611.6	3,611.2	3,611.8
578409-MST	3,712.4	3,589.6	1,399,559	1,940,088	3,611.2	3,611.3	3,611.2	3,611.5
578409-UBN	3,712.1	3,570.9	1,399,568	1,940,077	3,603.7	3,601.9	3,601.9	3,601.7
578415-CRN-MST	3,614.3	3,470.6	1,404,292	1,936,078	3,491.5	3,491.6	3,492.3	3,493.1
578417-CRN	3,929.1	3,786.7	1,391,364	1,939,152	3,796.0	3,795.8	3,796.0	3,795.6
578417-MST	3,928.7	3,764.9	1,391,382	1,939,175	3,767.9	3,768.2	3,768.5	3,768.2
578418-AL	3,690.2	3,665.7	1,386,058	1,935,962	3,669.6	3,669.4	3,669.6	3,670.1
578418-CRN	3,884.5	3,730.7	1,387,102	1,936,928	3,737.8	3,738.0	3,737.9	3,737.9
578418-MST	3,885.8	3,700.1	1,387,131	1,936,923	3,701.5	3,701.4	3,701.4	3,701.3
578510-CRN	3,965.4	3,872.7	1,371,807	1,941,542	3,873.2	Dry	Dry	Dry
578510-MST	3,964.4	3,817.2	1,371,823	1,941,558	3,821.0	3,818.3	3,818.1	3,818.1
578511-CRN	3,896.1	3,767.2	1,377,926	1,940,246	3,776.6	3,776.5	3,776.5	3,776.5
578511-MST	3,896.4	3,738.4	1,377,945	1,940,244	3,746.3	3,746.3	Dry	3,746.5
578512-AL	3,760.5	3,739.3	1,381,530	1,940,880	3,756.5	3,756.7	3,756.8	3,756.9
578512-CRN	3,932.5	3,882.7	1,382,758	1,943,160	Dry	Dry	Dry	Dry
578512-MST	3,932.7	3,817.7	1,382,743	1,943,172	3,820.8	3,820.8	3,820.8	3,820.8
578513-AL	3,724.0	3,703.2	1,383,970	1,938,634	3,714.5	3,714.6	3,716.3	3,717.8
578513-MST	3,850.6	3,706.6	1,381,680	1,938,341	3,742.4	3,742.1	3,741.8	3,742.7
578513-CRN	3,850.0	3,732.7	1,381,665	1,938,329	3,733.5	3,733.0	3,733.1	3,733.2

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Table D6-2. 2018-2019 Collected Groundwater Elevations

StationName	Measuring Point Elevation (ft)	Drill Hole TD Elevation (ft)	Ground Coordinates		Water Elevation (ft MSL)			
			Easting	Northing	1Q18	2Q18	3Q18	4Q18
578524-AL-1	3,673.9	3,631.9	1,381,927	1,934,069	3661.28	3661.66	3661.21	3661.13
578415-SPL-1	3,603.7	3,560.7	1,404,656	1,934,127	No Data	3587.78	3587.57	3585.56
578415-SPL-2	3,611.5	3,499.5	1,404,636	1,935,619	No Data	3547.23	3540.73	3540.58
578420-AL-1	3,634.4	3,616.8	1,392,945	1,931,385	No Data	3626.91	3626.20	3624.49
578524-CRN-PUMP	3,672.9	3,602.9	1,381,899	1,934,182	No Data	3659.27	P&A	
578420-CRN-PUMP	3,633.5	3,603.0	1,393,062	1,931,289	No Data	3633.53	3625.72	3624.33
578513-OVB-1	3,753.2	3,681.2	1,384,174	1,936,174	No Data	No Data	Dry	Dry
578511-CRN	3,896.1	3,896.1	1,377,926	1,940,246	3776.53			
578511-MST	3,896.4	3,896.4	1,377,945	1,940,244	3746.70			
578513-MST	3,850.6	3,706.6	1,381,680	1,938,341	3733.63			
578513-CRN	3,850.0	3,732.7	1,381,665	1,938,329	3744.65			
578512-CRN	3,932.5	3,882.7	1,382,758	1,943,160	Dry			
578512-MST	3,932.7	3,817.7	1,382,743	1,943,172	3820.81			
578512-AL	3,760.5	3,739.3	1,381,530	1,940,880	3756.81			
578513-AL	3,724.0	3,703.2	1,383,970	1,938,634	3717.12			
578418-AL	3,690.2	3,665.7	1,386,058	1,935,962	3669.41			
578418-CRN	3,884.5	3,730.7	1,387,102	1,936,928	3738.80			
578418-MST	3,885.8	3,700.1	1,387,131	1,936,923	3701.28			
578417-CRN	3,929.1	3,786.7	1,391,364	1,939,152	3795.70			
578417-MST	3,928.7	3,764.9	1,391,382	1,939,175	3768.80			
578408-CRN	3,890.0	3,791.7	1,394,416	1,941,810	3802.60			
578408-MST	3,890.5	3,770.3	1,394,423	1,941,802	3786.66			
578433-AL-1	3,645.0	3,628.4	1,402,206	1,922,703	3638.41			
578434-AL-1	3,650.0	3,636.1	1,403,229	1,921,551	3645.30			
578434-AL-2	3,654.5	3,637.3	1,404,529	1,919,747	3649.44			

StationName	Measuring Point Elevation (ft)	Drill Hole TD Elevation (ft)	Ground Coordinates		Water Elevation (ft MSL)			
			Easting	Northing	1Q19	2Q19	3Q19	4Q19
578415-SPL-1	3,603.7	3,560.7	1,404,656	1,934,127	3585.43			
578415-SPL-2	3,611.5	3,499.5	1,404,636	1,935,619	3540.88			
578420-AL-1	3,634.4	3,616.8	1,392,945	1,931,385	3624.33			
578420-CRN-PUMP	3,633.5	3,603.0	1,393,062	1,931,289	3624.14	3624.59		
578513-OVB-1	3,753.2	3,681.2	1,384,174	1,936,174	Dry	Dry		
578409-CRN	3,712.7	3,602.2	1,399,549	1,940,097	3,624.0			
578409-CRN-OB	3,713.0	3,601.7	1,399,538	1,940,108	3,624.4			
578409-MST-OB	3,713.3	3,589.5	1,399,547	1,940,085	3,617.3			
578409-MST	3,712.4	3,589.6	1,399,559	1,940,088	3,615.7			
578409-UBN	3,712.1	3,570.9	1,399,568	1,940,077	3,599.7			
LAYA #1	3,680.0	No Data	1,377,935	1,934,015		No Data		
578415-AL-1	3,576.0	3,542.0	1,404,303	1,936,458			3,545.8	3,544.9
TDAW-01	3,675.0	No Data	1,381,761	1,934,264			No Data	
LAYA #2	3,711.0	No Data	1,377,304	1,936,401		No Data	No Data	
LAYA #3	3,679.0	No Data	1,397,044	1,936,358			No Data	

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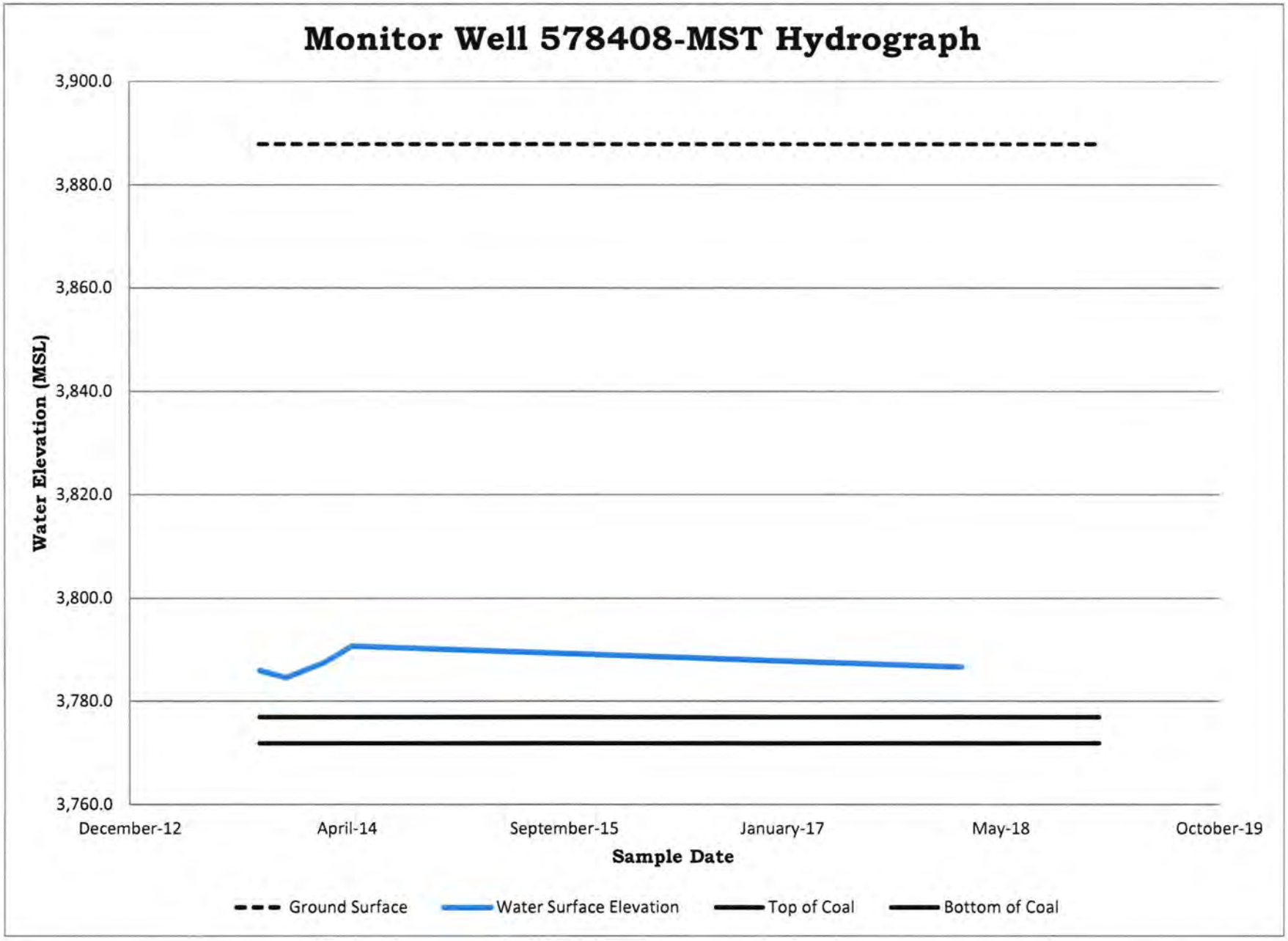

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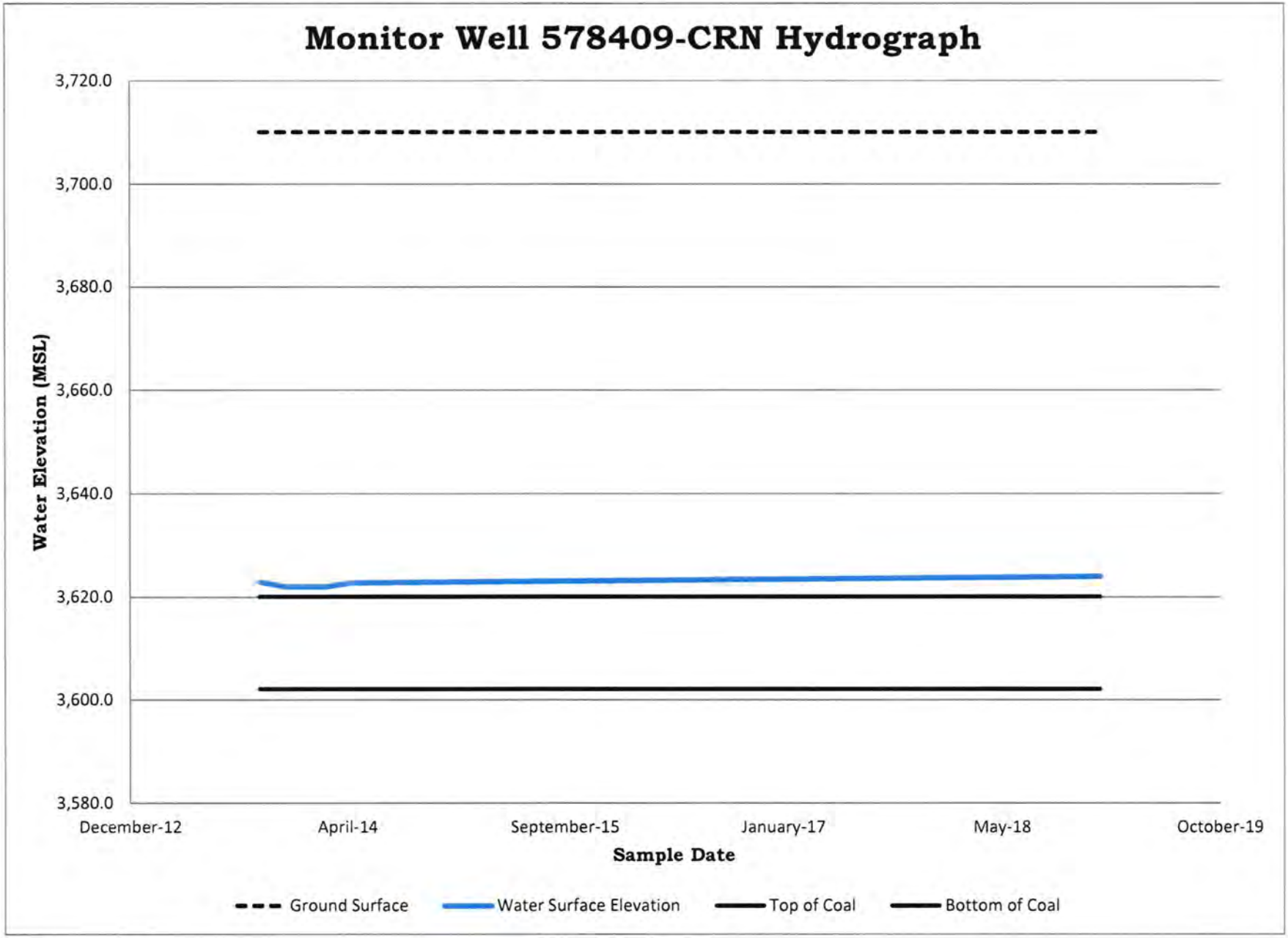

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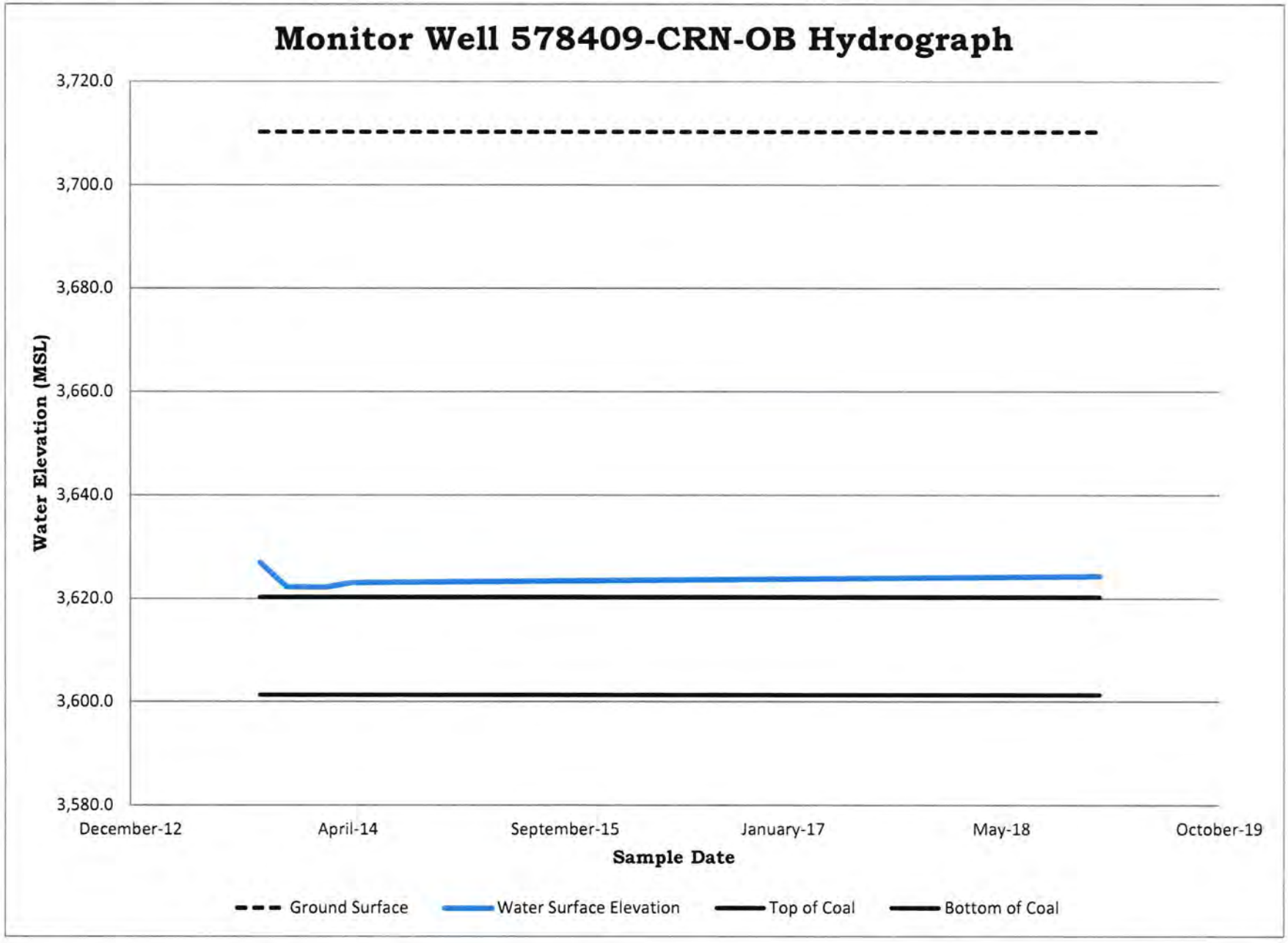

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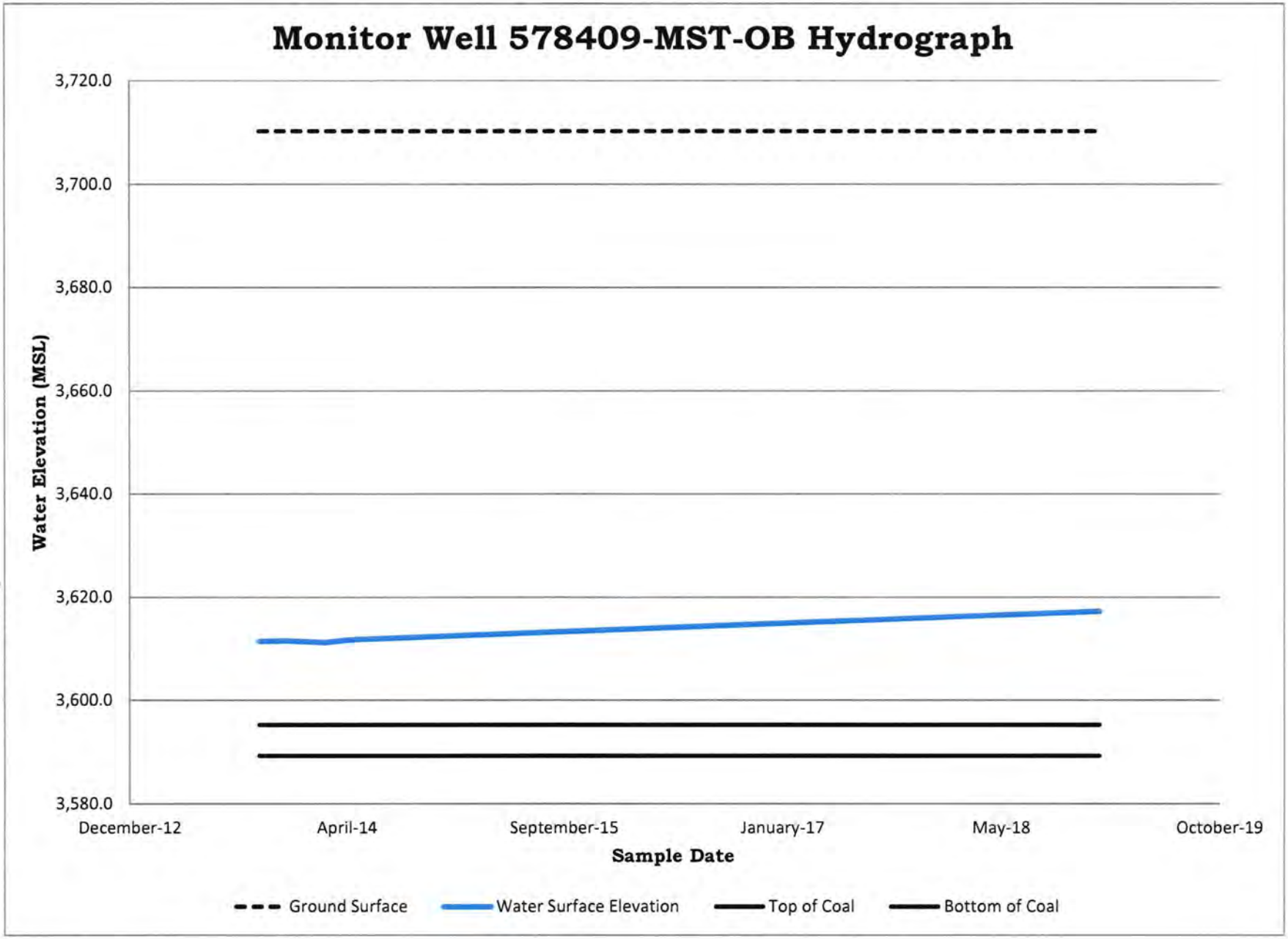
Monitor Well 578409-MST-OB Hydrograph



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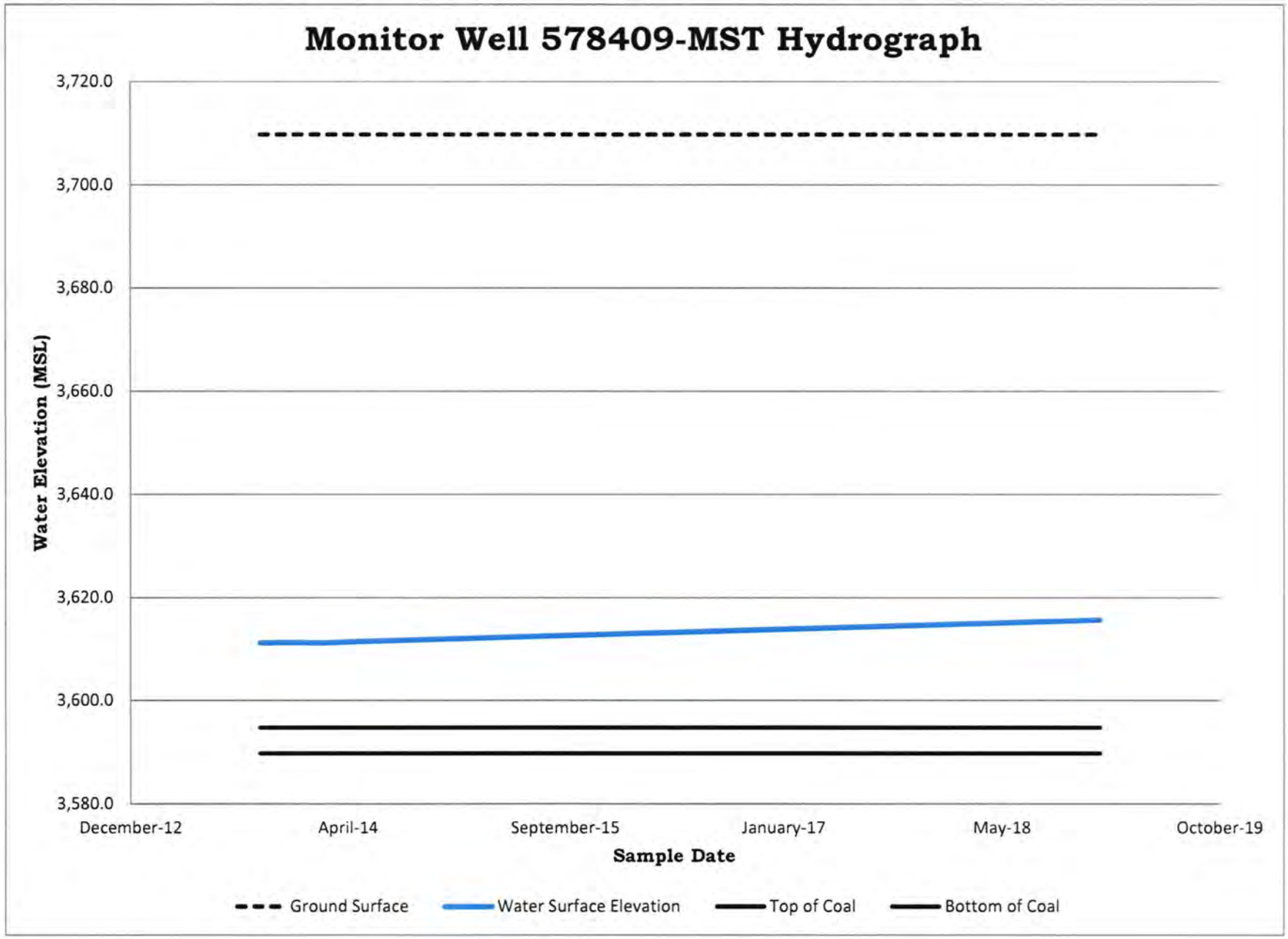

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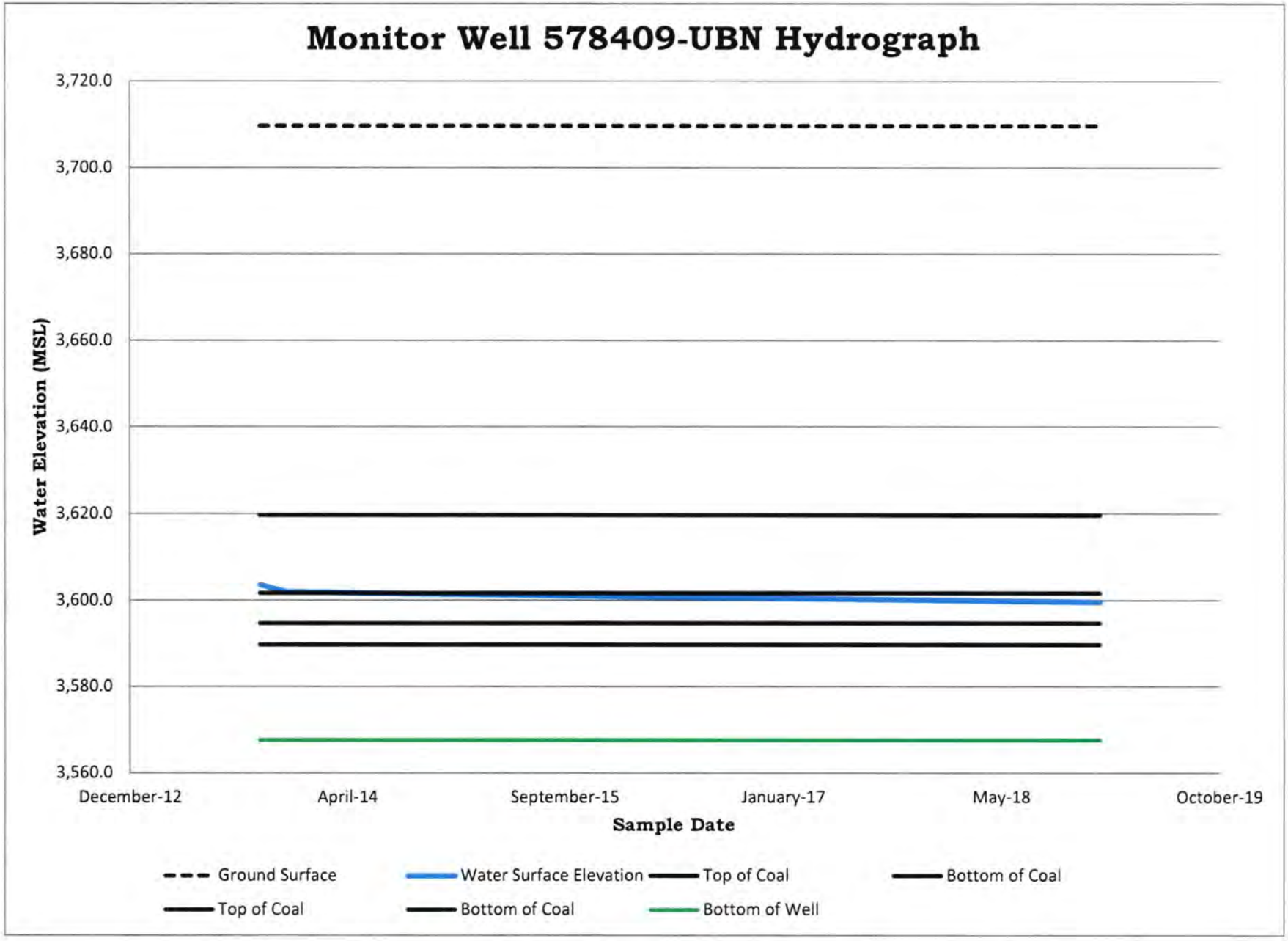
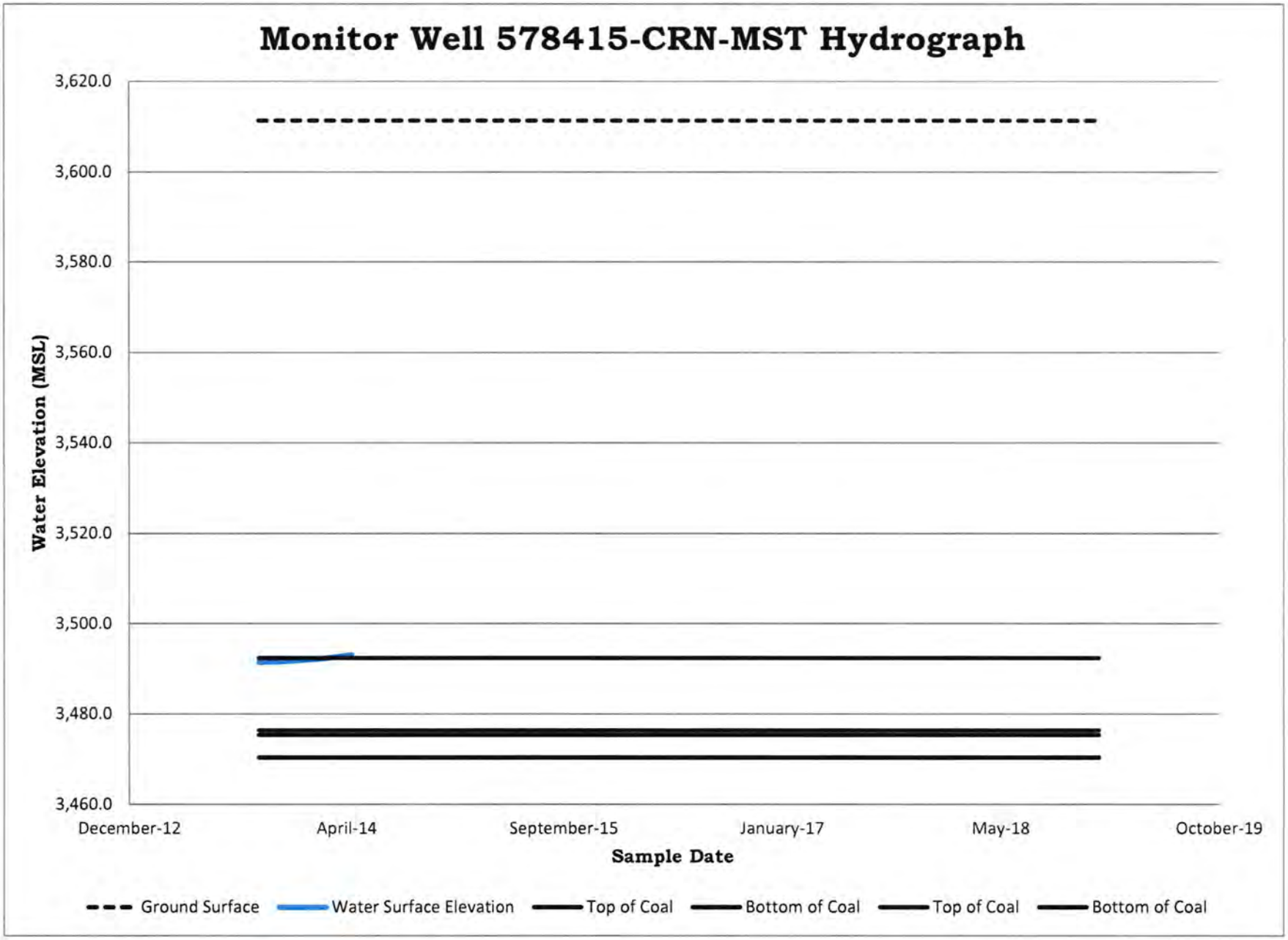


DEQ Ex. 3-463

Scanned, 02/28/2020

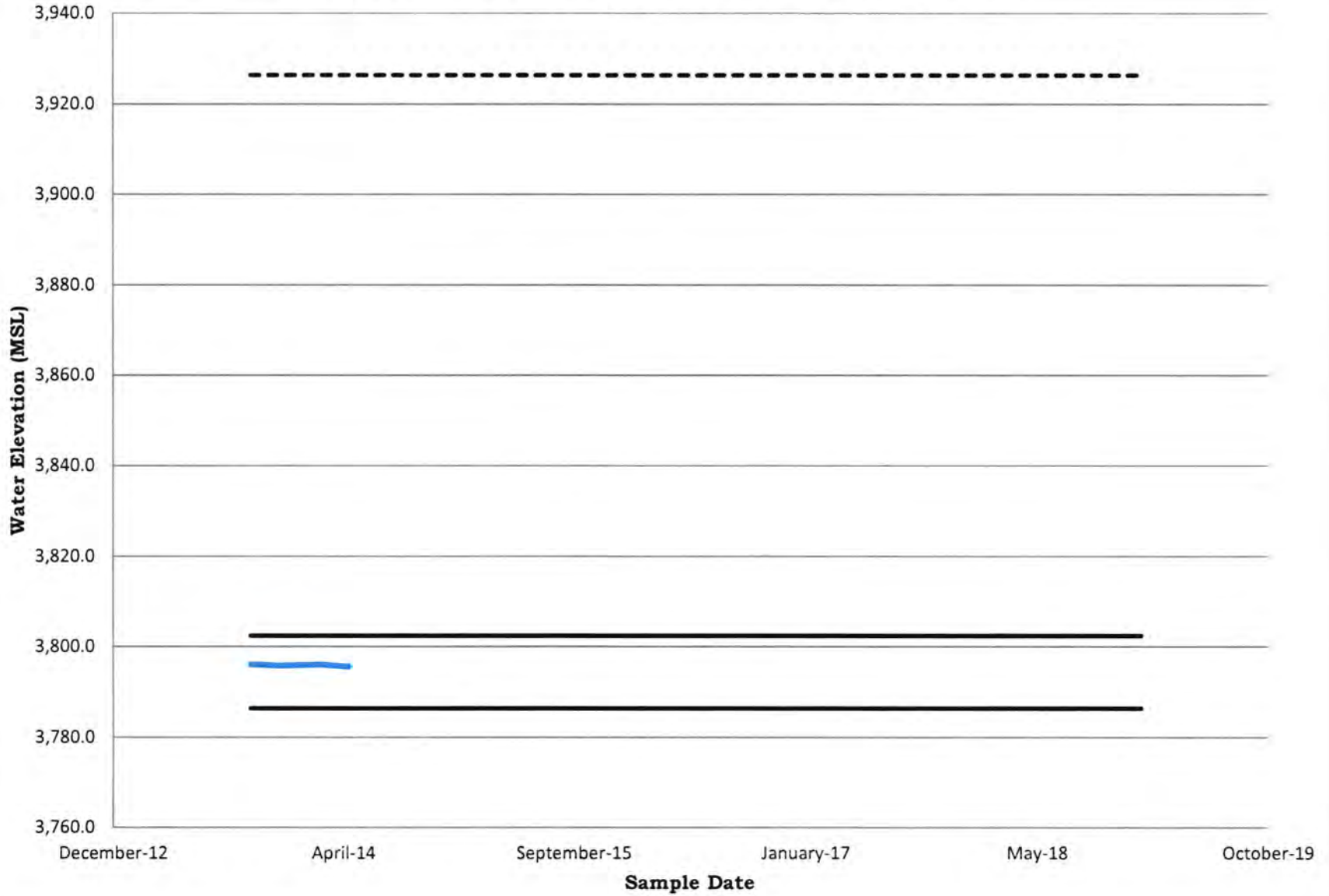


TFN6 2/025
RECD MAY 23, 2019

DEQ Ex. 3-464

Scanned, 02/28/2020

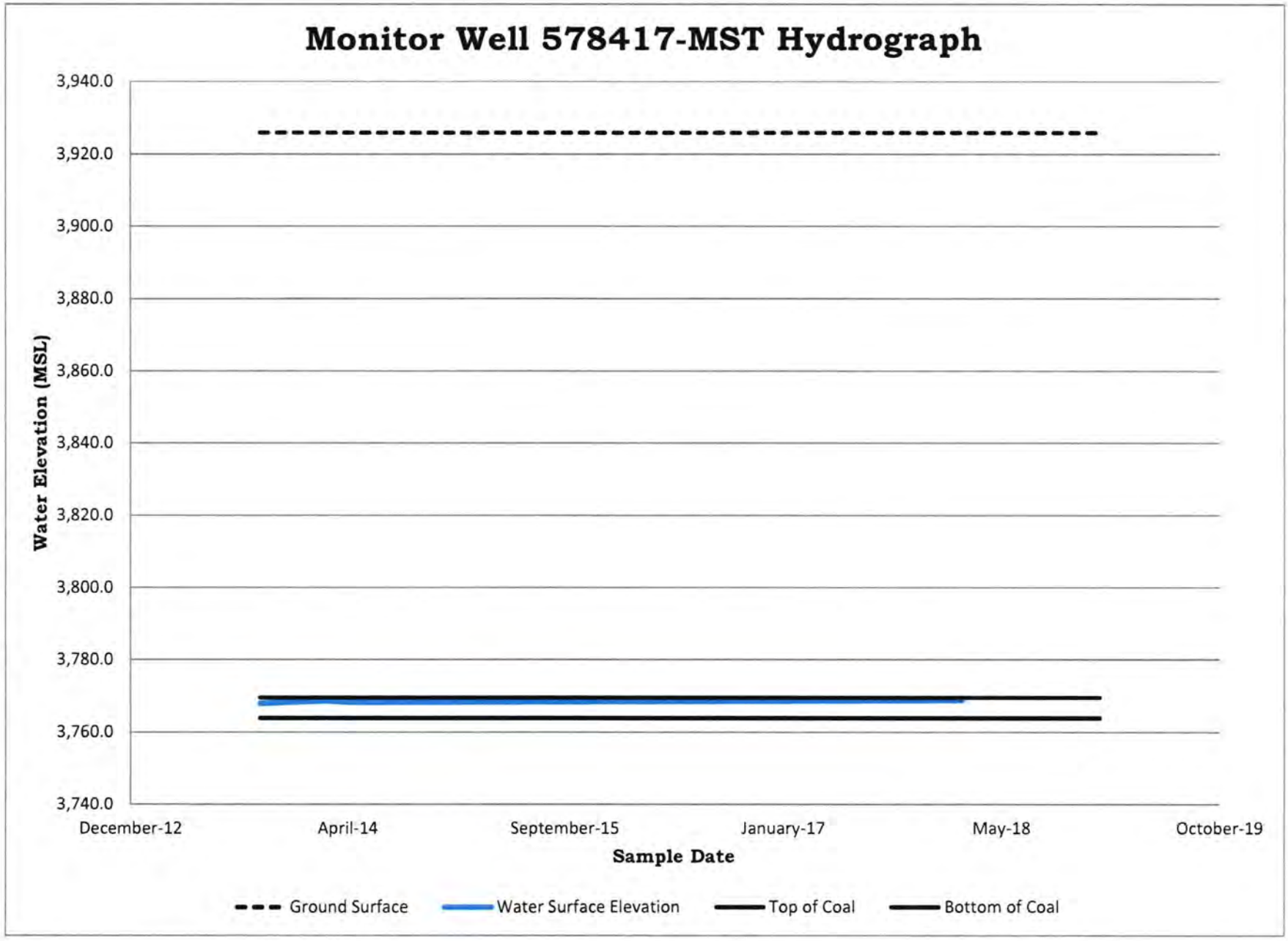
Monitor Well 578417-CRN Hydrograph



TFN6 2/025
RECD MAY 23, 2019

DEQ Ex. 3-465

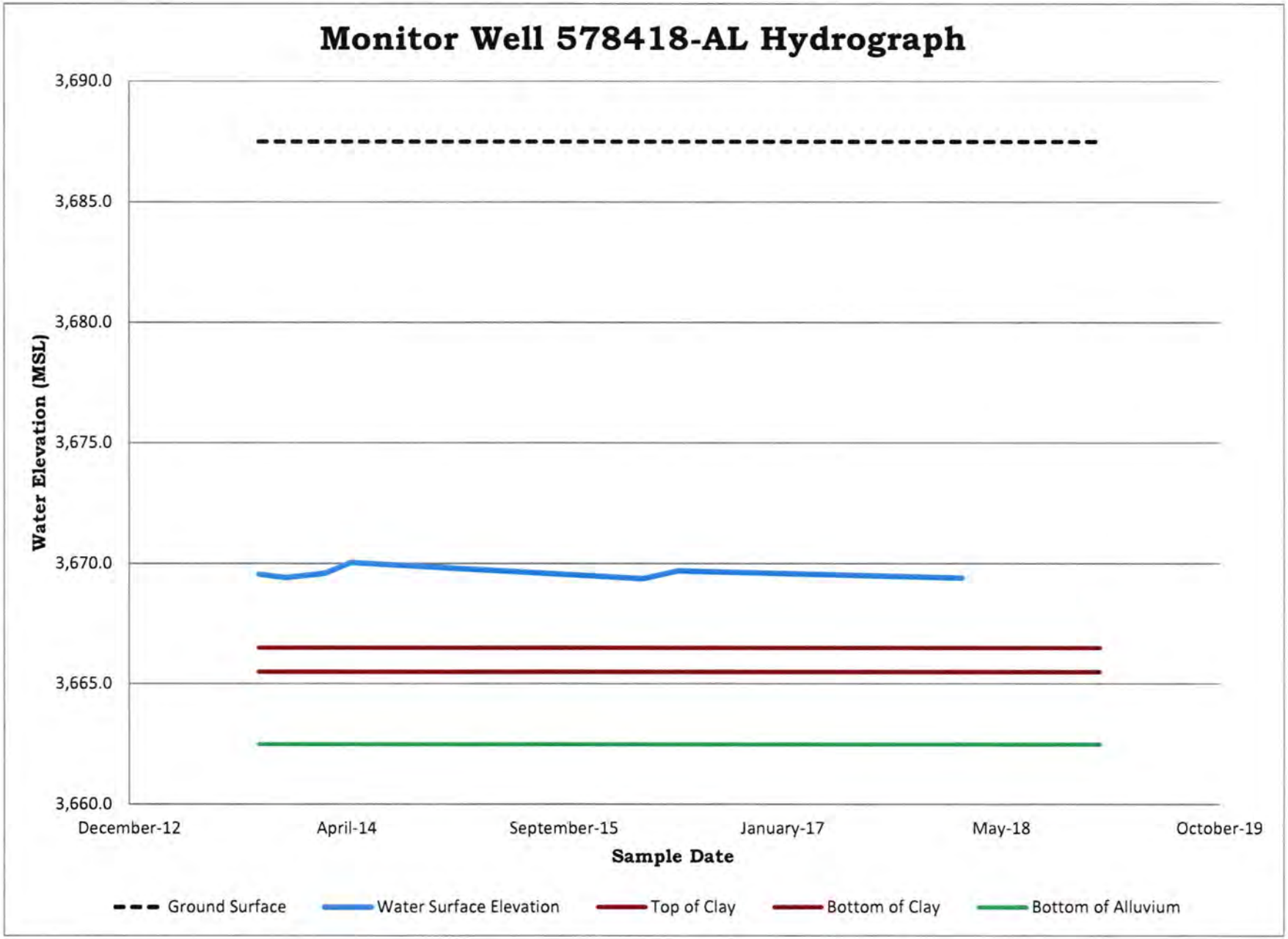
Scanned, 02/28/2020



TFN 2/025
RECD MAY 23, 2013

DEQ Ex. 3-466

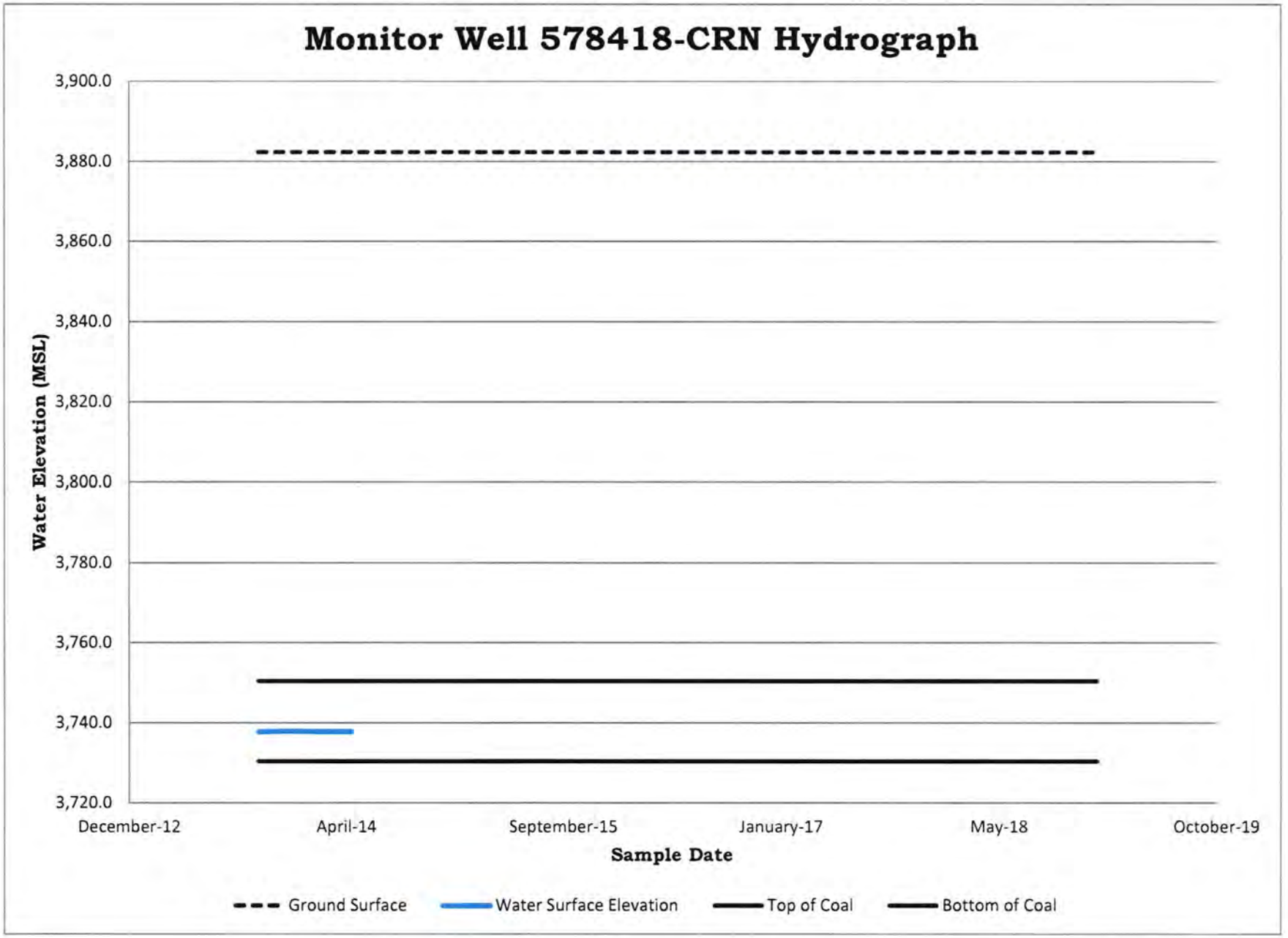
Scanned, 02/28/2020



TFNS 2/625
RECD MAY 23, 2019

DEQ Ex. 3-467

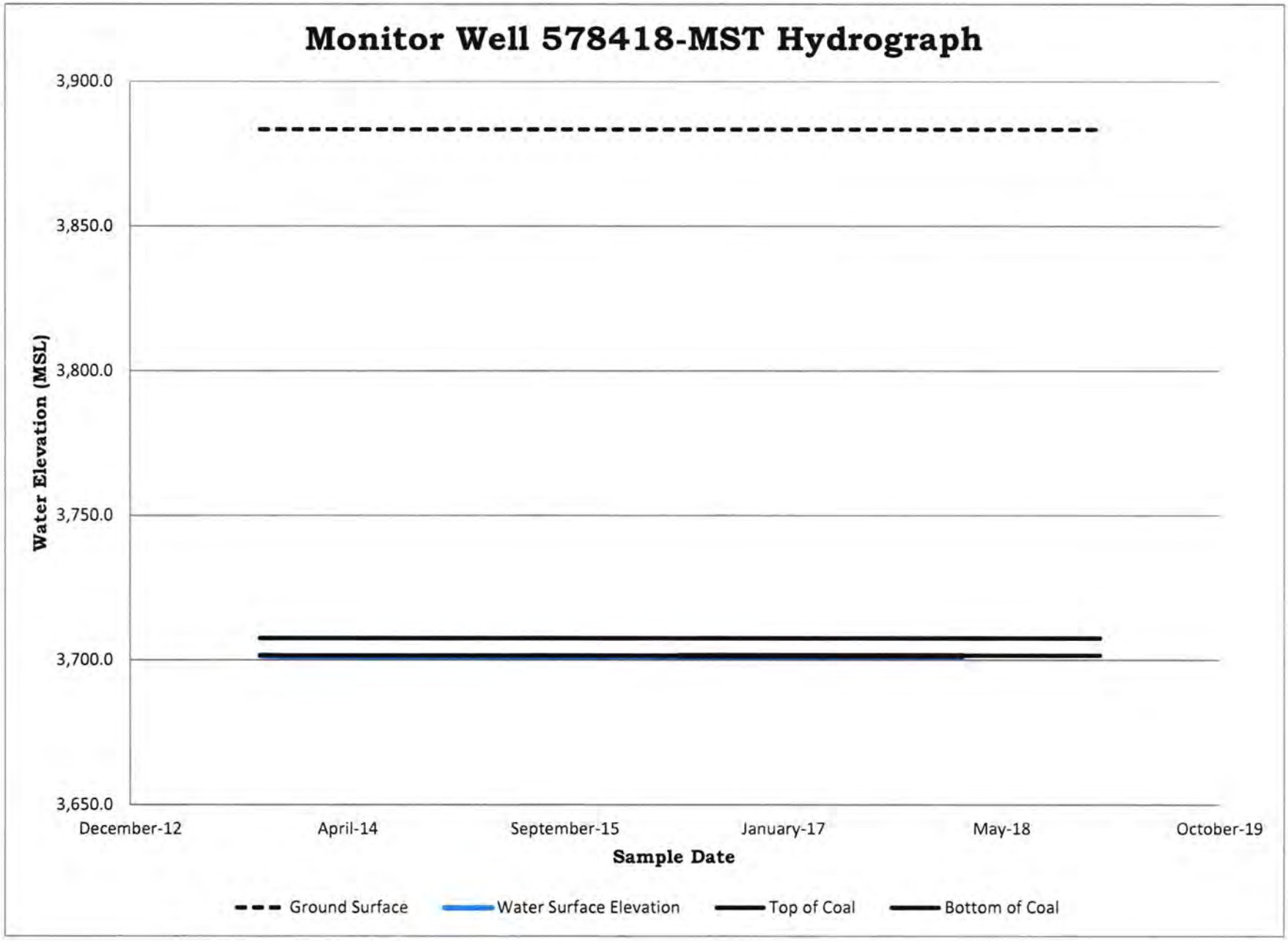
Scanned, 02/28/2020



TFN 2/3/25
RECD MAY 23, 2019

DEQ Ex. 3-468

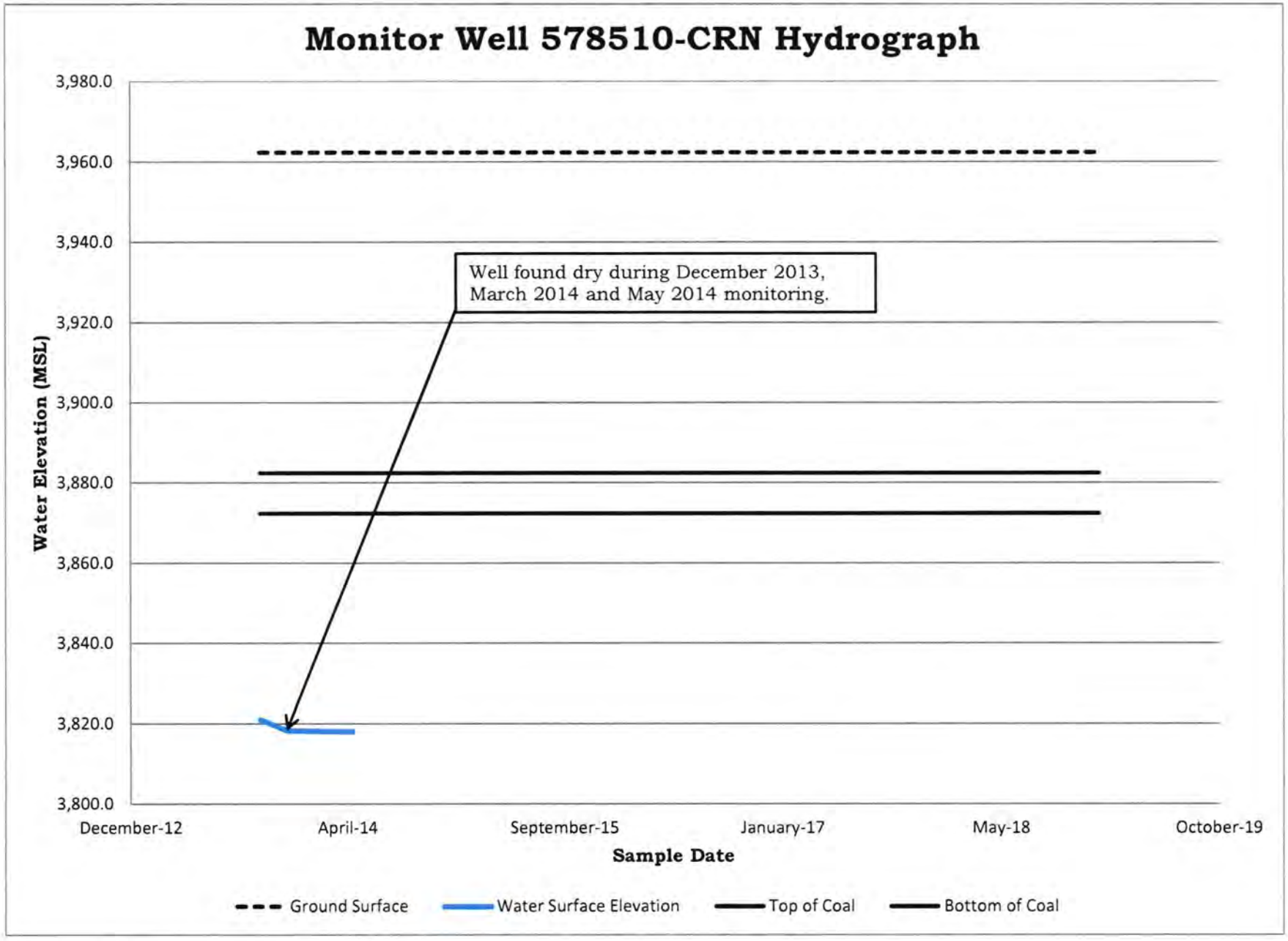
Scanned, 02/28/2020



TFNS 2/625
RECD MAY 23, 2019

DEQ Ex. 3-469

Scanned, 02/28/2020

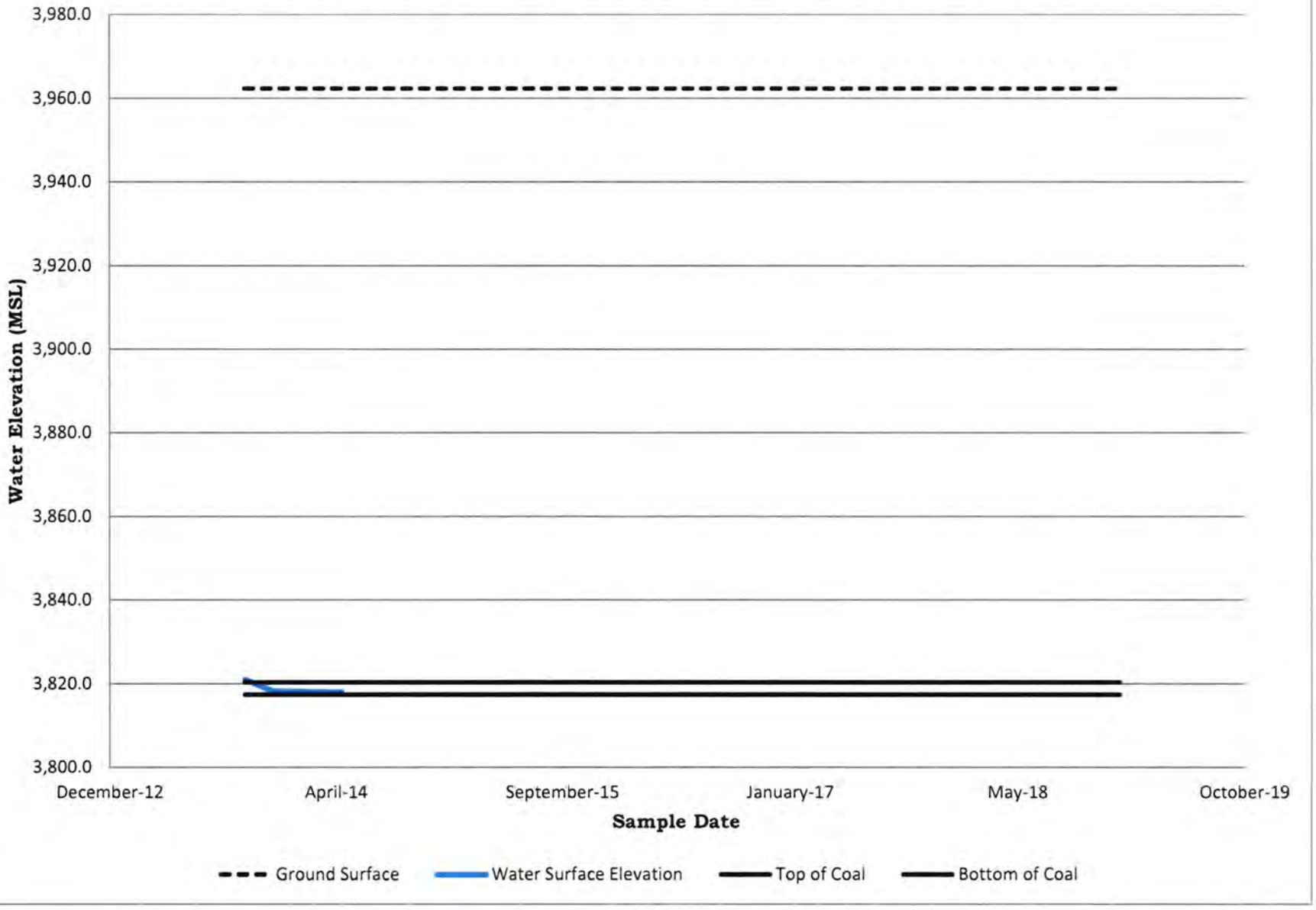


TFNS 2/625
RECD MAY 23, 2019

DEQ Ex. 3-470

Scanned, 02/28/2020

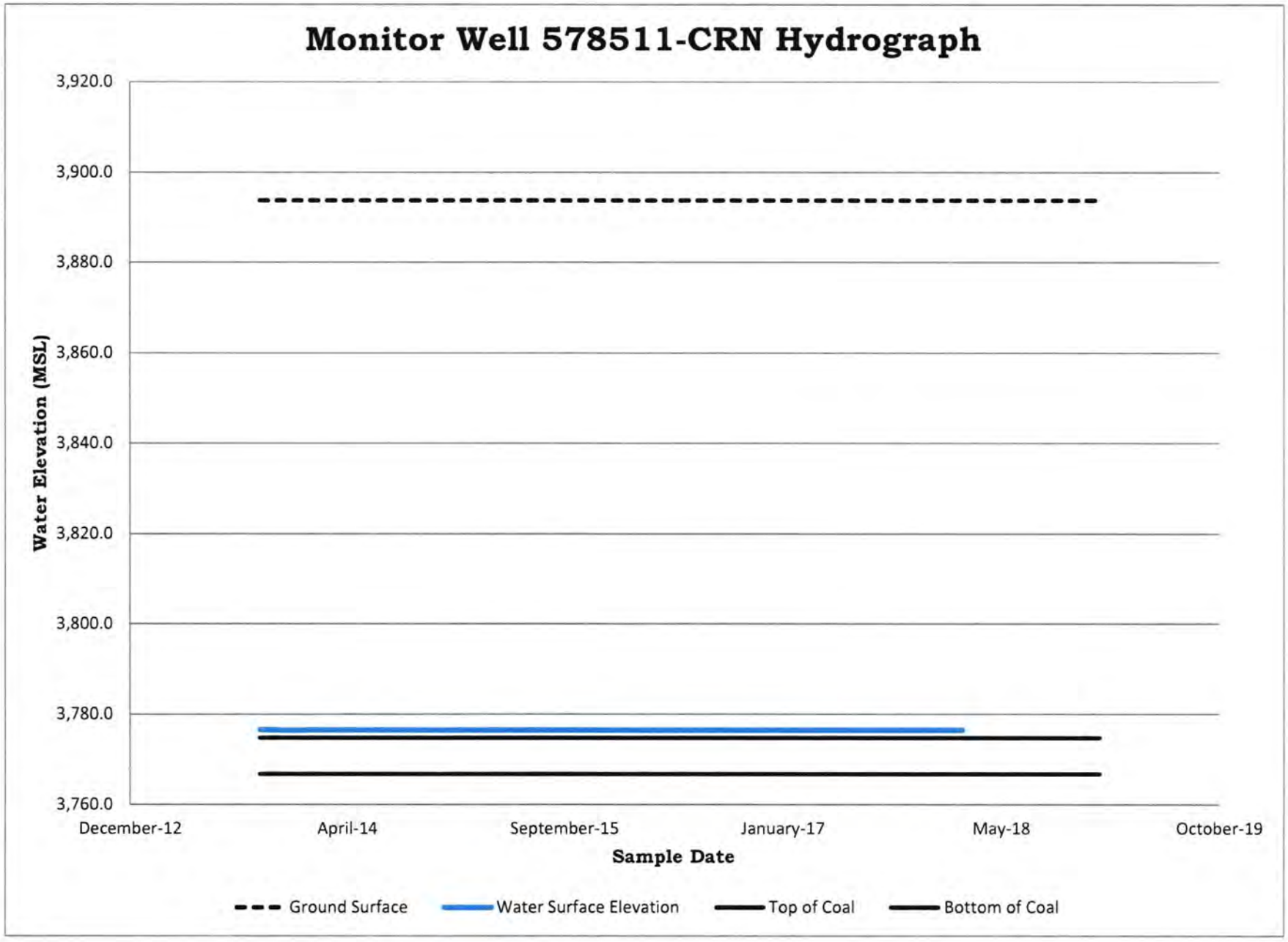
Monitor Well 578510-MST Hydrograph



TFNS 2/625
RECD MAY 23, 2019

DEQ Ex. 3-471

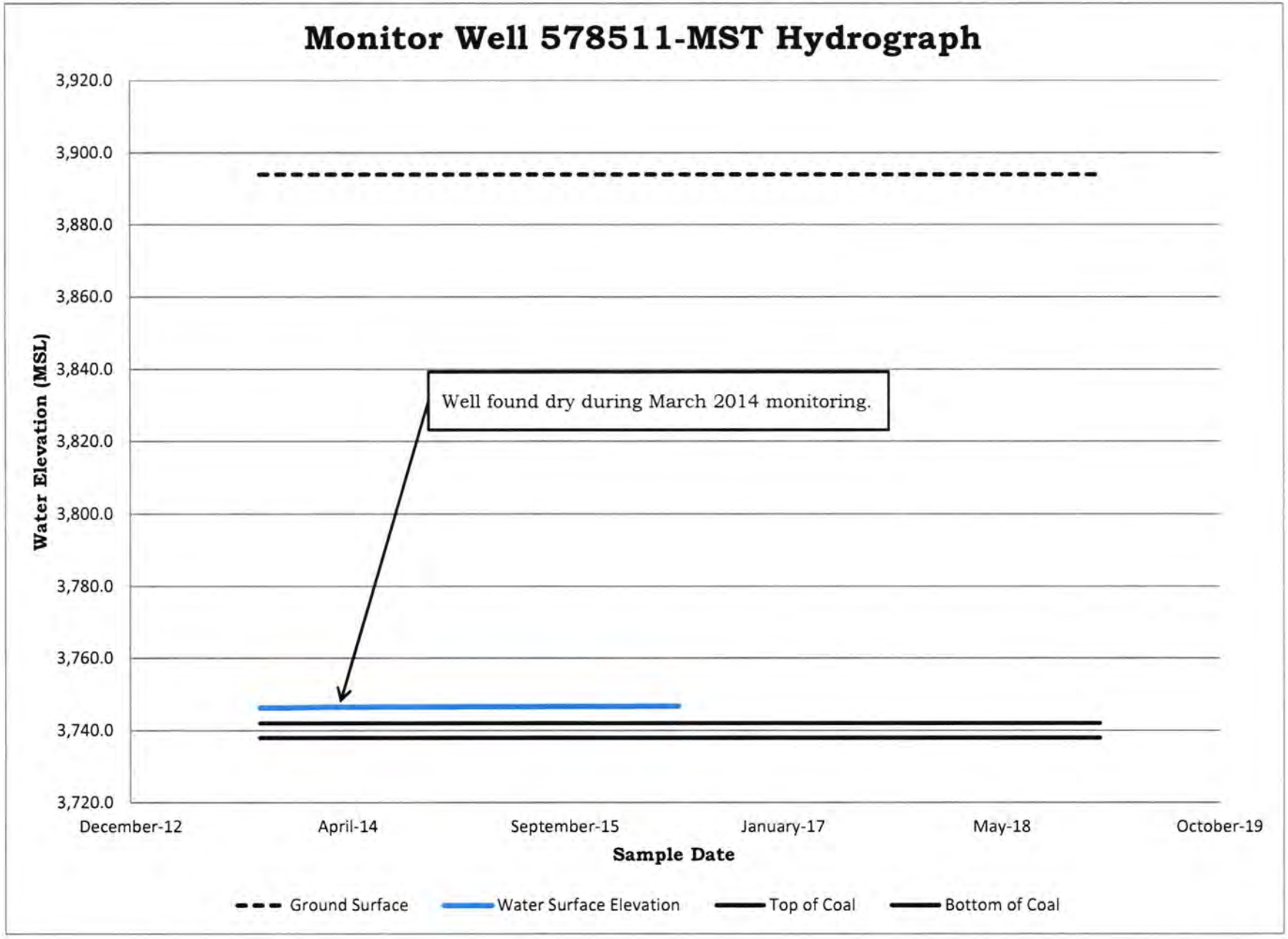
Scanned, 02/28/2020



TFN 2/225
RECD MAY 23, 2019

DEQ Ex. 3-472

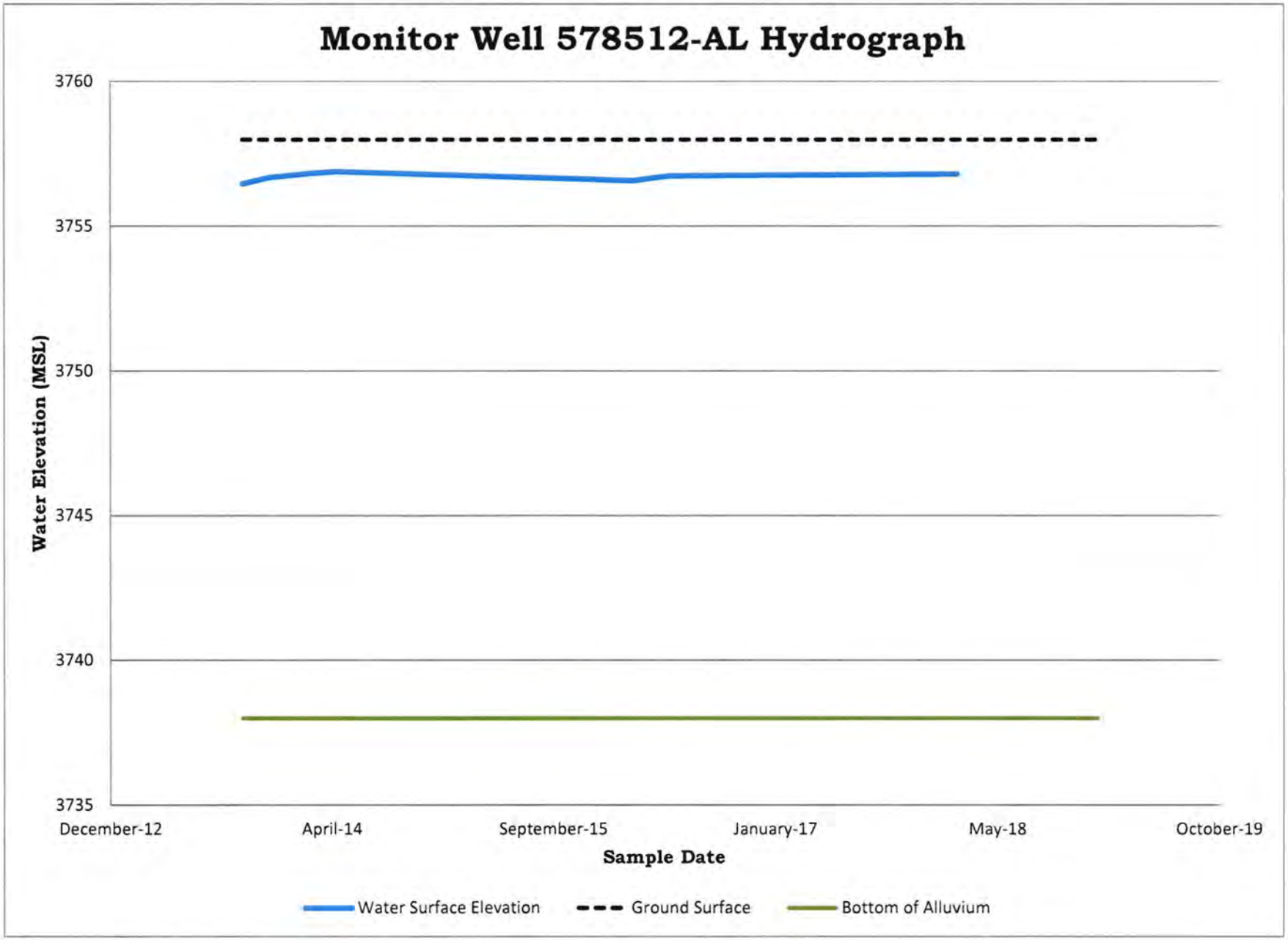
Scanned, 02/28/2020



TFNS 2/625
RECD MAY 23, 2019

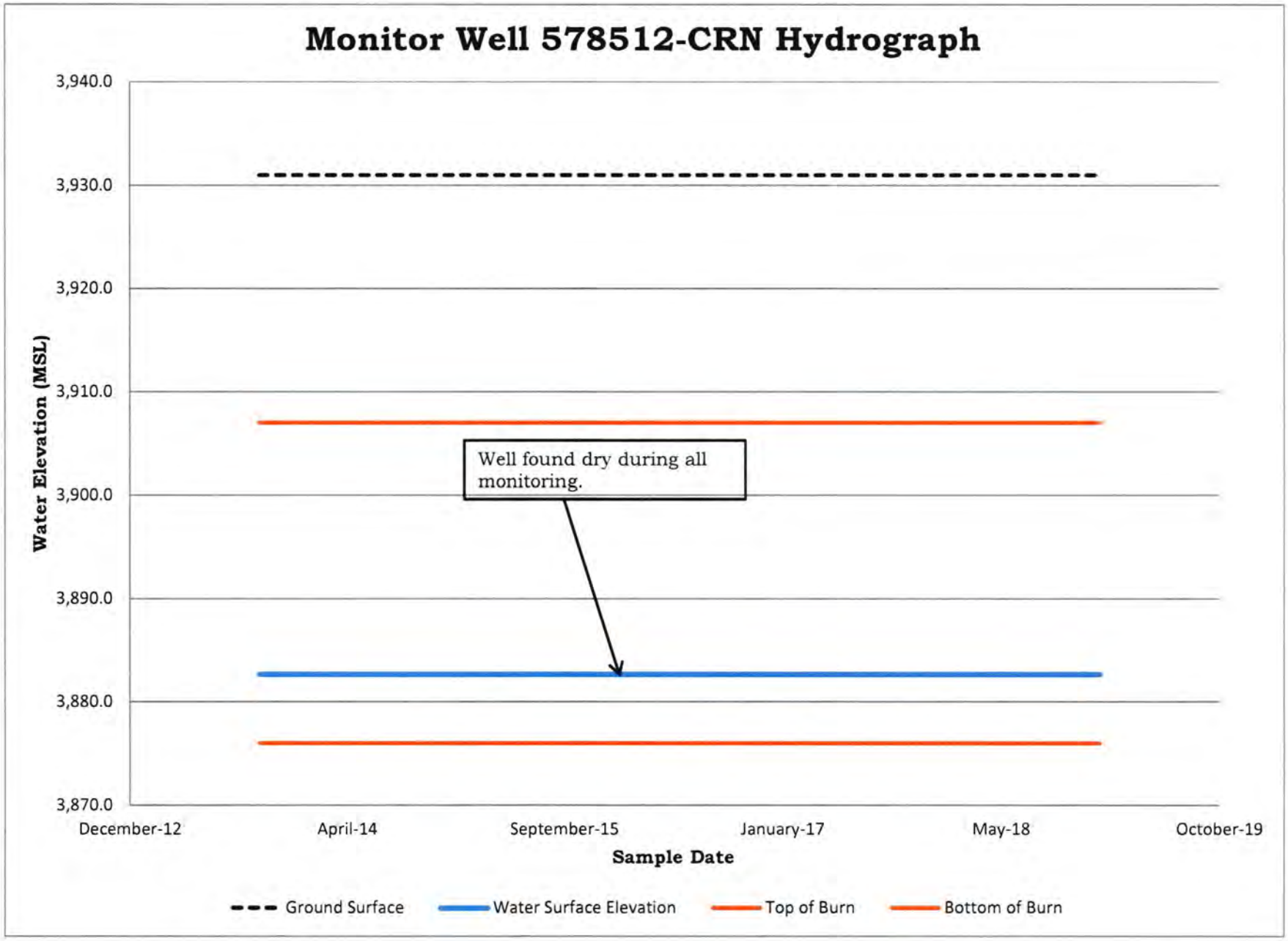
DEQ Ex. 3-473

Scanned, 02/28/2020



TFNS 2/825
RECD MAY 23, 2019

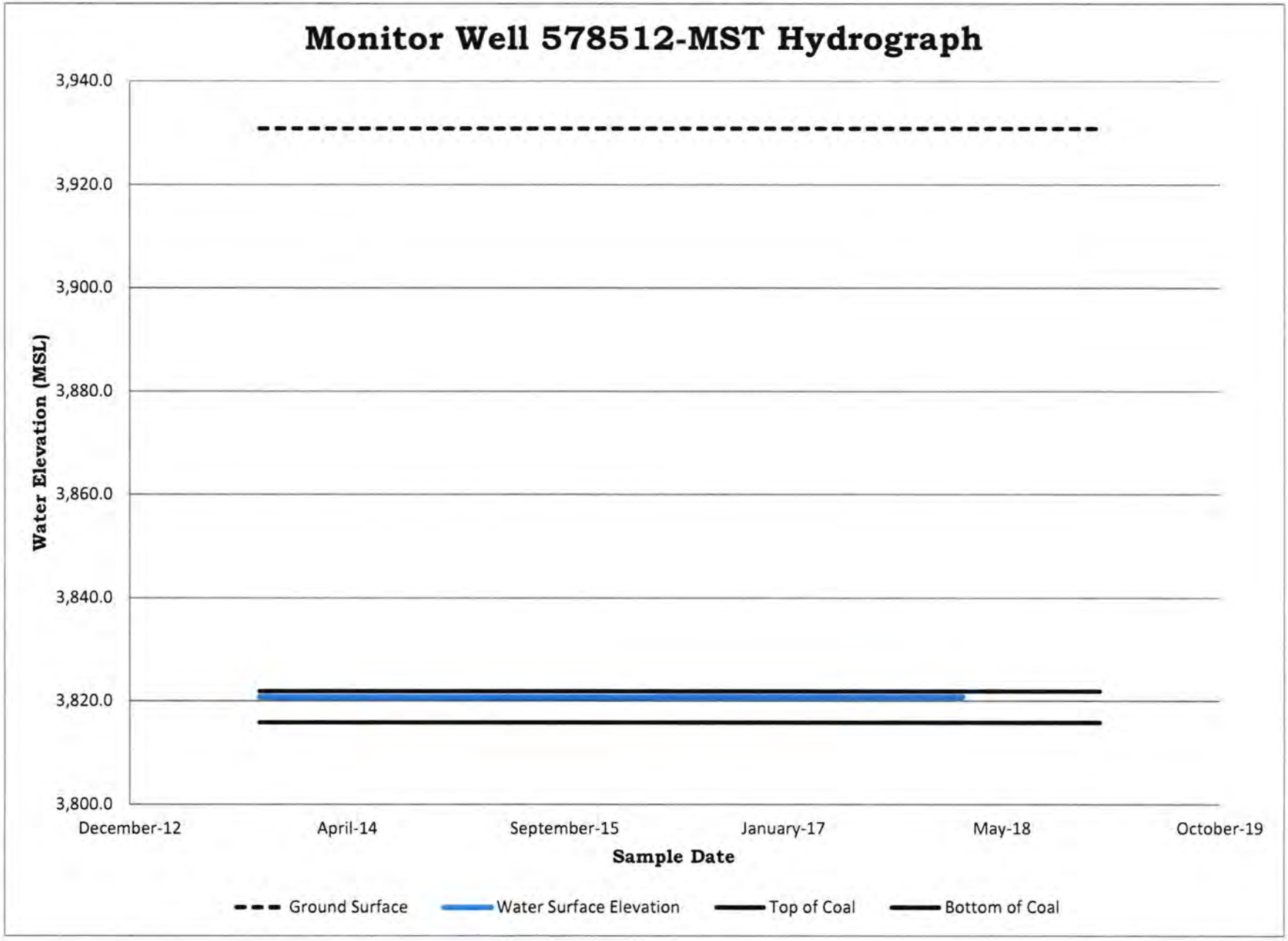
Scanned, 02/28/2020



TFNS 2/025
RECD MAY 29, 2019

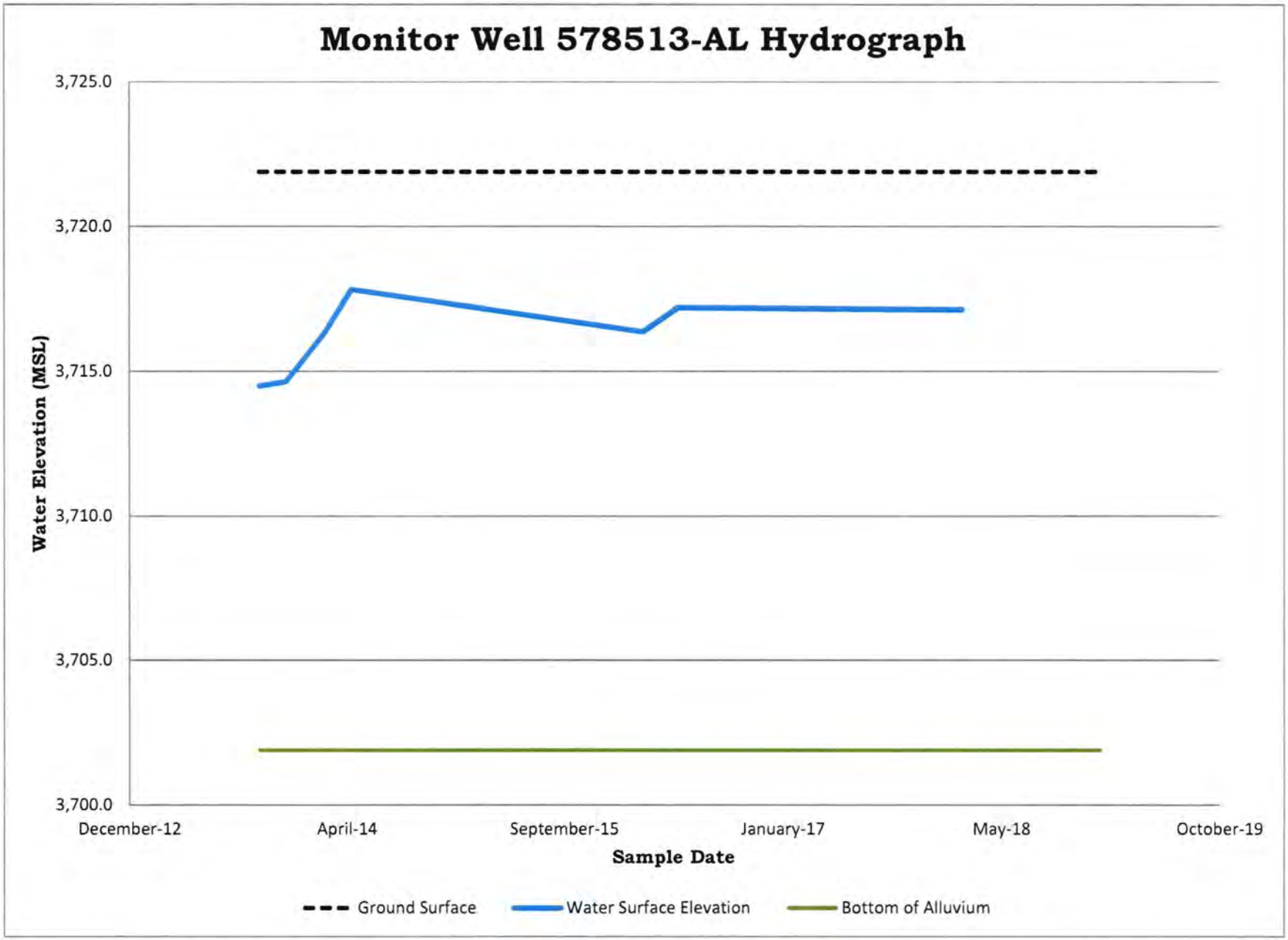
DEQ Ex. 3-475

Scanned, 02/28/2020



TFNS 2/825
RECD MAY 23, 2019

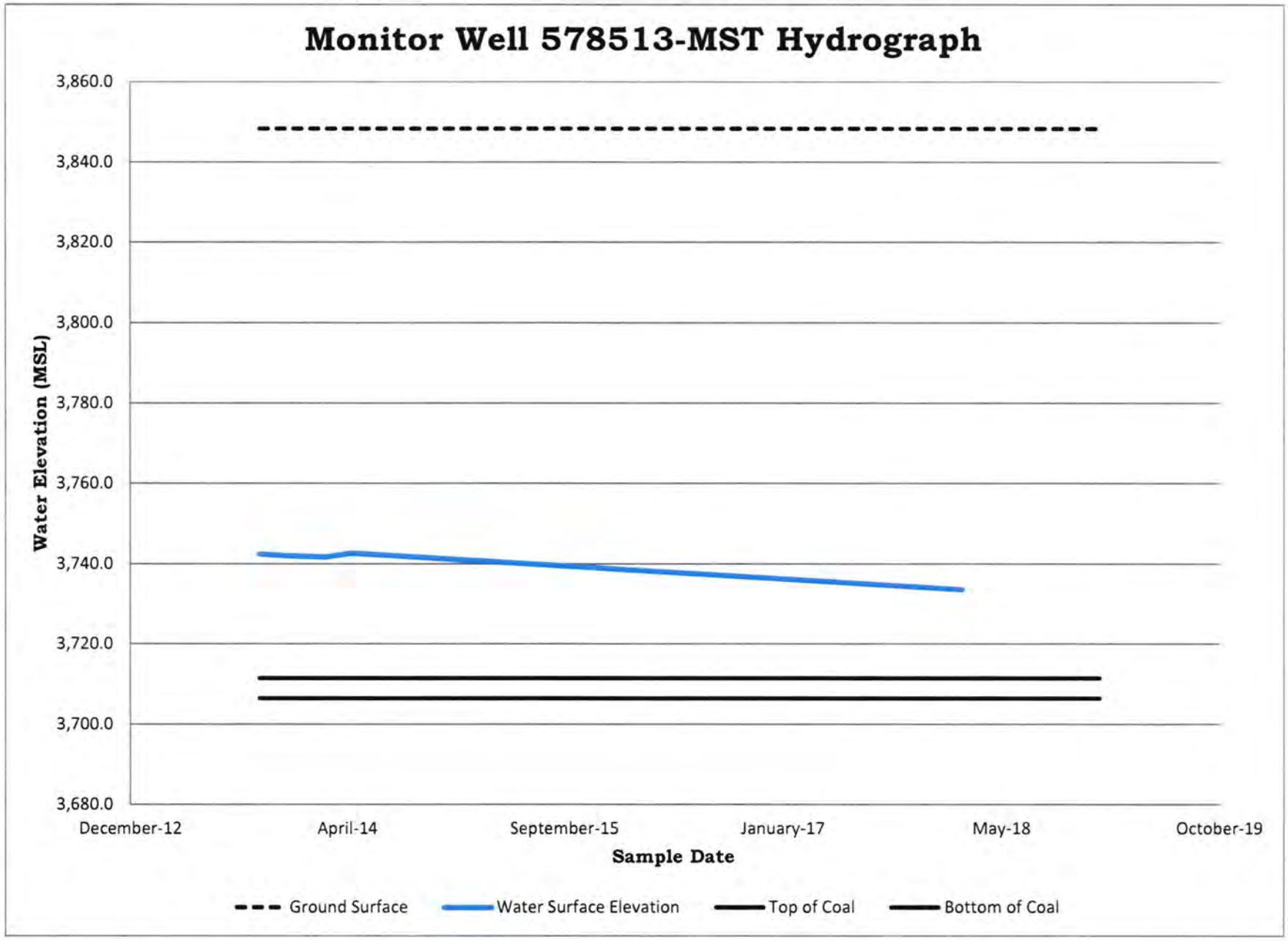
Scanned, 02/28/2020



TFRB 2/2025
RECD MAY 23, 2019

DEQ Ex. 3-477

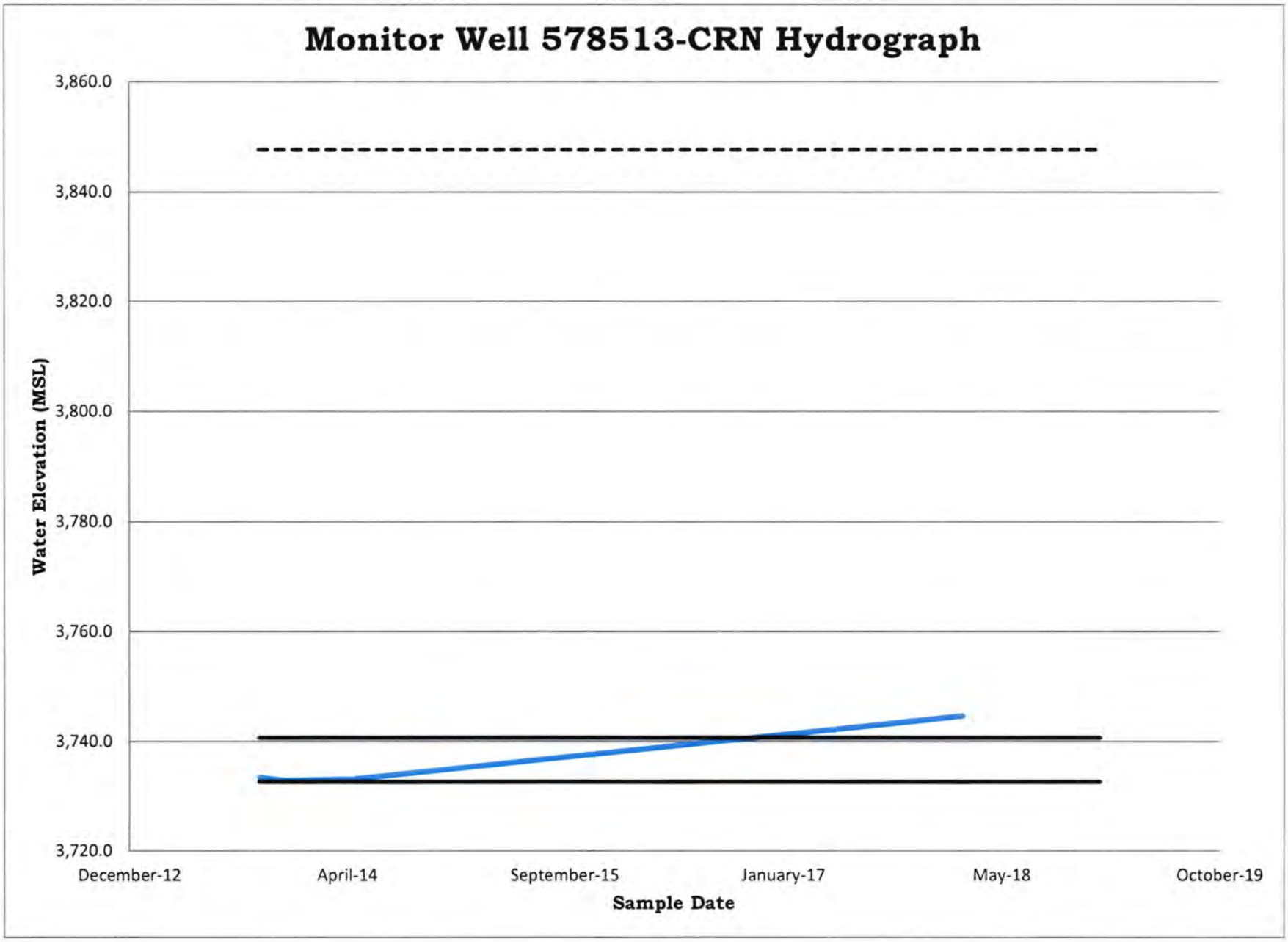
Scanned, 02/28/2020



TFNS 2/025
RECD MAY 23, 2019

DEQ Ex. 3-478

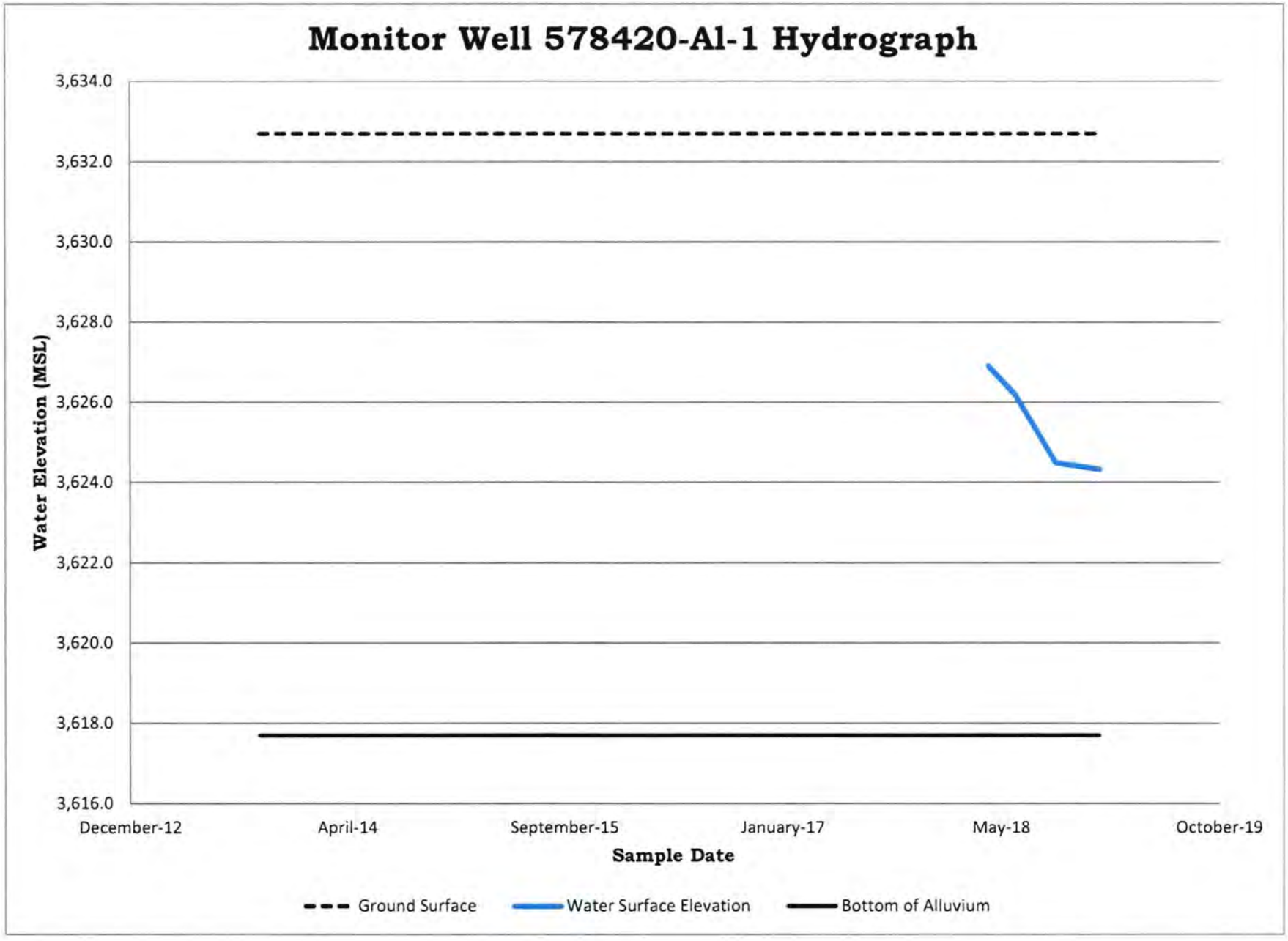
Scanned, 02/28/2020



TFNS 2/825
RECD MAY 29, 2019

DEQ Ex. 3-479

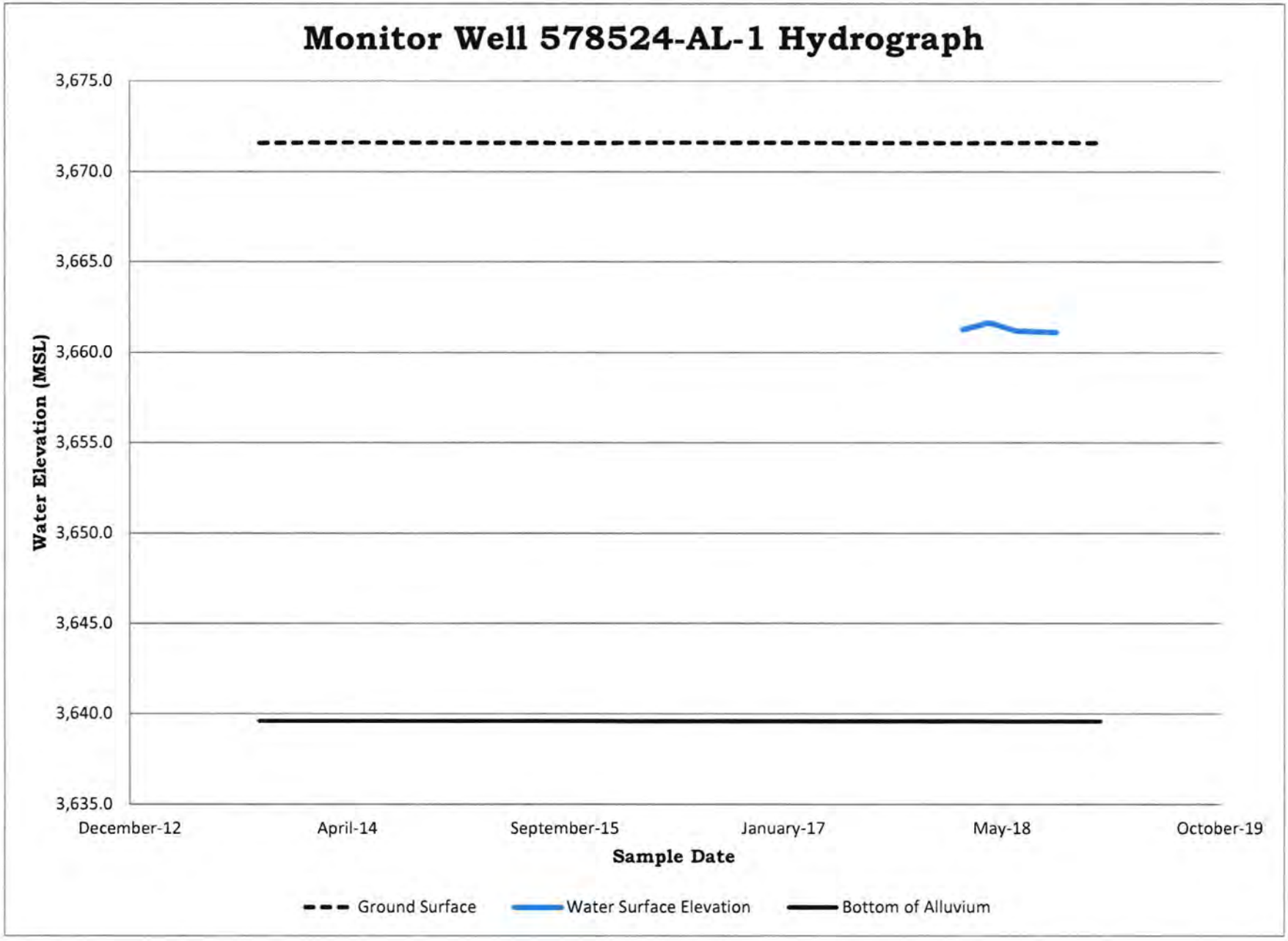
Scanned, 02/28/2020



TFNS 2/425
RECD MAY 29, 2019

DEQ Ex. 3-480

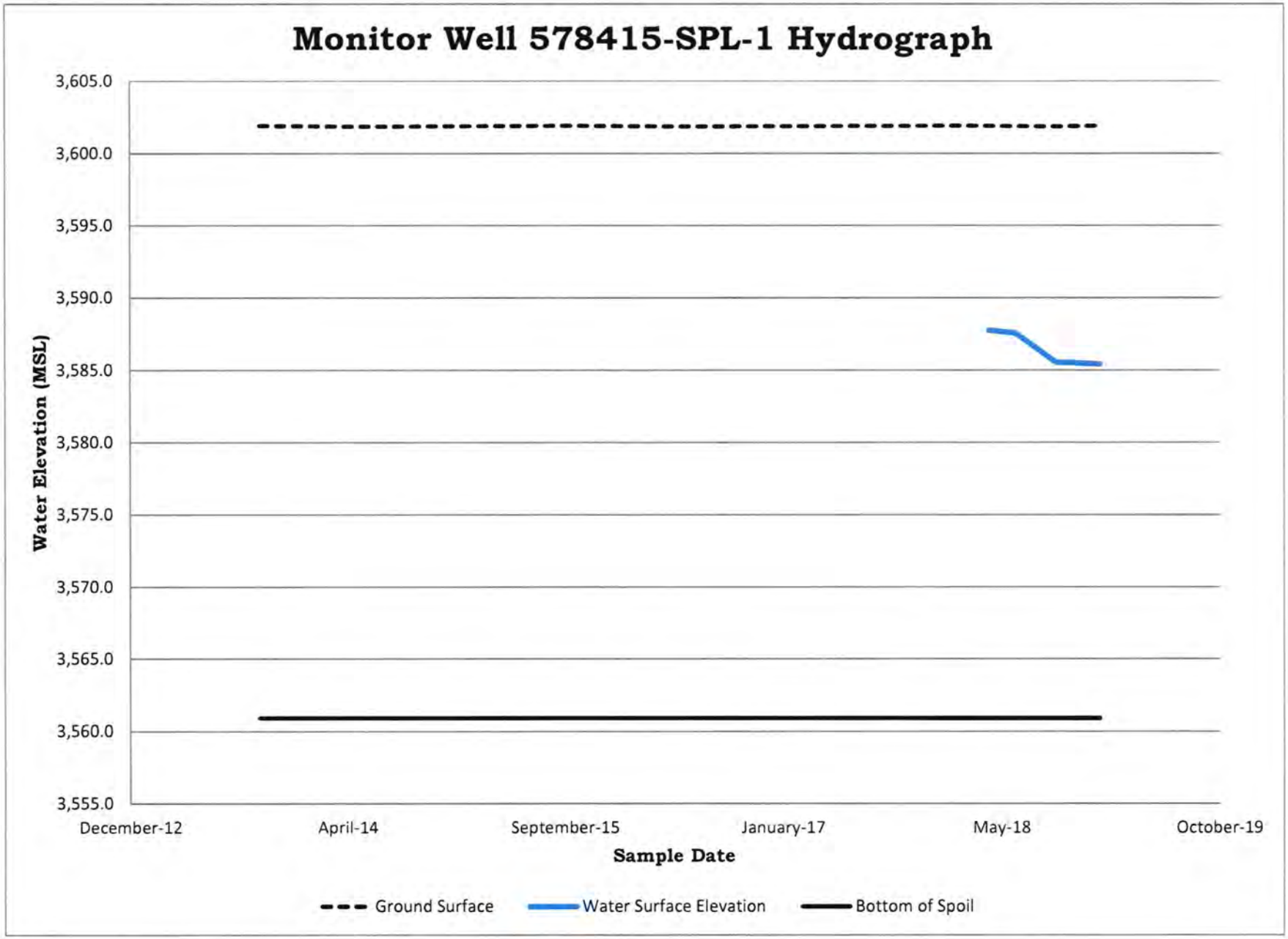
Scanned, 02/28/2020



TFNS 2/025
RECD MAY 23, 2019

DEQ Ex. 3-481

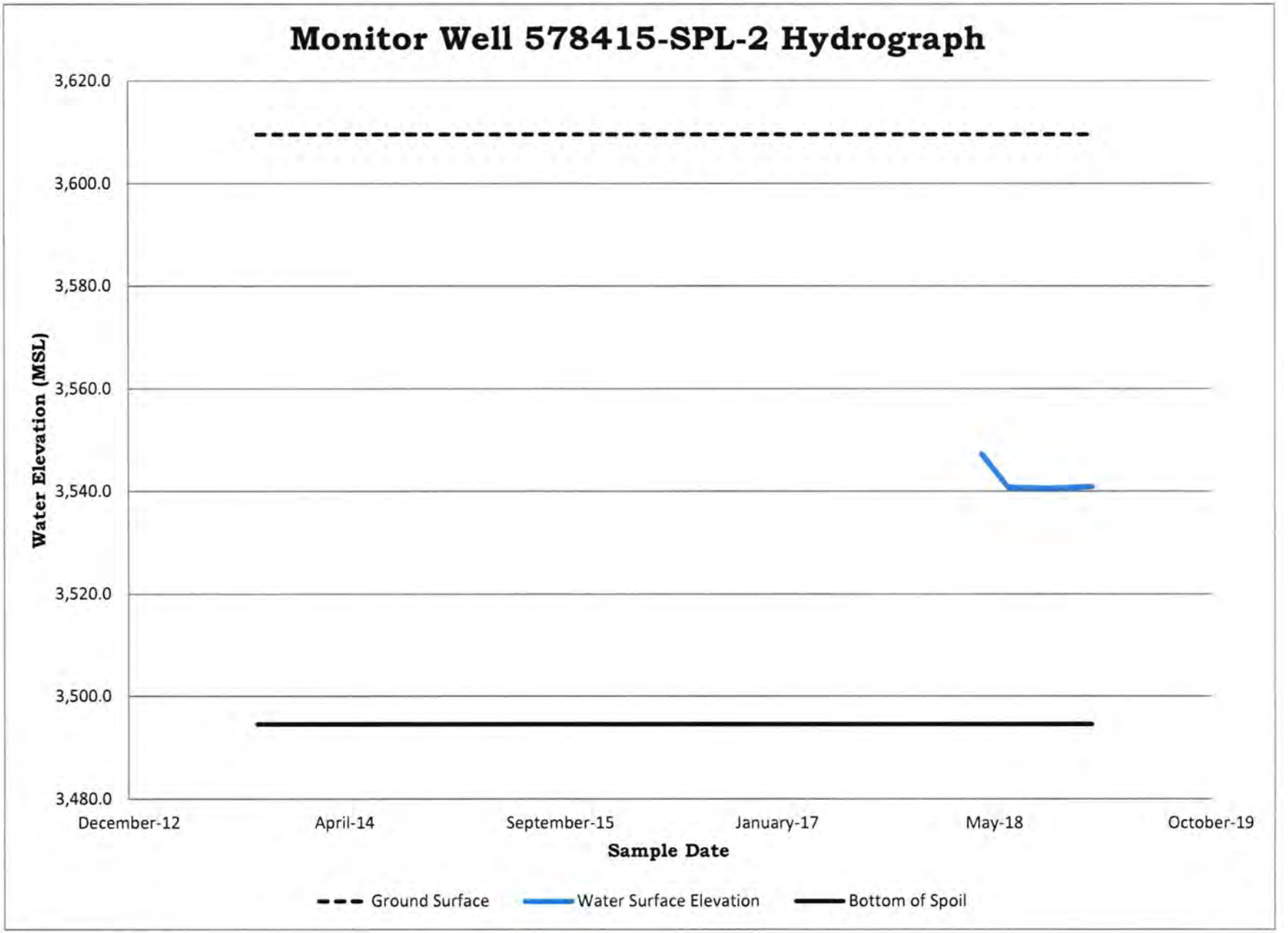
Scanned, 02/28/2020



TFNS 2/625
RECD MAY 23, 2019

DEQ Ex. 3-482

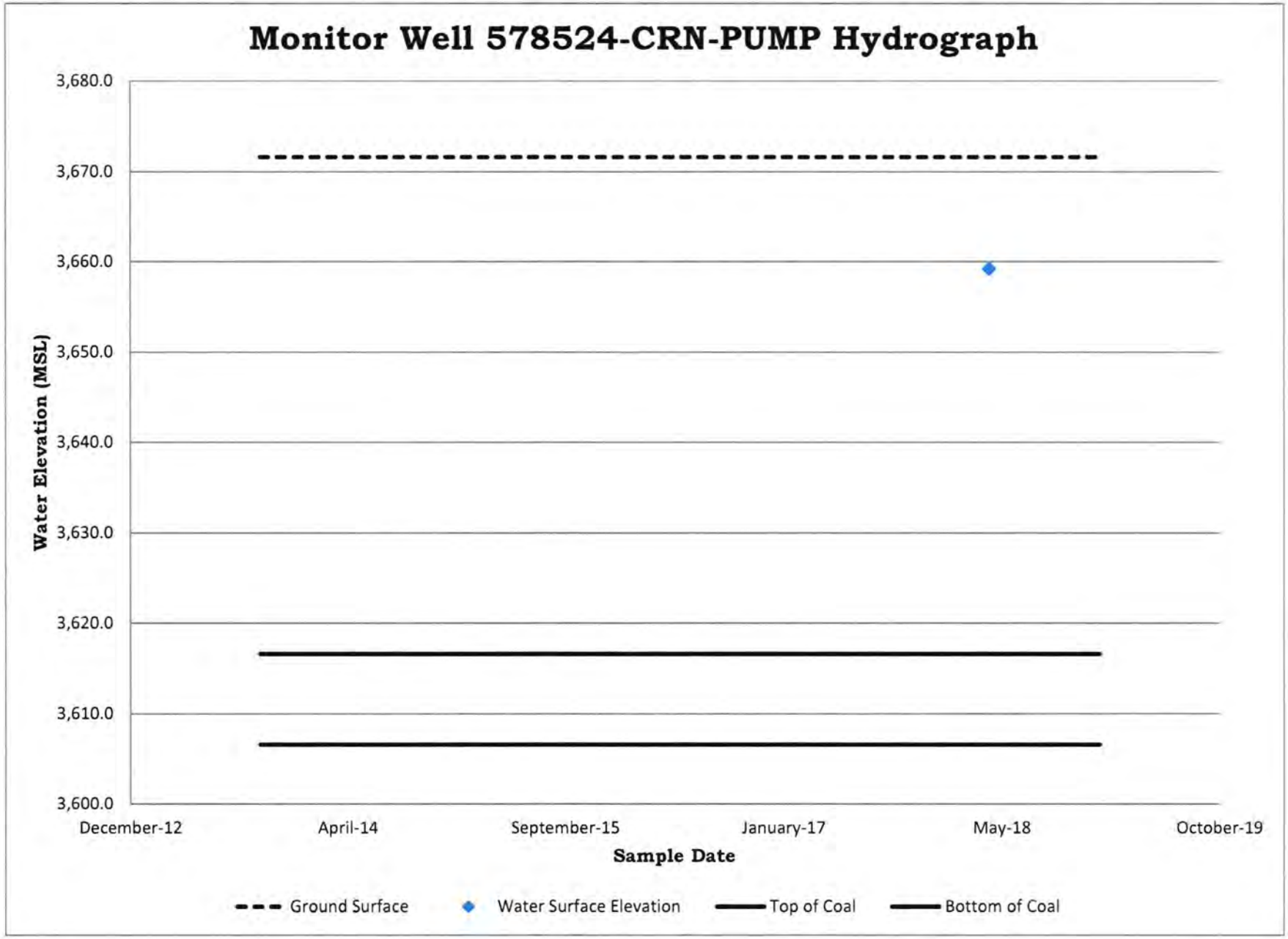
Scanned, 02/28/2020



TFNS 2/825
RECD MAY 23, 2019

DEQ Ex. 3-483

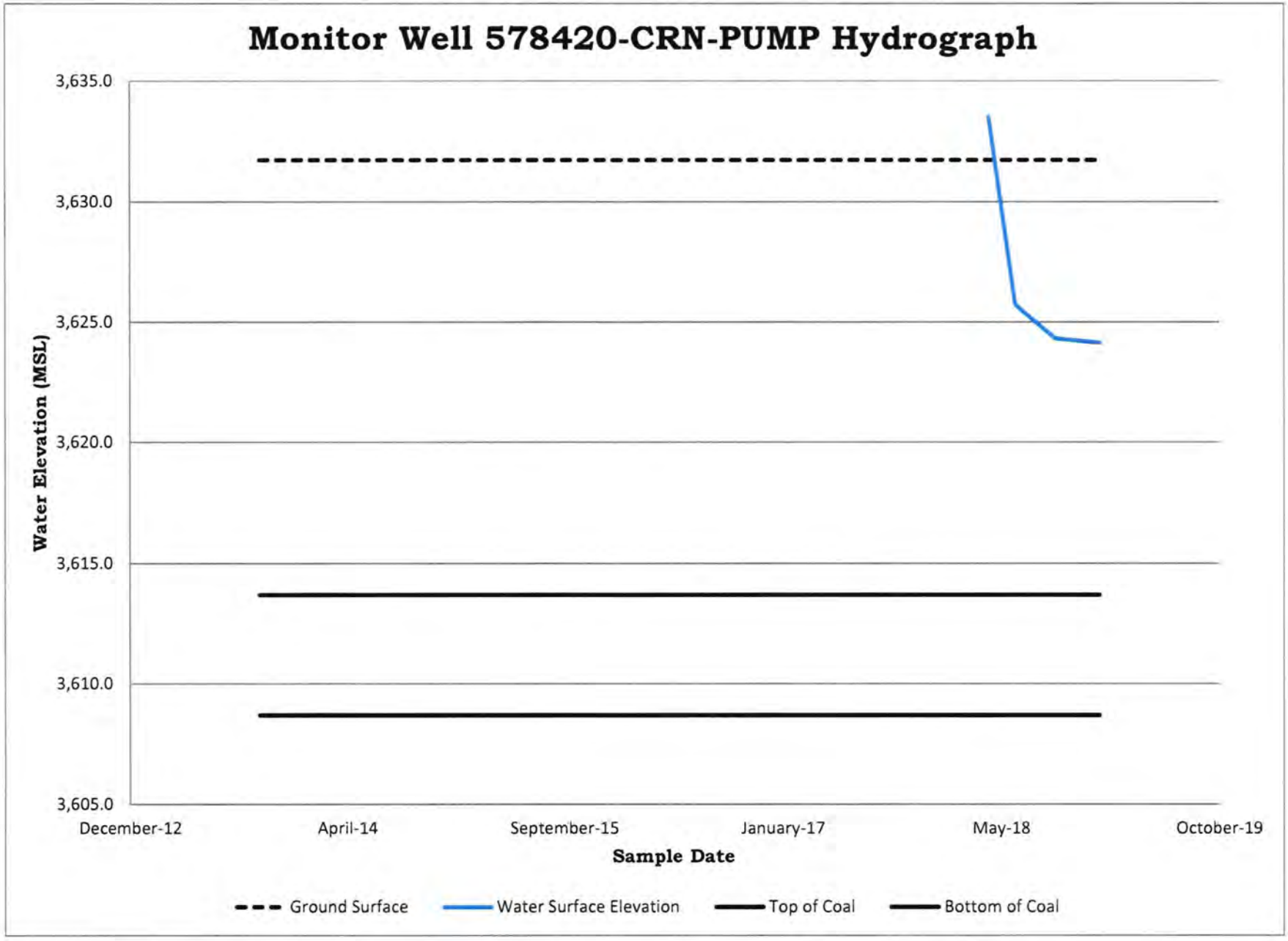
Scanned, 02/28/2020



TFNS 2/825
RECD MAY 29, 2019

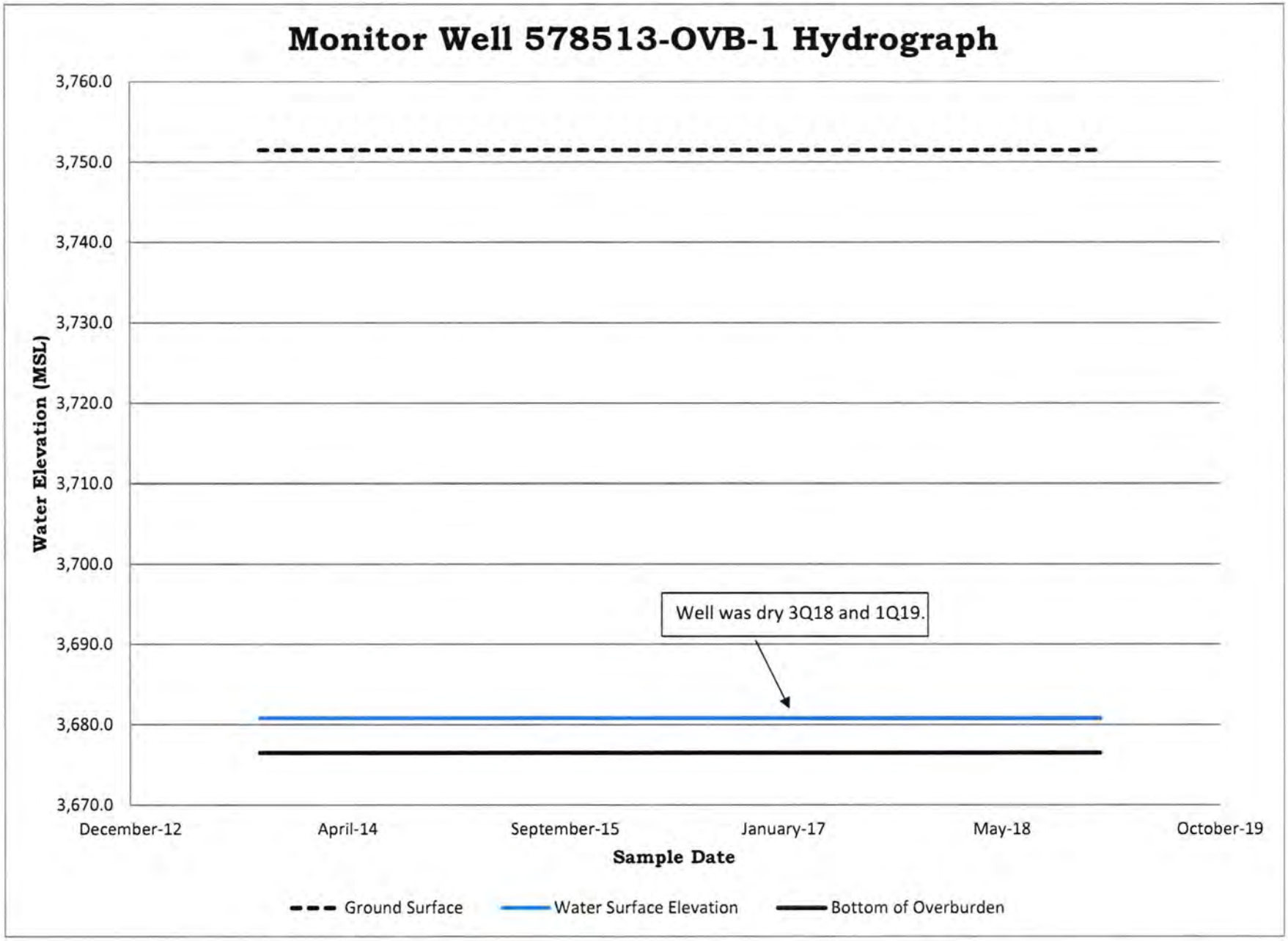
DEQ Ex. 3-484

Scanned, 02/28/2020



TFNS 2/825
RECD MAY 23, 2019

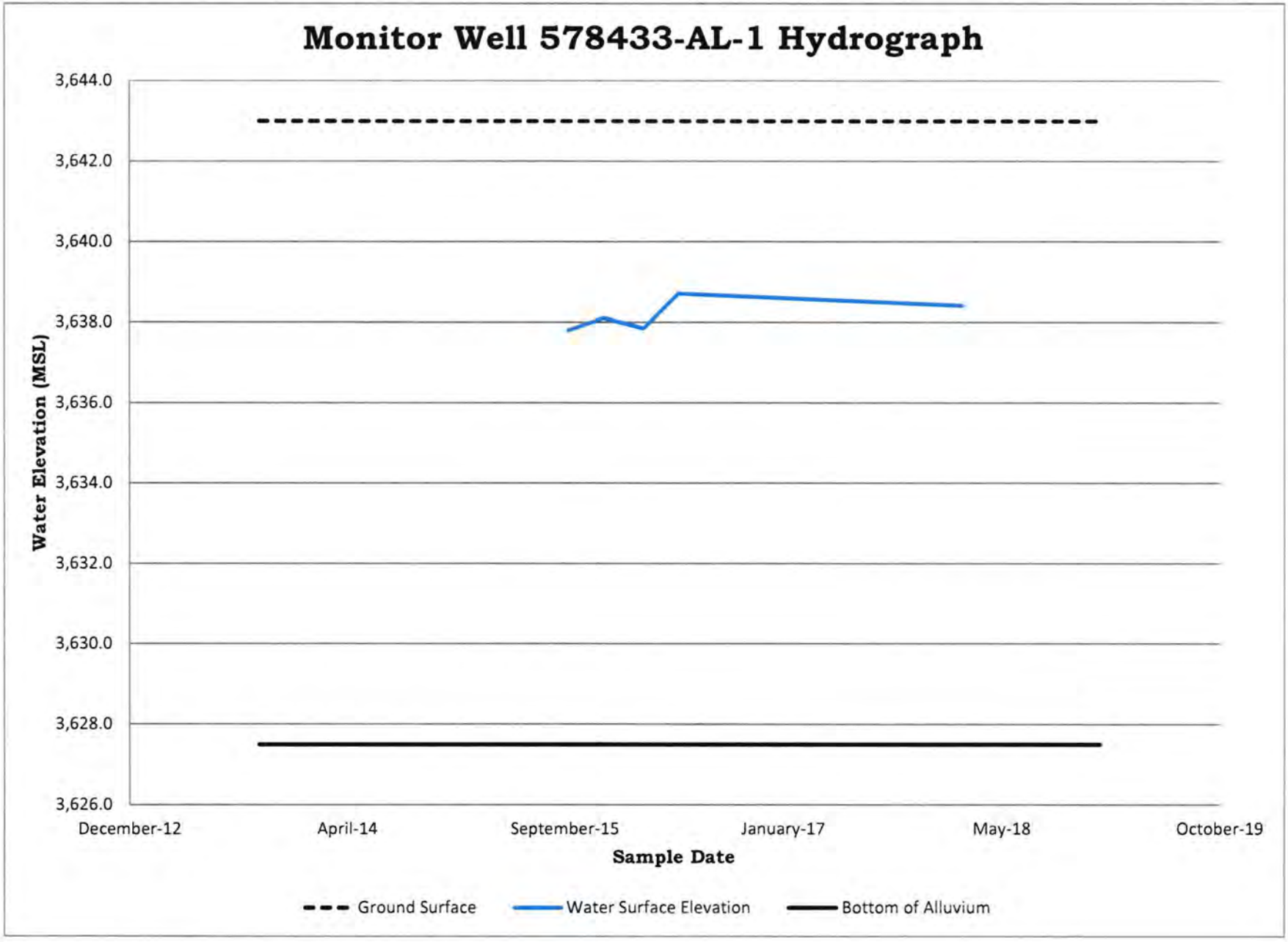
Scanned, 02/28/2020



TFNS 2/025
RECD MAY 23, 2019

DEQ Ex. 3-486

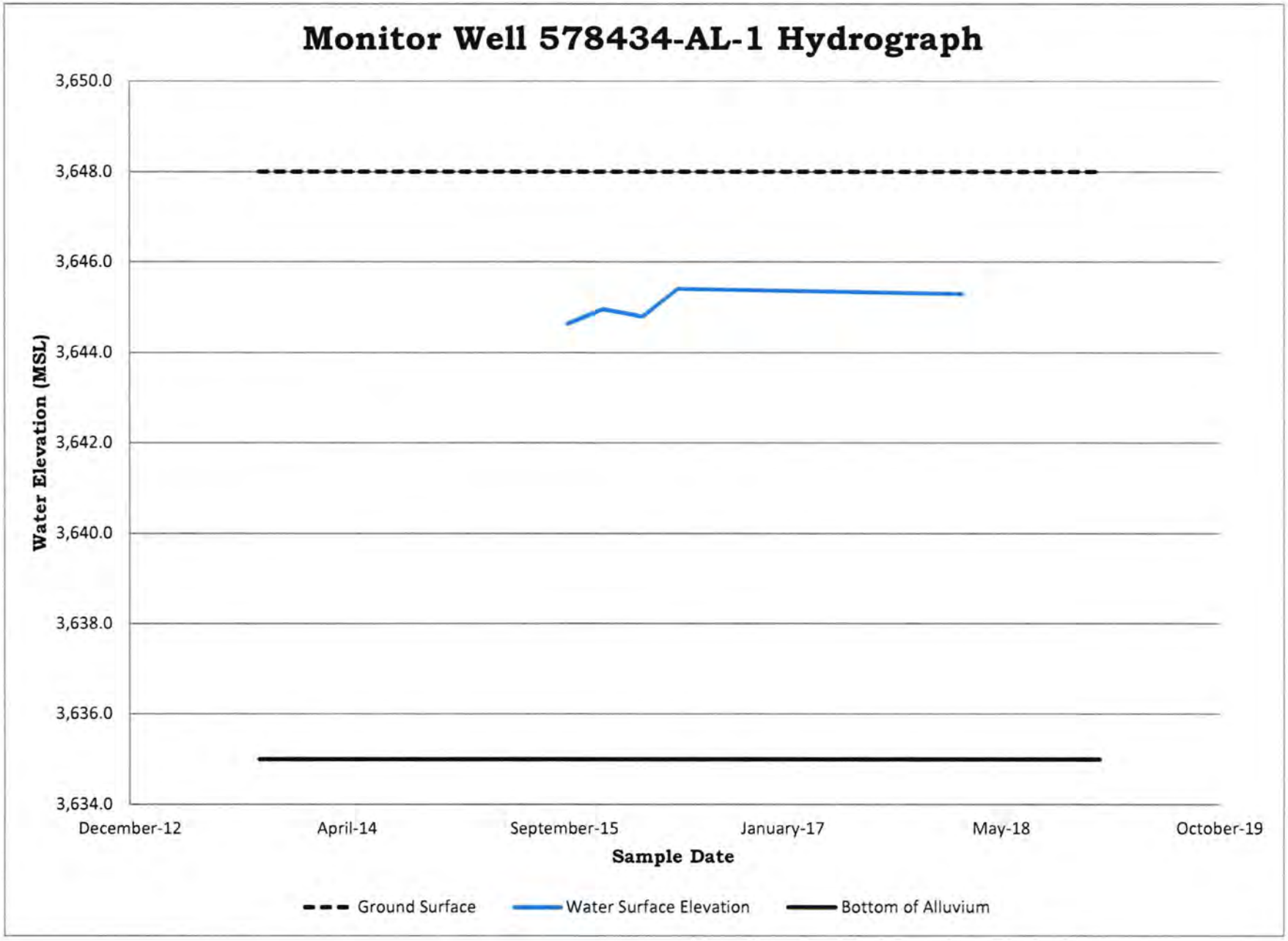
Scanned, 02/28/2020



TFNS 2/625
RECD MAY 23, 2019

DEQ Ex. 3-487

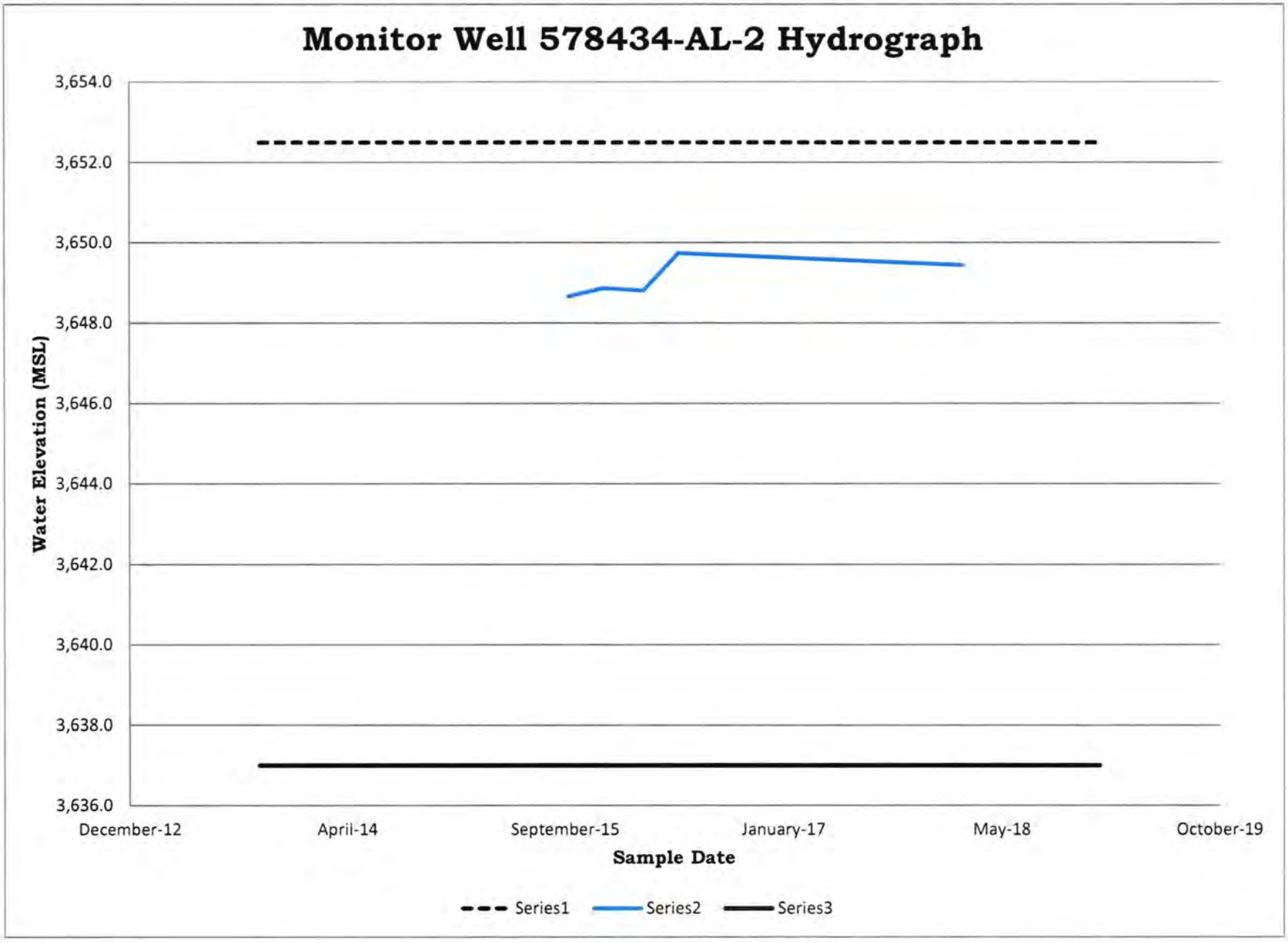
Scanned, 02/28/2020



TFNS 2/825
RECD MAY 23, 2019

DEQ Ex. 3-488

Scanned, 02/28/2020



TFNS 2/525
RECD MAY 23, 2019

DEQ Ex. 3-489

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ADDENDUM D6-10

Groundwater Quality

TFN 6 2/025
RECD NOV 14, 2014

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RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578408-CRN-1 Project Ramaco

Location _____ W.O.# _____

Sample ID# SM578408-CRN-1 Date Sampled 10 / 9 / 13 Time 1540 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 98.27 ft below MP Depth to Water (below MP) 87.66 ft Casing Diameter 2 in

Date 10 / 9 / 13 Time 1415 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' (Bladder)

' Tap ' Bailer _____

Pump intake or bailer set at 96 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1530	7.83	2470	13.3	170	—	↓	150 mL/30sec
1540	7.79	2440	13.3	370	—	≈ 3.0	↓

Pumping Start Time 1515 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC# 150183

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578408-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled 10 / 9 / 13 Time 1500 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 120.20 ft below MP Depth to Water (below MP) 104.49 ft Casing Diameter 2 in

Date 10 / 9 / 13 Time 1410 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' (Bladder)

' Tap ' Bailer _____

Pump intake or bailer set at 116 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1450	7.40	2380	14.2	779	—	↓	150mL/30sec
1500	7.38	2380	13.7	552	—	≈3.0	↓

Pumping Start Time 1435 WL _____ Pumping End Time _____ WL _____

Comments: Water very turbid - no odor

HCF

COC #

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578409-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# [illegible] Date Sampled [illegible] Time _____ am pm

Describe Sampling Point _____

Well Depth 110.55 ft below MP Depth to Water (below MP) 89.77 ft Casing Diameter _____ in

Date 10/9/13 Time 1620 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time [illegible] WL _____ Pumping End Time _____ WL _____

Comments: No Sample - sampled SM578409-CRN-OB-1 Swayne said that the OB well would be better to sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578409-CRN-OB-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SM578409-CRN-OB-1 Date Sampled 10 / 10 / 13 Time ~~0935~~ 0935 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 111.33 ft below MP Depth to Water (below MP) 85.99 ft Casing Diameter 5 in

Date 10 / 9 / 13 Time 1625 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' Bladder

' Tap ' Bailer _____

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

Pump intake or bailer set at 105 ft below MP.

ıbing (type: Plastic). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0925	7.93	1991	10.3	99.7	—	↓	150mL/30sec
0935	8.04	1977	10.3	91.9	—	≈ 3.0	↓

Pumping Start Time 0910 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC# 151960

TFN 8 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578409-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SM578409-MST-1 Date Sampled 10 / 9 / 13 Time 1730 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 122.83 ft below MP Depth to Water (below MP) 101.18 ft Casing Diameter 5 in

Date 10 / 9 / 13 Time 1610 am pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' Bladder

' Tap ' Bailer _____

Pump intake or bailer set at 115 ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1720	8.47	2480	14.2	49.2	—	↓	150mL/30sec
1730	8.49	2450	13.9	78.1	—	≈3.0	↓

Pumping Start Time 1705 WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

COC# 150183

HCF

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* No Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578409-MST-OB-1 Project Ramaco

Location _____ W.O.# 2013134-07

Sample ID# [redacted] Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 123.80 ft below MP Depth to Water (below MP) 101.83 ft Casing Diameter _____ in

Date 10 / 9 / 13 Time 1615 am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: NO Sample - Sampled SM578409-MST-1

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-496

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578409-UBN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SM578409-UBN-1 Date Sampled 10 / 10 / 13 Time 1030 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 141.20 ft below MP Depth to Water (below MP) 108.44 ft Casing Diameter ~~2~~ 5 in

Date 10 / 9 / 13 Time 1630 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' (Bladder)

' Tap ' Bailer _____

Pump intake or bailer set at 130 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1015	8.72	4140	11.1	5.39	—	↓	150ml/30sec
1030	8.74	4110	10.9	4.61	—	≈3.5	↓

Pumping Start Time 1000 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF

COC # 151960

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-497

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578415-MST/CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SM578415-MST/CRN-1 Date Sampled 10 / 31 / 13 Time 1240 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 143.70 ft below MP Depth to Water (below MP) 122.85 ft Casing Diameter 5 in

Date 10 / 31 / 13 Time 1200 am (pm) Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' Bladder

' Tap ' Bailer _____

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

Pump intake or bailer set at 140 ft below MP.

Tubing (type: Plastic). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1230	8.58	2830	~~14.0~~ 14.6	+1000	—	↓	150 ML/30sec
1240	8.56	2590	12.8	330	—	23.5	↓

Pumping Start Time 1210 WL _____ Pumping End Time _____ WL _____

Comments: Can hear water bubbling in well (methane gas?)
- water turbid - no odor
HCF
COC# 151965

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM 578415-MST/CRM-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point _____

Well Depth _____ ft below MP Depth to Water (below MP) _____ ft Casing Diameter _____ in

Date ___/___/___ Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Drilling Company just completed this well and has not removed drill rig from over the well, so no monitoring could be done at this time.

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RECD NOV 14, 2014

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Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578415-MST/CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SM578415-MST/CRN-1 Date Sampled 10 / 31 / 13 Time 1240 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 143.70 ft below MP Depth to Water (below MP) 122.85 ft Casing Diameter 5 in

Date 10 / 31 / 13 Time 1200 am (pm) Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' (Bladder)

' Tap ' Bailer _____

Pump intake or bailer set at 140 ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1230	8.58	2830	~~4.6~~	+1000	—	↓	150 mL/30sec
1240	8.56	2590	12.8	330	—	23.5	↓

Pumping Start Time 1210 WL _____ Pumping End Time _____ WL _____

Comments: Can hear water bubbling in well (methane gas?)
- water turbid - no odor
HCF
COC# 151965

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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SAMPLING INFORMATION

Sampling Point SM578415-MST/CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SM578415-MST/CRN-1 Date Sampled 10 / 31 / 13 Time 1240 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 143.70 ft below MP Depth to Water (below MP) 122.85 ft Casing Diameter 5 in

Date 10 / 31 / 13 Time 1200 am (pm) Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' (Bladder)

' Tap ' Bailer _____

Pump intake or bailer set at 140 ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1230	8.58	2830	~~14.6~~	+1000	—	↓	150 ML/30sec
1240	8.56	2590	12.8	330	—	23.5	↓

Pumping Start Time 1210 WL _____ Pumping End Time _____ WL _____

Comments: Can hear water bubbling in well (methane gas?)
- water turbid - no odor
HCF
COC# 151965

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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WWC ENGINEERING

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(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578417-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SM578417-CRN-1 Date Sampled 10 / 9 / 13 Time 1325 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 142.41 ft below MP Depth to Water (below MP) 133.05 ft Casing Diameter 2 in

Date 10 / 9 / 13 Time 1230 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' (Bladder)

' Tap ' Bailer _____

Pump intake or bailer set at 140 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for N/A

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1315	8.12	1432	14.8	672	—	↓	150 mL/30 sec
1325	8.16	1421	14.6	302	—	3.0	↓

Pumping Start Time 1300 WL _____ Pumping End Time _____ WL _____

Comments: Water very turbid - no odor

HCF
COC# 150183

TFN 6 2/025
RECD NOV 14, 201

Form completed by: Jack Fuller Witnessed by: _____

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RAMACO

* no sample

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Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM 578417-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 163.82 ft below MP Depth to Water (below MP) 160.80 ft Casing Diameter 2 in

Date 10 / 9 / 13 Time 1225 am (pm) Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well almost dry - not enough water sample

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RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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WWC ENGINEERING

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Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SMS78418-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SMS78418-AL-1 Date Sampled 10 / 9 / 13 Time 1040 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 24.50 ft below MP Depth to Water (below MP) 20.65 ft Casing Diameter 5 in

Date 10 / 9 / 13 Time 1010 (am) pm Casing Volume _____ gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' Bladder

' Tap ' Bailer _____

Pump intake or bailer set at 23 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

ıbing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for N/A

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1030	8.72	1226	12.6	203	—	↓	150mL/30sec
1040	8.72	1179	12.3	257	—	≈3.0	↓

Pumping Start Time 1015 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no oder

HCF

COC# 150183

TFN 6 2;025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

*no Sample

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Sheridan, Wyoming 82801
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SAMPLING INFORMATION

Sampling Point SM578418-CRM-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 153.79 ft below MP Depth to Water (below MP) 146.69 ft Casing Diameter 5 in

Date 10 / 9 / 13 Time 1130 am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - Not enough water to Sample

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RAMACO

* No Sample

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SAMPLING INFORMATION

Sampling Point SM578418-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point _____

Well Depth 185.75 ft below MP Depth to Water (below MP) 184.28 ft Casing Diameter _____ in

Date 10 / 9 / 13 Time 1145 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well almost dry - not enough water to sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-506

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RAMACO

* no Sample

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Sheridan, Wyoming 82801
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SAMPLING INFORMATION

Sampling Point 578510-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth ~~92.74~~ 92.74' ft below MP Depth to Water (below MP) 92.18 ft Casing Diameter 5 in

Date 10/2/13 Time 1110 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well almost dry - not enough water to sample

TFN 6 2/025
RECD NOV 14, 201

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* no Sample

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Sheridan, Wyoming 82801
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SAMPLING INFORMATION

Sampling Point SM578510-MST-1 Project Ramaco

Location _____ W.O.# 2013139 -

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW Monitoring well

Well Depth ~~147.24~~ 147.24 ft below MP Depth to Water (below MP) 143.4 ft Casing Diameter 5 in

Date 10 / 02 / 13 Time 1100 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well almost dry - not enough water to Sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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Brook Mine

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SAMPLING INFORMATION

Sampling Point 578511-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-

Sample ID# 578511-CRN-1 Date Sampled 10 / 2 / 13 Time 1250 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 128.92 ft below MP Depth to Water (below MP) 119.53 ft Casing Diameter 5 in

Date 10 / 2 / 13 Time 1155 (am) pm Casing Volume N/A gal

At least N/A bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' Bladder

' Tap ' Bailer ~~BLR~~

Pump intake or bailer set at 127 ft below MP.

DISCHARGE RATE	
	gpm
x	0.00223
	cfs

ıbing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for N/A

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1240	8.24	3290	17.6	200	—		150mL/30sec
1250	8.33	3280	16.8	86.7	—	≈ 3.5	↓

Pumping Start Time 1220 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF
COC # 150182

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

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SAMPLING INFORMATION

Sampling Point 578511-MST-1 Project Ramaco

Location _____ W.O.# 2013139

Sample ID# _____ Date Sampled 10 / 2 / 13 Time 1340 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 158.00 ft below MP Depth to Water (below MP) 150.10 ft Casing Diameter 5 in

Date 10 / 2 / 13 Time 1200 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' (Bladder)

' Tap ' Bailer _____

Pump intake or bailer set at 156 ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

ıbing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1330	8.48	2550	15.8	32.4	—	↓	150ML/30sec
1340	8.57	2300	17.6	35.0	—	≈ 3.5	↓

Pumping Start Time 1310 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor - Ran out of water at the end of pumping.

HCF

COC# 150182

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

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SAMPLING INFORMATION

Sampling Point 578512-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578512-AL-1 Date Sampled 10 / 2 / 13 Time 1720 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 21.21 ft below MP Depth to Water (below MP) 4.03 ft Casing Diameter 5 in

Date 10 / 2 / 13 Time 1640 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' Bladder

' Tap ' Bailer _____

Pump intake or bailer set at 15 ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

ıbing (type: Plastic). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1710	7.95	5220	13.8	3.63	—	↓	150ml/30sec
1720	8.02	5180	13.4	3.51	—	≈3.5	↓

Pumping Start Time 1650 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF

COC # 150182

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* no sample

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Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578512-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 49.85 ft below MP Depth to Water (below MP) Dry ft Casing Diameter _____ in

Date 10 / 2 / 13 Time 1610 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well dry - no sample

TEN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* no sample

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1849 Terra Avenue
Sheridan, Wyoming 82801
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SAMPLING INFORMATION

Sampling Point 578512-MST Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 114.96 ft below MP Depth to Water (below MP) 111.91 ft Casing Diameter 5 in

Date 10 / 2 / 13 Time 1615 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

)bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well almost dry - not enough water to sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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1849 Terra Avenue
Sheridan, Wyoming 82801
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SAMPLING INFORMATION

Sampling Point SM578513-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# SM578513-AL-1 Date Sampled 10 / 9 / 13 Time 0950 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 20.77 ft below MP Depth to Water (below MP) 9.51 ft Casing Diameter 5 in

Date 10 / 9 / 13 Time 0910 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' Bladder

' Tap ' Bailer _____

Pump intake or bailer set at 18.00 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0940	7.87	4770	12.4	4.07	—	↓	150mL/30sec
0950	7.95	4870	12.3	2.05	—	≈3.0	↓

Pumping Start Time 0925 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF

COC # 150183

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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Scanned, 02/28/2020

RAMACO * no sample

WWC ENGINEERING

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1849 Terra Avenue
Sheridan, Wyoming 82801
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SAMPLING INFORMATION

Sampling Point 578513-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 117.28 ft below MP Depth to Water (below MP) 116.51 ft Casing Diameter 5 in

Date 10 / 2 / 13 Time 1435 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' _____

' Tap ' Bailer _____ _____

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well almost dry - not enough water to sample

TFN 6-2-025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578513-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578513-MST-1 Date Sampled 10 / 21 / 13 Time 1530 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 144.00 ft below MP Depth to Water (below MP) 108.20 ft Casing Diameter 5 in

Date 10 / 21 / 13 Time 1445 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method ' Submersible pump ' (Bladder)

' Tap ' Bailer _____

Pump intake or bailer set at 135 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

ubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Water Level (nearest 0.01 ft)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1520	7.49	4130	15.0	11.38	—	1	150 mL/30 sec
1530	7.51	4110	14.6	9.82	—	≈3.5	↓

Pumping Start Time 1500 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF
COC# 150182

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

Sample Analysis Reports

Premining water quality sampling was conducted in accordance with WDEQ/LQD Guideline No. 8 Hydrology Coal and Non-Coal. Constituents and associated units in these reports can be found in Appendix 1 of the aforementioned Guideline. Sampled zone nomenclature is defined as follows: MST = Masters, CRN = Carney, AL = Alluvium, OB = observation, and UBN = underburden.

TFN 6 2/025
RECD OCT 23, 2015

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/15/2013
Report ID: S1310062001

Project: RAMACO
Lab ID: S1310062-001
Client Sample ID: 578511-CRN-1
COC: 150182

Work Order: S1310062
Collection Date: 10/2/2013 12:50:00 PM
Date Received: 10/3/2013 8:28:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.33			s.u.	10/02/2013 1250	Field
Conductivity	3280			µmhos/cm	10/02/2013 1250	Field
Turbidity	86.7			NTU	10/02/2013 1250	Field
Temperature	16.8			°C	10/02/2013 1250	Field
Static Water Level	119.53			ft	10/02/2013 1250	Field
General Parameters						
pH	8.2	0.1		s.u.	10/04/2013 0050 KV	SM 4500 H B
Electrical Conductivity	3400	5		µmhos/cm	10/04/2013 0050 KV	SM 2510B
Total Dissolved Solids (180)	2400	10		mg/L	10/03/2013 1329 EC	SM 2540
Solids, Total Dissolved (Calc)	2220	10		mg/L	10/15/2013 1429 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	525	5		mg/L	10/04/2013 0050 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	565	1		mg/L	10/15/2013 1429 JJ	SM 2340B
Nitrogen, Ammonia (As N)	6.8	0.1		mg/L	10/14/2013 1046 RH	EPA 350.1
ium Adsorption Ratio	9.8	0.1			10/15/2013 1429 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	641	5		mg/L	10/04/2013 0050 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/04/2013 0050 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/04/2013 0050 KV	SM 2320B
Chloride	24	1		mg/L	10/05/2013 2230 AMB	EPA 300.0
Fluoride	1.1	0.1		mg/L	10/04/2013 0050 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	7.9	0.1		mg/L	10/08/2013 1304 RH	EPA 353.2
Sulfate	1110	1		mg/L	10/05/2013 2230 AMB	EPA 300.0
Cations						
Calcium	85	1		mg/L	10/03/2013 1808 DG	EPA 200.7
Magnesium	86	1		mg/L	10/03/2013 1808 DG	EPA 200.7
Potassium	26	1		mg/L	10/03/2013 1808 DG	EPA 200.7
Sodium	535	1		mg/L	10/03/2013 1808 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2014

DEQ Ex. 3-518

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/15/2013
Report ID: S1310062001

Project: RAMACO
Lab ID: S1310062-001
Client Sample ID: 578511-CRN-1
COC: 150182

Work Order: S1310062
Collection Date: 10/2/2013 12:50:00 PM
Date Received: 10/3/2013 8:28:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	10.50	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Chloride	0.67	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Nitrate + Nitrite as N	0.56	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Sulfate	23.14	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Calcium	4.23	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Magnesium	7.06	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Potassium	0.66	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Sodium	23.28	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	35.74	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
›n Sum	34.94	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
ıon-Anion Balance	1.12	0.01		%	10/15/2013 1429 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/03/2013 1808 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/03/2013 1417 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/03/2013 1417 MS	EPA 200.8
Boron	0.3	0.1		mg/L	10/03/2013 1808 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/03/2013 1417 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/03/2013 1808 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/03/2013 1417 MS	EPA 200.8
Iron	ND	0.05		mg/L	10/03/2013 1808 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/03/2013 1417 MS	EPA 200.8
Manganese	0.19	0.02		mg/L	10/03/2013 1808 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/04/2013 1345 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/03/2013 1417 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/03/2013 1808 DG	EPA 200.7
Selenium	0.005	0.005		mg/L	10/03/2013 1417 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/03/2013 1808 DG	EPA 200.7
Total Metals						
Iron	0.18	0.05		mg/L	10/08/2013 0246 DG	EPA 200.7
Manganese	0.24	0.02		mg/L	10/08/2013 0246 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/15/2013
Report ID: S1310062001

Project: RAMACO
Lab ID: S1310062-002
Client Sample ID: 578511-MST-1
COC: 150182

Work Order: S1310062
Collection Date: 10/2/2013 1:40:00 PM
Date Received: 10/3/2013 8:28:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.57			s.u.	10/02/2013 1340	Field
Conductivity	2300			µmhos/cm	10/02/2013 1340	Field
Turbidity	35.0			NTU	10/02/2013 1340	Field
Temperature	17.6			°C	10/02/2013 1340	Field
Static Water Level	150.10			ft	10/02/2013 1340	Field
General Parameters						
pH	8.3	0.1		s.u.	10/04/2013 0100 KV	SM 4500 H B
Electrical Conductivity	2280	5		µmhos/cm	10/04/2013 0100 KV	SM 2510B
Total Dissolved Solids (180)	1500	10		mg/L	10/03/2013 1330 EC	SM 2540
Solids, Total Dissolved (Calc)	1430	10		mg/L	10/15/2013 1429 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	443	5		mg/L	10/09/2013 1313 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	382	1		mg/L	10/15/2013 1429 JJ	SM 2340B
Nitrogen, Ammonia (As N)	4.5	0.1		mg/L	10/14/2013 1047 RH	EPA 350.1
ium Adsorption Ratio	7.9	0.1			10/15/2013 1429 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	540	5		mg/L	10/09/2013 1313 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/09/2013 1313 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/09/2013 1313 KV	SM 2320B
Chloride	16	1		mg/L	10/09/2013 1626 AMB	EPA 300.0
Fluoride	0.9	0.1		mg/L	10/04/2013 0100 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	8.0	0.1		mg/L	10/08/2013 1305 RH	EPA 353.2
Sulfate	624	1		mg/L	10/09/2013 1626 AMB	EPA 300.0
Cations						
Calcium	59	1		mg/L	10/10/2013 0201 DG	EPA 200.7
Magnesium	57	1		mg/L	10/10/2013 0201 DG	EPA 200.7
Potassium	19	1		mg/L	10/10/2013 0201 DG	EPA 200.7
Sodium	353	1		mg/L	10/10/2013 0201 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
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H	Holding times for preparation or analysis exceeded
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ND	Not Detected at the Reporting Limit
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RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
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TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/15/2013
Report ID: S1310062001

Project: RAMACO
Lab ID: S1310062-002
Client Sample ID: 578511-MST-1
COC: 150182

Work Order: S1310062
Collection Date: 10/2/2013 1:40:00 PM
Date Received: 10/3/2013 8:28:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.85	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Chloride	0.45	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Nitrate + Nitrite as N	0.57	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Sulfate	12.98	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Calcium	2.94	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Magnesium	4.69	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Potassium	0.48	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Sodium	15.36	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	23.80	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
n Sum	22.91	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
on-Anion Balance	1.90	0.01		%	10/15/2013 1429 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/03/2013 1810 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/03/2013 1423 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/03/2013 1423 MS	EPA 200.8
Boron	0.3	0.1		mg/L	10/03/2013 1810 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/03/2013 1423 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/03/2013 1810 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/03/2013 1423 MS	EPA 200.8
Iron	ND	0.05		mg/L	10/03/2013 1810 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/03/2013 1423 MS	EPA 200.8
Manganese	0.09	0.02		mg/L	10/03/2013 1810 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/04/2013 1353 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/03/2013 1423 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/03/2013 1810 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/03/2013 1423 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/03/2013 1810 DG	EPA 200.7
Total Metals						
Iron	0.29	0.05		mg/L	10/08/2013 0255 DG	EPA 200.7
Manganese	0.11	0.02		mg/L	10/08/2013 0255 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/15/2013
Report ID: S1310062001

Project: RAMACO
Lab ID: S1310062-004
Client Sample ID: 578512-AL-1
COC: 150182

Work Order: S1310062
Collection Date: 10/2/2013 5:20:00 PM
Date Received: 10/3/2013 8:28:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.02			s.u.	10/02/2013 1720	Field
Conductivity	5180			µmhos/cm	10/02/2013 1720	Field
Turbidity	3.51			NTU	10/02/2013 1720	Field
Temperature	13.4			°C	10/02/2013 1720	Field
Static Water Level	4.03			ft	10/02/2013 1720	Field
General Parameters						
pH	8.0	0.1		s.u.	10/04/2013 0119 KV	SM 4500 H B
Electrical Conductivity	5650	5		µmhos/cm	10/04/2013 0119 KV	SM 2510B
Total Dissolved Solids (180)	5210	10		mg/L	10/03/2013 1332 EC	SM 2540
Solids, Total Dissolved (Calc)	4740	10		mg/L	10/15/2013 1429 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	638	5		mg/L	10/04/2013 0119 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2840	1		mg/L	10/15/2013 1429 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	10/14/2013 1049 RH	EPA 350.1
ium Adsorption Ratio	4.0	0.1			10/15/2013 1429 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	778	5		mg/L	10/04/2013 0119 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/04/2013 0119 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/04/2013 0119 KV	SM 2320B
Chloride	17	1		mg/L	10/05/2013 2311 AMB	EPA 300.0
Fluoride	1.0	0.1		mg/L	10/04/2013 0119 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	10/08/2013 1308 RH	EPA 353.2
Sulfate	2990	1		mg/L	10/05/2013 2311 AMB	EPA 300.0
Cations						
Calcium	369	1		mg/L	10/03/2013 1815 DG	EPA 200.7
Magnesium	466	1		mg/L	10/03/2013 1815 DG	EPA 200.7
Potassium	26	1		mg/L	10/03/2013 1815 DG	EPA 200.7
Sodium	490	1		mg/L	10/03/2013 1815 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2014

DEQ Ex. 3-522

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/15/2013
Report ID: S1310062001

Project: RAMACO
Lab ID: S1310062-004
Client Sample ID: 578512-AL-1
COC: 150182

Work Order: S1310062
Collection Date: 10/2/2013 5:20:00 PM
Date Received: 10/3/2013 8:28:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.75	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Chloride	0.48	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Sulfate	62.21	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Calcium	18.40	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Magnesium	38.33	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Potassium	0.65	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Sodium	21.32	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	78.72	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
·n Sum	75.49	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
on-Anion Balance	2.09	0.01		%	10/15/2013 1429 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/03/2013 1815 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/03/2013 1434 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/03/2013 1434 MS	EPA 200.8
Boron	0.4	0.1		mg/L	10/03/2013 1815 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/03/2013 1434 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/03/2013 1815 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/03/2013 1434 MS	EPA 200.8
Iron	0.91	0.05		mg/L	10/03/2013 1815 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/03/2013 1434 MS	EPA 200.8
Manganese	2.28	0.02		mg/L	10/03/2013 1815 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/04/2013 1357 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/03/2013 1434 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/03/2013 1815 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/03/2013 1434 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/03/2013 1815 DG	EPA 200.7
Total Metals						
Iron	0.96	0.05		mg/L	10/08/2013 0300 DG	EPA 200.7
Manganese	2.20	0.02		mg/L	10/08/2013 0300 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/15/2013
Report ID: S1310062001

Project: RAMACO
Lab ID: S1310062-003
Client Sample ID: 578513-MST-1
COC: 150182

Work Order: S1310062
Collection Date: 10/2/2013 3:30:00 PM
Date Received: 10/3/2013 8:28:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.51			s.u.	10/02/2013 1530	Field
Conductivity	4110			µmhos/cm	10/02/2013 1530	Field
Turbidity	9.82			NTU	10/02/2013 1530	Field
Temperature	14.6			°C	10/02/2013 1530	Field
Static Water Level	108.20			ft	10/02/2013 1530	Field
General Parameters						
pH	7.8	0.1		s.u.	10/04/2013 0109 KV	SM 4500 H B
Electrical Conductivity	4290	5		µmhos/cm	10/04/2013 0109 KV	SM 2510B
Total Dissolved Solids (180)	3370	10		mg/L	10/03/2013 1331 EC	SM 2540
Solids, Total Dissolved (Calc)	3070	10		mg/L	10/15/2013 1429 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	604	5		mg/L	10/04/2013 0109 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1040	1		mg/L	10/15/2013 1429 JJ	SM 2340B
Nitrogen, Ammonia (As N)	10.6	0.1		mg/L	10/14/2013 1048 RH	EPA 350.1
ium Adsorption Ratio	8.3	0.1			10/15/2013 1429 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	736	5		mg/L	10/04/2013 0109 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/04/2013 0109 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/04/2013 0109 KV	SM 2320B
Chloride	15	1		mg/L	10/05/2013 2257 AMB	EPA 300.0
Fluoride	0.6	0.1		mg/L	10/04/2013 0109 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	10/08/2013 1307 RH	EPA 353.2
Sulfate	1740	1		mg/L	10/05/2013 2257 AMB	EPA 300.0
Cations						
Calcium	128	1		mg/L	10/03/2013 1813 DG	EPA 200.7
Magnesium	175	1		mg/L	10/03/2013 1813 DG	EPA 200.7
Potassium	32	1		mg/L	10/03/2013 1813 DG	EPA 200.7
Sodium	613	1		mg/L	10/03/2013 1813 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2014

DEQ Ex. 3-524

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/15/2013
Report ID: S1310062001

Project: RAMACO
Lab ID: S1310062-003
Client Sample ID: 578513-MST-1
COC: 150182

Work Order: S1310062
Collection Date: 10/2/2013 3:30:00 PM
Date Received: 10/3/2013 8:28:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.07	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Chloride	0.43	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Sulfate	36.31	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Calcium	6.37	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Magnesium	14.39	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Potassium	0.80	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Sodium	26.67	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	48.99	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
'on Sum	48.85	0.01		meq/L	10/15/2013 1429 JJ	SM 1030E
ion-Anion Balance	0.15	0.01		%	10/15/2013 1429 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/03/2013 1813 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/03/2013 1428 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/03/2013 1428 MS	EPA 200.8
Boron	0.3	0.1		mg/L	10/03/2013 1813 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/03/2013 1428 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/03/2013 1813 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/03/2013 1428 MS	EPA 200.8
Iron	0.19	0.05		mg/L	10/03/2013 1813 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/03/2013 1428 MS	EPA 200.8
Manganese	0.09	0.02		mg/L	10/03/2013 1813 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/04/2013 1355 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/03/2013 1428 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/03/2013 1813 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/03/2013 1428 MS	EPA 200.8
Zinc	0.01	0.01		mg/L	10/03/2013 1813 DG	EPA 200.7
Total Metals						
Iron	0.34	0.05		mg/L	10/08/2013 0258 DG	EPA 200.7
Manganese	0.13	0.02		mg/L	10/08/2013 0258 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-005
Client Sample ID: SM578408-CRN-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 3:40:00 PM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.79			s.u.	10/09/2013 1540	Field
Conductivity	2440			µmhos/cm	10/09/2013 1540	Field
Turbidity	370			NTU	10/09/2013 1540	Field
Temperature	13.3			°C	10/09/2013 1540	Field
Static Water Level	87.66			ft	10/09/2013 1540	Field
General Parameters						
pH	7.9	0.1		s.u.	10/11/2013 2016 KV	SM 4500 H B
Electrical Conductivity	2290	5		µmhos/cm	10/11/2013 2016 KV	SM 2510B
Total Dissolved Solids (180)	1870	10		mg/L	10/10/2013 1118 EC	SM 2540
Solids, Total Dissolved (Calc)	1760	10		mg/L	10/16/2013 1109 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	577	5		mg/L	10/11/2013 2016 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1300	1		mg/L	10/16/2013 1109 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	10/14/2013 1149 RH	EPA 350.1
ium Adsorption Ratio	1.0	0.1			10/16/2013 1109 JJ	Calculation
ns						
Alkalinity, Bicarbonate as HCO3	705	5		mg/L	10/11/2013 2016 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/11/2013 2016 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/11/2013 2016 KV	SM 2320B
Chloride	8	1		mg/L	10/10/2013 1651 AMB	EPA 300.0
Fluoride	0.7	0.1		mg/L	10/11/2013 2016 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	10/15/2013 1244 RH	EPA 353.2
Sulfate	918	1		mg/L	10/10/2013 1651 AMB	EPA 300.0
Cations						
Calcium	165	1		mg/L	10/10/2013 1613 DG	EPA 200.7
Magnesium	214	1		mg/L	10/10/2013 1613 DG	EPA 200.7
Potassium	27	1		mg/L	10/10/2013 1613 DG	EPA 200.7
Sodium	82	1		mg/L	10/10/2013 1613 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-005
Client Sample ID: SM578408-CRN-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 3:40:00 PM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	11.54	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Chloride	0.23	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sulfate	19.11	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Calcium	8.25	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Magnesium	17.64	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Potassium	0.68	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sodium	3.56	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	30.16	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
ın Sum	30.94	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
ion-Anion Balance	1.27	0.01		%	10/16/2013 1109 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/10/2013 1613 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/10/2013 1441 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/10/2013 1441 MS	EPA 200.8
Boron	0.5	0.1		mg/L	10/10/2013 1613 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/10/2013 1441 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/10/2013 1613 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/10/2013 1441 MS	EPA 200.8
Iron	ND	0.05		mg/L	10/10/2013 1613 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/10/2013 1441 MS	EPA 200.8
Manganese	0.44	0.02		mg/L	10/10/2013 1613 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/11/2013 1237 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/10/2013 1441 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/10/2013 1613 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/10/2013 1441 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/10/2013 1613 DG	EPA 200.7
Total Metals						
Iron	4.57	0.05		mg/L	10/14/2013 1829 DG	EPA 200.7
Manganese	0.54	0.02		mg/L	10/14/2013 1829 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John C. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

:NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-004
Client Sample ID: SM578408-MST-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 3:00:00 PM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.38			s.u.	10/09/2013 1500	Field
Conductivity	2380			µmhos/cm	10/09/2013 1500	Field
Turbidity	552			NTU	10/09/2013 1500	Field
Temperature	13.7			°C	10/09/2013 1500	Field
Static Water Level	104.49			ft	10/09/2013 1500	Field
General Parameters						
pH	7.6	0.1		s.u.	10/11/2013 2003 KV	SM 4500 H B
Electrical Conductivity	2230	5		µmhos/cm	10/11/2013 2003 KV	SM 2510B
Total Dissolved Solids (180)	1720	10		mg/L	10/10/2013 1117 EC	SM 2540
Solids, Total Dissolved (Calc)	1650	10		mg/L	10/16/2013 1109 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	464	5		mg/L	10/11/2013 2003 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1040	1		mg/L	10/16/2013 1109 JJ	SM 2340B
Nitrogen, Ammonia (As N)	3.1	0.1		mg/L	10/14/2013 1148 RH	EPA 350.1
ium Adsorption Ratio	1.9	0.1			10/16/2013 1109 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	566	5		mg/L	10/11/2013 2003 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/11/2013 2003 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/11/2013 2003 KV	SM 2320B
Chloride	8	1		mg/L	10/10/2013 1638 AMB	EPA 300.0
Fluoride	0.5	0.1		mg/L	10/11/2013 2003 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	10/15/2013 1243 RH	EPA 353.2
Sulfate	891	1		mg/L	10/10/2013 1638 AMB	EPA 300.0
Cations						
Calcium	129	1		mg/L	10/10/2013 1611 DG	EPA 200.7
Magnesium	174	1		mg/L	10/10/2013 1611 DG	EPA 200.7
Potassium	29	1		mg/L	10/10/2013 1611 DG	EPA 200.7
Sodium	140	1		mg/L	10/10/2013 1611 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-004
Client Sample ID: SM578408-MST-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 3:00:00 PM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.27	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Chloride	0.21	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sulfate	18.56	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Calcium	6.45	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Magnesium	14.34	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Potassium	0.74	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sodium	6.10	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	27.86	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
n Sum	28.07	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
on-Anion Balance	0.36	0.01		%	10/16/2013 1109 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.8	0.1		mg/L	10/10/2013 1611 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/10/2013 1435 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/10/2013 1435 MS	EPA 200.8
Boron	0.4	0.1		mg/L	10/10/2013 1611 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/10/2013 1435 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/10/2013 1611 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/10/2013 1435 MS	EPA 200.8
Iron	0.68	0.05		mg/L	10/10/2013 1611 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/10/2013 1435 MS	EPA 200.8
Manganese	0.92	0.02		mg/L	10/10/2013 1611 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/11/2013 1235 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/10/2013 1435 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/10/2013 1611 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/10/2013 1435 MS	EPA 200.8
Zinc	0.02	0.01		mg/L	10/10/2013 1611 DG	EPA 200.7
Total Metals						
Iron	5.95	0.05		mg/L	10/14/2013 1826 DG	EPA 200.7
Manganese	0.94	0.02		mg/L	10/14/2013 1826 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/16/2013
Report ID: S1310172001

Project: Ramaco
Lab ID: S1310172-001
Client Sample ID: SM578409-CRN-OB-1
COC: 151960

Work Order: S1310172
Collection Date: 10/10/2013 9:35:00 AM
Date Received: 10/10/2013 12:00:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.04			s.u.	10/10/2013 0935	Field
Conductivity	1977			µmhos/cm	10/10/2013 0935	Field
Turbidity	91.9			NTU	10/10/2013 0935	Field
Temperature	10.3			°C	10/10/2013 0935	Field
Static Water Level	85.99			ft	10/10/2013 0935	Field
General Parameters						
pH	8.1	0.1		s.u.	10/12/2013 0016 KV	SM 4500 H B
Electrical Conductivity	2020	5		µmhos/cm	10/12/2013 0016 KV	SM 2510B
Total Dissolved Solids (180)	1510	10		mg/L	10/10/2013 1132 EC	SM 2540
Solids, Total Dissolved (Calc)	1480	10		mg/L	10/16/2013 1000 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	421	5		mg/L	10/12/2013 0016 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	879	1		mg/L	10/16/2013 1000 JJ	SM 2340B
Nitrogen, Ammonia (As N)	1.5	0.1		mg/L	10/14/2013 1205 RH	EPA 350.1
ium Adsorption Ratio	2.3	0.1			10/16/2013 1000 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	513	5		mg/L	10/12/2013 0016 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/12/2013 0016 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/12/2013 0016 KV	SM 2320B
Chloride	12	1		mg/L	10/10/2013 2347 AMB	EPA 300.0
Fluoride	0.5	0.1		mg/L	10/12/2013 0016 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	10/15/2013 1306 RH	EPA 353.2
Sulfate	778	1		mg/L	10/10/2013 2347 AMB	EPA 300.0
Cations						
Calcium	127	1		mg/L	10/11/2013 1330 DG	EPA 200.7
Magnesium	136	1		mg/L	10/11/2013 1330 DG	EPA 200.7
Potassium	18	1		mg/L	10/11/2013 1330 DG	EPA 200.7
Sodium	156	1		mg/L	10/11/2013 1330 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/16/2013
Report ID: S1310172001

Project: Ramaco
Lab ID: S1310172-001
Client Sample ID: SM578409-CRN-OB-1
COC: 151960

Work Order: S1310172
Collection Date: 10/10/2013 9:35:00 AM
Date Received: 10/10/2013 12:00:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.41	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Chloride	0.33	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Sulfate	16.19	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Calcium	6.34	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Magnesium	11.22	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Potassium	0.46	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Sodium	6.79	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	24.94	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
n Sum	24.97	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
on-Anion Balance	0.05	0.01		%	10/16/2013 1000 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/11/2013 1330 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/10/2013 2029 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/10/2013 2029 MS	EPA 200.8
Boron	0.2	0.1		mg/L	10/11/2013 1330 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/10/2013 2029 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/11/2013 1330 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/10/2013 2029 MS	EPA 200.8
Iron	ND	0.05		mg/L	10/11/2013 1330 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/10/2013 2029 MS	EPA 200.8
Manganese	0.09	0.02		mg/L	10/11/2013 1330 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/15/2013 1011 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/10/2013 2029 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/11/2013 1330 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/10/2013 2029 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/11/2013 1330 DG	EPA 200.7
Total Metals						
Iron	1.36	0.05		mg/L	10/14/2013 1835 DG	EPA 200.7
Manganese	0.17	0.02		mg/L	10/14/2013 1835 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Work Order: S1310156
Project: Ramaco
Collection Date: 10/9/2013 5:30:00 PM
Lab ID: S1310156-006
Date Received: 10/10/2013 8:06:00 AM
Client Sample ID: SM578409-MST-1
Sampler: RF
COC: 150183
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.49			s.u.	10/09/2013 1730	Field
Conductivity	2450			µmhos/cm	10/09/2013 1730	Field
Turbidity	78.1			NTU	10/09/2013 1730	Field
Temperature	13.9			°C	10/09/2013 1730	Field
Static Water Level	101.18			ft	10/09/2013 1730	Field
General Parameters						
pH	8.4	0.1		s.u.	10/11/2013 2028 KV	SM 4500 H B
Electrical Conductivity	2300	5		µmhos/cm	10/11/2013 2028 KV	SM 2510B
Total Dissolved Solids (180)	1500	10		mg/L	10/10/2013 1119 EC	SM 2540
Solids, Total Dissolved (Calc)	1470	10		mg/L	10/16/2013 1109 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	577	5		mg/L	10/11/2013 2028 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	171	1		mg/L	10/16/2013 1109 JJ	SM 2340B
Nitrogen, Ammonia (As N)	2.0	0.1		mg/L	10/14/2013 1150 RH	EPA 350.1
'um Adsorption Ratio	16.1	0.1			10/16/2013 1109 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	685	5		mg/L	10/11/2013 2028 KV	SM 2320B
Alkalinity, Carbonate as CO3	9	5		mg/L	10/11/2013 2028 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/11/2013 2028 KV	SM 2320B
Chloride	10	1		mg/L	10/10/2013 1705 AMB	EPA 300.0
Fluoride	1.4	0.1		mg/L	10/11/2013 2028 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.4	0.1		mg/L	10/15/2013 1245 RH	EPA 353.2
Sulfate	560	1		mg/L	10/10/2013 1705 AMB	EPA 300.0
Cations						
Calcium	29	1		mg/L	10/10/2013 1615 DG	EPA 200.7
Magnesium	24	1		mg/L	10/10/2013 1615 DG	EPA 200.7
Potassium	15	1		mg/L	10/10/2013 1615 DG	EPA 200.7
Sodium	484	1		mg/L	10/10/2013 1615 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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C	Calculated Value
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L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-006
Client Sample ID: SM578409-MST-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 5:30:00 PM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	11.22	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Carbonate as CO3	0.31	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Chloride	0.29	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Fluoride	0.07	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Nitrate + Nitrite as N	0.02	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sulfate	11.65	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Calcium	1.44	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Magnesium	1.98	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Potassium	0.38	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sodium	21.05	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	25.01	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
on Sum	23.58	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
ion-Anion Balance	2.94	0.01		%	10/16/2013 1109 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.3	0.1		mg/L	10/10/2013 1615 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/10/2013 1446 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/10/2013 1446 MS	EPA 200.8
Boron	0.2	0.1		mg/L	10/10/2013 1615 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/10/2013 1446 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/10/2013 1615 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/10/2013 1446 MS	EPA 200.8
Iron	0.12	0.05		mg/L	10/10/2013 1615 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/10/2013 1446 MS	EPA 200.8
Manganese	0.08	0.02		mg/L	10/10/2013 1615 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/11/2013 1239 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/10/2013 1446 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/10/2013 1615 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/10/2013 1446 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/10/2013 1615 DG	EPA 200.7
Total Metals						
Iron	1.13	0.05		mg/L	10/14/2013 1831 DG	EPA 200.7
Manganese	0.11	0.02		mg/L	10/14/2013 1831 DG	EPA 200.7

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RL - Reporting Limit

Qualifiers:

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ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/16/2013
Report ID: S1310172001

Project: Ramaco
Lab ID: S1310172-002
Client Sample ID: SM578409-UBN-1
COC: 151960

Work Order: S1310172
Collection Date: 10/10/2013 10:30:00 AM
Date Received: 10/10/2013 12:00:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.74			s.u.	10/10/2013 1030	Field
Conductivity	4110			µmhos/cm	10/10/2013 1030	Field
Turbidity	4.61			NTU	10/10/2013 1030	Field
Temperature	10.9			°C	10/10/2013 1030	Field
Static Water Level	108.44			ft	10/10/2013 1030	Field
General Parameters						
pH	8.5	0.1		s.u.	10/12/2013 0028 KV	SM 4500 H B
Electrical Conductivity	3880	5		µmhos/cm	10/12/2013 0028 KV	SM 2510B
Total Dissolved Solids (180)	2860	10		mg/L	10/10/2013 1133 EC	SM 2540
Solids, Total Dissolved (Calc)	2900	10		mg/L	10/16/2013 1000 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	435	5		mg/L	10/12/2013 0028 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	373	1		mg/L	10/16/2013 1000 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	10/14/2013 1206 RH	EPA 350.1
ium Adsorption Ratio	18.0	0.1			10/16/2013 1000 JJ	Calculation
ns						
Alkalinity, Bicarbonate as HCO3	505	5		mg/L	10/12/2013 0028 KV	SM 2320B
Alkalinity, Carbonate as CO3	13	5		mg/L	10/12/2013 0028 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/12/2013 0028 KV	SM 2320B
Chloride	34	1		mg/L	10/11/2013 0001 AMB	EPA 300.0
Fluoride	1.0	0.1		mg/L	10/12/2013 0028 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	13.6	0.1		mg/L	10/15/2013 1305 RH	EPA 353.2
Sulfate	1620	1		mg/L	10/11/2013 0001 AMB	EPA 300.0
Cations						
Calcium	67	1		mg/L	10/11/2013 1338 DG	EPA 200.7
Magnesium	50	1		mg/L	10/11/2013 1338 DG	EPA 200.7
Potassium	12	1		mg/L	10/11/2013 1338 DG	EPA 200.7
Sodium	801	1		mg/L	10/11/2013 1338 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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Reviewed by: John N. Jacobs
John Jacobs, Project Manager

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

:NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/16/2013
Report ID: S1310172001

Project: Ramaco
Lab ID: S1310172-002
Client Sample ID: SM578409-UBN-1
COC: 151960

Work Order: S1310172
Collection Date: 10/10/2013 10:30:00 AM
Date Received: 10/10/2013 12:00:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.28	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Carbonate as CO3	0.41	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Chloride	0.94	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Nitrate + Nitrite as N	0.97	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Sulfate	33.70	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Calcium	3.33	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Magnesium	4.12	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Potassium	0.31	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Sodium	34.82	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	42.60	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
n Sum	44.37	0.01		meq/L	10/16/2013 1000 JJ	SM 1030E
on-Anion Balance	2.03	0.01		%	10/16/2013 1000 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/11/2013 1338 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/10/2013 2102 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/10/2013 2102 MS	EPA 200.8
Boron	0.2	0.1		mg/L	10/11/2013 1338 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/10/2013 2102 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/11/2013 1338 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/10/2013 2102 MS	EPA 200.8
Iron	ND	0.05		mg/L	10/11/2013 1338 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/10/2013 2102 MS	EPA 200.8
Manganese	0.04	0.02		mg/L	10/11/2013 1338 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/15/2013 1019 CS	EPA 245.1
Molybdenum	0.03	0.02		mg/L	10/10/2013 2102 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/11/2013 1338 DG	EPA 200.7
Selenium	0.012	0.005		mg/L	10/10/2013 2102 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/11/2013 1338 DG	EPA 200.7
Total Metals						
Iron	0.09	0.05		mg/L	10/14/2013 1840 DG	EPA 200.7
Manganese	0.05	0.02		mg/L	10/14/2013 1840 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

October 2014

DEQ Ex. 3-535

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 11/11/2013
Report ID: S1310501001

Project: Ramaco
Lab ID: S1310501-001
Client Sample ID: SM578415-MST/CRN-1
COC: 151965

Work Order: S1310501
Collection Date: 10/31/2013 12:40:00 PM
Date Received: 10/31/2013 2:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.56			s.u.	10/31/2013 1240	Field
Conductivity	2590			µmhos/cm	10/31/2013 1240	Field
Turbidity	330			NTU	10/31/2013 1240	Field
Temperature	12.8			°C	10/31/2013 1240	Field
Static Water Level	122.85			ft	10/31/2013 1240	Field
General Parameters						
pH	8.4	0.1		s.u.	11/01/2013 1836 KV	SM 4500 H B
Electrical Conductivity	2720	5		µmhos/cm	11/01/2013 1836 KV	SM 2510B
Total Dissolved Solids (180)	1640	10		mg/L	11/01/2013 1021 EC	SM 2540
Solids, Total Dissolved (Calc)	1580	10		mg/L	11/08/2013 1057 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	958	5		mg/L	11/01/2013 1836 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	72	1		mg/L	11/08/2013 1057 JJ	SM 2340B
Nitrogen, Ammonia (As N)	1.0	0.1		mg/L	11/07/2013 1041 RH	EPA 350.1
ium Adsorption Ratio	29.0	0.1			11/08/2013 1057 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	1110	5		mg/L	11/01/2013 1836 KV	SM 2320B
Alkalinity, Carbonate as CO3	27	5		mg/L	11/01/2013 1836 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	11/01/2013 1836 KV	SM 2320B
Chloride	24	1		mg/L	11/03/2013 0338 AMB	EPA 300.0
Fluoride	1.7	0.1		mg/L	11/01/2013 1836 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	1.2	0.1		mg/L	11/01/2013 1257 RH	EPA 353.2
Sulfate	374	1		mg/L	11/05/2013 1419 AMB	EPA 300.0
Cations						
Calcium	15	1		mg/L	11/04/2013 2020 DG	EPA 200.7
Magnesium	8	1		mg/L	11/04/2013 2020 DG	EPA 200.7
Potassium	9	1		mg/L	11/04/2013 2020 DG	EPA 200.7
Sodium	567	1		mg/L	11/04/2013 2020 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 11/11/2013
Report ID: S1310501001

Project: Ramaco
Lab ID: S1310501-001
Client Sample ID: SM578415-MST/CRN-1
COC: 151965

Work Order: S1310501
Collection Date: 10/31/2013 12:40:00 PM
Date Received: 10/31/2013 2:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	18.25	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Carbonate as CO3	0.89	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Chloride	0.66	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Fluoride	0.09	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Nitrate + Nitrite as N	0.08	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Sulfate	7.79	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Calcium	0.76	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Magnesium	0.67	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Potassium	0.22	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Sodium	24.67	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	26.41	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
n Sum	27.78	0.01		meq/L	11/08/2013 1057 JJ	SM 1030E
on-Anion Balance	2.52	0.01		%	11/08/2013 1057 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	11/04/2013 2020 DG	EPA 200.7
Arsenic	0.007	0.005		mg/L	11/01/2013 2128 MS	EPA 200.8
Barium	ND	0.1		mg/L	11/01/2013 2128 MS	EPA 200.8
Boron	0.1	0.1		mg/L	11/04/2013 2020 DG	EPA 200.7
Cadmium	0.001	0.001		mg/L	11/01/2013 2128 MS	EPA 200.8
Chromium	ND	0.01		mg/L	11/04/2013 2020 DG	EPA 200.7
Copper	ND	0.01		mg/L	11/01/2013 2128 MS	EPA 200.8
Iron	ND	0.05		mg/L	11/04/2013 2020 DG	EPA 200.7
Lead	ND	0.02		mg/L	11/05/2013 1836 MS	EPA 200.8
Manganese	0.05	0.02		mg/L	11/04/2013 2020 DG	EPA 200.7
Mercury	ND	0.001		mg/L	11/08/2013 1104 CS	EPA 245.1
Molybdenum	0.03	0.02		mg/L	11/01/2013 2128 MS	EPA 200.8
Nickel	ND	0.01		mg/L	11/04/2013 2020 DG	EPA 200.7
Selenium	0.005	0.005		mg/L	11/01/2013 2128 MS	EPA 200.8
Zinc	ND	0.01		mg/L	11/04/2013 2020 DG	EPA 200.7
Total Metals						
Iron	3.67	0.05		mg/L	11/05/2013 0034 DG	EPA 200.7
Manganese	0.14	0.02		mg/L	11/05/2013 0034 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-003
Client Sample ID: SM578417-CRN-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 1:25:00 PM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.16			s.u.	10/09/2013 1325	Field
Conductivity	1421			µmhos/cm	10/09/2013 1325	Field
Turbidity	302			NTU	10/09/2013 1325	Field
Temperature	14.6			°C	10/09/2013 1325	Field
Static Water Level	133.05			ft	10/09/2013 1325	Field
General Parameters						
pH	8.3	0.1		s.u.	10/11/2013 1952 KV	SM 4500 H B
Electrical Conductivity	1420	5		µmhos/cm	10/11/2013 1952 KV	SM 2510B
Total Dissolved Solids (180)	880	10		mg/L	10/10/2013 1116 EC	SM 2540
Solids, Total Dissolved (Calc)	860	10		mg/L	10/16/2013 1109 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	465	5		mg/L	10/11/2013 1952 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	147	1		mg/L	10/16/2013 1109 JJ	SM 2340B
Nitrogen, Ammonia (As N)	2.7	0.1		mg/L	10/14/2013 1147 RH	EPA 350.1
'um Adsorption Ratio	9.8	0.1			10/16/2013 1109 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	563	5		mg/L	10/11/2013 1952 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/11/2013 1952 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/11/2013 1952 KV	SM 2320B
Chloride	7	1		mg/L	10/10/2013 1624 AMB	EPA 300.0
Fluoride	1.9	0.1		mg/L	10/11/2013 1952 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	10/15/2013 1242 RH	EPA 353.2
Sulfate	242	1		mg/L	10/10/2013 1624 AMB	EPA 300.0
Cations						
Calcium	19	1		mg/L	10/10/2013 1557 DG	EPA 200.7
Magnesium	24	1		mg/L	10/10/2013 1557 DG	EPA 200.7
Potassium	15	1		mg/L	10/10/2013 1557 DG	EPA 200.7
Sodium	272	1		mg/L	10/10/2013 1557 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-003
Client Sample ID: SM578417-CRN-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 1:25:00 PM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.23	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Chloride	0.20	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Fluoride	0.10	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sulfate	5.02	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Calcium	0.93	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Magnesium	2.00	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Potassium	0.39	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sodium	11.85	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	15.37	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
ın Sum	14.64	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
on-Anion Balance	2.42	0.01		%	10/16/2013 1109 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.9	0.1		mg/L	10/10/2013 1557 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/10/2013 1430 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/10/2013 1430 MS	EPA 200.8
Boron	0.1	0.1		mg/L	10/10/2013 1557 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/10/2013 1430 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/10/2013 1557 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/10/2013 1430 MS	EPA 200.8
Iron	0.21	0.05		mg/L	10/10/2013 1557 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/10/2013 1430 MS	EPA 200.8
Manganese	0.07	0.02		mg/L	10/10/2013 1557 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/11/2013 1233 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/10/2013 1430 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/10/2013 1557 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/10/2013 1430 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/10/2013 1557 DG	EPA 200.7
Total Metals						
Iron	3.56	0.05		mg/L	10/14/2013 1824 DG	EPA 200.7
Manganese	0.19	0.02		mg/L	10/14/2013 1824 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

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C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

:NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-002
Client Sample ID: SM578418-AL-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 10:40:00 AM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.72			s.u.	10/09/2013 1040	Field
Conductivity	1179			µmhos/cm	10/09/2013 1040	Field
Turbidity	257			NTU	10/09/2013 1040	Field
Temperature	12.3			°C	10/09/2013 1040	Field
Static Water Level	20.65			ft	10/09/2013 1040	Field
General Parameters						
pH	8.4	0.1		s.u.	10/11/2013 1940 KV	SM 4500 H B
Electrical Conductivity	1160	5		µmhos/cm	10/11/2013 1940 KV	SM 2510B
Total Dissolved Solids (180)	760	10		mg/L	10/10/2013 1115 EC	SM 2540
Solids, Total Dissolved (Calc)	780	10		mg/L	10/16/2013 1109 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	205	5		mg/L	10/11/2013 1940 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	254	1		mg/L	10/16/2013 1109 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	10/14/2013 1146 RH	EPA 350.1
ium Adsorption Ratio	4.3	0.1			10/16/2013 1109 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	242	5		mg/L	10/11/2013 1940 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/11/2013 1940 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/11/2013 1940 KV	SM 2320B
Chloride	9	1		mg/L	10/15/2013 2357 AMB	EPA 300.0
Fluoride	1.1	0.1		mg/L	10/11/2013 1940 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	1.4	0.1		mg/L	10/15/2013 1241 RH	EPA 353.2
Sulfate	393	1		mg/L	10/15/2013 2357 AMB	EPA 300.0
Cations						
Calcium	26	1		mg/L	10/15/2013 1524 DG	EPA 200.7
Magnesium	46	1		mg/L	10/15/2013 1524 DG	EPA 200.7
Potassium	13	1		mg/L	10/10/2013 1552 DG	EPA 200.7
Sodium	159	1		mg/L	10/15/2013 1524 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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J	Analyte detected below quantitation limits
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TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-002
Client Sample ID: SM578418-AL-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 10:40:00 AM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	3.97	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Chloride	0.24	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Nitrate + Nitrite as N	0.09	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sulfate	8.17	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Calcium	1.31	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Magnesium	3.75	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Potassium	0.32	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sodium	6.92	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	12.32	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
ın Sum	12.67	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
ıon-Anion Balance	1.43	0.01		%	10/16/2013 1109 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/10/2013 1552 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/10/2013 1358 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/10/2013 1358 MS	EPA 200.8
Boron	0.2	0.1		mg/L	10/10/2013 1552 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/10/2013 1358 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/10/2013 1552 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/10/2013 1358 MS	EPA 200.8
Iron	ND	0.05		mg/L	10/10/2013 1552 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/10/2013 1358 MS	EPA 200.8
Manganese	ND	0.02		mg/L	10/10/2013 1552 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/11/2013 1231 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/10/2013 1358 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/10/2013 1552 DG	EPA 200.7
Selenium	0.006	0.005		mg/L	10/10/2013 1358 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/10/2013 1552 DG	EPA 200.7
Total Metals						
Iron	2.24	0.05		mg/L	10/14/2013 1822 DG	EPA 200.7
Manganese	0.16	0.02		mg/L	10/14/2013 1822 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
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O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-001
Client Sample ID: SM578513-AL-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 9:50:00 AM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.95			s.u.	10/09/2013 0950	Field
Conductivity	4870			µmhos/cm	10/09/2013 0950	Field
Turbidity	2.05			NTU	10/09/2013 0950	Field
Temperature	12.3			°C	10/09/2013 0950	Field
Static Water Level	9.51			ft	10/09/2013 0950	Field
General Parameters						
pH	8.0	0.1		s.u.	10/11/2013 1915 KV	SM 4500 H B
Electrical Conductivity	4800	5		µmhos/cm	10/11/2013 1915 KV	SM 2510B
Total Dissolved Solids (180)	4530	10		mg/L	10/10/2013 1113 EC	SM 2540
Solids, Total Dissolved (Calc)	4500	10		mg/L	10/16/2013 1109 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	636	5		mg/L	10/11/2013 1915 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2340	1		mg/L	10/16/2013 1109 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	10/14/2013 1145 RH	EPA 350.1
um Adsorption Ratio	4.3	0.1			10/16/2013 1109 JJ	Calculation
A s						
Alkalinity, Bicarbonate as HCO3	776	5		mg/L	10/11/2013 1915 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	10/11/2013 1915 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	10/11/2013 1915 KV	SM 2320B
Chloride	22	1		mg/L	10/10/2013 1556 AMB	EPA 300.0
Fluoride	0.9	0.1		mg/L	10/11/2013 1915 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	10/15/2013 1239 RH	EPA 353.2
Sulfate	2910	1		mg/L	10/10/2013 1556 AMB	EPA 300.0
Cations						
Calcium	275	1		mg/L	10/10/2013 1550 DG	EPA 200.7
Magnesium	401	1		mg/L	10/10/2013 1550 DG	EPA 200.7
Potassium	33	1		mg/L	10/10/2013 1550 DG	EPA 200.7
Sodium	474	1		mg/L	10/10/2013 1550 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

October 2014

DEQ Ex. 3-542

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 10/17/2013
Report ID: S1310156001

Project: Ramaco
Lab ID: S1310156-001
Client Sample ID: SM578513-AL-1
COC: 150183

Work Order: S1310156
Collection Date: 10/9/2013 9:50:00 AM
Date Received: 10/10/2013 8:06:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.71	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Chloride	0.62	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sulfate	60.54	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Calcium	13.73	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Magnesium	33.03	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Potassium	0.84	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Sodium	20.63	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	68.24	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
n Sum	73.93	0.01		meq/L	10/16/2013 1109 JJ	SM 1030E
on-Anion Balance	4.00	0.01		%	10/16/2013 1109 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	10/10/2013 1550 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	10/10/2013 1352 MS	EPA 200.8
Barium	ND	0.1		mg/L	10/10/2013 1352 MS	EPA 200.8
Boron	0.4	0.1		mg/L	10/10/2013 1550 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	10/10/2013 1352 MS	EPA 200.8
Chromium	ND	0.01		mg/L	10/10/2013 1550 DG	EPA 200.7
Copper	ND	0.01		mg/L	10/10/2013 1352 MS	EPA 200.8
Iron	ND	0.05		mg/L	10/10/2013 1550 DG	EPA 200.7
Lead	ND	0.02		mg/L	10/10/2013 1352 MS	EPA 200.8
Manganese	0.37	0.02		mg/L	10/10/2013 1550 DG	EPA 200.7
Mercury	ND	0.001		mg/L	10/11/2013 1229 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	10/10/2013 1352 MS	EPA 200.8
Nickel	ND	0.01		mg/L	10/10/2013 1550 DG	EPA 200.7
Selenium	ND	0.005		mg/L	10/10/2013 1352 MS	EPA 200.8
Zinc	ND	0.01		mg/L	10/10/2013 1550 DG	EPA 200.7
Total Metals						
Iron	0.10	0.05		mg/L	10/14/2013 1813 DG	EPA 200.7
Manganese	0.62	0.02		mg/L	10/14/2013 1813 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

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Inter-Mountain Labs

Sheridan, WY and Gillette, WY

Page _____ of _____

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Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC/RAMACO	RAMACO	Rod Fuller	

Report Address	Contact Name	Email	Phone	Purchase Order #	Quote #
WWC	Jeff Barron				439

Invoice Address: WWC

ANALYSES / PARAMETERS: Quote # 439

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME	SAMPLE IDENTIFICATION	Matrix	# of Containers	REMARKS
1		10/2/13	1250	578511-CRN-1	WT	4	✓
2				pH = 8.33, EC = 3280, T = 16.8, TUR = 86.7, SWL = 119.53'			
3		10/2/13	1340	578511-MST-1	WT	4	✓
4				pH = 8.57, EC = 2300, T = 17.6, TUR = 35.0, SWL = 150.10'			
5		10/2/13	1530	578513-MST-1	WT	4	✓
6				pH = 7.51, EC = 4110, T = 14.6, TUR = 9.82, SWL = 108.20'			
7		10/3/13	1720	578512-AL-1	WT	4	✓
8				pH = 8.02, EC = 5180, T = 13.4, TUR = 3.51, SWL = 4.03'			
9							
10							
11							
12							
13							
14							

IFN 621025 REQD NOV 14, 201

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
RC	Rod Fuller	10/3/13	0627		10/3/13	8:28

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
☐ UPS	Water	WT	Check desired service	Compliance Monitoring? Y / N	
☐ Fed Express	Soil	SL	☐ Standard turnaround	Program (SDWA, NPDES,...)	
☐ US Mail	Solid	SD	☐ RUSH - 5 Working Days	PWSID / Permit #	
☐ Hand Carried	Filter	FT	☐ URGENT - < 2 Working Days	Chlorinated? Y / N	
☐ Other _____	Other	OT	*Rush & Urgent Surcharges will be applied*	Sample Disposal: Lab / Client	

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Sheridan, WY and Gillette, WY

CHAIN OF CUSTODY RECORD

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Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC	Ramaco	Rod Fuller	

Report Address	Contact Name	Email	Phone
WWC	Jeff Barron - WWC		

Invoice Address	Purchase Order #	Quote #
WWC		439

ANALYSES / PARAMETERS

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME SAMPLED	SAMPLE IDENTIFICATION	Matrix	# of Containers	Quote # 439	REMARKS
1		10/9/13	0950	SM578513-AL-1	WT	4	✓	
2				pH = 7.85, EC = 4870, T = 12.3, TUR = 2.05, SWL = 9.51'				
3		10/9/13	1040	SM578418-AL-1	WT	4	✓	
4				pH = 8.72, EC = 1179, T = 12.3, TUR = 257, SWL = 20.65'				
5		10/9/13	1325	SM578417-CRN-1	WT	4	✓	
6				pH = 8.16, EC = 1421, T = 14.6, TUR = 302, SWL = 133.65'				
7		10/9/13	1500	SM578408-MST-1	WT	4	✓	
8				pH = 7.38, EC = 2380, T = 13.7, TUR = 552, SWL = 104.49				
9		10/9/13	1540	SM578408-CRN-1	WT	4	✓	
10				pH = 7.79, EC = 2440, T = 13.3, TUR = 370, SWL = 87.66'				
11		10/9/13	1730	SM578409-MST-1	WT	4		
12				pH = 8.49, EC = 2450, T = 13.9, TUR = 78.1, SWL = 101.18				
13								
14								

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
3.5 C	Rod Fuller	10/10/13	0802	Kathy Pad	10.10.13	8:2[illegible]

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
☐ UPS	Water	WT	Check desired service	Compliance Monitoring? Y / N	
☐ Fed Express	Soil	SL	☑ Standard turnaround	Program (SDWA, NPDES,...)	
☐ US Mail	Solid	SD	☐ RUSH - 5 Working Days	PWSID / Permit #	
☐ Hand Carried	Filter	FT	☐ URGENT - < 2 Working Days	Chlorinated? Y / N	
☐ Other _____	Other	OT	Rush & Urgent Surcharges will be applied	Sample Disposal: Lab / Client	

DEQ Ex. 3-545

October 2014 RAMACO Brook Mine Addendum D6-10-55 TFN 6 2/025

0202/82/20 'pauuas

Inter-Mountain Labs

Sheridan, WY and Gillette, WY

- CHAIN OF CUSTODY RECORD -

Page ___ of ___

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1960

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC	Ramaco		

Report Address	Contact Name	ANALYSES / PARAMETERS
	Email	
Invoice Address	Phone	
	Purchase Order # / Quote #	

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME SAMPLED	SAMPLE IDENTIFICATION	Matrix	# of Containers		REMARKS
1		10/10/13	0935	SM578409-CRN-OB-1	WT	4	✓	
2				pH = 8.04, EC = 1977, T = 10.3, TUR = 91.9, SWL = 85.99'				
3		10/10/13	1030	SM578409-UBN-1	WT	4	✓	
4				pH: 8.74, EC = 4110, T = 10.9, TUR = 4.61, SWL = 108.44'				
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

TFN 6 2/025
RECD NOV 14, 2014

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
				Kathy Bolp	10.10.13	12.00

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
☐ UPS	Water	WT	Standard turnaround	Compliance Monitoring?	
☐ Fed Express	Soil	SL	**RUSH - 5 Working Days**	Program (SDWA, NPDES,...)	
☐ US Mail	Solid	SD	**URGENT - < 2 Working Days**	PWSID / Permit #	
☐ Hand Carried	Filter	FT		Chlorinated?	
☐ Other _____	Other	OT	*Rush & Urgent Surcharges will be Applied*	Sample Disposal: Lab / Client	

DEQ Ex. 3-546

October 2014

RAMACO

Addendum D6-10-56

Brook Mine

Inter-Mountain Labs
Sheridan, WY and Gillette, WY

- CHAIN OF CUSTODY RECORD -

Page ___ of ___

.965

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Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
Ramaco	Ramaco		

Report Address	Contact Name	ANALYSES / PARAMETERS

Email
Phone

Invoice Address

Purchase Order # | Quote #

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME	SAMPLE IDENTIFICATION	Matrix	# of Containers	REMARKS
1		10/31/13	1240	SM578415-MST/CRN-1	WT	4	
2				pH = 8.56, EC = 2590, T = 12.8, TUR = 330, SWL = 122.85'			
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

TEN 6 2/0 25
RECD NOV 14, 2014

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
					10-31-13	1430

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
☐ UPS	Water	(WT)	Standard turnaround	Compliance Monitoring?	
☐ Fed Express	Soil	SL	RUSH - 5 Working Days	Program (SDWA, NPDES,...)	
☐ US Mail	Solid	SD	URGENT - < 2 Working Days	PWSID / Permit #	
☐ Hand Carried	Filter	FT		Chlorinated?	
☐ Other _____	Other	OT	Rush & Urgent Surcharges will be Applied	Sample Disposal: Lab / Client	

DEQ Ex. 3-547

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October 2014
Addendum D6-10-57
RAMACO
Brook Mine

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING
Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578408-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578408-CRN-1 Date Sampled 12 / 15 / 13 Time 1420 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 98.27 ft below MP Depth to Water (below MP) 87.70 ft Casing Diameter 2 in

Date 12 / 15 / 13 Time 1343 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 96 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1410	6.88	2640	10.4	217	↓	150mL/30sec.
1420	6.88	2650	10.4	355	≈3.0	↓

Pumping Start Time 1355 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC# 150196

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578408-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578408-MST-1 Date Sampled 12/15/13 Time 1500 am (pm)

Describe Sampling Point GW monitoring Well

Well Depth 120.20 ft below MP Depth to Water (below MP) 105.89 ft Casing Diameter 2 in

Date 12/15/13 Time 1430 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 115 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1450	6.56	2410	10.2	537	↓	150 mL/30sec
1500	6.53	2430	10.3	518	≥ 3.0	↓

Pumping Start Time 1435 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC # 150196

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* No Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578409-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 110.55 ft below MP Depth to Water (below MP) 90.72 ft Casing Diameter _____ in

Date 12 / 15 / 13 Time 1230 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No Sample - GW only

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578409-CRN-OB-1 Project Ramaco

Location _____ W.O.# _____

Sample ID# 578409-CRN-OB-1 Date Sampled 12/15/13 Time 1320 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 111.33 ft below MP Depth to Water (below MP) 90.76 ft Casing Diameter 5 in

Date 12/15/13 Time 12:52 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)) Tap Bailer _____

Pump intake or bailer set at 105 ft below MP.

Tubing (type: Plastic). (New or previously used) was used to collect all samples (yes or no) and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1310	7.23	2370	10.3	10.15	↓	150 mL / 30 sec
1320	7.25	2390	10.2	15.13	≥3.0	~~the~~ ↓

Pumping Start Time 1255 WL _____ Pumping End Time _____ WL _____

Comments: water clear - no odor

2 CF

COC # 150196

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578409-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578409-MST-1 Date Sampled 12/15/13 Time 1245 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 122.83 ft below MP Depth to Water (below MP) 101.10 ft Casing Diameter 5 in

Date 12/15/13 Time 1215 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 115 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1235	7.70	2480	10.7	2.56	↓	150 mL/30 sec
1245	7.70	2470	10.7	1.45	≥ 3.0	↓

Pumping Start Time 1220 WL _____ Pumping End Time _____ WL _____

Comments: Water Clear - no odor

LCF

COC# 150196

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* no Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578409-MST-OB-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 123.80 ft below MP Depth to Water (below MP) 101.73 ft Casing Diameter 5 in

Date 12/19/13 Time ~~1220~~ 1220 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no - sample - water level only

TEN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-553

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578409-UBN-1 Project Ramaco

Location _____ W.O.# _____

Sample ID# 578409-UBN-1 Date Sampled 12/15/13 Time 1200 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 141.20 ft below MP Depth to Water (below MP) 110.20 ft Casing Diameter 5 in

Date 12/15/13 Time 1125 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)) Tap Bailer _____

Pump intake or bailer set at 135 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1150	7.63	4220	11.6	5.50	↓	150 mL/30 sec
1200	7.76	4220	11.4	3.62	3.0	↓

Pumping Start Time 1135 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF

COC # 150196

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-554

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point ~~578~~ 578415 - MST/CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578415 - MST/CRN-1 Date Sampled 12 / 15 / 13 Time 1045 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 143.70 ft below MP Depth to Water (below MP) 122.68 ft Casing Diameter 5 in

Date 12 / 15 / 13 Time 1010 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)) Tap Bailer

Pump intake or bailer set at 138 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1035	7.63	2520	10.7	+1000	↓	150 ML/30 Sec.
1045	7.68	1952	10.5	225	3.0	↓

Pumping Start Time 1020 WL — Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC# 150196

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578417-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-67

Sample ID# 578417-CRN-1 Date Sampled 12 / 15 / 13 Time 1600 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 142.41 ft below MP Depth to Water (below MP) 133.31 ft Casing Diameter 2 in

Date 12 / 15 / 13 Time 1525 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 130 ft below MP.

ubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1545	7.33	1491	10.0	653	↓	150 mL/30 sec
1600	7.39	1483	9.9	615	3.0	↓

Pumping Start Time 1530 WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF

TFN 6 2/025
RECD NOV 14, 2014

COC# 150196

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

*no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578417-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 163.82 ft below MP Depth to Water (below MP) 160.47 ft Casing Diameter 2 in

Date 12 / 15 / 13 Time 1532 am (pm) Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no sample - not enough water to sample. - water level only

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-557

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578418-AL-1 Project Ramaco

Location _____ W.O.# _____

Sample ID# 578418-AL-1 Date Sampled 12 / 16 / 13 Time 1505 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 24.50 ft below MP Depth to Water (below MP) 20.78 ft Casing Diameter 5 in

Date 12 / 16 / 13 Time 1436 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 22 ft below MP.

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1455	7.62	3050	9.9	64.4	↓	150mL/30sec
1505	7.67	3050	9.6	38.2	3.0	↓

Pumping Start Time 1440 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC# 150197

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

x no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 570418-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 153.79 ft below MP Depth to Water (below MP) 146.55 ft Casing Diameter 5 in

Date 12 / 18 / 13 Time 1340 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no sample - not enough water to sample - site has not been reclaimed yet

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO *no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578418-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 185.75 ft below MP Depth to Water (below MP) 184.45 ft Casing Diameter 5 in

Date 12 / 18 / 13 Time 1345 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no sample - not enough water to sample - site has not been reclaimed yet, and the well shelter has not been set yet.

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578510 - CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point _____

Well Depth 92.74 ft below MP Depth to Water (below MP) 92.68 ft Casing Diameter 5 in

Date 12/18/13 Time 1130 (am) pm Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no sample - not enough water to sample - Site has not been reclaimed yet

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point TM578510-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 147.24 ft below MP Depth to Water (below MP) 146.12 ft Casing Diameter 5 in

Date 12 / 18 / 13 Time 1125 (am) pm Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no sample - not enough water to sample - site has not been reclaimed yet

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578511-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578511-CRN-1 Date Sampled 12/16/13 Time 0940 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 128.92 ft below MP Depth to Water (below MP) 119.63 ft Casing Diameter 5 in

Date 12/16/13 Time 0900 (am) pm Casing Volume _____ gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 125 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
0930	7.31	3830	10.4	124	↓	150ML/30 sec
0940	7.41	3800	10.0	72.6	≈3.0	↓

Pumping Start Time 0915 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC # 150197

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578511-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578511-MST-1 Date Sampled 12 / 16 / 13 Time 1035 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 158.00 ft below MP Depth to Water (below MP) 150.12 ft Casing Diameter 5 in

Date 12 / 16 / 13 Time 9:52 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 155 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1025	7.65	3700	8.6	18.56	↓	150mL/30sec
1035	7.52	4180	9.9	171	≈ 3.0	↓

Pumping Start Time 1010 WL _____ Pumping End Time _____ WL _____

Comments: Water was clear but turned turbid - no odor - almost not enough water to sample.

HCF - COC# 150197

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578512-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578512-AL-1 Date Sampled 12/16/13 Time 1300 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 21.2 ft below MP Depth to Water (below MP) 3.81 ft Casing Diameter 5 in

Date 12/16/13 Time 1227 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 15 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1250	7.19	5460	10.7	23.8	↓	150 ml/30sec
1300	7.22	5460	10.5	20.0	≈ 3.0	↓

Pumping Start Time 1235 WL _____ Pumping End Time _____ WL _____

Comments: Water slightly turbid - no odor

HCF

COC# 150197

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

*no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578512-CRM-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 49.85 ft below MP Depth to Water (below MP) Dry ft Casing Diameter 5 in

Date 12 / 18 / 13 Time 1240 am (pm) Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - well dry

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-566

Scanned, 02/28/2020

RAMACO *no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578512-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 114.96 ft below MP Depth to Water (below MP) 111.92 ft Casing Diameter _____ in

Date 12/18/2013 Time 1250 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - not enough water sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuder Witnessed by: _____

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578513-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578513-AL-1 Date Sampled 12/16/13 Time 1415 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 20.77 ft below MP Depth to Water (below MP) 9.36 ft Casing Diameter 5 in

Date 12/16/13 Time 1:42 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 18 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1405	7.13	5150	10.5	2.05	↓	150 ML/30 sec
1415	7.18	5130	10.2	0.57	≥3.0	↓

Pumping Start Time 1350 WL _____ Pumping End Time _____ WL _____

Comments: Water Clear - no odor

LCF

COC # 150197

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fulks Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578513-CRN-1 Project Ramaco

Location _____ W.O.# 2012139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point _____

Well Depth 117.28 ft below MP Depth to Water (below MP) 117.05 ft Casing Diameter 5 in

Date 12/16/13 Time 1430 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: NO sample - Not enough water to sample

TFN 6 2;025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-569

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578513-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578513-MST-1 Date Sampled 12/16/13 Time 1200 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 144.00 ft below MP Depth to Water (below MP) 108.54 ft Casing Diameter 5 in

Date 12/16/13 Time 1125 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 140 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1150	6.71	4210	10.9	29.1	↓	150 mL/30 sec.
1200	6.77	4230	10.6	2.96	≈3.0	↓

Pumping Start Time 1135 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF

COC # 150197

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-005
Client Sample ID: 578408-CRN-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 2:20:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.88			s.u.	12/15/2013 1420	Field
Conductivity	2650			µmhos/cm	12/15/2013 1420	Field
Turbidity	355			NTU	12/15/2013 1420	Field
Temperature	10.4			°C	12/15/2013 1420	Field
Static Water Level	87.70			ft	12/15/2013 1420	Field
General Parameters						
pH	7.9	0.1		s.u.	12/17/2013 2153 KV	SM 4500 H B
Electrical Conductivity	2470	5		µmhos/cm	12/17/2013 2153 KV	SM 2510B
Total Dissolved Solids (180)	2000	10		mg/L	12/16/2013 1208 EC	SM 2540
Solids, Total Dissolved (Calc)	1830	10		mg/L	12/20/2013 1056 BC	SM 1030E
Alkalinity, Total (As CaCO3)	584	5		mg/L	12/17/2013 2153 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1380	1		mg/L	12/20/2013 1056 BC	SM 2340B
Nitrogen, Ammonia (As N)	0.2	0.1		mg/L	12/23/2013 1456 RH	EPA 350.1
ium Adsorption Ratio	0.9	0.1			12/20/2013 1056 BC	Calculation
ns						
Alkalinity, Bicarbonate as HCO3	712	5		mg/L	12/17/2013 2153 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/17/2013 2153 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2153 KV	SM 2320B
Chloride	9	1		mg/L	12/17/2013 2246 AMB	EPA 300.0
Fluoride	0.7	0.1		mg/L	12/17/2013 2153 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1107 RH	EPA 353.2
Sulfate	963	1		mg/L	12/17/2013 2246 AMB	EPA 300.0
Cations						
Calcium	173	1		mg/L	12/16/2013 1904 DG	EPA 200.7
Magnesium	232	1		mg/L	12/16/2013 1904 DG	EPA 200.7
Potassium	30	1		mg/L	12/16/2013 1904 DG	EPA 200.7
Sodium	79	1		mg/L	12/16/2013 1904 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:
- * Value exceeds Maximum Contaminant Level
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

RL - Reporting Limit
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL
- O Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-005
Client Sample ID: 578408-CRN-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 2:20:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	11.67	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Chloride	0.24	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Fluoride	0.03	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sulfate	20.04	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Calcium	8.61	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Magnesium	19.08	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Potassium	0.75	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sodium	3.42	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	31.87	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
n Sum	31.99	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
on-Anion Balance	0.19	0.01		%	12/20/2013 1056 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/16/2013 1904 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/16/2013 1454 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/16/2013 1454 MS	EPA 200.8
Boron	0.5	0.1		mg/L	12/16/2013 1904 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/16/2013 1454 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/16/2013 1904 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/16/2013 1454 MS	EPA 200.8
Iron	0.05	0.05		mg/L	12/16/2013 1904 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/16/2013 1454 MS	EPA 200.8
Manganese	0.64	0.02		mg/L	12/16/2013 1904 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/17/2013 1418 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/16/2013 1454 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/16/2013 1904 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/16/2013 1454 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/16/2013 1904 DG	EPA 200.7
Total Metals						
Iron	2.85	0.05		mg/L	12/18/2013 1942 DG	EPA 200.7
Manganese	0.81	0.02		mg/L	12/18/2013 1942 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-006
Client Sample ID: 578408-MST-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 3:00:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.53			s.u.	12/15/2013 1500	Field
Conductivity	2430			µmhos/cm	12/15/2013 1500	Field
Turbidity	518			NTU	12/15/2013 1500	Field
Temperature	10.3			°C	12/15/2013 1500	Field
Static Water Level	105.89			ft	12/15/2013 1500	Field
General Parameters						
pH	7.8	0.1		s.u.	12/17/2013 2204 KV	SM 4500 H B
Electrical Conductivity	2230	5		µmhos/cm	12/17/2013 2204 KV	SM 2510B
Total Dissolved Solids (180)	1690	10		mg/L	12/16/2013 1209 EC	SM 2540
Solids, Total Dissolved (Calc)	1610	10		mg/L	12/20/2013 1056 BC	SM 1030E
Alkalinity, Total (As CaCO3)	472	5		mg/L	12/17/2013 2204 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1040	1		mg/L	12/20/2013 1056 BC	SM 2340B
Nitrogen, Ammonia (As N)	4.2	0.1		mg/L	12/23/2013 1457 RH	EPA 350.1
ium Adsorption Ratio	1.7	0.1			12/20/2013 1056 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	576	5		mg/L	12/17/2013 2204 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/17/2013 2204 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2204 KV	SM 2320B
Chloride	7	1		mg/L	12/17/2013 2259 AMB	EPA 300.0
Fluoride	0.5	0.1		mg/L	12/17/2013 2204 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1108 RH	EPA 353.2
Sulfate	858	1		mg/L	12/17/2013 2259 AMB	EPA 300.0
Cations						
Calcium	124	1		mg/L	12/16/2013 1917 DG	EPA 200.7
Magnesium	177	1		mg/L	12/16/2013 1917 DG	EPA 200.7
Potassium	30	1		mg/L	12/16/2013 1917 DG	EPA 200.7
Sodium	129	1		mg/L	12/16/2013 1917 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-006
Client Sample ID: 578408-MST-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 3:00:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.44	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Chloride	0.20	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Fluoride	0.02	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sulfate	17.85	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Calcium	6.17	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Magnesium	14.53	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Potassium	0.77	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sodium	5.59	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	27.07	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
n Sum	27.54	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
on-Anion Balance	0.85	0.01		%	12/20/2013 1056 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/16/2013 1917 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/16/2013 1459 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/16/2013 1459 MS	EPA 200.8
Boron	0.4	0.1		mg/L	12/16/2013 1917 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/16/2013 1459 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/16/2013 1917 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/16/2013 1459 MS	EPA 200.8
Iron	0.61	0.05		mg/L	12/16/2013 1917 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/16/2013 1459 MS	EPA 200.8
Manganese	0.29	0.02		mg/L	12/16/2013 1917 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/17/2013 1426 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/16/2013 1459 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/16/2013 1917 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/16/2013 1459 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/16/2013 1917 DG	EPA 200.7
Total Metals						
Iron	3.53	0.05		mg/L	12/18/2013 1944 DG	EPA 200.7
Manganese	0.36	0.02		mg/L	12/18/2013 1944 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-004
Client Sample ID: 578409-CRN-OB-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 1:20:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.25			s.u.	12/15/2013 1320	Field
Conductivity	2390			µmhos/cm	12/15/2013 1320	Field
Turbidity	15.13			NTU	12/15/2013 1320	Field
Temperature	10.2			°C	12/15/2013 1320	Field
Static Water Level	90.76			ft	12/15/2013 1320	Field
General Parameters						
pH	8.2	0.1		s.u.	12/17/2013 2130 KV	SM 4500 H B
Electrical Conductivity	2200	5		µmhos/cm	12/17/2013 2130 KV	SM 2510B
Total Dissolved Solids (180)	1560	10		mg/L	12/16/2013 1207 EC	SM 2540
Solids, Total Dissolved (Calc)	1540	10		mg/L	12/20/2013 1056 BC	SM 1030E
Alkalinity, Total (As CaCO3)	509	5		mg/L	12/17/2013 2130 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	730	1		mg/L	12/20/2013 1056 BC	SM 2340B
Nitrogen, Ammonia (As N)	4.2	0.1		mg/L	12/23/2013 1455 RH	EPA 350.1
'um Adsorption Ratio	3.6	0.1			12/20/2013 1056 BC	Calculation
A s						
Alkalinity, Bicarbonate as HCO3	621	5		mg/L	12/17/2013 2130 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/17/2013 2130 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2130 KV	SM 2320B
Chloride	11	1		mg/L	12/17/2013 2232 AMB	EPA 300.0
Fluoride	0.6	0.1		mg/L	12/17/2013 2130 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1106 RH	EPA 353.2
Sulfate	753	1		mg/L	12/17/2013 2232 AMB	EPA 300.0
Cations						
Calcium	110	1		mg/L	12/16/2013 1859 DG	EPA 200.7
Magnesium	111	1		mg/L	12/16/2013 1859 DG	EPA 200.7
Potassium	22	1		mg/L	12/16/2013 1859 DG	EPA 200.7
Sodium	226	1		mg/L	12/16/2013 1859 DG	EPA 200.7

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TFN 6 2/025
RECD NOV 14,2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-004
Client Sample ID: 578409-CRN-OB-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 1:20:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	10.18	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Chloride	0.30	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Fluoride	0.03	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sulfate	15.67	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Calcium	5.49	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Magnesium	9.09	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Potassium	0.55	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sodium	9.83	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	24.97	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
ın Sum	26.19	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
on-Anion Balance	2.38	0.01		%	12/20/2013 1056 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/16/2013 1859 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/16/2013 1448 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/16/2013 1448 MS	EPA 200.8
Boron	0.2	0.1		mg/L	12/16/2013 1859 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/16/2013 1448 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/16/2013 1859 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/16/2013 1448 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/16/2013 1859 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/16/2013 1448 MS	EPA 200.8
Manganese	0.19	0.02		mg/L	12/16/2013 1859 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/17/2013 1409 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/16/2013 1448 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/16/2013 1859 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/16/2013 1448 MS	EPA 200.8
Zinc	0.01	0.01		mg/L	12/16/2013 1859 DG	EPA 200.7
Total Metals						
Iron	0.19	0.05		mg/L	12/18/2013 1939 DG	EPA 200.7
Manganese	0.23	0.02		mg/L	12/18/2013 1939 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

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J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-003
Client Sample ID: 578409-MST-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 12:45:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.70			s.u.	12/15/2013 1245	Field
Conductivity	2470			µmhos/cm	12/15/2013 1245	Field
Turbidity	1.45			NTU	12/15/2013 1245	Field
Temperature	10.7			°C	12/15/2013 1245	Field
Static Water Level	101.10			ft	12/15/2013 1245	Field
General Parameters						
pH	8.4	0.1		s.u.	12/17/2013 2116 KV	SM 4500 H B
Electrical Conductivity	2260	5		µmhos/cm	12/17/2013 2116 KV	SM 2510B
Total Dissolved Solids (180)	1510	10		mg/L	12/16/2013 1206 EC	SM 2540
Solids, Total Dissolved (Calc)	1430	10		mg/L	12/20/2013 1056 BC	SM 1030E
Alkalinity, Total (As CaCO3)	655	5		mg/L	12/17/2013 2116 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	91	1		mg/L	12/20/2013 1056 BC	SM 2340B
Nitrogen, Ammonia (As N)	4.0	0.1		mg/L	12/23/2013 1454 RH	EPA 350.1
ium Adsorption Ratio	22.0	0.1			12/20/2013 1056 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	773	5		mg/L	12/17/2013 2116 KV	SM 2320B
Alkalinity, Carbonate as CO3	12	5		mg/L	12/17/2013 2116 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2116 KV	SM 2320B
Chloride	9	1		mg/L	12/17/2013 2219 AMB	EPA 300.0
Fluoride	1.5	0.1		mg/L	12/17/2013 2116 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1058 RH	EPA 353.2
Sulfate	497	1		mg/L	12/17/2013 2219 AMB	EPA 300.0
Cations						
Calcium	16	1		mg/L	12/16/2013 1857 DG	EPA 200.7
Magnesium	12	1		mg/L	12/16/2013 1857 DG	EPA 200.7
Potassium	16	1		mg/L	12/16/2013 1857 DG	EPA 200.7
Sodium	484	1		mg/L	12/16/2013 1857 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
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TFN 6 2/025
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Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-003
Client Sample ID: 578409-MST-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 12:45:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.67	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Carbonate as CO3	0.41	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Chloride	0.26	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Fluoride	0.07	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sulfate	10.35	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Calcium	0.80	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Magnesium	1.01	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Potassium	0.40	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sodium	21.06	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	23.29	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
n Sum	23.78	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
on-Anion Balance	1.04	0.01		%	12/20/2013 1056 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/16/2013 1857 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/16/2013 1443 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/16/2013 1443 MS	EPA 200.8
Boron	0.1	0.1		mg/L	12/16/2013 1857 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/16/2013 1443 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/16/2013 1857 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/16/2013 1443 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/16/2013 1857 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/16/2013 1443 MS	EPA 200.8
Manganese	0.21	0.02		mg/L	12/16/2013 1857 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/17/2013 1407 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/16/2013 1443 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/16/2013 1857 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/16/2013 1443 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/16/2013 1857 DG	EPA 200.7
Total Metals						
Iron	0.06	0.05		mg/L	12/18/2013 1937 DG	EPA 200.7
Manganese	0.22	0.02		mg/L	12/18/2013 1937 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-002
Client Sample ID: 578409-UBN-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 12:00:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.76			s.u.	12/15/2013 1200	Field
Conductivity	4220			µmhos/cm	12/15/2013 1200	Field
Turbidity	3.62			NTU	12/15/2013 1200	Field
Temperature	11.4			°C	12/15/2013 1200	Field
Static Water Level	110.20			ft	12/15/2013 1200	Field
General Parameters						
pH	8.3	0.1		s.u.	12/17/2013 2104 KV	SM 4500 H B
Electrical Conductivity	4010	5		µmhos/cm	12/17/2013 2104 KV	SM 2510B
Total Dissolved Solids (180)	2820	10		mg/L	12/16/2013 1205 EC	SM 2540
Solids, Total Dissolved (Calc)	2850	10		mg/L	12/20/2013 1056 BC	SM 1030E
Alkalinity, Total (As CaCO3)	459	5		mg/L	12/17/2013 2104 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	395	1		mg/L	12/20/2013 1056 BC	SM 2340B
Nitrogen, Ammonia (As N)	0.7	0.1		mg/L	12/23/2013 1453 RH	EPA 350.1
um Adsorption Ratio	16.9	0.1			12/20/2013 1056 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	553	5		mg/L	12/17/2013 2104 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/17/2013 2104 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2104 KV	SM 2320B
Chloride	32	1		mg/L	12/17/2013 2206 AMB	EPA 300.0
Fluoride	1.0	0.1		mg/L	12/17/2013 2104 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	7.5	0.1		mg/L	12/19/2013 1057 RH	EPA 353.2
Sulfate	1600	1		mg/L	12/17/2013 2206 AMB	EPA 300.0
Cations						
Calcium	70	1		mg/L	12/16/2013 1855 DG	EPA 200.7
Magnesium	53	1		mg/L	12/16/2013 1855 DG	EPA 200.7
Potassium	14	1		mg/L	12/16/2013 1855 DG	EPA 200.7
Sodium	771	1		mg/L	12/16/2013 1855 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-002
Client Sample ID: 578409-UBN-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 12:00:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.06	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Chloride	0.91	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Fluoride	0.05	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Nitrate + Nitrite as N	0.53	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sulfate	33.31	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Calcium	3.49	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Magnesium	4.39	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Potassium	0.35	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sodium	33.54	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	41.79	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
n Sum	44.01	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
on-Anion Balance	2.58	0.01		%	12/20/2013 1056 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/16/2013 1855 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/16/2013 1427 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/16/2013 1427 MS	EPA 200.8
Boron	0.3	0.1		mg/L	12/16/2013 1855 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/16/2013 1427 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/16/2013 1855 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/16/2013 1427 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/16/2013 1855 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/16/2013 1427 MS	EPA 200.8
Manganese	0.16	0.02		mg/L	12/16/2013 1855 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/17/2013 1405 CS	EPA 245.1
Molybdenum	0.03	0.02		mg/L	12/16/2013 1427 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/16/2013 1855 DG	EPA 200.7
Selenium	0.010	0.005		mg/L	12/16/2013 1427 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/16/2013 1855 DG	EPA 200.7
Total Metals						
Iron	ND	0.05		mg/L	12/18/2013 1923 DG	EPA 200.7
Manganese	0.19	0.02		mg/L	12/18/2013 1923 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

DEQ Ex. 3-580

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-001
Client Sample ID: 578415-MST/CRN-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 10:45:00 AM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.68			s.u.	12/15/2013 1045	Field
Conductivity	1952			µmhos/cm	12/15/2013 1045	Field
Turbidity	225			NTU	12/15/2013 1045	Field
Temperature	10.5			°C	12/15/2013 1045	Field
Static Water Level	122.68			ft	12/15/2013 1045	Field
General Parameters						
pH	8.4	0.1		s.u.	12/17/2013 2052 KV	SM 4500 H B
Electrical Conductivity	1950	5		µmhos/cm	12/17/2013 2052 KV	SM 2510B
Total Dissolved Solids (180)	1180	10		mg/L	12/16/2013 1204 EC	SM 2540
Solids, Total Dissolved (Calc)	1180	10		mg/L	12/20/2013 1056 BC	SM 1030E
Alkalinity, Total (As CaCO3)	707	5		mg/L	12/17/2013 2052 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	56	1		mg/L	12/20/2013 1056 BC	SM 2340B
Nitrogen, Ammonia (As N)	1.6	0.1		mg/L	12/23/2013 1452 RH	EPA 350.1
ium Adsorption Ratio	25.1	0.1			12/20/2013 1056 BC	Calculation
ns						
Alkalinity, Bicarbonate as HCO3	831	5		mg/L	12/17/2013 2052 KV	SM 2320B
Alkalinity, Carbonate as CO3	16	5		mg/L	12/17/2013 2052 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2052 KV	SM 2320B
Chloride	13	1		mg/L	12/17/2013 2152 AMB	EPA 300.0
Fluoride	1.9	0.1		mg/L	12/17/2013 2052 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1056 RH	EPA 353.2
Sulfate	280	1		mg/L	12/17/2013 2152 AMB	EPA 300.0
Cations						
Calcium	12	1		mg/L	12/16/2013 1852 DG	EPA 200.7
Magnesium	6	1		mg/L	12/16/2013 1852 DG	EPA 200.7
Potassium	10	1		mg/L	12/16/2013 1852 DG	EPA 200.7
Sodium	431	1		mg/L	12/16/2013 1852 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-581

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-001
Client Sample ID: 578415-MST/CRN-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 10:45:00 AM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.62	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Carbonate as CO3	0.52	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Chloride	0.36	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Fluoride	0.09	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sulfate	5.82	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Calcium	0.60	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Magnesium	0.51	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Potassium	0.25	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sodium	18.74	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	20.12	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
›n Sum	20.43	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
on-Anion Balance	0.77	0.01		%	12/20/2013 1056 BC	SM 1030E
Dissolved Metals						
Aluminum	0.7	0.1		mg/L	12/16/2013 1852 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/16/2013 1406 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/16/2013 1406 MS	EPA 200.8
Boron	0.1	0.1		mg/L	12/16/2013 1852 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/16/2013 1406 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/16/2013 1852 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/16/2013 1406 MS	EPA 200.8
Iron	0.21	0.05		mg/L	12/16/2013 1852 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/16/2013 1406 MS	EPA 200.8
Manganese	0.10	0.02		mg/L	12/16/2013 1852 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/17/2013 1403 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/16/2013 1406 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/16/2013 1852 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/16/2013 1406 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/16/2013 1852 DG	EPA 200.7
Total Metals						
Iron	0.95	0.05		mg/L	12/18/2013 1919 DG	EPA 200.7
Manganese	0.17	0.02		mg/L	12/18/2013 1919 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

DEQ Ex. 3-582

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-007
Client Sample ID: 578417-CRN-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 4:00:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.39			s.u.	12/15/2013 1600	Field
Conductivity	1483			µmhos/cm	12/15/2013 1600	Field
Turbidity	615			NTU	12/15/2013 1600	Field
Temperature	9.9			°C	12/15/2013 1600	Field
Static Water Level	133.31			ft	12/15/2013 1600	Field
General Parameters						
pH	8.3	0.1		s.u.	12/17/2013 2218 KV	SM 4500 H B
Electrical Conductivity	1450	5		µmhos/cm	12/17/2013 2218 KV	SM 2510B
Total Dissolved Solids (180)	880	10		mg/L	12/16/2013 1210 EC	SM 2540
Solids, Total Dissolved (Calc)	890	10		mg/L	12/20/2013 1056 BC	SM 1030E
Alkalinity, Total (As CaCO3)	508	5		mg/L	12/17/2013 2218 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	150	1		mg/L	12/20/2013 1056 BC	SM 2340B
Nitrogen, Ammonia (As N)	3.6	0.1		mg/L	12/23/2013 1458 RH	EPA 350.1
ium Adsorption Ratio	9.2	0.1			12/20/2013 1056 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	607	5		mg/L	12/17/2013 2218 KV	SM 2320B
Alkalinity, Carbonate as CO3	6	5		mg/L	12/17/2013 2218 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2218 KV	SM 2320B
Chloride	8	1		mg/L	12/17/2013 2312 AMB	EPA 300.0
Fluoride	1.9	0.1		mg/L	12/17/2013 2218 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1110 RH	EPA 353.2
Sulfate	255	1		mg/L	12/17/2013 2312 AMB	EPA 300.0
Cations						
Calcium	19	1		mg/L	12/16/2013 1920 DG	EPA 200.7
Magnesium	25	1		mg/L	12/16/2013 1920 DG	EPA 200.7
Potassium	17	1		mg/L	12/16/2013 1920 DG	EPA 200.7
Sodium	258	1		mg/L	12/16/2013 1920 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:
- * Value exceeds Maximum Contaminant Level
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

RL - Reporting Limit
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL
- O Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312200001

Project: Ramaco
Lab ID: S1312200-007
Client Sample ID: 578417-CRN-1
COC: 150196

Work Order: S1312200
Collection Date: 12/15/2013 4:00:00 PM
Date Received: 12/16/2013 8:16:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.95	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Carbonate as CO3	0.19	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Chloride	0.21	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Fluoride	0.09	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sulfate	5.30	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Calcium	0.92	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Magnesium	2.08	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Potassium	0.42	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Sodium	11.23	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	14.66	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
n Sum	15.76	0.01		meq/L	12/20/2013 1056 BC	SM 1030E
on-Anion Balance	3.60	0.01		%	12/20/2013 1056 BC	SM 1030E
Dissolved Metals						
Aluminum	0.4	0.1		mg/L	12/16/2013 1920 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/16/2013 1504 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/16/2013 1504 MS	EPA 200.8
Boron	0.1	0.1		mg/L	12/16/2013 1920 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/16/2013 1504 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/16/2013 1920 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/16/2013 1504 MS	EPA 200.8
Iron	0.22	0.05		mg/L	12/16/2013 1920 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/16/2013 1504 MS	EPA 200.8
Manganese	0.06	0.02		mg/L	12/16/2013 1920 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/17/2013 1428 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/16/2013 1504 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/16/2013 1920 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/16/2013 1504 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/16/2013 1920 DG	EPA 200.7
Total Metals						
Iron	12.7	0.05		mg/L	12/18/2013 1946 DG	EPA 200.7
Manganese	0.18	0.02		mg/L	12/18/2013 1946 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

DEQ Ex. 3-584

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-006
Client Sample ID: 578418-AL-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 3:05:00 PM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.67			s.u.	12/16/2013 1505	Field
Conductivity	3050			µmhos/cm	12/16/2013 1505	Field
Turbidity	38.2			NTU	12/16/2013 1505	Field
Temperature	9.6			°C	12/16/2013 1505	Field
Static Water Level	20.78			ft	12/16/2013 1505	Field
General Parameters						
pH	8.3	0.1		s.u.	12/18/2013 0007 KV	SM 4500 H B
Electrical Conductivity	2800	5		µmhos/cm	12/18/2013 0007 KV	SM 2510B
Total Dissolved Solids (180)	2220	10		mg/L	12/17/2013 1209 EC	SM 2540
Solids, Total Dissolved (Calc)	2080	10		mg/L	12/20/2013 0811 BC	SM 1030E
Alkalinity, Total (As CaCO3)	411	5		mg/L	12/18/2013 0007 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	909	1		mg/L	12/20/2013 0811 BC	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	12/23/2013 1510 RH	EPA 350.1
ium Adsorption Ratio	4.8	0.1			12/20/2013 0811 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	501	5		mg/L	12/18/2013 0007 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/18/2013 0007 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/18/2013 0007 KV	SM 2320B
Chloride	14	1		mg/L	12/18/2013 0233 AMB	EPA 300.0
Fluoride	1.2	0.1		mg/L	12/18/2013 0007 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.2	0.1		mg/L	12/19/2013 1117 RH	EPA 353.2
Sulfate	1200	1		mg/L	12/18/2013 0233 AMB	EPA 300.0
Cations						
Calcium	114	1		mg/L	12/17/2013 1533 DG	EPA 200.7
Magnesium	152	1		mg/L	12/17/2013 1533 DG	EPA 200.7
Potassium	22	1		mg/L	12/17/2013 1533 DG	EPA 200.7
Sodium	332	1		mg/L	12/17/2013 1533 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-006
Client Sample ID: 578418-AL-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 3:05:00 PM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.21	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Chloride	0.39	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Fluoride	0.06	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Nitrate + Nitrite as N	0.01	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sulfate	25.03	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Calcium	5.68	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Magnesium	12.49	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Potassium	0.57	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sodium	14.44	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	33.20	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
n Sum	33.73	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
on-Anion Balance	0.79	0.01		%	12/20/2013 0811 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/17/2013 1533 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/17/2013 1340 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/17/2013 1340 MS	EPA 200.8
Boron	0.3	0.1		mg/L	12/17/2013 1533 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/17/2013 1340 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/17/2013 1533 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/17/2013 1340 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/17/2013 1533 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/17/2013 1340 MS	EPA 200.8
Manganese	0.03	0.02		mg/L	12/17/2013 1533 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/23/2013 0915 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/17/2013 1340 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/17/2013 1533 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/17/2013 1340 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/17/2013 1533 DG	EPA 200.7
Total Metals						
Iron	0.80	0.05		mg/L	12/20/2013 1255 DG	EPA 200.7
Manganese	0.07	0.02		mg/L	12/20/2013 1255 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-001
Client Sample ID: 578511-CRN-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 9:40:00 AM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.41			s.u.	12/16/2013 0940	Field
Conductivity	3800			µmhos/cm	12/16/2013 0940	Field
Turbidity	72.6			NTU	12/16/2013 0940	Field
Temperature	10.0			°C	12/16/2013 0940	Field
Static Water Level	119.63			ft	12/16/2013 0940	Field
General Parameters						
pH	8.2	0.1		s.u.	12/17/2013 2253 KV	SM 4500 H B
Electrical Conductivity	3570	5		µmhos/cm	12/17/2013 2253 KV	SM 2510B
Total Dissolved Solids (180)	2910	10		mg/L	12/17/2013 1204 EC	SM 2540
Solids, Total Dissolved (Calc)	2530	10		mg/L	12/20/2013 0811 BC	SM 1030E
Alkalinity, Total (As CaCO3)	678	5		mg/L	12/17/2013 2253 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	552	1		mg/L	12/20/2013 0811 BC	SM 2340B
Nitrogen, Ammonia (As N)	6.7	0.1		mg/L	12/23/2013 1459 RH	EPA 350.1
ium Adsorption Ratio	11.6	0.1			12/20/2013 0811 BC	Calculation
ns						
Alkalinity, Bicarbonate as HCO3	827	5		mg/L	12/17/2013 2253 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/17/2013 2253 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2253 KV	SM 2320B
Chloride	26	1		mg/L	12/18/2013 0126 AMB	EPA 300.0
Fluoride	1.1	0.1		mg/L	12/17/2013 2253 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	1.7	0.1		mg/L	12/19/2013 1111 RH	EPA 353.2
Sulfate	1270	1		mg/L	12/18/2013 0126 AMB	EPA 300.0
Cations						
Calcium	79	1		mg/L	12/17/2013 1509 DG	EPA 200.7
Magnesium	86	1		mg/L	12/17/2013 1509 DG	EPA 200.7
Potassium	28	1		mg/L	12/17/2013 1509 DG	EPA 200.7
Sodium	625	1		mg/L	12/17/2013 1509 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

DEQ Ex. 3-587

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-001
Client Sample ID: 578511-CRN-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 9:40:00 AM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.56	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Chloride	0.74	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Fluoride	0.05	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Nitrate + Nitrite as N	0.12	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sulfate	26.50	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Calcium	3.92	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Magnesium	7.11	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Potassium	0.71	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sodium	27.17	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	38.92	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
n Sum	40.99	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
on-Anion Balance	2.58	0.01		%	12/20/2013 0811 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/17/2013 1509 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/17/2013 1247 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/17/2013 1247 MS	EPA 200.8
Boron	0.2	0.1		mg/L	12/17/2013 1509 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/17/2013 1247 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/17/2013 1509 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/17/2013 1247 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/17/2013 1509 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/17/2013 1247 MS	EPA 200.8
Manganese	0.48	0.02		mg/L	12/17/2013 1509 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/23/2013 0855 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/17/2013 1247 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/17/2013 1509 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/17/2013 1247 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/17/2013 1509 DG	EPA 200.7
Total Metals						
Iron	1.03	0.05		mg/L	12/20/2013 1230 DG	EPA 200.7
Manganese	0.66	0.02		mg/L	12/20/2013 1230 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-002
Client Sample ID: 578511-MST-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 10:35:00 AM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.52			s.u.	12/16/2013 1035	Field
Conductivity	4180			µmhos/cm	12/16/2013 1035	Field
Turbidity	171			NTU	12/16/2013 1035	Field
Temperature	9.9			°C	12/16/2013 1035	Field
Static Water Level	150.12			ft	12/16/2013 1035	Field
General Parameters						
pH	8.3	0.1		s.u.	12/17/2013 2307 KV	SM 4500 H B
Electrical Conductivity	3970	5		µmhos/cm	12/17/2013 2307 KV	SM 2510B
Total Dissolved Solids (180)	2740	10		mg/L	12/17/2013 1205 EC	SM 2540
Solids, Total Dissolved (Calc)	2790	10		mg/L	12/20/2013 0811 BC	SM 1030E
Alkalinity, Total (As CaCO3)	1230	5		mg/L	12/17/2013 2307 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	506	1		mg/L	12/20/2013 0811 BC	SM 2340B
Nitrogen, Ammonia (As N)	6.9	0.1		mg/L	12/23/2013 1500 RH	EPA 350.1
ium Adsorption Ratio	15.3	0.1			12/20/2013 0811 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	1470	5		mg/L	12/17/2013 2307 KV	SM 2320B
Alkalinity, Carbonate as CO3	11	5		mg/L	12/17/2013 2307 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2307 KV	SM 2320B
Chloride	30	1		mg/L	12/18/2013 0139 AMB	EPA 300.0
Fluoride	1.1	0.1		mg/L	12/17/2013 2307 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1112 RH	EPA 353.2
Sulfate	1050	1		mg/L	12/18/2013 0139 AMB	EPA 300.0
Cations						
Calcium	74	1		mg/L	12/17/2013 1511 DG	EPA 200.7
Magnesium	78	1		mg/L	12/17/2013 1511 DG	EPA 200.7
Potassium	29	1		mg/L	12/17/2013 1511 DG	EPA 200.7
Sodium	793	1		mg/L	12/17/2013 1511 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:
- * Value exceeds Maximum Contaminant Level
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

RL - Reporting Limit
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL
- O Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-002
Client Sample ID: 578511-MST-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 10:35:00 AM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	24.17	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Carbonate as CO3	0.35	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Chloride	0.84	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Fluoride	0.05	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sulfate	21.82	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Calcium	3.71	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Magnesium	6.40	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Potassium	0.74	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sodium	34.47	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	45.33	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
on Sum	47.25	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
ion-Anion Balance	2.06	0.01		%	12/20/2013 0811 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/17/2013 1511 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/17/2013 1308 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/17/2013 1308 MS	EPA 200.8
Boron	0.2	0.1		mg/L	12/17/2013 1511 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/17/2013 1308 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/17/2013 1511 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/17/2013 1308 MS	EPA 200.8
Iron	0.47	0.05		mg/L	12/17/2013 1511 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/17/2013 1308 MS	EPA 200.8
Manganese	0.23	0.02		mg/L	12/17/2013 1511 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/23/2013 0903 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/17/2013 1308 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/17/2013 1511 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/17/2013 1308 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/17/2013 1511 DG	EPA 200.7
Total Metals						
Iron	25.6	0.05		mg/L	12/20/2013 1232 DG	EPA 200.7
Manganese	0.68	0.02		mg/L	12/20/2013 1232 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

DEQ Ex. 3-590

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-004
Client Sample ID: 578512-AL-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 1:00:00 PM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.22			s.u.	12/16/2013 1300	Field
Conductivity	5460			µmhos/cm	12/16/2013 1300	Field
Turbidity	20.0			NTU	12/16/2013 1300	Field
Temperature	10.5			°C	12/16/2013 1300	Field
Static Water Level	3.81			ft	12/16/2013 1300	Field
General Parameters						
pH	8.0	0.1		s.u.	12/17/2013 2330 KV	SM 4500 H B
Electrical Conductivity	5370	5		µmhos/cm	12/17/2013 2330 KV	SM 2510B
Total Dissolved Solids (180)	5150	10		mg/L	12/17/2013 1207 EC	SM 2540
Solids, Total Dissolved (Calc)	4780	10		mg/L	12/20/2013 0811 BC	SM 1030E
Alkalinity, Total (As CaCO3)	662	5		mg/L	12/17/2013 2330 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2560	1		mg/L	12/20/2013 0811 BC	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	12/23/2013 1508 RH	EPA 350.1
ium Adsorption Ratio	4.0	0.1			12/20/2013 0811 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	807	5		mg/L	12/17/2013 2330 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/17/2013 2330 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2330 KV	SM 2320B
Chloride	17	1		mg/L	12/18/2013 0206 AMB	EPA 300.0
Fluoride	1.0	0.1		mg/L	12/17/2013 2330 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1114 RH	EPA 353.2
Sulfate	3130	1		mg/L	12/18/2013 0206 AMB	EPA 300.0
Cations						
Calcium	322	1		mg/L	12/17/2013 1529 DG	EPA 200.7
Magnesium	427	1		mg/L	12/17/2013 1529 DG	EPA 200.7
Potassium	23	1		mg/L	12/17/2013 1529 DG	EPA 200.7
Sodium	465	1		mg/L	12/17/2013 1529 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-004
Client Sample ID: 578512-AL-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 1:00:00 PM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.23	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Chloride	0.48	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Fluoride	0.05	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sulfate	65.18	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Calcium	16.08	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Magnesium	35.12	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Potassium	0.57	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sodium	20.20	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	71.99	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
n Sum	78.95	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
on-Anion Balance	4.60	0.01		%	12/20/2013 0811 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/17/2013 1529 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/17/2013 1329 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/17/2013 1329 MS	EPA 200.8
Boron	0.4	0.1		mg/L	12/17/2013 1529 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/17/2013 1329 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/17/2013 1529 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/17/2013 1329 MS	EPA 200.8
Iron	0.92	0.05		mg/L	12/17/2013 1529 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/17/2013 1329 MS	EPA 200.8
Manganese	1.92	0.02		mg/L	12/17/2013 1529 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/23/2013 0907 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/17/2013 1329 MS	EPA 200.8
Nickel	0.01	0.01		mg/L	12/17/2013 1529 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/17/2013 1329 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/17/2013 1529 DG	EPA 200.7
Total Metals						
Iron	5.29	0.05		mg/L	12/20/2013 1246 DG	EPA 200.7
Manganese	2.69	0.02		mg/L	12/20/2013 1246 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-005
Client Sample ID: 578513-AL-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 2:15:00 PM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.18			s.u.	12/16/2013 1415	Field
Conductivity	5130			µmhos/cm	12/16/2013 1415	Field
Turbidity	0.57			NTU	12/16/2013 1415	Field
Temperature	10.2			°C	12/16/2013 1415	Field
Static Water Level	9.36			ft	12/16/2013 1415	Field
General Parameters						
pH	8.0	0.1		s.u.	12/17/2013 2343 KV	SM 4500 H B
Electrical Conductivity	4980	5		µmhos/cm	12/17/2013 2343 KV	SM 2510B
Total Dissolved Solids (180)	4790	10		mg/L	12/17/2013 1208 EC	SM 2540
Solids, Total Dissolved (Calc)	4290	10		mg/L	12/20/2013 0811 BC	SM 1030E
Alkalinity, Total (As CaCO3)	674	5		mg/L	12/17/2013 2343 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2240	1		mg/L	12/20/2013 0811 BC	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	12/23/2013 1509 RH	EPA 350.1
ium Adsorption Ratio	4.1	0.1			12/20/2013 0811 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	823	5		mg/L	12/17/2013 2343 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/17/2013 2343 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2343 KV	SM 2320B
Chloride	22	1		mg/L	12/18/2013 0220 AMB	EPA 300.0
Fluoride	0.8	0.1		mg/L	12/17/2013 2343 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1116 RH	EPA 353.2
Sulfate	2740	1		mg/L	12/18/2013 0220 AMB	EPA 300.0
Cations						
Calcium	267	1		mg/L	12/17/2013 1531 DG	EPA 200.7
Magnesium	383	1		mg/L	12/17/2013 1531 DG	EPA 200.7
Potassium	26	1		mg/L	12/17/2013 1531 DG	EPA 200.7
Sodium	448	1		mg/L	12/17/2013 1531 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-005
Client Sample ID: 578513-AL-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 2:15:00 PM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.48	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Chloride	0.60	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Fluoride	0.04	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sulfate	57.07	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Calcium	13.34	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Magnesium	31.53	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Potassium	0.67	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sodium	19.49	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	65.04	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
ın Sum	71.21	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
ion-Anion Balance	4.52	0.01		%	12/20/2013 0811 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/17/2013 1531 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/17/2013 1335 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/17/2013 1335 MS	EPA 200.8
Boron	0.4	0.1		mg/L	12/17/2013 1531 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/17/2013 1335 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/17/2013 1531 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/17/2013 1335 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/17/2013 1531 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/17/2013 1335 MS	EPA 200.8
Manganese	0.35	0.02		mg/L	12/17/2013 1531 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/23/2013 0909 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/17/2013 1335 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/17/2013 1531 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/17/2013 1335 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/17/2013 1531 DG	EPA 200.7
Total Metals						
Iron	0.08	0.05		mg/L	12/20/2013 1253 DG	EPA 200.7
Manganese	0.47	0.02		mg/L	12/20/2013 1253 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

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E	Value above quantitation range
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O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-003
Client Sample ID: 578513-MST-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 12:00:00 PM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.77			s.u.	12/16/2013 1200	Field
Conductivity	4230			µmhos/cm	12/16/2013 1200	Field
Turbidity	2.96			NTU	12/16/2013 1200	Field
Temperature	10.6			°C	12/16/2013 1200	Field
Static Water Level	108.54			ft	12/16/2013 1200	Field
General Parameters						
pH	7.8	0.1		s.u.	12/17/2013 2319 KV	SM 4500 H B
Electrical Conductivity	4010	5		µmhos/cm	12/17/2013 2319 KV	SM 2510B
Total Dissolved Solids (180)	3120	10		mg/L	12/17/2013 1206 EC	SM 2540
Solids, Total Dissolved (Calc)	3080	10		mg/L	12/20/2013 0811 BC	SM 1030E
Alkalinity, Total (As CaCO3)	611	5		mg/L	12/17/2013 2319 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1030	1		mg/L	12/20/2013 0811 BC	SM 2340B
Nitrogen, Ammonia (As N)	9.1	0.1		mg/L	12/23/2013 1507 RH	EPA 350.1
'um Adsorption Ratio	7.9	0.1			12/20/2013 0811 BC	Calculation
s						
Alkalinity, Bicarbonate as HCO3	745	5		mg/L	12/17/2013 2319 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/17/2013 2319 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/17/2013 2319 KV	SM 2320B
Chloride	16	1		mg/L	12/18/2013 0153 AMB	EPA 300.0
Fluoride	0.7	0.1		mg/L	12/17/2013 2319 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/19/2013 1113 RH	EPA 353.2
Sulfate	1780	1		mg/L	12/18/2013 0153 AMB	EPA 300.0
Cations						
Calcium	124	1		mg/L	12/17/2013 1516 DG	EPA 200.7
Magnesium	175	1		mg/L	12/17/2013 1516 DG	EPA 200.7
Potassium	34	1		mg/L	12/17/2013 1516 DG	EPA 200.7
Sodium	586	1		mg/L	12/17/2013 1516 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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H	Holding times for preparation or analysis exceeded
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ND	Not Detected at the Reporting Limit
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E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
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TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/24/2013
Report ID: S1312211001

Project: Ramaco
Lab ID: S1312211-003
Client Sample ID: 578513-MST-1
COC: 150197

Work Order: S1312211
Collection Date: 12/16/2013 12:00:00 PM
Date Received: 12/16/2013 3:50:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.21	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Chloride	0.44	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Fluoride	0.03	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sulfate	37.10	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Calcium	6.19	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Magnesium	14.42	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Potassium	0.87	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Sodium	25.47	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	46.96	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
n Sum	49.79	0.01		meq/L	12/20/2013 0811 BC	SM 1030E
on-Anion Balance	2.92	0.01		%	12/20/2013 0811 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/17/2013 1516 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/17/2013 1324 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/17/2013 1324 MS	EPA 200.8
Boron	0.3	0.1		mg/L	12/17/2013 1516 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/17/2013 1324 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/17/2013 1516 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/17/2013 1324 MS	EPA 200.8
Iron	0.40	0.05		mg/L	12/17/2013 1516 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/17/2013 1324 MS	EPA 200.8
Manganese	0.08	0.02		mg/L	12/17/2013 1516 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/23/2013 0905 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/17/2013 1324 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/17/2013 1516 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/17/2013 1324 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/17/2013 1516 DG	EPA 200.7
Total Metals						
Iron	0.51	0.05		mg/L	12/20/2013 1241 DG	EPA 200.7
Manganese	0.09	0.02		mg/L	12/20/2013 1241 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned 02/27/2020

Inter-Mountain Labs

Sheridan, WY and Gillette, WY

Page ___ of ___

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All shaded fields must be completed.
This is a legal document: any misrepresentation may be construed as fraud.

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC	RAMACO	Rod Fuller	

Report Address	Contact Name	Email	Phone
WWC	Jeff Barron - WWC		

Invoice Address	Purchase Order #	Quote #
WWC		439

ANALYSES / PARAMETERS: SHIP VIA

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME SAMPLED	SAMPLE IDENTIFICATION	Matrix	# of Containers	SHIP VIA							REMARKS
1		2/15/13	1045	578415-MST/CRN-1	WT	4	✓							
2				PH=7.68, EC=1952, T=10.5, TUR=225, SWL=122.68'										
3		2/15/13	1200	578409-UBN-1	WT	4	✓							
4				PH=7.76, EC=4220, T=11.4, TUR=3.62, SWL=110.20'										
5		2/15/13	1245	578409-MST-1	WT	4	✓							
6				PH=7.70, EC=2470, T=10.7, TUR=1.45, SWL=101.10'										
7		2/15/13	1320	578409-CRN-OB-1	WT	4	✓							
8				PH=7.25, EC=2390, T=10.2, TUR=15.13, SWL=90.76'										
9		2/15/13	1420	578408-CRN-1	WT	4	✓							
10				PH=6.88, EC=2650, T=10.4, TUR=355, SWL=87.70'										
11		2/15/13	1500	578408-MST-1	WT	4	✓							
12				PH=6.53, EC=2430 T=10.3, TUR=518, SWL=105.89										
13		2/15/13	1600	578417-CRN-1	WT	4	✓							
14				PH=7.39, EC=1483, T=9.9, TUR=615, SWL=										133.31'

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
1-4	Rod Fuller	12/16/13	0816	Kathy Boyd	12.16.13	8:16

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION		ADDITIONAL REMARKS
☐ UPS	Water	(WT)	Check desired service	Compliance Monitoring?	Y/N	
☐ Fed Express	Soil	SL	☒ Standard turnaround	Program (SDWA, NPDES,...)		
☐ US Mail	Solid	SD	☐ RUSH - 5 Working Days	PWSID / Permit #		
☐ Hand Carried	Filter	FT	☐ URGENT - < 2 Working Days	Chlorinated?	Y/N	
☐ Other _____	Other	OT	Rush & Urgent Surcharges will be applied	Sample Disposal: Lab	Client	

DEQ EX. 3-597

October 2014 Addendum D6-10-107
TFN 6 2 025
RECD NOV 14, 2014
RAMACO
BROOK MINE

Scanned 07/07/2020

Inter-Mountain Labs

Sheridan, WY and Gillette, WY

All shaded fields must be completed.
This is a legal document: any misrepresentation may be construed as fraud.

Page of # 0197

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC	RAMACO	Rod Fuller	

Report Address	Contact Name	Email	Phone
WWC	Jeff Barron - WWC		

Invoice Address	Purchase Order #	Quote #
WWC		439

ANALYSES / PARAMETERS

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME SAMPLED	SAMPLE IDENTIFICATION	Matrix	# of Containers	Full Suite	GEN #	REMARKS
1		12/16/13	0940	578511 - CRN - 1	WT	4	✓		
2				PH = 7.41, EC = 3800, T = 10.0, TUR = 72.6, SWL = 119.63'					
3		12/16/13	1035	578511 - MST - 1	WT	4			
4				PH = 7.52, EC = 4180, T = 9.9, TUR = 171, SWL = 150.12'					
5		12/16/13	1200	578513 - MST - 1	WT	4			
6				PH = 6.77, EC = 4230, T = 10.6, TUR = 2.96, SWL = 108.54'					
7		12/16/13	1300	578512 - AL - 1	WT	4			
8				PH = 7.22, EC = 5460 T = 10.5, TUR = 20.0, SWL = 3.81'					
9		12/16/13	1415	578513 - AL - 1	WT	4			
10				PH = 7.18, EC = 5130, T = 10.2, TUR = 0.57, SWL =					9.36'
11		12/16/13	1505	578418 - AL - 1	WT	4			
12				PH = 7.67, EC = 3050, T = 9.6, TUR = 38.2, SWL =					20.78'
13									
14									

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
2.7°C	Rod Fuller	12/16/13	1547	Tom Patton	12/16/13	15:50

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
☐ UPS	Water	(WT)	Check desired service	Compliance Monitoring? Y/N	
☐ Fed Express	Soil	SL	☒ Standard turnaround	Program (SDWA, NPDES,...)	
☐ US Mail	Solid	SD	☐ RUSH - 5 Working Days	PWSID / Permit #	
☐ Hand Carried	Filter	FT	☐ URGENT - < 2 Working Days	Chlorinated? Y/N	
☐ Other _____	Other	OT	Rush & Urgent Surcharges will be applied	Sample Disposal: Lab / Client	

DEQ Ex. 3-538

October 2014
TFN 6 2/025
RECD NOV 14, 2014
Addendum D6-10-108
RAMACO
BLOCK MINE

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SW1578408-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578408-CRN-1 Date Sampled 3/6/14 Time 0940 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 98.27 ft below MP Depth to Water (below MP) 87.70 ft Casing Diameter 2 in

Date 3/6/14 Time 0925 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at NA ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
0930	7.26	2600	9.4	66.0	↓	150mL/30sec
0940	7.22	2600	9.1	65.9	3.0	↓

Pumping Start Time 0915 WL _____ Pumping End Time _____ WL _____

Comments:

HCF

CCH 151519

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578408-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled 3 / 6 / 14 Time 0855 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 120.26 ft below MP Depth to Water (below MP) 102.93 ft Casing Diameter 2 in

Date 3 / 6 / 14 Time 0822 (am) pm Casing Volume NA gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer

Pump intake or bailer set at 115 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
0845	6.84	1976	9.5	45.6	↓	150mL/30sec
0855	6.87	1984	9.4	53.7	3.0	↓

Pumping Start Time 0830 WL _____ Pumping End Time _____ WL _____

Comments: HCF

CCC# 151519

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* No Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SW1578409-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 110.55 ft below MP Depth to Water (below MP) 90.71 ft Casing Diameter 5 in

Date 3 / 5 / 14 Time 1025 am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: GW sample

TEN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-601

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RAMACO

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578409-CRN-OB-1 Project Ramaco

Location _____ W.O.# 2013139-C7

Sample ID# 578409-CRN-OB-1 Date Sampled 3/5/14 Time 1220 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 111.33 ft below MP Depth to Water (below MP) 70.78 ft Casing Diameter 5 in

Date 3/5/14 Time 1070 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 105 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1210	7.64	1956	12.4	3.30	↓	150mL/30sec
1220	7.62	1960	11.9	4.36	3.0	↓

Pumping Start Time 1155 WL _____ Pumping End Time _____ WL _____

Comments:

LCF

CCC# 151518

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578409-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578409-MST-1 Date Sampled 3 / 5 / 14 Time 1135 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 122.83 ft below MP Depth to Water (below MP) 101.21 ft Casing Diameter 5 in

Date 3 / 5 / 14 Time 1035 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)) Tap Bailer _____

Pump intake or bailer set at 115 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1125	8.05	2330	13.1	4.78	↓	150ML / 30 Sec.
1135	8.05	2310	12.8	1.86	3.0	↓

Pumping Start Time 1110 WL _____ Pumping End Time _____ WL _____

Comments:

LCF

CCC# 151518

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* No sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM1578409-MST-OB-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 123.80 ft below MP Depth to Water (below MP) 102.11 ft Casing Diameter 5 in

Date 3/5/14 Time 1030 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578409-UBN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578409-UBN-1 Date Sampled 3/5/14 Time 1050 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 141.20 ft below MP Depth to Water (below MP) 110.25 ft Casing Diameter 5 in

Date 3/5/14 Time 1015 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 135 ft below MP.

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1040	8.03	3911	12.4	73.3	↓	150mL/30 sec
1050	8.04	3921	12.9	59.7	3.0	↓

Pumping Start Time 1025 WL _____ Pumping End Time _____ WL _____

Comments:

HCT

CCC# 151518

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578415-MST/CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578415-MST/CRN-1 Date Sampled 3/5/14 Time 0930 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 143.70 ft below MP Depth to Water (below MP) 122.01 ft Casing Diameter 5 in

Date 3/5/14 Time 0855 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 135 ft below MP.

ubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for N/A

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
0920	8.04	1746	10.4	11.21	↓	150 ml/30 sec
0930	8.11	1930	10.5	8.38	~~3.0~~ 3.0	↓

Pumping Start Time 0905 WL _____ Pumping End Time _____ WL _____

Comments:

LCF

CCC# 151518

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578417-CRM-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578417-CRM-1 Date Sampled 3/6/14 Time 1040 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 142.4 ft below MP Depth to Water (below MP) 133.13 ft Casing Diameter 2 in

Date 3/6/14 Time 1008 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)) Tap Bailer _____

Pump intake or bailer set at 138 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1030	7.70	1363	9.5	956	↓	150mL/30sec
1040	7.76	1347	9.5	971	3.0	↓

Pumping Start Time 1015 WL _____ Pumping End Time _____ WL _____

Comments:

HCF

COC# 151519

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578417-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point _____

Well Depth 163.82 ft below MP Depth to Water (below MP) 160.17 ft Casing Diameter 2 in

Date 3/6/14 Time 1045 am pm Casing Volume - gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - not enough water to sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* No sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578418-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point _____

Well Depth 24.50 ft below MP Depth to Water (below MP) 20.62 ft Casing Diameter 5 in

Date 3 / 4 / 14 Time 1520 am/pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

STATIC WATER LEVEL OF ASSOCIATED WELLS

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time 1525 WL _____ Pumping End Time _____ WL _____

Comments: No sample - not enough water to sample - Pumped for five minutes and ran out of water. Slow recovery

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* No Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578418-CRM-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 153.79 ft below MP Depth to Water (below MP) 146.64 ft Casing Diameter 5 in

Date 3/6/14 Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No Sample - not enough water to sample. Site still needs reclaimed.

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* No Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578418-MST-1 Project Ramaco

Location _____ W.O.# 2013134-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 185.75 ft below MP Depth to Water (below MP) 184.43 ft Casing Diameter _____ in

Date 3/6/14 Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - not enough water to sample - well shelter still needs set and site still needs reclaimed.

Form completed by: Rod Fuller Witnessed by: _____

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578510-CRN-1 Project Ramaco

Location _____ W.O.# 2013L31-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 92.74 ft below MP Depth to Water (below MP) Dry ft Casing Diameter _____ in

Date 3/6/14 Time _____ am pm Casing Volume _____ gal

STATIC WATER LEVEL OF ASSOCIATED WELLS

At least _____ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No Sample - not enough water to sample - Dry - Site still needs reclaimed

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* No sample

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM 578510-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 147.24 ft below MP Depth to Water (below MP) 146.31 ft Casing Diameter 5 in

Date 3/6/14 Time _____ am pm Casing Volume _____ gal

STATIC WATER LEVEL OF ASSOCIATED WELLS

At least _____ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - not enough water to sample - Site still needs reclaimed

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-613

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RAMACO

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578511-CRM-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578511-CRM-1 Date Sampled 3 / 4 / 14 Time 1030 (am pm

Describe Sampling Point GW monitoring well

Well Depth 128.92 ft below MP Depth to Water (below MP) 119.59 ft Casing Diameter 5 in

Date 3 / 4 / 14 Time 0905 (am pm Casing Volume 7/4 gal

At least 7/4 bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at 125 ft below MP.

Tubing (type: Plastic). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for 7/4

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1020	7.66	3730	12.0	32.9	↓	150 mL/30 sec
1030	7.66	3690	12.3	28.3	≈3.0	↓

Pumping Start Time 1005 WL _____ Pumping End Time _____ WL _____

Comments: HCF, COC # 151517

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-614

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RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM57851I-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point _____

Well Depth 158 ft below MP Depth to Water (below MP) 150.08 ft Casing Diameter 5 in

Date 3/4/14 Time 1048 (am) pm Casing Volume 2H gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - not enough water to sample - pumped for ± 15 min. and ran out of water - slow recharge.

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578512-AL-1 Project Ramaco

Location _____ W.O.# 2013139-C7

Sample ID# 578512-AL-1 Date Sampled 3 / 4 / 14 Time 1355 am (pm)

Describe Sampling Point CW monitoring well

Well Depth 21.21 ft below MP Depth to Water (below MP) 3.67 ft Casing Diameter 5 in

Date 3 / 4 / 14 Time 1325 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer

Pump intake or bailer set at 15 ft below MP.

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1345	7.50	5440	9.6	252	↓	150 ML/30 Sec
1355	7.59	5370	9.6	173	≈ 3.0	↓

Pumping Start Time 1330 WL _____ Pumping End Time _____ WL _____

Comments: Water rust colored

HCF

COC# 151517

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* No Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578512-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 49.85 ft below MP Depth to Water (below MP) Dry ft Casing Diameter 5 in

Date 3/6/14 Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No Sample - Dry.

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* No sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SMS78512-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 114.96 ft below MP Depth to Water (below MP) 111.95 ft Casing Diameter 5 in

Date / / Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - not enough water for sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578513-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578513-AL-1 Date Sampled 3/4/14 Time 1450 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 20.77 ft below MP Depth to Water (below MP) 7.66 ft Casing Diameter 5 in

Date 3/4/14 Time 1420 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer

Pump intake or bailer set at 15 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1440	7.54	491C	10.C	3.35	↓	150mL/30.dec
1450	7.57	490C	9.9	0.93	≈3.0	↓

Pumping Start Time 1425 WL _____ Pumping End Time _____ WL _____

Comments:

KCF

COC# 151517

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no Sample

WWC ENGINEERING

Brook Mine

1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point Sm 578513-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-01

Sample ID# _____ Date Sampled / / Time _____ am pm

Describe Sampling Point On monitoring well

Well Depth 117.28 ft below MP Depth to Water (below MP) 116.96 ft Casing Diameter 5 in

Date 3 / 4 / 14 Time 1215 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - not enough water to sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SMS78513-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578513-MST-1 Date Sampled 3 / 4 / 14 Time 1255 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 144 ft below MP Depth to Water (below MP) 108.82 ft Casing Diameter 5 in

Date 3 / 4 / 13 Time 1220 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 140 ft below MP.

ubing (type: Plastic). (New or (previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1245	7.11	4080	10.9	4.02	↓	150 mL / 30 sec
1255	7.12	3920	10.7	2.06	≈ 3.0	↓

Pumping Start Time 1230 WL _____ Pumping End Time _____ WL _____

Comments: LCF , CCC# 151517

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/17/2014
Report ID: S1403082001

Project: Ramaco
Lab ID: S1403082-001
Client Sample ID: 578408-MST-1
COC: 151519

Work Order: S1403082
Collection Date: 3/6/2014 8:55:00 AM
Date Received: 3/6/2014 11:35:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.87			s.u.	03/06/2014 0855	Field
Conductivity	1984			µmhos/cm	03/06/2014 0855	Field
Turbidity	53.7			NTU	03/06/2014 0855	Field
Temperature	9.4			°C	03/06/2014 0855	Field
Static Water Level	102.93			ft	03/06/2014 0855	Field
General Parameters						
pH	7.6	0.1		s.u.	03/10/2014 1956 KV	SM 4500 H B
Electrical Conductivity	2120	5		µmhos/cm	03/10/2014 1956 KV	SM 2510B
Total Dissolved Solids (180)	1650	10		mg/L	03/07/2014 1312 EC	SM 2540
Solids, Total Dissolved (Calc)	1510	10		mg/L	03/13/2014 1443 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	496	5		mg/L	03/10/2014 1956 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1020	1		mg/L	03/13/2014 1443 JJ	SM 2340B
Nitrogen, Ammonia (As N)	5.4	0.1		mg/L	03/13/2014 0850 RH	EPA 350.1
ium Adsorption Ratio	1.6	0.1			03/13/2014 1443 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	605	5		mg/L	03/10/2014 1956 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/10/2014 1956 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/10/2014 1956 KV	SM 2320B
Chloride	7	1		mg/L	03/10/2014 2149 AMB	EPA 300.0
Fluoride	0.5	0.1		mg/L	03/10/2014 1956 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/12/2014 0754 RH	EPA 353.2
Sulfate	767	1		mg/L	03/10/2014 2149 AMB	EPA 300.0
Cations						
Calcium	120	1		mg/L	03/07/2014 2005 DG	EPA 200.7
Magnesium	175	1		mg/L	03/07/2014 2005 DG	EPA 200.7
Potassium	28	1		mg/L	03/07/2014 2005 DG	EPA 200.7
Sodium	114	1		mg/L	03/07/2014 2005 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

DEQ Ex. 3-622

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/17/2014
Report ID: S1403082001

Project: Ramaco
Lab ID: S1403082-001
Client Sample ID: 578408-MST-1
COC: 151519

Work Order: S1403082
Collection Date: 3/6/2014 8:55:00 AM
Date Received: 3/6/2014 11:35:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.91	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Chloride	0.18	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Sulfate	15.96	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Calcium	5.98	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Magnesium	14.38	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Potassium	0.72	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Sodium	4.95	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	26.43	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
n Sum	26.09	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
on-Anion Balance	0.64	0.01		%	03/13/2014 1443 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/07/2014 2005 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 1500 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 1500 MS	EPA 200.8
Boron	0.4	0.1		mg/L	03/07/2014 2005 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 1500 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 2005 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 1500 MS	EPA 200.8
Iron	0.59	0.05		mg/L	03/07/2014 2005 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 1500 MS	EPA 200.8
Manganese	0.15	0.02		mg/L	03/07/2014 2005 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/14/2014 1034 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 1500 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 2005 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 1500 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 2005 DG	EPA 200.7
Total Metals						
Iron	1.41	0.05		mg/L	03/11/2014 1529 DG	EPA 200.7
Manganese	0.16	0.02		mg/L	03/11/2014 1529 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

DEQ Ex. 3-623

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/17/2014
Report ID: S1403082001

Project: Ramaco
Lab ID: S1403082-002
Client Sample ID: 578408-CRN-1
COC: 151519

Work Order: S1403082
Collection Date: 3/6/2014 9:40:00 AM
Date Received: 3/6/2014 11:35:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.22			s.u.	03/06/2014 0940	Field
Conductivity	2600			µmhos/cm	03/06/2014 0940	Field
Turbidity	65.9			NTU	03/06/2014 0940	Field
Temperature	9.1			°C	03/06/2014 0940	Field
Static Water Level	87.70			ft	03/06/2014 0940	Field
General Parameters						
pH	7.9	0.1		s.u.	03/10/2014 2007 KV	SM 4500 H B
Electrical Conductivity	2480	5		µmhos/cm	03/10/2014 2007 KV	SM 2510B
Total Dissolved Solids (180)	2040	10		mg/L	03/07/2014 1313 EC	SM 2540
Solids, Total Dissolved (Calc)	1870	10		mg/L	03/13/2014 1443 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	605	5		mg/L	03/10/2014 2007 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1430	1		mg/L	03/13/2014 1443 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.4	0.1		mg/L	03/13/2014 0851 RH	EPA 350.1
ium Adsorption Ratio	0.9	0.1			03/13/2014 1443 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	738	5		mg/L	03/10/2014 2007 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/10/2014 2007 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/10/2014 2007 KV	SM 2320B
Chloride	8	1		mg/L	03/10/2014 2202 AMB	EPA 300.0
Fluoride	0.7	0.1		mg/L	03/10/2014 2007 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/12/2014 0755 RH	EPA 353.2
Sulfate	973	1		mg/L	03/10/2014 2202 AMB	EPA 300.0
Cations						
Calcium	177	1		mg/L	03/07/2014 2007 DG	EPA 200.7
Magnesium	240	1		mg/L	03/07/2014 2007 DG	EPA 200.7
Potassium	29	1		mg/L	03/07/2014 2007 DG	EPA 200.7
Sodium	82	1		mg/L	03/07/2014 2007 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

DEQ Ex. 3-624

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/17/2014
Report ID: S1403082001

Project: Ramaco
Lab ID: S1403082-002
Client Sample ID: 578408-CRN-1
COC: 151519

Work Order: S1403082
Collection Date: 3/6/2014 9:40:00 AM
Date Received: 3/6/2014 11:35:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.10	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Chloride	0.23	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Sulfate	20.26	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Calcium	8.81	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Magnesium	19.74	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Potassium	0.74	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Sodium	3.57	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	32.90	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
n Sum	32.63	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
on-Anion Balance	0.40	0.01		%	03/13/2014 1443 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.2	0.1		mg/L	03/07/2014 2007 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 1516 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 1516 MS	EPA 200.8
Boron	0.5	0.1		mg/L	03/07/2014 2007 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 1516 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 2007 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 1516 MS	EPA 200.8
Iron	0.14	0.05		mg/L	03/07/2014 2007 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 1516 MS	EPA 200.8
Manganese	0.51	0.02		mg/L	03/07/2014 2007 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/14/2014 1036 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 1516 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 2007 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 1516 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 2007 DG	EPA 200.7
Total Metals						
Iron	1.05	0.05		mg/L	03/11/2014 1533 DG	EPA 200.7
Manganese	0.50	0.02		mg/L	03/11/2014 1533 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2014
Report ID: S1403049001

Project: Ramaco
Lab ID: S1403049-004
Client Sample ID: 578409-CRN-OB-1
COC: 151518

Work Order: S1403049
Collection Date: 3/5/2014 12:20:00 PM
Date Received: 3/5/2014 2:07:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.62			s.u.	03/05/2014 1220	Field
Conductivity	1960			µmhos/cm	03/05/2014 1220	Field
Turbidity	4.36			NTU	03/05/2014 1220	Field
Temperature	11.9			°C	03/05/2014 1220	Field
Static Water Level	90.78			ft	03/05/2014 1220	Field
General Parameters						
pH	8.1	0.1		s.u.	03/06/2014 2058 KV	SM 4500 H B
Electrical Conductivity	2100	5		µmhos/cm	03/06/2014 2058 KV	SM 2510B
Total Dissolved Solids (180)	1450	10		mg/L	03/06/2014 1613 EC	SM 2540
Solids, Total Dissolved (Calc)	1430	10		mg/L	03/10/2014 1211 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	473	5		mg/L	03/06/2014 2058 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	665	1		mg/L	03/10/2014 1211 JJ	SM 2340B
Nitrogen, Ammonia (As N)	5.1	0.1		mg/L	03/07/2014 0921 RH	EPA 350.1
ium Adsorption Ratio	4.3	0.1			03/10/2014 1211 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	577	5		mg/L	03/06/2014 2058 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/06/2014 2058 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/06/2014 2058 KV	SM 2320B
Chloride	12	1		mg/L	03/09/2014 0338 AMB	EPA 300.0
Fluoride	0.6	0.1		mg/L	03/06/2014 2058 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/07/2014 1130 RH	EPA 353.2
Sulfate	655	1		mg/L	03/09/2014 0338 AMB	EPA 300.0
Cations						
Calcium	101	1		mg/L	03/07/2014 1809 DG	EPA 200.7
Magnesium	100	1		mg/L	03/07/2014 1809 DG	EPA 200.7
Potassium	21	1		mg/L	03/07/2014 1809 DG	EPA 200.7
Sodium	253	1		mg/L	03/07/2014 1809 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:
- * Value exceeds Maximum Contaminant Level
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

RL - Reporting Limit
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL
- O Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2014
Report ID: S1403049001

Project: Ramaco
Lab ID: S1403049-004
Client Sample ID: 578409-CRN-OB-1
COC: 151518

Work Order: S1403049
Collection Date: 3/5/2014 12:20:00 PM
Date Received: 3/5/2014 2:07:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.46	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Chloride	0.33	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Sulfate	13.63	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Calcium	5.03	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Magnesium	8.26	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Potassium	0.53	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Sodium	10.99	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	25.19	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
›n Sum	23.47	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
on-Anion Balance	3.53	0.01		%	03/10/2014 1211 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/07/2014 1809 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 0500 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 0500 MS	EPA 200.8
Boron	0.2	0.1		mg/L	03/07/2014 1809 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 0500 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 1809 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 0500 MS	EPA 200.8
Iron	ND	0.05		mg/L	03/07/2014 1809 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 0500 MS	EPA 200.8
Manganese	0.14	0.02		mg/L	03/07/2014 1809 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/11/2014 1251 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 0500 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 1809 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 0500 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 1809 DG	EPA 200.7
Total Metals						
Iron	0.12	0.05		mg/L	03/10/2014 2038 DG	EPA 200.7
Manganese	0.15	0.02		mg/L	03/10/2014 2038 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2014
Report ID: S1403049001

Project: Ramaco
Lab ID: S1403049-003
Client Sample ID: 578409-MST-1
COC: 151518

Work Order: S1403049
Collection Date: 3/5/2014 11:35:00 AM
Date Received: 3/5/2014 2:07:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.05			s.u.	03/05/2014 1135	Field
Conductivity	2310			µmhos/cm	03/05/2014 1135	Field
Turbidity	1.86			NTU	03/05/2014 1135	Field
Temperature	12.8			°C	03/05/2014 1135	Field
Static Water Level	101.21			ft	03/05/2014 1135	Field
General Parameters						
pH	8.4	0.1		s.u.	03/06/2014 2047 KV	SM 4500 H B
Electrical Conductivity	2230	5		µmhos/cm	03/06/2014 2047 KV	SM 2510B
Total Dissolved Solids (180)	1430	10		mg/L	03/06/2014 1612 EC	SM 2540
Solids, Total Dissolved (Calc)	1420	10		mg/L	03/10/2014 1211 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	658	5		mg/L	03/06/2014 2047 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	89	1		mg/L	03/10/2014 1211 JJ	SM 2340B
Nitrogen, Ammonia (As N)	3.3	0.1		mg/L	03/07/2014 0920 RH	EPA 350.1
ium Adsorption Ratio	24.2	0.1			03/10/2014 1211 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	775	5		mg/L	03/06/2014 2047 KV	SM 2320B
Alkalinity, Carbonate as CO3	13	5		mg/L	03/06/2014 2047 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/06/2014 2047 KV	SM 2320B
Chloride	9	1		mg/L	03/09/2014 0325 AMB	EPA 300.0
Fluoride	1.5	0.1		mg/L	03/06/2014 2047 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/07/2014 1128 RH	EPA 353.2
Sulfate	449	1		mg/L	03/09/2014 0325 AMB	EPA 300.0
Cations						
Calcium	16	1		mg/L	03/07/2014 1807 DG	EPA 200.7
Magnesium	12	1		mg/L	03/07/2014 1807 DG	EPA 200.7
Potassium	15	1		mg/L	03/07/2014 1807 DG	EPA 200.7
Sodium	525	1		mg/L	03/07/2014 1807 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
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H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2014
Report ID: S1403049001

Project: Ramaco
Lab ID: S1403049-003
Client Sample ID: 578409-MST-1
COC: 151518

Work Order: S1403049
Collection Date: 3/5/2014 11:35:00 AM
Date Received: 3/5/2014 2:07:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.70	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Carbonate as CO3	0.44	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Chloride	0.26	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Fluoride	0.07	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Sulfate	9.34	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Calcium	0.78	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Magnesium	0.98	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Potassium	0.37	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Sodium	22.82	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	25.21	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
n Sum	22.83	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
on-Anion Balance	4.94	0.01		%	03/10/2014 1211 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/07/2014 1807 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 0455 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 0455 MS	EPA 200.8
Boron	0.1	0.1		mg/L	03/07/2014 1807 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 0455 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 1807 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 0455 MS	EPA 200.8
Iron	ND	0.05		mg/L	03/07/2014 1807 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 0455 MS	EPA 200.8
Manganese	0.23	0.02		mg/L	03/07/2014 1807 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/11/2014 1249 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 0455 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 1807 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 0455 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 1807 DG	EPA 200.7
Total Metals						
Iron	ND	0.05		mg/L	03/10/2014 2036 DG	EPA 200.7
Manganese	0.24	0.02		mg/L	03/10/2014 2036 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2014
Report ID: S1403049001

Project: Ramaco
Lab ID: S1403049-002
Client Sample ID: 578409-UBN-1
COC: 151518

Work Order: S1403049
Collection Date: 3/5/2014 10:50:00 AM
Date Received: 3/5/2014 2:07:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.04			s.u.	03/05/2014 1050	Field
Conductivity	3920			µmhos/cm	03/05/2014 1050	Field
Turbidity	59.7			NTU	03/05/2014 1050	Field
Temperature	12.9			°C	03/05/2014 1050	Field
Static Water Level	110.25			ft	03/05/2014 1050	Field
General Parameters						
pH	8.2	0.1		s.u.	03/06/2014 2011 KV	SM 4500 H B
Electrical Conductivity	3840	5		µmhos/cm	03/06/2014 2011 KV	SM 2510B
Total Dissolved Solids (180)	2760	10		mg/L	03/06/2014 1611 EC	SM 2540
Solids, Total Dissolved (Calc)	2810	10		mg/L	03/10/2014 1211 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	460	5		mg/L	03/06/2014 2011 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	479	1		mg/L	03/10/2014 1211 JJ	SM 2340B
Nitrogen, Ammonia (As N)	1.7	0.1		mg/L	03/07/2014 0919 RH	EPA 350.1
'um Adsorption Ratio	15.6	0.1			03/10/2014 1211 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	561	5		mg/L	03/06/2014 2011 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/06/2014 2011 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/06/2014 2011 KV	SM 2320B
Chloride	30	1		mg/L	03/09/2014 0312 AMB	EPA 300.0
Fluoride	1.1	0.1		mg/L	03/06/2014 2011 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	4.9	0.1		mg/L	03/07/2014 1127 RH	EPA 353.2
Sulfate	1530	1		mg/L	03/09/2014 0312 AMB	EPA 300.0
Cations						
Calcium	80	1		mg/L	03/07/2014 1804 DG	EPA 200.7
Magnesium	68	1		mg/L	03/07/2014 1804 DG	EPA 200.7
Potassium	15	1		mg/L	03/07/2014 1804 DG	EPA 200.7
Sodium	784	1		mg/L	03/07/2014 1804 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

:NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2014
Report ID: S1403049001

Project: Ramaco
Lab ID: S1403049-002
Client Sample ID: 578409-UBN-1
COC: 151518

Work Order: S1403049
Collection Date: 3/5/2014 10:50:00 AM
Date Received: 3/5/2014 2:07:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.19	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Chloride	0.84	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Nitrate + Nitrite as N	0.34	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Sulfate	31.89	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Calcium	3.99	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Magnesium	5.58	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Potassium	0.37	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Sodium	34.09	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	44.17	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
on Sum	42.33	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
on-Anion Balance	2.12	0.01		%	03/10/2014 1211 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.2	0.1		mg/L	03/07/2014 1804 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 0449 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 0449 MS	EPA 200.8
Boron	0.3	0.1		mg/L	03/07/2014 1804 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 0449 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 1804 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 0449 MS	EPA 200.8
Iron	0.30	0.05		mg/L	03/07/2014 1804 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 0449 MS	EPA 200.8
Manganese	0.41	0.02		mg/L	03/07/2014 1804 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/11/2014 1247 CS	EPA 245.1
Molybdenum	0.04	0.02		mg/L	03/07/2014 0449 MS	EPA 200.8
Nickel	0.01	0.01		mg/L	03/07/2014 1804 DG	EPA 200.7
Selenium	0.006	0.005		mg/L	03/07/2014 0449 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 1804 DG	EPA 200.7
Total Metals						
Iron	1.88	0.05		mg/L	03/10/2014 2034 DG	EPA 200.7
Manganese	1.00	0.02		mg/L	03/10/2014 2034 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2014
Report ID: S1403049001

Project: Ramaco
Lab ID: S1403049-001
Client Sample ID: 578415-MST/CRN-1
COC: 151518

Work Order: S1403049
Collection Date: 3/5/2014 9:30:00 AM
Date Received: 3/5/2014 2:07:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.11			s.u.	03/05/2014 0930	Field
Conductivity	1930			µmhos/cm	03/05/2014 0930	Field
Turbidity	8.38			NTU	03/05/2014 0930	Field
Temperature	10.5			°C	03/05/2014 0930	Field
Static Water Level	122.01			ft	03/05/2014 0930	Field
General Parameters						
pH	8.4	0.1		s.u.	03/06/2014 1947 KV	SM 4500 H B
Electrical Conductivity	1850	5		µmhos/cm	03/06/2014 1947 KV	SM 2510B
Total Dissolved Solids (180)	1140	10		mg/L	03/06/2014 1610 EC	SM 2540
Solids, Total Dissolved (Calc)	1140	10		mg/L	03/10/2014 1211 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	679	5		mg/L	03/06/2014 1947 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	48	1		mg/L	03/10/2014 1211 JJ	SM 2340B
Nitrogen, Ammonia (As N)	2.1	0.1		mg/L	03/07/2014 0918 RH	EPA 350.1
ium Adsorption Ratio	28.1	0.1			03/10/2014 1211 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	805	5		mg/L	03/06/2014 1947 KV	SM 2320B
Alkalinity, Carbonate as CO3	12	5		mg/L	03/06/2014 1947 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/06/2014 1947 KV	SM 2320B
Chloride	14	1		mg/L	03/09/2014 0158 AMB	EPA 300.0
Fluoride	2.0	0.1		mg/L	03/06/2014 1947 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/07/2014 1126 RH	EPA 353.2
Sulfate	249	1		mg/L	03/09/2014 0158 AMB	EPA 300.0
Cations						
Calcium	10	1		mg/L	03/07/2014 1751 DG	EPA 200.7
Magnesium	6	1		mg/L	03/07/2014 1751 DG	EPA 200.7
Potassium	9	1		mg/L	03/07/2014 1751 DG	EPA 200.7
Sodium	449	1		mg/L	03/07/2014 1751 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

:NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2014
Report ID: S1403049001

Project: Ramaco
Lab ID: S1403049-001
Client Sample ID: 578415-MST/CRN-1
COC: 151518

Work Order: S1403049
Collection Date: 3/5/2014 9:30:00 AM
Date Received: 3/5/2014 2:07:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.20	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Carbonate as CO3	0.38	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Chloride	0.39	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Fluoride	0.10	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Sulfate	5.18	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Calcium	0.49	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Magnesium	0.47	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Potassium	0.24	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Sodium	19.51	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	20.86	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
on Sum	19.27	0.01		meq/L	03/10/2014 1211 JJ	SM 1030E
on-Anion Balance	3.97	0.01		%	03/10/2014 1211 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/07/2014 1751 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 0428 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 0428 MS	EPA 200.8
Boron	ND	0.1		mg/L	03/07/2014 1751 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 0428 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 1751 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 0428 MS	EPA 200.8
Iron	0.06	0.05		mg/L	03/07/2014 1751 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 0428 MS	EPA 200.8
Manganese	0.09	0.02		mg/L	03/07/2014 1751 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/11/2014 1245 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 0428 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 1751 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 0428 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 1751 DG	EPA 200.7
Total Metals						
Iron	0.29	0.05		mg/L	03/10/2014 2032 DG	EPA 200.7
Manganese	0.10	0.02		mg/L	03/10/2014 2032 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney
Bill Courtney, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/17/2014
Report ID: S1403082001

Project: Ramaco
Lab ID: S1403082-003
Client Sample ID: 578417-CRN-1
COC: 151519

Work Order: S1403082
Collection Date: 3/6/2014 10:40:00 AM
Date Received: 3/6/2014 11:35:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.76			s.u.	03/06/2014 1040	Field
Conductivity	1347			µmhos/cm	03/06/2014 1040	Field
Turbidity	971			NTU	03/06/2014 1040	Field
Temperature	9.5			°C	03/06/2014 1040	Field
Static Water Level	133.13			ft	03/06/2014 1040	Field
General Parameters						
pH	8.2	0.1		s.u.	03/10/2014 2019 KV	SM 4500 H B
Electrical Conductivity	1400	5		µmhos/cm	03/10/2014 2019 KV	SM 2510B
Total Dissolved Solids (180)	890	10		mg/L	03/07/2014 1315 EC	SM 2540
Solids, Total Dissolved (Calc)	880	10		mg/L	03/13/2014 1443 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	449	5		mg/L	03/10/2014 2019 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	151	1		mg/L	03/13/2014 1443 JJ	SM 2340B
Nitrogen, Ammonia (As N)	1.7	0.1		mg/L	03/13/2014 0852 RH	EPA 350.1
um Adsorption Ratio	10	0.1			03/13/2014 1443 JJ	Calculation
A s						
Alkalinity, Bicarbonate as HCO3	548	5		mg/L	03/10/2014 2019 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/10/2014 2019 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/10/2014 2019 KV	SM 2320B
Chloride	8	1		mg/L	03/10/2014 2216 AMB	EPA 300.0
Fluoride	1.9	0.1		mg/L	03/10/2014 2019 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	2.3	0.1		mg/L	03/12/2014 0757 RH	EPA 353.2
Sulfate	250	1		mg/L	03/10/2014 2216 AMB	EPA 300.0
Cations						
Calcium	18	1		mg/L	03/07/2014 2010 DG	EPA 200.7
Magnesium	26	1		mg/L	03/07/2014 2010 DG	EPA 200.7
Potassium	16	1		mg/L	03/07/2014 2010 DG	EPA 200.7
Sodium	282	1		mg/L	03/07/2014 2010 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/17/2014
Report ID: S1403082001

Project: Ramaco
Lab ID: S1403082-003
Client Sample ID: 578417-CRN-1
COC: 151519

Work Order: S1403082
Collection Date: 3/6/2014 10:40:00 AM
Date Received: 3/6/2014 11:35:00 AM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.98	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Chloride	0.21	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Fluoride	0.10	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Nitrate + Nitrite as N	0.16	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Sulfate	5.21	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Calcium	0.91	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Magnesium	2.11	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Potassium	0.41	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Sodium	12.25	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	15.81	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
·n Sum	14.67	0.01		meq/L	03/13/2014 1443 JJ	SM 1030E
on-Anion Balance	3.74	0.01		%	03/13/2014 1443 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.3	0.1		mg/L	03/07/2014 2010 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 1521 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 1521 MS	EPA 200.8
Boron	0.1	0.1		mg/L	03/07/2014 2010 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 1521 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 2010 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 1521 MS	EPA 200.8
Iron	0.08	0.05		mg/L	03/07/2014 2010 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 1521 MS	EPA 200.8
Manganese	0.02	0.02		mg/L	03/07/2014 2010 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/14/2014 1038 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 1521 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 2010 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 1521 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 2010 DG	EPA 200.7
Total Metals						
Iron	11.3	0.05		mg/L	03/11/2014 1547 DG	EPA 200.7
Manganese	0.11	0.02		mg/L	03/11/2014 1547 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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H	Holding times for preparation or analysis exceeded
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ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

DEQ Ex. 3-635

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

ENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/14/2014
Report ID: S1403028001

Project: Ramaco
Lab ID: S1403028-001
Client Sample ID: 578511-CRN-1
COC: 151517

Work Order: S1403028
Collection Date: 3/4/2014 10:30:00 AM
Date Received: 3/4/2014 4:44:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.66			s.u.	03/04/2014 1030	Field
Conductivity	3690			µmhos/cm	03/04/2014 1030	Field
Turbidity	28.3			NTU	03/04/2014 1030	Field
Temperature	12.3			°C	03/04/2014 1030	Field
Static Water Level	119.59			ft	03/04/2014 1030	Field
General Parameters						
pH	8.0	0.1		s.u.	03/06/2014 1456 KV	SM 4500 H B
Electrical Conductivity	3660	5		µmhos/cm	03/06/2014 1456 KV	SM 2510B
Total Dissolved Solids (180)	3150	10		mg/L	03/05/2014 1306 EC	SM 2540
Solids, Total Dissolved (Calc)	2560	10		mg/L	03/14/2014 0819 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	737	5		mg/L	03/06/2014 1456 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	542	1		mg/L	03/14/2014 0819 JJ	SM 2340B
Nitrogen, Ammonia (As N)	7.6	0.1		mg/L	03/07/2014 0901 RH	EPA 350.1
ium Adsorption Ratio	12.6	0.1			03/14/2014 0819 JJ	Calculation
ns						
Alkalinity, Bicarbonate as HCO3	899	5		mg/L	03/06/2014 1456 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/06/2014 1456 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/06/2014 1456 KV	SM 2320B
Chloride	27	1		mg/L	03/07/2014 2105 AMB	EPA 300.0
Fluoride	1.0	0.1		mg/L	03/06/2014 1456 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/07/2014 1100 RH	EPA 353.2
Sulfate	1230	1		mg/L	03/07/2014 2105 AMB	EPA 300.0
Cations						
Calcium	76	1		mg/L	03/07/2014 1614 DG	EPA 200.7
Magnesium	86	1		mg/L	03/07/2014 1614 DG	EPA 200.7
Potassium	24	1		mg/L	03/07/2014 1614 DG	EPA 200.7
Sodium	675	1		mg/L	03/07/2014 1614 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/14/2014
Report ID: S1403028001

Project: Ramaco
Lab ID: S1403028-001
Client Sample ID: 578511-CRN-1
COC: 151517

Work Order: S1403028
Collection Date: 3/4/2014 10:30:00 AM
Date Received: 3/4/2014 4:44:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	14.73	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Chloride	0.77	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Sulfate	25.66	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Calcium	3.77	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Magnesium	7.07	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Potassium	0.61	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Sodium	29.37	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	41.37	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
n Sum	41.22	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
on-Anion Balance	0.18	0.01		%	03/14/2014 0819 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/07/2014 1614 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 0147 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 0147 MS	EPA 200.8
Boron	0.2	0.1		mg/L	03/07/2014 1614 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 0147 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 1614 DG	EPA 200.7
Copper	0.02	0.01		mg/L	03/07/2014 0147 MS	EPA 200.8
Iron	0.07	0.05		mg/L	03/07/2014 1614 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 0147 MS	EPA 200.8
Manganese	0.53	0.02		mg/L	03/07/2014 1614 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/11/2014 1151 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 0147 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 1614 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 0147 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 1614 DG	EPA 200.7
Total Metals						
Iron	0.38	0.05		mg/L	03/07/2014 2117 DG	EPA 200.7
Manganese	0.70	0.02		mg/L	03/07/2014 2117 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/14/2014
Report ID: S1403028001

Project: Ramaco
Lab ID: S1403028-003
Client Sample ID: 578512-AL-1
COC: 151517

Work Order: S1403028
Collection Date: 3/4/2014 1:55:00 PM
Date Received: 3/4/2014 4:44:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.59			s.u.	03/04/2014 1355	Field
Conductivity	5370			µmhos/cm	03/04/2014 1355	Field
Turbidity	173			NTU	03/04/2014 1355	Field
Temperature	9.6			°C	03/04/2014 1355	Field
Static Water Level	3.67			ft	03/04/2014 1355	Field
General Parameters						
pH	7.9	0.1		s.u.	03/06/2014 1519 KV	SM 4500 H B
Electrical Conductivity	5340	5		µmhos/cm	03/06/2014 1519 KV	SM 2510B
Total Dissolved Solids (180)	4590	10		mg/L	03/05/2014 1308 EC	SM 2540
Solids, Total Dissolved (Calc)	4760	10		mg/L	03/14/2014 0819 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	652	5		mg/L	03/06/2014 1519 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2920	1		mg/L	03/14/2014 0819 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.2	0.1		mg/L	03/07/2014 0903 RH	EPA 350.1
um Adsorption Ratio	3.9	0.1			03/14/2014 0819 JJ	Calculation
A s						
Alkalinity, Bicarbonate as HCO3	795	5		mg/L	03/06/2014 1519 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/06/2014 1519 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/06/2014 1519 KV	SM 2320B
Chloride	22	1		mg/L	03/07/2014 2238 AMB	EPA 300.0
Fluoride	0.9	0.1		mg/L	03/06/2014 1519 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/07/2014 1103 RH	EPA 353.2
Sulfate	2990	1		mg/L	03/07/2014 2238 AMB	EPA 300.0
Cations						
Calcium	360	1		mg/L	03/07/2014 1621 DG	EPA 200.7
Magnesium	490	1		mg/L	03/07/2014 1621 DG	EPA 200.7
Potassium	23	1		mg/L	03/07/2014 1621 DG	EPA 200.7
Sodium	488	1		mg/L	03/07/2014 1621 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

*	Value exceeds Maximum Contaminant Level
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/14/2014
Report ID: S1403028001

Project: Ramaco
Lab ID: S1403028-003
Client Sample ID: 578512-AL-1
COC: 151517

Work Order: S1403028
Collection Date: 3/4/2014 1:55:00 PM
Date Received: 3/4/2014 4:44:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.03	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Chloride	0.62	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Sulfate	62.18	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Calcium	17.95	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Magnesium	40.34	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Potassium	0.59	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Sodium	21.22	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	80.14	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
n Sum	75.89	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
on-Anion Balance	2.72	0.01		%	03/14/2014 0819 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.1	0.1		mg/L	03/07/2014 1621 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 0224 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 0224 MS	EPA 200.8
Boron	0.3	0.1		mg/L	03/07/2014 1621 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 0224 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 1621 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 0224 MS	EPA 200.8
Iron	1.04	0.05		mg/L	03/07/2014 1621 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 0224 MS	EPA 200.8
Manganese	2.13	0.02		mg/L	03/07/2014 1621 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/11/2014 1159 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 0224 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 1621 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 0224 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 1621 DG	EPA 200.7
Total Metals						
Iron	25.4	0.05		mg/L	03/07/2014 2122 DG	EPA 200.7
Manganese	2.71	0.02		mg/L	03/07/2014 2122 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

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H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL
O	Outside the Range of Dilutions

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/14/2014
Report ID: S1403028001

Project: Ramaco
Lab ID: S1403028-004
Client Sample ID: 578513-AL-1
COC: 151517

Work Order: S1403028
Collection Date: 3/4/2014 2:50:00 PM
Date Received: 3/4/2014 4:44:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.57			s.u.	03/04/2014 1450	Field
Conductivity	4900			µmhos/cm	03/04/2014 1450	Field
Turbidity	0.93			NTU	03/04/2014 1450	Field
Temperature	9.9			°C	03/04/2014 1450	Field
Static Water Level	7.66			ft	03/04/2014 1450	Field
General Parameters						
pH	7.9	0.1		s.u.	03/06/2014 1530 KV	SM 4500 H B
Electrical Conductivity	4670	5		µmhos/cm	03/10/2014 1703 KV	SM 2510B
Total Dissolved Solids (180)	4610	10		mg/L	03/10/2014 1405 EC	SM 2540
Solids, Total Dissolved (Calc)	4340	10		mg/L	03/14/2014 0819 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	651	5		mg/L	03/06/2014 1530 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2350	1		mg/L	03/14/2014 0819 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	03/07/2014 0904 RH	EPA 350.1
ium Adsorption Ratio	3.9	0.1			03/14/2014 0819 JJ	Calculation
ns						
Alkalinity, Bicarbonate as HCO3	794	5		mg/L	03/06/2014 1530 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/06/2014 1530 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/06/2014 1530 KV	SM 2320B
Chloride	24	1		mg/L	03/07/2014 2251 AMB	EPA 300.0
Fluoride	0.8	0.1		mg/L	03/06/2014 1530 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/07/2014 1104 RH	EPA 353.2
Sulfate	2790	1		mg/L	03/07/2014 2251 AMB	EPA 300.0
Cations						
Calcium	272	1		mg/L	03/07/2014 1635 DG	EPA 200.7
Magnesium	406	1		mg/L	03/07/2014 1635 DG	EPA 200.7
Potassium	25	1		mg/L	03/07/2014 1635 DG	EPA 200.7
Sodium	435	1		mg/L	03/07/2014 1635 DG	EPA 200.7

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O	Outside the Range of Dilutions

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RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

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Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/14/2014
Report ID: S1403028001

Project: Ramaco
Lab ID: S1403028-004
Client Sample ID: 578513-AL-1
COC: 151517

Work Order: S1403028
Collection Date: 3/4/2014 2:50:00 PM
Date Received: 3/4/2014 4:44:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.02	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Chloride	0.66	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Sulfate	58.07	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Calcium	13.59	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Magnesium	33.39	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Potassium	0.63	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Sodium	18.90	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	66.52	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
n Sum	71.79	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
on-Anion Balance	3.80	0.01		%	03/14/2014 0819 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.1	0.1		mg/L	03/07/2014 1635 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 0230 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 0230 MS	EPA 200.8
Boron	0.5	0.1		mg/L	03/07/2014 1635 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 0230 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 1635 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 0230 MS	EPA 200.8
Iron	0.09	0.05		mg/L	03/07/2014 1635 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 0230 MS	EPA 200.8
Manganese	0.31	0.02		mg/L	03/07/2014 1635 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/11/2014 1200 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 0230 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 1635 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 0230 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 1635 DG	EPA 200.7
Total Metals						
Iron	0.11	0.05		mg/L	03/07/2014 2124 DG	EPA 200.7
Manganese	0.39	0.02		mg/L	03/07/2014 2124 DG	EPA 200.7

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Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

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Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/14/2014
Report ID: S1403028001

Project: Ramaco
Lab ID: S1403028-002
Client Sample ID: 578513-MST-1
COC: 151517

Work Order: S1403028
Collection Date: 3/4/2014 12:55:00 PM
Date Received: 3/4/2014 4:44:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.12			s.u.	03/04/2014 1255	Field
Conductivity	3920			µmhos/cm	03/04/2014 1255	Field
Turbidity	2.06			NTU	03/04/2014 1255	Field
Temperature	10.7			°C	03/04/2014 1255	Field
Static Water Level	108.82			ft	03/04/2014 1255	Field
General Parameters						
pH	7.6	0.1		s.u.	03/06/2014 1508 KV	SM 4500 H B
Electrical Conductivity	3900	5		µmhos/cm	03/10/2014 1659 KV	SM 2510B
Total Dissolved Solids (180)	3090	10		mg/L	03/10/2014 1404 EC	SM 2540
Solids, Total Dissolved (Calc)	3040	10		mg/L	03/14/2014 0819 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	605	5		mg/L	03/06/2014 1508 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1080	1		mg/L	03/14/2014 0819 JJ	SM 2340B
Nitrogen, Ammonia (As N)	10.4	0.1		mg/L	03/07/2014 0902 RH	EPA 350.1
ium Adsorption Ratio	8.2	0.1			03/14/2014 0819 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	738	5		mg/L	03/06/2014 1508 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/06/2014 1508 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/06/2014 1508 KV	SM 2320B
Chloride	18	1		mg/L	03/07/2014 2225 AMB	EPA 300.0
Fluoride	0.6	0.1		mg/L	03/06/2014 1508 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/07/2014 1102 RH	EPA 353.2
Sulfate	1700	1		mg/L	03/07/2014 2225 AMB	EPA 300.0
Cations						
Calcium	129	1		mg/L	03/07/2014 1617 DG	EPA 200.7
Magnesium	184	1		mg/L	03/07/2014 1617 DG	EPA 200.7
Potassium	32	1		mg/L	03/07/2014 1617 DG	EPA 200.7
Sodium	622	1		mg/L	03/07/2014 1617 DG	EPA 200.7

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COC: 151517

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Collection Date: 3/4/2014 12:55:00 PM
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Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.09	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Chloride	0.50	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Sulfate	35.32	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Calcium	6.41	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Magnesium	15.15	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Potassium	0.82	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Sodium	27.05	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	50.18	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
n Sum	47.95	0.01		meq/L	03/14/2014 0819 JJ	SM 1030E
on-Anion Balance	2.27	0.01		%	03/14/2014 0819 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/07/2014 1617 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/07/2014 0219 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/07/2014 0219 MS	EPA 200.8
Boron	0.3	0.1		mg/L	03/07/2014 1617 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/07/2014 0219 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/07/2014 1617 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/07/2014 0219 MS	EPA 200.8
Iron	0.55	0.05		mg/L	03/07/2014 1617 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/07/2014 0219 MS	EPA 200.8
Manganese	0.07	0.02		mg/L	03/07/2014 1617 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/11/2014 1153 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/07/2014 0219 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/07/2014 1617 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/07/2014 0219 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/07/2014 1617 DG	EPA 200.7
Total Metals						
Iron	0.74	0.05		mg/L	03/07/2014 2120 DG	EPA 200.7
Manganese	0.08	0.02		mg/L	03/07/2014 2120 DG	EPA 200.7

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TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

Inter-Mountain Labs

Sheridan, WY and Gillette, WY

- CHAIN OF CUSTODY RECORD -

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101517

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC	RAMACO	Rod Fuller	

Report Address	Contact Name	Purchase Order #	Quote #
	Jeff Barron		439
Invoice Address	Email		
	Phone		

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME	SAMPLE IDENTIFICATION	Matrix	# of Containers	ANALYSES / PARAMETERS: Quote 439	REMARKS
1		3/4/14	1030	578511-CRN-1	WT	4	✓	
2				PH = 7.66, EC = 3610, T = 12.3, TUR = 28.3, SWL = 112.59'				
3		3/4/14	1255	578513-MST-1	WT	4	✓	
4				PH = 7.12, EC = 3130, T = 10.7, TUR = 2.06, SWL = 198.82'				
5		3/4/14	1355	578512-AL-1	WT	4	✓	
6				PH = 7.51, EC = 5370, T = 7.6, TUR = 173, SWL = 3.67'				
7		3/4/14	1450	578513-AL-1	WT	4	✓	
8				PH = 7.07, EC = 4900, T = 9.1, TUR = 0.93, SWL = 7.66'				
9								
10								
11								
12								
13								
14								

TFN 6 2/025
RECD NOV 14, 2014

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
2.8 C	Rod Fuller	3/4/14	1643	S Stucki	3/4/14	16:44

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
❑ UPS	Water	WT	Check desired service	Compliance Monitoring? Y / N	
❑ Fed Express	Soil	SL	❑ Standard turnaround	Program (SDWA, NPDES,...)	
❑ US Mail	Solid	SD	❑ RUSH - 5 Working Days	PWSID / Permit #	
❑ Hand Carried	Filter	FT	❑ URGENT - < 2 Working Days	Chlorinated? Y / N	
❑ Other _____	Other	OT	*Rush & Urgent Surcharges will be Applied*	Sample Disposal: Lab / Client	

DEQ Ex. 3644

RAMACO

October 2014

Addendum D6-10-154

Brook Mine

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Inter-Mountain Labs

Sheridan, WY and Gillette, WY

- CHAIN OF CUSTODY RECORD -

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1518

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC	Ramaco	Rod Fuller	

Report Address	Contact Name	Email	Phone
	Jeff Barron		

Invoice Address

Purchase Order # | Quote # 439

ANALYSES / PARAMETERS: Quote 439

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME	SAMPLE IDENTIFICATION	Matrix	# of Containers	REMARKS
1		3/5/14	~~0930~~	578415-MST/OBN-1	WT	4	✓
2			0930	pH: 8.11, EC: 1930, T: 10.5, TUR: 8.38, SWL: 122.01'			
3		3/5/14	1050	578409-uBN-1	WT	4	✓
4				pH: 8.04, EC: 3920, T: 12.9, TUR: 59.7, SWL: 110.25'			
5		3/5/14	1135	578409-MST-1	WT	4	✓
6				pH: 8.05, EC: 2310, T: 12.8, TUR: 1.86, SWL: 101.21'			
7		3/5/14	1220	578409-CRN-OB-1	WT	4	✓
8				pH: 7.62, EC: 1760, T: 11.9, TUR: 4.36, SWL: 70.78'			
9							
10							
11							
12							
13							
14							

TFN 6 2/025
RECD NOV 14, 2014

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
1.2°C	Rod Fuller	3/5/14	1403	Bill Cushing	3-05-14	14:07PM

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
❑ UPS	Water	WT	Check desired service	Compliance Monitoring? Y / N	
❑ Fed Express	Soil	SL	❑ Standard turnaround	Program (SDWA, NPDES,...)	
❑ US Mail	Solid	SD	❑ RUSH - 5 Working Days	PWSID / Permit #	
❑ Hand Carried	Filter	FT	❑ URGENT - < 2 Working Days	Chlorinated? Y / N	
❑ Other _____	Other	OT	*Rush & Urgent Surcharges will be applied*	Sample Disposal: Lab / Client	

DEQ Ex. 3-645

October 2014 Addendum D6-10-15

RAMACO

Brook Mine

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Inter-Mountain Labs
Sheridan, WY and Gillette, WY

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151519

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WRC	Ramaco	Rod Fuller	

Report Address	Contact Name	Email	Phone	Purchase Order #	Quote #
	Jeff Barron				439

Invoice Address

ANALYSES / PARAMETERS: Quote 439

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME SAMPLED	SAMPLE IDENTIFICATION	Matrix	# of Containers	REMARKS
1	3140 3082	3/6/14	0855	578408-MST-1	WT	4	✓
2				pH= 6.87, EC = 1984, T= 9.4, TUR = 53.7,			SWL = 102.93'
3	002	3/6/14	0940	578408-CRN-1	WT	4	✓
4				pH= 7.22, EC = 2600, T= 9.1, TUR = 65.9,			SWL = 87.70'
5	003	3/6/14	0940	578417-CRN-1	WT	4	✓
6				pH= 7.76, EC = 1347, T= 9.5, TUR = 991,			SWL = 133.13'
7							
8							
9							
10							
11							
12							
13							
14							

TFN 6 2/025
RECD NOV 14, 2014

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
6.8° C	Rod Fuller	3/6/14	1135	Kathy Bays	3/6/14	11:35

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
❑ UPS	Water	WT	Check desired service	Compliance Monitoring? Y / N	
❑ Fed Express	Soil	SL	❑ Standard turnaround	Program (SDWA, NPDES,...)	
❑ US Mail	Solid	SD	❑ RUSH - 5 Working Days	PWSID / Permit #	
❑ Hand Carried	Filter	FT	❑ URGENT - < 2 Working Days	Chlorinated? Y / N	
❑ Other _____	Other	OT	Rush & Urgent Surcharges will be applied	Sample Disposal: Lab Client	

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578408-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578408-CRN-1 Date Sampled 5 / 20 / 14 Time 1530 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 98.27 ft below MP Depth to Water (below MP) 87.71 ft Casing Diameter 5 in

Date 5 / 20 / 14 Time 1455 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)) Tap Bailer

Pump intake or bailer set at 95 ft below MP.

bing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1520	6.97	2710	13.5	44.2	↓	150 mL/30 sec
1530	6.91	2700	13.7	64.7	3.0	↓

Pumping Start Time 1505 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid (Black in color) - no odor

HCF

COC # 151524

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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SAMPLING INFORMATION

Sampling Point SMS78408-MST-1 Project Ramaco

Location _____ W.O.# 201339-07

Sample ID# 578408-MST-1 Date Sampled 5 / 22 / 14 Time 0830 am pm

Describe Sampling Point GW monitoring well

Well Depth 142.41 ft below MP Depth to Water (below MP) 99.82 ft Casing Diameter 2 in

Date 5 / 22 / 14 Time 0755 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 135 ft below MP.

bing (type: Plastic). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
0820	6.65	1974	14.5	28.6	↓	150mL/30sec
0830	6.62	~~1980~~ 1982	14.5	26.3	3.0	↓

Pumping Start Time 0805 WL _____ Pumping End Time _____ WL _____

Comments: water slightly turbid - no odor

HCF

COC # 151525

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* No sample

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SAMPLING INFORMATION

Sampling Point SM578409-CRM-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 110.55 ft below MP Depth to Water (below MP) 89.85 ft Casing Diameter 5 in

Date 5 / 20 / 14 Time 1150 am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - water level only

TFN 6 2/025
RECD NOV 14, 2014

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SAMPLING INFORMATION

Sampling Point SM578409-CRN-OB-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578409-CRN-OB-1 Date Sampled 5 / 20 / 14 Time 1400 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 111.33 ft below MP Depth to Water (below MP) 89.87 ft Casing Diameter 5 in

Date 5 / 20 / 14 Time 1140 (am) pm Casing Volume _____ gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 108 ft below MP.

bing (type: Plastic). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1350	7.40	1944	15.5	5.15	↓	150ML/30 sec.
1400	7.38	1944	14.6	3.90	3.0	↓

Pumping Start Time 1335 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF

COC# 151524

TFN 6 2/025
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Form completed by: Rod Fuller Witnessed by: _____

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Sheridan, Wyoming 82801
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SAMPLING INFORMATION

Sampling Point SM578409-MST-1 Project Ramaco

Location _____ W.O.# 2014139-07

Sample ID# 578409-MST-1 Date Sampled 5 / 20 / 14 Time 1310 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 122.83 ft below MP Depth to Water (below MP) 100.95 ft Casing Diameter 5 in

Date 5 / 20 / 14 Time 1135 (am) pm Casing Volume _____ gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 115 ft below MP.

bing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1300	7.85	2390	16.0	0.21	↓	150 mL/30 sec.
1310	7.82	2390	17.2	0.36	3.0	↓

Pumping Start Time 1245 WL _____ Pumping End Time _____ WL _____

Comments: water clear - no odor

LCF

COC# 151524

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RECD NOV 14, 2014

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RAMACO

* No Sample

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SAMPLING INFORMATION

Sampling Point SM578409-MST-OB-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 123.80 ft below MP Depth to Water (below MP) 101.55 ft Casing Diameter 5 in

Date 5 / 20 / 14 Time 1145 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - Water level only

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SAMPLING INFORMATION

Sampling Point SM578409-UBN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578409-UBN-1 Date Sampled 5 / 20 / 14 Time 1225 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 141.20 ft below MP Depth to Water (below MP) 110.40 ft Casing Diameter 5 in

Date 5 / 20 / 14 Time 1130 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 135 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1215	7.80	3980	14.7	0.88	↓	150 ml/30 sec
1225	7.79	3990	14.5	1.01	3.0	↓

Pumping Start Time 1200 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF

COC# 151524

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RECD NOV 14, 2014

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SAMPLING INFORMATION

Sampling Point SM578415-MST/CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578415-MST/CRN-1 Date Sampled 5 / 20 / 14 Time 1030 (am) pm

Describe Sampling Point Groundwater monitoring well

Well Depth 143.70 ft below MP Depth to Water (below MP) 121.23 ft Casing Diameter 5 in

Date 5 / 20 / 14 Time 0945 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer

Pump intake or bailer set at 135 ft below MP.

bing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1015	7.91	1773	15.3	5.24	↓	150 ml/30sec
1030	7.91	1778	15.1	3.55	3.5	↓

Pumping Start Time 1000 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor - water in well bubbling from CBNG

LCF - COC # 151524

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SAMPLING INFORMATION

Sampling Point SM578417-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578417-CRN-1 Date Sampled 5 / 22 / 14 Time 0950 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 142.41 ft below MP Depth to Water (below MP) 133.55 ft Casing Diameter 2 in

Date 5 / 22 / 14 Time 0910 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)) Tap Bailer

Pump intake or bailer set at 138 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no) and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
0940	7.60	1372	17.2	990	↓	150mL/30Sec
0950	7.56	1375	18.0	998	3.0	↓

Pumping Start Time 0925 WL _____ Pumping End Time _____ WL _____

Comments: Water very turbid - no odor - Well site still needs reclaimed.

HCF - COC# 151525

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RECD NOV 14, 2014

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RAMACO

* no sample

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SAMPLING INFORMATION

Sampling Point SMS784 17 -MST-1 Project Ramaco

Location _____ W.O.# 2013134-07

Sample ID# _____ Date Sampled 5 / / Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 163.82' ft below MP Depth to Water (below MP) 160.55 ft Casing Diameter 2 in

Date 5 / 22 / 14 Time 0905 am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - water level only - not enough water to sample - Site still needs reclaimed.

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*No sample

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SAMPLING INFORMATION

Sampling Point SM578418-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 24.50 ft below MP Depth to Water (below MP) 20.15 ft Casing Diameter 5 in

Date 5 / 22 / 14 Time 1520 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - water level only - not enough water to sample

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* No sample

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SAMPLING INFORMATION

Sampling Point SM578418-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 153.79 ft below MP Depth to Water (below MP) 146.63 ft Casing Diameter 5 in

Date 5 / 22 / 14 Time 1030 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - water level only - not enough water to sample - Site still needs reclaimed

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* No sample

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SAMPLING INFORMATION

Sampling Point SM578418-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW Monitoring Well

Well Depth 185.75 ft below MP Depth to Water (below MP) 184.49 ft Casing Diameter 5 in

Date 5 / 22 / 14 Time 1035 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - Water level only - not enough water to sample - site needs reclaimed

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

WWC ENGINEERING

* No sample

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SAMPLING INFORMATION

Sampling Point SM 578510-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 92.74 ft below MP Depth to Water (below MP) Dry ft Casing Diameter 5 in

Date 5 / 23 / 14 Time 0920 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no sample - water level only - not enough water to sample - Site still needs reclaimed

TEN 6 2;025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

* no sample

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SAMPLING INFORMATION

Sampling Point SM578510-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 147.24 ft below MP Depth to Water (below MP) 146.34 ft Casing Diameter 5 in

Date 5 / 23 / 14 Time 0915 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no sample - Water level only - not enough water to sample - site still needs reclaimed

Form completed by: Rod Fuller Witnessed by: _____

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SAMPLING INFORMATION

Sampling Point SM 578511-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578511-CRN-1 Date Sampled 5/23/14 Time 1110 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 128.92 ft below MP Depth to Water (below MP) 119.58 ft Casing Diameter 5 in

Date 5/23/14 Time 1020 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow)) Tap Bailer

Pump intake or bailer set at 125 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1100	7.45	4120	18.8	131	↓	150ML/30 sec.
1110	7.42	4050	18.2	88.5	3.0	↓

Pumping Start Time 1045 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC# 151525

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO

*No sample

WWC ENGINEERING

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Sheridan, Wyoming 82801
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SAMPLING INFORMATION

Sampling Point SM5785M - MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 158.00 ft below MP Depth to Water (below MP) 149.91 ft Casing Diameter 5 in

Date 5 / 23 / 14 Time 1015 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: no sample - water level only - not enough water to sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578512-AL-1 Project Ramaco

Location _____ W.O.# 2012139-07

Sample ID# 578512-AL-1 Date Sampled 5 / 22 / 14 Time 1335 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 21.21 ft below MP Depth to Water (below MP) 3.61 ft Casing Diameter 5 in

Date 5 / 22 / 14 Time 1300 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 15 ft below MP.

bing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1325	7.36	5540	16.8	32.3	↓	150ML/ 30 sec
1335	7.33	5530	16.3	21.6	3.0	↓

Pumping Start Time 1310 WL _____ Pumping End Time _____ WL _____

Comments: water slightly turbid - no odor

LCF

COC # 151525

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578512-CRM-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 49.85 ft below MP Depth to Water (below MP) Dry ft Casing Diameter 5 in

Date 5 / 22 / 14 Time 1240 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ıbing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - water level only - well is dry

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

* no sample

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578512-MST-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 114.96 ft below MP Depth to Water (below MP) 111.93 ft Casing Diameter 5 in

Date 5 / 22 / 14 Time 1245 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

ubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - Water level only - not enough water to sample

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578513-AL-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# 578513-AL-1 Date Sampled 5 / 22 / 14 Time 1500 am pm

Describe Sampling Point GW monitoring well

Well Depth 20.77 ft below MP Depth to Water (below MP) 6.18 ft Casing Diameter 5 in

Date 5 / 22 / 14 Time 1420 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 15 ft below MP.

Tubing (type: Plastic). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1450	7.29	4690	17.6	0.69	↓	150 mL / 30 sec.
1500	7.26	4686	17.5	0.17	3.0	↓

Pumping Start Time 1435 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCF

COC # 151525

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Rod Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578513-CRN-1 Project Ramaco

Location _____ W.O.# 2013139-07

Sample ID# _____ Date Sampled ___ / ___ / ___ Time _____ am pm

Describe Sampling Point GW monitoring well

Well Depth 117.28 ft below MP Depth to Water (below MP) 116.81 ft Casing Diameter 5 in

Date 5 / 22 / 14 Time 1125 (am) pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump Bladder pump (low flow)

Tap Bailer _____

Pump intake or bailer set at _____ ft below MP.

bing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: No sample - water level only - not enough water to sample

Form completed by: Rod Fuller Witnessed by: _____

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point SM578513-MST-1 Project Ramaco

Location _____ W.O.# 3013139-07

Sample ID# 578513-MST-1 Date Sampled 5/22/14 Time 1205 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 144.00 ft below MP Depth to Water (below MP) 107.94 ft Casing Diameter 5 in

Date 5/22/14 Time 1130 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

STATIC WATER LEVEL OF ASSOCIATED WELLS

Sampling method Submersible pump (Bladder pump (low flow))

Tap Bailer _____

Pump intake or bailer set at 135 ft below MP.

bing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temp. (°C)	Turbidity (NTU)	Volume of Water Removed (gallons)	Pumping Rate (gpm)
1155	6.89	4130	17.5	8.01	↓	150 mL/30 sec
1205	6.87	4130	17.2	2.22	3.0	↓

Pumping Start Time 1140 WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor

LCT

COC # 151525

TFN 6 2/025
RECD NOV 14, 2014

Form completed by: Josh Fuller Witnessed by: _____

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-005
Client Sample ID: 578408-CRN-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 3:30:00 PM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.91			s.u.	05/20/2014 1530	Field
Conductivity	2700			µmhos/cm	05/20/2014 1530	Field
Turbidity	64.7			NTU	05/20/2014 1530	Field
Temperature	13.7			°C	05/20/2014 1530	Field
Static Water Level	87.71			ft	05/20/2014 1530	Field
General Parameters						
pH	7.6	0.1		s.u.	05/21/2014 1734 KV	SM 4500 H B
Electrical Conductivity	2440	5		µmhos/cm	05/21/2014 1734 KV	SM 2510B
Total Dissolved Solids (180)	2190	10		mg/L	05/21/2014 0414 BT	SM 2540
Solids, Total Dissolved (Calc)	1870	10		mg/L	05/29/2014 0955 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	613	5		mg/L	05/21/2014 1734 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1420	1		mg/L	05/29/2014 0955 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.6	0.1		mg/L	05/21/2014 1437 CA	EPA 350.1
ium Adsorption Ratio	0.9	0.1			05/29/2014 0955 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	748	5		mg/L	05/21/2014 1734 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/21/2014 1734 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/21/2014 1734 KV	SM 2320B
Chloride	9	1		mg/L	05/22/2014 2023 AMB	EPA 300.0
Fluoride	0.7	0.1		mg/L	05/21/2014 1734 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/22/2014 1321 CA	EPA 353.2
Sulfate	969	1		mg/L	05/22/2014 2023 AMB	EPA 300.0
Cations						
Calcium	175	1		mg/L	05/22/2014 2141 DG	EPA 200.7
Magnesium	238	1		mg/L	05/22/2014 2141 DG	EPA 200.7
Potassium	29	1		mg/L	05/22/2014 2141 DG	EPA 200.7
Sodium	79	1		mg/L	05/22/2014 2141 DG	EPA 200.7

TFN 6 2/025
RECD NOV 14,2014

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-005
Client Sample ID: 578408-CRN-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 3:30:00 PM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.26	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Chloride	0.24	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sulfate	20.17	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Calcium	8.73	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Magnesium	19.58	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Potassium	0.74	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sodium	3.43	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	32.52	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
n Sum	32.71	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
on-Anion Balance	0.28	0.01		%	05/29/2014 0955 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/22/2014 2141 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/21/2014 1504 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/21/2014 1504 MS	EPA 200.8
Boron	0.5	0.1		mg/L	05/22/2014 2141 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/21/2014 1504 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/22/2014 2141 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/21/2014 1504 MS	EPA 200.8
Iron	0.13	0.05		mg/L	05/22/2014 2141 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/21/2014 1504 MS	EPA 200.8
Manganese	0.40	0.02		mg/L	05/22/2014 2141 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/28/2014 1035 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/21/2014 1504 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/22/2014 2141 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/21/2014 1504 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/22/2014 2141 DG	EPA 200.7
Total Metals						
Iron	0.96	0.05		mg/L	05/23/2014 1308 DG	EPA 200.7
Manganese	0.43	0.02		mg/L	05/23/2014 1308 DG	EPA 200.7

TFN 6 2/025
RECD NOV 14,2014

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-001
Client Sample ID: 578408-MST-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 8:30:00 AM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.62			s.u.	05/22/2014 0830	Field
Conductivity	1982			µmhos/cm	05/22/2014 0830	Field
Turbidity	20.3			NTU	05/22/2014 0830	Field
Temperature	14.5			°C	05/22/2014 0830	Field
Static Water Level	99.82			ft	05/22/2014 0830	Field
General Parameters						
pH	7.8	0.1		s.u.	05/28/2014 0002 KV	SM 4500 H B
Electrical Conductivity	1980	5		µmhos/cm	05/28/2014 0002 KV	SM 2510B
Total Dissolved Solids (180)	1570	10		mg/L	05/27/2014 1400 BT	SM 2540
Solids, Total Dissolved (Calc)	1430	10		mg/L	06/05/2014 1609 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	462	5		mg/L	05/28/2014 0002 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	950	1		mg/L	06/05/2014 1609 JJ	SM 2340B
Nitrogen, Ammonia (As N)	5.0	0.1		mg/L	05/27/2014 1640 CA	EPA 350.1
ium Adsorption Ratio	1.4	0.1			06/05/2014 1609 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	563	5		mg/L	05/28/2014 0002 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/28/2014 0002 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/28/2014 0002 KV	SM 2320B
Chloride	7	1		mg/L	05/27/2014 2049 AMB	EPA 300.0
Fluoride	0.5	0.1		mg/L	05/28/2014 0002 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/28/2014 1251 CA	EPA 353.2
Sulfate	742	1		mg/L	05/27/2014 2049 AMB	EPA 300.0
Cations						
Calcium	112	1		mg/L	05/27/2014 1253 DG	EPA 200.7
Magnesium	163	1		mg/L	05/27/2014 1253 DG	EPA 200.7
Potassium	27	1		mg/L	05/27/2014 1253 DG	EPA 200.7
Sodium	101	1		mg/L	05/27/2014 1253 DG	EPA 200.7

TFN 6 2:025
RECD NOV 14,2014

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by a contract laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

October 2014

DEQ Ex. 3-672

Addendum D6-10-182

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-001
Client Sample ID: 578408-MST-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 8:30:00 AM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.23	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Chloride	0.19	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sulfate	15.45	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Calcium	5.60	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Magnesium	13.40	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Potassium	0.68	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sodium	4.40	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	24.45	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
n Sum	24.90	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
on-Anion Balance	0.91	0.01		%	06/05/2014 1609 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/27/2014 1253 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/24/2014 0507 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/24/2014 0507 MS	EPA 200.8
Boron	0.4	0.1		mg/L	05/27/2014 1253 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/24/2014 0507 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/27/2014 1253 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/24/2014 0507 MS	EPA 200.8
Iron	0.37	0.05		mg/L	05/27/2014 1253 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/24/2014 0507 MS	EPA 200.8
Manganese	0.07	0.02		mg/L	05/27/2014 1253 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/05/2014 1006 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/24/2014 0507 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/27/2014 1253 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/24/2014 0507 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/27/2014 1253 DG	EPA 200.7
Total Metals						
Iron	0.77	0.05		mg/L	05/28/2014 2003 DG	EPA 200.7
Manganese	0.07	0.02		mg/L	05/28/2014 2003 DG	EPA 200.7

TFN 6 2/025
RECD NOV 14, 2014

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-004
Client Sample ID: 578409-CRN-OB-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 2:00:00 PM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.38			s.u.	05/20/2014 1400	Field
Conductivity	1944			µmhos/cm	05/20/2014 1400	Field
Turbidity	3.90			NTU	05/20/2014 1400	Field
Temperature	14.6			°C	05/20/2014 1400	Field
Static Water Level	89.87			ft	05/20/2014 1400	Field
General Parameters						
pH	7.9	0.1		s.u.	05/21/2014 1723 KV	SM 4500 H B
Electrical Conductivity	1950	5		µmhos/cm	05/21/2014 1723 KV	SM 2510B
Total Dissolved Solids (180)	1410	10		mg/L	05/21/2014 0413 BT	SM 2540
Solids, Total Dissolved (Calc)	1390	10		mg/L	05/29/2014 0955 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	510	5		mg/L	05/21/2014 1723 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	588	1		mg/L	05/29/2014 0955 JJ	SM 2340B
Nitrogen, Ammonia (As N)	5.2	0.1		mg/L	05/21/2014 1436 CA	EPA 350.1
ium Adsorption Ratio	4.2	0.1			05/29/2014 0955 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	622	5		mg/L	05/21/2014 1723 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/21/2014 1723 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/21/2014 1723 KV	SM 2320B
Chloride	10	1		mg/L	05/22/2014 2009 AMB	EPA 300.0
Fluoride	0.6	0.1		mg/L	05/21/2014 1723 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/22/2014 1319 CA	EPA 353.2
Sulfate	637	1		mg/L	05/22/2014 2009 AMB	EPA 300.0
Cations						
Calcium	91	1		mg/L	05/22/2014 2128 DG	EPA 200.7
Magnesium	88	1		mg/L	05/22/2014 2128 DG	EPA 200.7
Potassium	20	1		mg/L	05/22/2014 2128 DG	EPA 200.7
Sodium	235	1		mg/L	05/22/2014 2128 DG	EPA 200.7

TFN 6 2/025
RECD NOV 14, 2014

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-004
Client Sample ID: 578409-CRN-OB-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 2:00:00 PM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	10.19	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Chloride	0.26	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sulfate	13.26	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Calcium	4.54	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Magnesium	7.20	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Potassium	0.50	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sodium	10.20	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	22.83	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
n Sum	23.75	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
on-Anion Balance	1.98	0.01		%	05/29/2014 0955 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/22/2014 2128 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/21/2014 1459 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/21/2014 1459 MS	EPA 200.8
Boron	0.2	0.1		mg/L	05/22/2014 2128 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/21/2014 1459 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/22/2014 2128 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/21/2014 1459 MS	EPA 200.8
Iron	ND	0.05		mg/L	05/22/2014 2128 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/21/2014 1459 MS	EPA 200.8
Manganese	0.11	0.02		mg/L	05/22/2014 2128 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/28/2014 1028 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/21/2014 1459 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/22/2014 2128 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/21/2014 1459 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/22/2014 2128 DG	EPA 200.7
Total Metals						
Iron	0.33	0.05		mg/L	05/23/2014 1259 DG	EPA 200.7
Manganese	0.12	0.02		mg/L	05/23/2014 1259 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
DEQ NOV 14, 2014

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-003
Client Sample ID: 578409-MST-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 1:10:00 PM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.82			s.u.	05/20/2014 1310	Field
Conductivity	2390			µmhos/cm	05/20/2014 1310	Field
Turbidity	0.36			NTU	05/20/2014 1310	Field
Temperature	17.2			°C	05/20/2014 1310	Field
Static Water Level	100.95			ft	05/20/2014 1310	Field
General Parameters						
pH	8.2	0.1		s.u.	05/21/2014 1710 KV	SM 4500 H B
Electrical Conductivity	2150	5		µmhos/cm	05/21/2014 1710 KV	SM 2510B
Total Dissolved Solids (180)	1520	10		mg/L	05/21/2014 0412 BT	SM 2540
Solids, Total Dissolved (Calc)	1440	10		mg/L	05/29/2014 0955 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	655	5		mg/L	05/21/2014 1710 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	86	1		mg/L	05/29/2014 0955 JJ	SM 2340B
Nitrogen, Ammonia (As N)	3.1	0.1		mg/L	05/21/2014 1435 CA	EPA 350.1
ium Adsorption Ratio	24.2	0.1			05/29/2014 0955 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	799	5		mg/L	05/21/2014 1710 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/21/2014 1710 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/21/2014 1710 KV	SM 2320B
Chloride	9	1		mg/L	05/22/2014 1827 AMB	EPA 300.0
Fluoride	1.4	0.1		mg/L	05/21/2014 1710 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.5	0.1		mg/L	05/22/2014 1318 CA	EPA 353.2
Sulfate	477	1		mg/L	05/22/2014 1827 AMB	EPA 300.0
Cations						
Calcium	15	1		mg/L	05/22/2014 2123 DG	EPA 200.7
Magnesium	12	1		mg/L	05/22/2014 2123 DG	EPA 200.7
Potassium	14	1		mg/L	05/22/2014 2123 DG	EPA 200.7
Sodium	516	1		mg/L	05/22/2014 2123 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-003
Client Sample ID: 578409-MST-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 1:10:00 PM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.09	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Chloride	0.25	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Fluoride	0.07	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Nitrate + Nitrite as N	0.03	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sulfate	9.92	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Calcium	0.77	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Magnesium	0.94	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Potassium	0.36	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sodium	22.43	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	24.74	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
n Sum	23.37	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
on-Anion Balance	2.83	0.01		%	05/29/2014 0955 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/22/2014 2123 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/21/2014 1453 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/21/2014 1453 MS	EPA 200.8
Boron	0.1	0.1		mg/L	05/22/2014 2123 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/21/2014 1453 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/22/2014 2123 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/21/2014 1453 MS	EPA 200.8
Iron	ND	0.05		mg/L	05/22/2014 2123 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/21/2014 1453 MS	EPA 200.8
Manganese	0.20	0.02		mg/L	05/22/2014 2123 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/28/2014 1022 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/21/2014 1453 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/22/2014 2123 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/21/2014 1453 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/22/2014 2123 DG	EPA 200.7
Total Metals						
Iron	ND	0.05		mg/L	05/23/2014 1257 DG	EPA 200.7
Manganese	0.23	0.02		mg/L	05/23/2014 1257 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

:NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-002
Client Sample ID: 578409-UBN-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 12:25:00 PM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.79			s.u.	05/20/2014 1225	Field
Conductivity	3990			µmhos/cm	05/20/2014 1225	Field
Turbidity	1.01			NTU	05/20/2014 1225	Field
Temperature	14.5			°C	05/20/2014 1225	Field
Static Water Level	110.40			ft	05/20/2014 1225	Field
General Parameters						
pH	8.1	0.1		s.u.	05/21/2014 1659 KV	SM 4500 H B
Electrical Conductivity	3620	5		µmhos/cm	05/21/2014 1659 KV	SM 2510B
Total Dissolved Solids (180)	2830	10		mg/L	05/21/2014 0411 BT	SM 2540
Solids, Total Dissolved (Calc)	2790	10		mg/L	05/29/2014 0955 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	466	5		mg/L	05/27/2014 1528 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	522	1		mg/L	05/29/2014 0955 JJ	SM 2340B
Nitrogen, Ammonia (As N)	2.2	0.1		mg/L	05/21/2014 1434 CA	EPA 350.1
ium Adsorption Ratio	13.5	0.1			05/29/2014 0955 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	569	5		mg/L	05/27/2014 1528 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/27/2014 1528 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/27/2014 1528 KV	SM 2320B
Chloride	28	1		mg/L	05/28/2014 0358 AMB	EPA 300.0
Fluoride	1.0	0.1		mg/L	05/21/2014 1659 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	3.2	0.1		mg/L	05/22/2014 1317 CA	EPA 353.2
Sulfate	1560	1		mg/L	05/22/2014 1813 AMB	EPA 300.0
Cations						
Calcium	85	1		mg/L	05/28/2014 1158 DG	EPA 200.7
Magnesium	75	1		mg/L	05/28/2014 1158 DG	EPA 200.7
Potassium	35	1		mg/L	05/22/2014 2121 DG	EPA 200.7
Sodium	707	1		mg/L	05/28/2014 1158 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-002
Client Sample ID: 578409-UBN-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 12:25:00 PM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	9.32	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Chloride	0.77	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Nitrate + Nitrite as N	0.22	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sulfate	32.53	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Calcium	4.24	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Magnesium	6.18	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Potassium	0.88	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sodium	30.77	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	42.24	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
ın Sum	42.92	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
on-Anion Balance	0.79	0.01		%	05/29/2014 0955 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/22/2014 2121 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/21/2014 1437 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/21/2014 1437 MS	EPA 200.8
Boron	0.5	0.1		mg/L	05/22/2014 2121 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/21/2014 1437 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/22/2014 2121 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/21/2014 1437 MS	EPA 200.8
Iron	ND	0.05		mg/L	05/22/2014 2121 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/21/2014 1437 MS	EPA 200.8
Manganese	0.36	0.02		mg/L	05/27/2014 1149 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/28/2014 1020 CS	EPA 245.1
Molybdenum	0.03	0.02		mg/L	05/21/2014 1437 MS	EPA 200.8
Nickel	0.03	0.01		mg/L	05/22/2014 2121 DG	EPA 200.7
Selenium	0.005	0.005		mg/L	05/21/2014 1437 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/22/2014 2121 DG	EPA 200.7
Total Metals						
Iron	ND	0.05		mg/L	05/23/2014 1250 DG	EPA 200.7
Manganese	0.58	0.02		mg/L	05/23/2014 1250 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-001
Client Sample ID: 578415-MST/CRN-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 10:30:00 AM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.91			s.u.	05/20/2014 1030	Field
Conductivity	1778			µmhos/cm	05/20/2014 1030	Field
Turbidity	3.55			NTU	05/20/2014 1030	Field
Temperature	15.1			°C	05/20/2014 1030	Field
Static Water Level	121.23			ft	05/20/2014 1030	Field
General Parameters						
pH	8.3	0.1		s.u.	05/21/2014 1647 KV	SM 4500 H B
Electrical Conductivity	1750	5		µmhos/cm	05/21/2014 1647 KV	SM 2510B
Total Dissolved Solids (180)	1210	10		mg/L	05/21/2014 0410 BT	SM 2540
Solids, Total Dissolved (Calc)	1160	10		mg/L	05/29/2014 0955 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	710	5		mg/L	05/21/2014 1647 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	43	1		mg/L	05/29/2014 0955 JJ	SM 2340B
Nitrogen, Ammonia (As N)	2.3	0.1		mg/L	05/21/2014 1433 CA	EPA 350.1
'um Adsorption Ratio	29.0	0.1			05/29/2014 0955 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	859	5		mg/L	05/21/2014 1647 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/21/2014 1647 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/21/2014 1647 KV	SM 2320B
Chloride	11	1		mg/L	05/22/2014 1758 AMB	EPA 300.0
Fluoride	2.0	0.1		mg/L	05/21/2014 1647 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/21/2014 1058 CA	EPA 353.2
Sulfate	263	1		mg/L	05/22/2014 1758 AMB	EPA 300.0
Cations						
Calcium	9	1		mg/L	05/22/2014 2119 DG	EPA 200.7
Magnesium	5	1		mg/L	05/22/2014 2119 DG	EPA 200.7
Potassium	9	1		mg/L	05/22/2014 2119 DG	EPA 200.7
Sodium	434	1		mg/L	05/22/2014 2119 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

DEQ Ex. 3-680

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 5/29/2014
Report ID: S1405349001

Project: Ramaco
Lab ID: S1405349-001
Client Sample ID: 578415-MST/CRN-1
COC: 151524

Work Order: S1405349
Collection Date: 5/20/2014 10:30:00 AM
Date Received: 5/20/2014 4:30:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	14.07	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Chloride	0.31	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Fluoride	0.10	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sulfate	5.47	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Calcium	0.45	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Magnesium	0.39	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Potassium	0.23	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Sodium	18.88	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	20.13	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
n Sum	20.10	0.01		meq/L	05/29/2014 0955 JJ	SM 1030E
on-Anion Balance	0.07	0.01		%	05/29/2014 0955 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/22/2014 2119 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/21/2014 1416 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/21/2014 1416 MS	EPA 200.8
Boron	ND	0.1		mg/L	05/22/2014 2119 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/21/2014 1416 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/22/2014 2119 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/21/2014 1416 MS	EPA 200.8
Iron	0.15	0.05		mg/L	05/22/2014 2119 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/21/2014 1416 MS	EPA 200.8
Manganese	0.07	0.02		mg/L	05/22/2014 2119 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/28/2014 1018 CS	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/21/2014 1416 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/22/2014 2119 DG	EPA 200.7
Selenium	0.005	0.005		mg/L	05/21/2014 1416 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/22/2014 2119 DG	EPA 200.7
Total Metals						
Iron	0.35	0.05		mg/L	05/23/2014 1246 DG	EPA 200.7
Manganese	0.08	0.02		mg/L	05/23/2014 1246 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-002
Client Sample ID: 578417-CRN-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 9:50:00 AM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.56			s.u.	05/22/2014 0950	Field
Conductivity	1375			µmhos/cm	05/22/2014 0950	Field
Turbidity	998			NTU	05/22/2014 0950	Field
Temperature	18.0			°C	05/22/2014 0950	Field
Static Water Level	133.55			ft	05/22/2014 0950	Field
General Parameters						
pH	8.3	0.1		s.u.	05/28/2014 0014 KV	SM 4500 H B
Electrical Conductivity	1370	5		µmhos/cm	05/28/2014 0014 KV	SM 2510B
Total Dissolved Solids (180)	870	10		mg/L	05/27/2014 1401 BT	SM 2540
Solids, Total Dissolved (Calc)	850	10		mg/L	06/05/2014 1609 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	430	5		mg/L	05/28/2014 0014 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	143	1		mg/L	06/05/2014 1609 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.5	0.1		mg/L	05/27/2014 1641 CA	EPA 350.1
ium Adsorption Ratio	8.9	0.1			06/05/2014 1609 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	513	5		mg/L	05/28/2014 0014 KV	SM 2320B
Alkalinity, Carbonate as CO3	6	5		mg/L	05/28/2014 0014 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/28/2014 0014 KV	SM 2320B
Chloride	7	1		mg/L	05/27/2014 2102 AMB	EPA 300.0
Fluoride	1.8	0.1		mg/L	05/28/2014 0014 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	4.6	0.1		mg/L	05/28/2014 1252 CA	EPA 353.2
Sulfate	258	1		mg/L	05/27/2014 2102 AMB	EPA 300.0
Cations						
Calcium	17	1		mg/L	05/27/2014 1255 DG	EPA 200.7
Magnesium	24	1		mg/L	05/27/2014 1255 DG	EPA 200.7
Potassium	15	1		mg/L	05/27/2014 1255 DG	EPA 200.7
Sodium	245	1		mg/L	05/27/2014 1255 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

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- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-002
Client Sample ID: 578417-CRN-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 9:50:00 AM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.40	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Carbonate as CO3	0.19	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Chloride	0.20	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Fluoride	0.09	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Nitrate + Nitrite as N	0.33	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sulfate	5.37	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Calcium	0.87	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Magnesium	1.99	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Potassium	0.37	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sodium	10.67	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	13.95	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
n Sum	14.61	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
on-Anion Balance	2.29	0.01		%	06/05/2014 1609 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/27/2014 1255 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/24/2014 0523 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/24/2014 0523 MS	EPA 200.8
Boron	ND	0.1		mg/L	05/27/2014 1255 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/24/2014 0523 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/27/2014 1255 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/24/2014 0523 MS	EPA 200.8
Iron	ND	0.05		mg/L	05/27/2014 1255 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/24/2014 0523 MS	EPA 200.8
Manganese	ND	0.02		mg/L	05/27/2014 1255 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/05/2014 1008 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/24/2014 0523 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/27/2014 1255 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/24/2014 0523 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/27/2014 1255 DG	EPA 200.7
Total Metals						
Iron	12.9	0.05		mg/L	05/28/2014 2005 DG	EPA 200.7
Manganese	0.10	0.02		mg/L	05/28/2014 2005 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

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- C Calculated Value
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- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-006
Client Sample ID: 578511-CRN-1
COC: 151525

Work Order: S1405432
Collection Date: 5/23/2014 11:10:00 AM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.42			s.u.	05/23/2014 1110	Field
Conductivity	4050			µmhos/cm	05/23/2014 1110	Field
Turbidity	88.5			NTU	05/23/2014 1110	Field
Temperature	18.2			°C	05/23/2014 1110	Field
Static Water Level	119.58			ft	05/23/2014 1110	Field
General Parameters						
pH	8.2	0.1		s.u.	05/28/2014 0103 KV	SM 4500 H B
Electrical Conductivity	3810	5		µmhos/cm	05/28/2014 0103 KV	SM 2510B
Total Dissolved Solids (180)	2650	10		mg/L	05/27/2014 1406 BT	SM 2540
Solids, Total Dissolved (Calc)	2740	10		mg/L	06/05/2014 1609 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	823	5		mg/L	05/28/2014 0103 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	581	1		mg/L	06/05/2014 1609 JJ	SM 2340B
Nitrogen, Ammonia (As N)	6.4	0.1		mg/L	05/27/2014 1645 CA	EPA 350.1
ium Adsorption Ratio	12.4	0.1			06/05/2014 1609 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	1000	5		mg/L	05/28/2014 0103 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/28/2014 0103 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/28/2014 0103 KV	SM 2320B
Chloride	27	1		mg/L	05/27/2014 2158 AMB	EPA 300.0
Fluoride	0.9	0.1		mg/L	05/28/2014 0103 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/28/2014 1151 CA	EPA 353.2
Sulfate	1340	1		mg/L	05/27/2014 2158 AMB	EPA 300.0
Cations						
Calcium	78	1		mg/L	05/27/2014 1325 DG	EPA 200.7
Magnesium	94	1		mg/L	05/27/2014 1325 DG	EPA 200.7
Potassium	25	1		mg/L	05/27/2014 1325 DG	EPA 200.7
Sodium	690	1		mg/L	05/27/2014 1325 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

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- X Matrix Effect
- C Calculated Value
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- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

TFN 6 2/025
RECD NOV 14,2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-006
Client Sample ID: 578511-CRN-1
COC: 151525

Work Order: S1405432
Collection Date: 5/23/2014 11:10:00 AM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	16.46	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Chloride	0.74	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sulfate	27.80	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Calcium	3.87	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Magnesium	7.74	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Potassium	0.64	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sodium	30.00	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	42.72	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
n Sum	45.05	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
on-Anion Balance	2.65	0.01		%	06/05/2014 1609 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/27/2014 1325 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/24/2014 0545 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/24/2014 0545 MS	EPA 200.8
Boron	0.2	0.1		mg/L	05/27/2014 1325 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/24/2014 0545 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/27/2014 1325 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/24/2014 0545 MS	EPA 200.8
Iron	0.18	0.05		mg/L	05/27/2014 1325 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/24/2014 0545 MS	EPA 200.8
Manganese	0.47	0.02		mg/L	05/27/2014 1325 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/05/2014 1019 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/24/2014 0545 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/27/2014 1325 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/24/2014 0545 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/27/2014 1325 DG	EPA 200.7
Total Metals						
Iron	1.63	0.05		mg/L	05/28/2014 2014 DG	EPA 200.7
Manganese	0.51	0.02		mg/L	05/28/2014 2014 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
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- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14,2014

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-004
Client Sample ID: 578512-AL-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 1:35:00 PM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.33			s.u.	05/22/2014 1335	Field
Conductivity	5530			µmhos/cm	05/22/2014 1335	Field
Turbidity	21.6			NTU	05/22/2014 1335	Field
Temperature	16.3			°C	05/22/2014 1335	Field
Static Water Level	3.61			ft	05/22/2014 1335	Field
General Parameters						
pH	8.1	0.1		s.u.	05/28/2014 0038 KV	SM 4500 H B
Electrical Conductivity	5190	5		µmhos/cm	05/28/2014 0038 KV	SM 2510B
Total Dissolved Solids (180)	5300	10		mg/L	05/27/2014 1403 BT	SM 2540
Solids, Total Dissolved (Calc)	4680	10		mg/L	06/05/2014 1609 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	655	5		mg/L	05/29/2014 1506 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2640	1		mg/L	06/05/2014 1609 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.2	0.1		mg/L	05/27/2014 1643 CA	EPA 350.1
ium Adsorption Ratio	3.6	0.1			06/05/2014 1609 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	799	5		mg/L	05/29/2014 1506 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/29/2014 1506 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/29/2014 1506 KV	SM 2320B
Chloride	16	1		mg/L	05/29/2014 1205 AMB	EPA 300.0
Fluoride	0.8	0.1		mg/L	05/28/2014 0038 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/28/2014 1149 CA	EPA 353.2
Sulfate	3050	1		mg/L	05/29/2014 1205 AMB	EPA 300.0
Cations						
Calcium	324	1		mg/L	05/29/2014 1713 DG	EPA 200.7
Magnesium	444	1		mg/L	05/29/2014 1713 DG	EPA 200.7
Potassium	20	1		mg/L	05/29/2014 1713 DG	EPA 200.7
Sodium	431	1		mg/L	05/29/2014 1713 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

:NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-004
Client Sample ID: 578512-AL-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 1:35:00 PM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.09	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Chloride	0.46	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sulfate	63.46	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Calcium	16.18	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Magnesium	36.54	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Potassium	0.51	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sodium	18.73	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	71.97	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
n Sum	77.06	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
on-Anion Balance	3.41	0.01		%	06/05/2014 1609 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/27/2014 1320 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/24/2014 0534 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/24/2014 0534 MS	EPA 200.8
Boron	0.4	0.1		mg/L	05/27/2014 1320 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/24/2014 0534 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/27/2014 1320 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/24/2014 0534 MS	EPA 200.8
Iron	0.86	0.05		mg/L	05/27/2014 1320 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/24/2014 0534 MS	EPA 200.8
Manganese	1.72	0.02		mg/L	05/27/2014 1320 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/05/2014 1012 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/24/2014 0534 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/27/2014 1320 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/24/2014 0534 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/27/2014 1320 DG	EPA 200.7
Total Metals						
Iron	5.17	0.05		mg/L	05/28/2014 2010 DG	EPA 200.7
Manganese	2.34	0.02		mg/L	05/28/2014 2010 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

NT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-005
Client Sample ID: 578513-AL-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 3:00:00 PM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.26			s.u.	05/22/2014 1500	Field
Conductivity	4686			µmhos/cm	05/22/2014 1500	Field
Turbidity	0.17			NTU	05/22/2014 1500	Field
Temperature	17.5			°C	05/22/2014 1500	Field
Static Water Level	6.18			ft	05/22/2014 1500	Field
General Parameters						
pH	8.1	0.1		s.u.	05/28/2014 0050 KV	SM 4500 H B
Electrical Conductivity	4380	5		µmhos/cm	05/28/2014 0050 KV	SM 2510B
Total Dissolved Solids (180)	3730	10		mg/L	05/27/2014 1405 BT	SM 2540
Solids, Total Dissolved (Calc)	3920	10		mg/L	06/05/2014 1609 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	661	5		mg/L	05/28/2014 0050 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2030	1		mg/L	06/05/2014 1609 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	05/27/2014 1644 CA	EPA 350.1
um Adsorption Ratio	4.1	0.1			06/05/2014 1609 JJ	Calculation
A s						
Alkalinity, Bicarbonate as HCO3	806	5		mg/L	05/28/2014 0050 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/28/2014 0050 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/28/2014 0050 KV	SM 2320B
Chloride	17	1		mg/L	05/27/2014 2144 AMB	EPA 300.0
Fluoride	0.7	0.1		mg/L	05/28/2014 0050 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/28/2014 1150 CA	EPA 353.2
Sulfate	2460	1		mg/L	05/27/2014 2144 AMB	EPA 300.0
Cations						
Calcium	235	1		mg/L	05/27/2014 1323 DG	EPA 200.7
Magnesium	352	1		mg/L	05/27/2014 1323 DG	EPA 200.7
Potassium	29	1		mg/L	05/27/2014 1323 DG	EPA 200.7
Sodium	426	1		mg/L	05/27/2014 1323 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by a contract laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-005
Client Sample ID: 578513-AL-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 3:00:00 PM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.21	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Chloride	0.46	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sulfate	51.25	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Calcium	11.70	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Magnesium	28.98	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Potassium	0.74	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sodium	18.52	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	59.95	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
n Sum	64.97	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
on-Anion Balance	4.02	0.01		%	06/05/2014 1609 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/27/2014 1323 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/24/2014 0540 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/24/2014 0540 MS	EPA 200.8
Boron	0.3	0.1		mg/L	05/27/2014 1323 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/24/2014 0540 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/27/2014 1323 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/24/2014 0540 MS	EPA 200.8
Iron	ND	0.05		mg/L	05/27/2014 1323 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/24/2014 0540 MS	EPA 200.8
Manganese	0.23	0.02		mg/L	05/27/2014 1323 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/05/2014 1017 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/24/2014 0540 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/27/2014 1323 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/24/2014 0540 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/27/2014 1323 DG	EPA 200.7
Total Metals						
Iron	0.06	0.05		mg/L	05/28/2014 2012 DG	EPA 200.7
Manganese	0.29	0.02		mg/L	05/28/2014 2012 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

TFN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

October 2014

DEQ Ex. 3-689

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-003
Client Sample ID: 578513-MST-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 12:05:00 PM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.87			s.u.	05/22/2014 1205	Field
Conductivity	4130			µmhos/cm	05/22/2014 1205	Field
Turbidity	2.22			NTU	05/22/2014 1205	Field
Temperature	17.2			°C	05/22/2014 1205	Field
Static Water Level	107.94			ft	05/22/2014 1205	Field
General Parameters						
pH	8.0	0.1		s.u.	05/28/2014 0025 KV	SM 4500 H B
Electrical Conductivity	3820	5		µmhos/cm	05/28/2014 0025 KV	SM 2510B
Total Dissolved Solids (180)	2970	10		mg/L	05/27/2014 1402 BT	SM 2540
Solids, Total Dissolved (Calc)	2920	10		mg/L	06/05/2014 1609 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	607	5		mg/L	05/28/2014 0025 KV	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	974	1		mg/L	06/05/2014 1609 JJ	SM 2340B
Nitrogen, Ammonia (As N)	9.4	0.1		mg/L	05/27/2014 1642 CA	EPA 350.1
'um Adsorption Ratio	7.4	0.1			06/05/2014 1609 JJ	Calculation
s						
Alkalinity, Bicarbonate as HCO3	740	5		mg/L	05/28/2014 0025 KV	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/28/2014 0025 KV	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/28/2014 0025 KV	SM 2320B
Chloride	15	1		mg/L	05/27/2014 2116 AMB	EPA 300.0
Fluoride	0.6	0.1		mg/L	05/28/2014 0025 KV	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.3	0.1		mg/L	05/28/2014 1148 CA	EPA 353.2
Sulfate	1690	1		mg/L	05/27/2014 2116 AMB	EPA 300.0
Cations						
Calcium	117	1		mg/L	05/27/2014 1300 DG	EPA 200.7
Magnesium	166	1		mg/L	05/27/2014 1300 DG	EPA 200.7
Potassium	30	1		mg/L	05/27/2014 1300 DG	EPA 200.7
Sodium	533	1		mg/L	05/27/2014 1300 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

TPN 6 2/025
RECD NOV 14, 2014

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/6/2014
Report ID: S1405432001

Project: Ramaco
Lab ID: S1405432-003
Client Sample ID: 578513-MST-1
COC: 151525

Work Order: S1405432
Collection Date: 5/22/2014 12:05:00 PM
Date Received: 5/23/2014 12:15:00 PM
Sampler: RF
Matrix: Water

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.13	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Chloride	0.42	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Nitrate + Nitrite as N	0.01	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sulfate	35.22	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Calcium	5.84	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Magnesium	13.64	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Potassium	0.75	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Sodium	23.20	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	44.11	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
n Sum	47.84	0.01		meq/L	06/05/2014 1609 JJ	SM 1030E
on-Anion Balance	4.05	0.01		%	06/05/2014 1609 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/27/2014 1300 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/24/2014 0529 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/24/2014 0529 MS	EPA 200.8
Boron	0.3	0.1		mg/L	05/27/2014 1300 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/24/2014 0529 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/27/2014 1300 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/24/2014 0529 MS	EPA 200.8
Iron	0.05	0.05		mg/L	05/27/2014 1300 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/24/2014 0529 MS	EPA 200.8
Manganese	0.05	0.02		mg/L	05/27/2014 1300 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/05/2014 1010 CJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/24/2014 0529 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/27/2014 1300 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/24/2014 0529 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/27/2014 1300 DG	EPA 200.7
Total Metals						
Iron	0.18	0.05		mg/L	05/28/2014 2007 DG	EPA 200.7
Manganese	0.05	0.02		mg/L	05/28/2014 2007 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by a contract laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD NOV 14, 2014

Scanned, 02/28/2020

Inter-Mountain Labs

Sheridan, WY and Gillette, WY

CHAIN OF CUSTODY RECORD -

Page of

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151524

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC	Ramaco	Rod Fuller	

Report Address	Contact Name	Purchase Order #	Quote #
	Jeff Barron - WWC		439
Invoice Address	Email		
	Phone		

ANALYSES / PARAMETERS: Quote 439

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME	SAMPLE IDENTIFICATION	Matrix	# of Containers	REMARKS
1	51405349-001	5/20/14	1030	578415-MST/CRN-1	WT	4	✓
2				pH= 7.91, EC= 1778, T= 15.1, TUR = 3.55, SWL = 121.23'			
3	002	5/20/14	1225	578409-UBN-1	WT	4	✓
4				pH= 7.79, EC= 3990, T= 14.5, TUR = 1.01, SWL = 110.40'			
5	003	5/20/14	1310	578409-MST-1	WT	4	✓
6				pH= 7.82, EC= 2390, T= 17.2, TUR = 0.36, SWL = 100.95'			
7	004	5/20/14	1400	578409-CRN-OB-1	WT	4	✓
8				pH= 7.38, EC= 1944, T= 14.6, TUR = 3.90, SWL = 89.87'			
9	005	5/20/14	1530	578408-CRN-1	WT	4	✓
10				pH= 6.91, EC= 2700, T= 13.7, TUR = 64.7, SWL = 87.71'			
11							
12							
13							
14							

TFN 6 2'025
RECD NOV 14, 2014

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
2.8°C	Rod Fuller	5/20/14	1628	S. Stadel	5/20/14	16:30

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
❑ UPS	Water	(WT)	Check desired service	Compliance Monitoring? Y / N	
❑ Fed Express	Soil	SL	☒ Standard turnaround	Program (SDWA, NPDES,...)	
❑ US Mail	Solid	SD	❑ RUSH - 5 Working Days	PWSID / Permit #	
❑ Hand Carried	Filter	FT	❑ URGENT - < 2 Working Days	Chlorinated? Y / N	
❑ Other _____	Other	OT	Rush & Urgent Surcharges will be [illegible]	Sample Disposal: Lab / Client	

DEQ Ex. 3-692

October 2014

Addendum D6-10-202

RAMACO

Brook Mine

Scanned, 02/28/2020

Inter-Mountain Labs
Sheridan, WY and Gillette, WY

CHAIN OF CUSTODY RECORD -

Page of

All shaded fields must be completed.
This is a legal document: any misrepresentation may be construed as fraud.

151525

Client Name	Project Identification	Sampler (Signature/Attestation of Authenticity)	Telephone #
WWC	Ramaco	Rod Fuller	

Report Address	Contact Name	Email	Phone
WWC	Jeff Barron - WWC		

Invoice Address	Purchase Order #	Quote #
WWC		439

ANALYSES / PARAMETERS

ITEM	LAB ID (Lab Use Only)	DATE SAMPLED	TIME	SAMPLE IDENTIFICATION	Matrix	# of Containers	Q# 439	REMARKS
1	1405432-001	5/22/14	0830	578408-MST-1	WT	4	✓	
2				pH = 6.62, EC = 1982, T = 14.5, TUR = 20.3, SWL = 99.82'				
3	002	5/22/14	0950	578417-CRN-1	WT	4	✓	
4				pH = 7.56, EC = 1375, T = 18.0, TUR = 998, SWL = 133.55'				
5	003	5/22/14	1205	578513-MST-1	WT	4	✓	
6				pH = 6.87, EC = 4130, T = 17.2, TUR = 2.22, SWL = 107.94'				
7	004	5/22/14	1335	578512-AL-1	WT	4	✓	
8				pH = 7.33, EC = 5530, T = 16.3, TUR = 21.6, SWL = 3.61'				
9	005	5/22/14	1500	578513-AL-1	WT	4	✓	
10				pH = 7.26, EC = 4686, T = 17.5, TUR = 0.17, SWL = 6.18'				
11	006	5/23/14	1110	578511-CRN-1	WT	4	✓	
12				pH = 7.42, EC = 4050, T = 18.2, TUR = 88.5, SWL = 119.58'				
13								
14								

TFN 6 2/025
RECD NOV 14, 2014

LAB COMMENTS	Relinquished By (Signature/Printed)	DATE	TIME	Received By (Signature/Printed)	DATE	TIME
0.4°C	Rod Fuller	5/23/14	1214	Kathy Boop	5.23.14	12:15

SHIPPING INFO	MATRIX CODES		TURNAROUND TIMES	COMPLIANCE INFORMATION	ADDITIONAL REMARKS
❑ UPS	Water	WT	Check desired service	Compliance Monitoring? Y / N	
❑ Fed Express	Soil	SL	☒ Standard turnaround	Program (SDWA, NPDES,...)	
❑ US Mail	Solid	SD	❑ RUSH - 5 Working Days	PWSID / Permit #	
❑ Hand Carried	Filter	FT	❑ URGENT - < 2 Working Days	Chlorinated? Y / N	
❑ Other _____	Other	OT	Rush & Urgent Surcharges will be [illegible]	Sample Disposal: Lab / Client	

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RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578524-AL-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578524-AL-1 Date Sampled 1 / 8 / 18 Time 1305 am (pm)

Describe Sampling Point 5" GW monitoring well

Well Depth 35.45 ft below MP Depth to Water (below MP) 12.58 ft Casing Diameter 5 in

Date 1 / 8 / 18 Time 1130 (am) pm Casing Volume 23.32 gal

At least 3+ bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap (Bailer) Grab

Pump intake or bailer set at NA ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

Tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1210	7.31	1223	9.5	51.9	25	NA
1230	7.44	1147	9.2	59.8	50	↓
1305	7.43	1083	9.0	36.2	75	

35.45
12.58
22.87 x 1.02 = 23.32 x 3. = 70.0 GAL

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water slightly turbid - no odor

HCF
COC# 171844

Form completed by: Rod Fulks Witnessed by: _____

DEQ 2/025
RECD 10-25-18

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RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 1/19/2018
Report ID: S1801095001

Work Order: S1801095
Collection Date: 1/8/2018 1:05:00 PM
Date Received: 1/8/2018 2:29:00 PM
Sampler: RF
Matrix: Water
COC: 171844

Project: Ramaco-2014163-98
Lab ID: S1801095-001
Client Sample ID: 578524-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.43			s.u.	01/08/2018 1305	Field
Conductivity	1083			µmhos/cm	01/08/2018 1305	Field
Turbidity	36.2			NTU	01/08/2018 1305	Field
Depth To Water	12.58			ft	01/08/2018 1305	Field
Temperature	9.0			°C	01/08/2018 1305	Field
General Parameters						
pH	8.2	0.1		s.u.	01/08/2018 2019 IBS	SM 4500 H B
Electrical Conductivity	1190	5		µmhos/cm	01/08/2018 2019 IBS	SM 2510B
Total Dissolved Solids (180)	800	10		mg/L	01/08/2018 1620 NLG	SM 2540
Solids, Total Dissolved (Calc)	750	10		mg/L	01/16/2018 0944 BC	SM 1030E
Alkalinity, Total (As CaCO3)	421	5		mg/L	01/08/2018 2019 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	499	1		mg/L	01/16/2018 0944 BC	SM 2340B
Nitrogen, Ammonia (As N)	0.1	0.1		mg/L	01/15/2018 1049 AMB	EPA 350.1
dium Adsorption Ratio	1.61	0.01			01/16/2018 0944 BC	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	513	5		mg/L	01/08/2018 2019 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	01/08/2018 2019 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	01/08/2018 2019 IBS	SM 2320B
Chloride	4	1		mg/L	01/09/2018 1900 AB	EPA 300.0
Fluoride	0.3	0.1		mg/L	01/08/2018 2019 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	01/10/2018 1356 AMB	EPA 353.2
Sulfate	245	1		mg/L	01/09/2018 1900 AB	EPA 300.0
Cations						
Calcium	93	1		mg/L	01/09/2018 1427 DG	EPA 200.7
Magnesium	65	1		mg/L	01/09/2018 1427 DG	EPA 200.7
Potassium	7	1		mg/L	01/09/2018 1427 DG	EPA 200.7
Sodium	83	1		mg/L	01/09/2018 1427 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect
C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

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8500-10-25-18

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RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 1/19/2018
Report ID: S1801095001

Work Order: S1801095
Collection Date: 1/8/2018 1:05:00 PM
Date Received: 1/8/2018 2:29:00 PM
Sampler: RF
Matrix: Water
COC: 171844

Project: Ramaco-2014163-98
Lab ID: S1801095-001
Client Sample ID: 578524-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.41	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Chloride	0.12	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Fluoride	0.01	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Sulfate	5.10	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Calcium	4.64	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Magnesium	5.33	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Potassium	0.17	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Sodium	3.61	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	13.77	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
ion Sum	13.65	0.01		meq/L	01/16/2018 0944 BC	SM 1030E
tion-Anion Balance	0.43	0.01		%	01/16/2018 0944 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	01/09/2018 1427 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	01/09/2018 0709 MS	EPA 200.8
Barium	ND	0.1		mg/L	01/09/2018 0709 MS	EPA 200.8
Boron	0.1	0.1		mg/L	01/09/2018 1427 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	01/09/2018 0709 MS	EPA 200.8
Chromium	ND	0.01		mg/L	01/09/2018 1427 DG	EPA 200.7
Copper	ND	0.01		mg/L	01/09/2018 0709 MS	EPA 200.8
Iron	3.17	0.05		mg/L	01/09/2018 1427 DG	EPA 200.7
Lead	ND	0.02		mg/L	01/09/2018 0709 MS	EPA 200.8
Manganese	0.20	0.02		mg/L	01/09/2018 1427 DG	EPA 200.7
Mercury	ND	0.001		mg/L	01/12/2018 1035 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	01/09/2018 0709 MS	EPA 200.8
Nickel	ND	0.01		mg/L	01/09/2018 1427 DG	EPA 200.7
Selenium	ND	0.005		mg/L	01/09/2018 0709 MS	EPA 200.8
Zinc	ND	0.01		mg/L	01/09/2018 1427 DG	EPA 200.7
Total Metals						
Iron	4.86	0.05		mg/L	01/09/2018 1550 DG	EPA 200.7
Manganese	0.21	0.02		mg/L	01/09/2018 1550 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

TFN D 2/025
RECD 10-26-18

October 2018

DEQ Ex. 3-697

Addendum D6-10-207

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RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578524-AL-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578524-AL-1 Date Sampled 4/19/18 Time 1130 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 35.40 ft below MP Depth to Water (below MP) 12.20 ft Casing Diameter 5 in

Date 4/19/18 Time 1015 (am) pm Casing Volume 23.66 gal

At least 3+ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap (Bailer)

Pump intake or bailer set at NA ft below MP

Tubing (type NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1045	7.33	11.71	8.6	11.7	25.0	
1110	7.38	11.29	8.5	10.8	50.0	
1130	7.42	11.06	8.5	8.38	75.0	

35.40
12.20
23.20 x 1.02 = 23.66 x 3 = 70.98 GAL

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water clear - no odor - measured water volume with 5 gallon bucket

LCF

COC# 171831

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-698
FEB 0 2 2020
RECD 10-25-18

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TRAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/30/2018
Report ID: S1804245001

Work Order: S1804245
Collection Date: 4/19/2018 11:30:00 AM
Date Received: 4/19/2018 3:12:00 PM
Sampler: RF
Matrix: Water
COC: 171831

Project: Ramaco 2014163-98
Lab ID: S1804245-001
Client Sample ID: 578524-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.42			s.u.	04/19/2018 1130	Field
Conductivity	1106			µmhos/cm	04/19/2018 1130	Field
Turbidity	8.38			NTU	04/19/2018 1130	Field
Depth To Water	12.20			ft	04/19/2018 1130	Field
Temperature	8.5			°C	04/19/2018 1130	Field
General Parameters						
pH	8.1	0.1		s.u.	04/20/2018 1622 IBS	SM 4500 H B
Electrical Conductivity	1200	5		µmhos/cm	04/20/2018 1622 IBS	SM 2510B
Total Dissolved Solids (180)	800	10		mg/L	04/20/2018 1401 NLG	SM 2540
Solids, Total Dissolved (Calc)	750	10		mg/L	04/30/2018 1033 BC	SM 1030E
Alkalinity, Total (As CaCO3)	424	5		mg/L	04/20/2018 1622 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	538	1		mg/L	04/30/2018 1033 BC	SM 2340B
Nitrogen, Ammonia (as N)	0.1	0.1		mg/L	04/27/2018 1016 AMB	EPA 350.1
dium Adsorption Ratio	1.14	0.01			04/30/2018 1033 BC	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	517	5		mg/L	04/20/2018 1622 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	04/20/2018 1622 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/20/2018 1622 IBS	SM 2320B
Chloride	4	1		mg/L	04/20/2018 1354 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	04/20/2018 1622 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/24/2018 1452 AMB	EPA 353.2
Sulfate	253	1		mg/L	04/20/2018 1354 AB	EPA 300.0
Cations						
Calcium	100	1		mg/L	04/20/2018 1348 DG	EPA 200.7
Magnesium	70	1		mg/L	04/20/2018 1348 DG	EPA 200.7
Potassium	4	1		mg/L	04/20/2018 1348 DG	EPA 200.7
Sodium	61	1		mg/L	04/20/2018 1348 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: Bill Courtney

Bill Courtney, Project Manager
October 2018

DEQ Ex. 3-699

10-25-18

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RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/30/2018
Report ID: S1804245001

Work Order: S1804245
Collection Date: 4/19/2018 11:30:00 AM
Date Received: 4/19/2018 3:12:00 PM
Sampler: RF
Matrix: Water
COC: 171831

Project: Ramaco 2014163-98
Lab ID: S1804245-001
Client Sample ID: 578524-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.48	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Chloride	0.11	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Fluoride	0.01	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Sulfate	5.26	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Calcium	4.98	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Magnesium	5.77	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Potassium	0.11	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Sodium	2.65	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
Cation / Anion Balance						
Cation Sum	13.53	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
ion Sum	13.87	0.01		meq/L	04/30/2018 1033 BC	SM 1030E
tion-Anion Balance	1.22	0.01		%	04/30/2018 1033 BC	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/20/2018 1348 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/20/2018 1508 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/20/2018 1508 MS	EPA 200.8
Boron	0.1	0.1		mg/L	04/20/2018 1348 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/20/2018 1508 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/20/2018 1348 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/20/2018 1508 MS	EPA 200.8
Iron	4.81	0.05		mg/L	04/20/2018 1348 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/20/2018 1508 MS	EPA 200.8
Manganese	0.23	0.02		mg/L	04/20/2018 1348 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/24/2018 0855 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/20/2018 1508 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/20/2018 1348 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/20/2018 1508 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/20/2018 1348 DG	EPA 200.7
Total Metals						
Iron	4.81	0.05		mg/L	04/23/2018 1544 DG	EPA 200.7
Manganese	0.22	0.02		mg/L	04/23/2018 1544 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: Bill Courtney

Bill Courtney, Project Manager

DEQ 10-25-18

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RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578524-AL-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578524-AL-1 Date Sampled 6/6/18 Time 1500 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 35.36 ft below MP Depth to Water (below MP) 10.97 ft Casing Diameter 5 in

Date 6/6/18 Time 1400 am (pm) Casing Volume _____ gal

At least 3 bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap (Bailer)

Pump intake or bailer set at NA ft below MP.

Tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1415	7.47	1096	10.8		25	
1435	7.45	1074	10.1		50	
1500	7.44	1061	10.1	8.45	75	
		35.36				
		-10.97	X 1.02 = 24.88 X 3 = 75			
		24.39				

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water Clear - no odor - sampled prior to cacl/alluvium pump test.

LCF

COC # 171832

Form completed by: Rod Fuller Witnessed by: _____

IFN 0 27025
RECD 10-25-18

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RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/21/2018
Report ID: S1806098001

Work Order: S1806098
Collection Date: 6/6/2018 3:00:00 PM
Date Received: 6/6/2018 4:39:00 PM
Sampler: RF
Matrix: Water
COC: 171832

Project: Ramaco-2014163-98
Lab ID: S1806098-001
Client Sample ID: 578524-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.44			s.u.	06/06/2018 1500	Field
Conductivity	1061			µmhos/cm	06/06/2018 1500	Field
Turbidity	8.45			NTU	06/06/2018 1500	Field
Depth To Water	10.97			ft	06/06/2018 1500	Field
Temperature	10.1			°C	06/06/2018 1500	Field
General Parameters						
pH	8.2	0.1		s.u.	06/08/2018 1730 IBS	SM 4500 H B
Electrical Conductivity	1200	5		µmhos/cm	06/07/2018 1840 IBS	SM 2510B
Total Dissolved Solids (180)	770	10		mg/L	06/07/2018 1215 NLG	SM 2540
Solids, Total Dissolved (Calc)	740	10		mg/L	06/21/2018 1004 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	419	5		mg/L	06/08/2018 1730 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	518	1		mg/L	06/21/2018 1004 JJ	SM 2340B
Nitrogen, Ammonia (as N)	0.1	0.1		mg/L	06/14/2018 1507 AMB	EPA 350.1
dium Adsorption Ratio	1.24	0.01			06/21/2018 1004 JJ	Calculation
...ons						
Alkalinity, Bicarbonate as HCO3	511	5		mg/L	06/08/2018 1730 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	06/08/2018 1730 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/08/2018 1730 IBS	SM 2320B
Chloride	4	1		mg/L	06/09/2018 0117 AB	EPA 300.0
Fluoride	0.3	0.1		mg/L	06/07/2018 1840 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	06/08/2018 1356 AMB	EPA 353.2
Sulfate	256	1		mg/L	06/07/2018 2051 AB	EPA 300.0
Cations						
Calcium	94	1		mg/L	06/11/2018 1503 DG	EPA 200.7
Magnesium	69	1		mg/L	06/11/2018 1503 DG	EPA 200.7
Potassium	4	1		mg/L	06/07/2018 1804 DG	EPA 200.7
Sodium	65	1		mg/L	06/07/2018 1804 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager
October 2018

JAN 0 2 2020

DEQ Ex. 3-702 10-25-18 Addendum D6-10-212

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/21/2018
Report ID: S1806098001

Work Order: S1806098
Collection Date: 6/6/2018 3:00:00 PM
Date Received: 6/6/2018 4:39:00 PM
Sampler: RF
Matrix: Water
COC: 171832

Project: Ramaco-2014163-98
Lab ID: S1806098-001
Client Sample ID: 578524-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.37	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Chloride	0.12	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Sulfate	5.32	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Calcium	4.68	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Magnesium	5.68	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Potassium	0.09	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Sodium	2.83	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	13.30	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
ıion Sum	13.83	0.01		meq/L	06/21/2018 1004 JJ	SM 1030E
ɔation-Anion Balance	1.94	0.01		%	06/21/2018 1004 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	06/07/2018 1804 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	06/07/2018 1805 MS	EPA 200.8
Barium	ND	0.1		mg/L	06/07/2018 1805 MS	EPA 200.8
Boron	0.1	0.1		mg/L	06/07/2018 1804 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	06/07/2018 1805 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/07/2018 1804 DG	EPA 200.7
Copper	ND	0.01		mg/L	06/07/2018 1805 MS	EPA 200.8
Iron	5.04	0.05		mg/L	06/07/2018 1804 DG	EPA 200.7
Lead	ND	0.02		mg/L	06/07/2018 1805 MS	EPA 200.8
Manganese	0.22	0.02		mg/L	06/07/2018 1804 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/12/2018 0845 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	06/07/2018 1805 MS	EPA 200.8
Nickel	ND	0.01		mg/L	06/07/2018 1804 DG	EPA 200.7
Selenium	ND	0.005		mg/L	06/07/2018 1805 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/07/2018 1804 DG	EPA 200.7
Total Metals						
Iron	5.78	0.05		mg/L	06/08/2018 2213 DG	EPA 200.7
Manganese	0.23	0.02		mg/L	06/08/2018 2213 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager
October 2018

DEQ Ex. 3-703

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578524-AL-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578524-AL-1 Date Sampled 7 / 12 / 18 Time 1005 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 35.47 ft below MP Depth to Water (below MP) 12.65 ft Casing Diameter 5 in

Date 7 / 12 / 18 Time 0925 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method : Submersible pump (Bladder)

Tap Bailer Grab

Pump intake or bailer set at 32 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0955	7.45	1140	20.5	13.1	↓	150 ML/30 sec
1005	7.47	1130	20.4	15.8	~3.0	↓

Pumping Start Time 0935 WL _____ Pumping End Time _____ WL _____

Comments: water clear - no odor

LCF
COC# 176173

Form completed by: Rod Fuller Witnessed by: _____

RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/26/2018
Report ID: S1807203001

Work Order: S1807203
Collection Date: 7/12/2018 10:05:00 AM
Date Received: 7/12/2018 12:08:00 PM
Sampler: RF
Matrix: Water
COC: 176173

Project: RAMACO-2014163-98
Lab ID: S1807203-001
Client Sample ID: 578524-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.47			s.u.	07/12/2018 1005	Field
Conductivity	1130			µmhos/cm	07/12/2018 1005	Field
Turbidity	15.8			NTU	07/12/2018 1005	Field
Depth To Water	12.65			ft	07/12/2018 1005	Field
Temperature	20.4			°C	07/12/2018 1005	Field
General Parameters						
pH	8.3	0.1		s.u.	07/13/2018 0637 IBS	SM 4500 H B
Electrical Conductivity	1200	5		µmhos/cm	07/13/2018 0637 IBS	SM 2510B
Total Dissolved Solids (180)	820	10		mg/L	07/13/2018 0851 NLG	SM 2540
Solids, Total Dissolved (Calc)	750	10		mg/L	07/26/2018 1042 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	450	5		mg/L	07/13/2018 0637 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	532	1		mg/L	07/26/2018 1042 JJ	SM 2340B
Nitrogen, Ammonia (as N)	0.1	0.1		mg/L	07/23/2018 0912 AMB	EPA 350.1
dium Adsorption Ratio	1.13	0.01			07/26/2018 1042 JJ	Calculation
ions						
Alkalinity, Bicarbonate as HCO3	534	5		mg/L	07/13/2018 0637 IBS	SM 2320B
Alkalinity, Carbonate as CO3	7	5		mg/L	07/13/2018 0637 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/13/2018 0637 IBS	SM 2320B
Chloride	4	1		mg/L	07/13/2018 1633 AB	EPA 300.0
Fluoride	0.3	0.1		mg/L	07/13/2018 0637 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/18/2018 1106 AMB	EPA 353.2
Sulfate	243	1		mg/L	07/13/2018 1633 AB	EPA 300.0
Cations						
Calcium	100	1		mg/L	07/16/2018 1951 DG	EPA 200.7
Magnesium	69	1		mg/L	07/16/2018 1951 DG	EPA 200.7
Potassium	4	1		mg/L	07/16/2018 1951 DG	EPA 200.7
Sodium	60	1		mg/L	07/16/2018 1951 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TFN 6 2/023
DEQ 10-25-18

DEQ Ex. 3-705

Addendum D6-10-215

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/26/2018
Report ID: S1807203001

Work Order: S1807203
Collection Date: 7/12/2018 10:05:00 AM
Date Received: 7/12/2018 12:08:00 PM
Sampler: RF
Matrix: Water
COC: 176173

Project: RAMACO-2014163-98
Lab ID: S1807203-001
Client Sample ID: 578524-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.75	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Carbonate as CO3	0.24	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Chloride	0.11	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Sulfate	5.05	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Calcium	4.99	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Magnesium	5.64	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Potassium	0.11	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Sodium	2.61	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	13.38	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
ion Sum	14.18	0.01		meq/L	07/26/2018 1042 JJ	SM 1030E
ation-Anion Balance	2.92	0.01		%	07/26/2018 1042 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/18/2018 1319 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/14/2018 0601 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/14/2018 0601 MS	EPA 200.8
Boron	0.1	0.1		mg/L	07/18/2018 1319 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/14/2018 0601 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/18/2018 1319 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/14/2018 0601 MS	EPA 200.8
Iron	2.85	0.05		mg/L	07/18/2018 1319 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/14/2018 0601 MS	EPA 200.8
Manganese	0.29	0.02		mg/L	07/18/2018 1319 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 1202 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/14/2018 0601 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/18/2018 1319 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/14/2018 0601 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/18/2018 1319 DG	EPA 200.7
Total Metals						
Iron	4.06	0.05		mg/L	07/18/2018 2145 DG	EPA 200.7
Manganese	0.29	0.02		mg/L	07/18/2018 2145 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TER 0 21025
RECD 10-25-18

DEQ Ex. 3-706

Addendum D6-10-216

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578420-AL-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578420-AL-1 Date Sampled 6/20/18 Time 1510 am pm

Describe Sampling Point GW monitoring well for pump test

Well Depth 17.45 ft below MP Depth to Water (below MP) 7.53 ft Casing Diameter 2 in

Date 6/20/18 Time 1445 am (pm) Casing Volume 1.62 gal

At least 3+ bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap (Bailer) Grab

Pump intake or bailer set at NA ft below MP

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1510	7.55	704	11.3	346	6	—
	1745					
	7.53					
	9.92 x 0.163 = 1.62 x 3 = 4.85 GAL					

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC # 176175

Form completed by: Rod Fuller Witnessed by: _____

WW G 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/5/2018
Report ID: S1806352001

Work Order: S1806352
Collection Date: 6/20/2018 3:10:00 PM
Date Received: 6/20/2018 4:26:00 PM
Sampler: RF
Matrix: Water
COC: 176175

Project: Ramaco-2014163-98
Lab ID: S1806352-001
Client Sample ID: 578420-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.55			s.u.	06/20/2018 1510	Field
Conductivity	704			µmhos/cm	06/20/2018 1510	Field
Turbidity	346			NTU	06/20/2018 1510	Field
Depth To Water	7.53			ft	06/20/2018 1510	Field
Temperature	11.3			°C	06/20/2018 1510	Field
General Parameters						
pH	8.2	0.1		s.u.	06/21/2018 1652 IBS	SM 4500 H B
Electrical Conductivity	847	5		µmhos/cm	06/21/2018 1652 IBS	SM 2510B
Total Dissolved Solids (180)	530	10		mg/L	06/21/2018 1559 NLG	SM 2540
Solids, Total Dissolved (Calc)	510	10		mg/L	07/05/2018 0810 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	328	5		mg/L	06/21/2018 1652 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	313	1		mg/L	07/05/2018 0810 JJ	SM 2340B
Nitrogen, Ammonia (as N)	0.1	0.1		mg/L	06/27/2018 1242 AMB	EPA 350.1
dium Adsorption Ratio	1.71	0.01			07/05/2018 0810 JJ	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	400	5		mg/L	06/21/2018 1652 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	06/21/2018 1652 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/21/2018 1652 IBS	SM 2320B
Chloride	5	1		mg/L	06/21/2018 1917 AB	EPA 300.0
Fluoride	0.6	0.1		mg/L	06/21/2018 1652 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.1	0.1		mg/L	06/27/2018 1320 AMB	EPA 353.2
Sulfate	127	1		mg/L	06/21/2018 1917 AB	EPA 300.0
Cations						
Calcium	73	1		mg/L	06/26/2018 1722 DG	EPA 200.7
Magnesium	32	1		mg/L	06/26/2018 1722 DG	EPA 200.7
Potassium	1	1		mg/L	06/26/2018 1722 DG	EPA 200.7
Sodium	70	1		mg/L	06/26/2018 1722 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

DEQ Ex. 3-708

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/5/2018
Report ID: S1806352001

Work Order: S1806352
Collection Date: 6/20/2018 3:10:00 PM
Date Received: 6/20/2018 4:26:00 PM
Sampler: RF
Matrix: Water
COC: 176175

Project: Ramaco-2014163-98
Lab ID: S1806352-001
Client Sample ID: 578420-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	6.55	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Chloride	0.14	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Sulfate	2.65	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Calcium	3.63	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Magnesium	2.62	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Potassium	0.03	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Sodium	3.04	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	9.33	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
ion Sum	9.39	0.01		meq/L	07/05/2018 0810 JJ	SM 1030E
ation-Anion Balance	0.28	0.01		%	07/05/2018 0810 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	06/26/2018 1722 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	06/22/2018 1826 MS	EPA 200.8
Barium	ND	0.1		mg/L	06/22/2018 1826 MS	EPA 200.8
Boron	ND	0.1		mg/L	06/26/2018 1722 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	06/22/2018 1826 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/26/2018 1722 DG	EPA 200.7
Copper	ND	0.01		mg/L	06/22/2018 1826 MS	EPA 200.8
Iron	ND	0.05		mg/L	06/26/2018 1722 DG	EPA 200.7
Lead	ND	0.02		mg/L	06/22/2018 1826 MS	EPA 200.8
Manganese	0.02	0.02		mg/L	06/26/2018 1722 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/27/2018 1027 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	06/22/2018 1826 MS	EPA 200.8
Nickel	ND	0.01		mg/L	06/26/2018 1722 DG	EPA 200.7
Selenium	ND	0.005		mg/L	06/22/2018 1826 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/26/2018 1722 DG	EPA 200.7
Total Metals						
Iron	6.38	0.05		mg/L	06/27/2018 0235 DG	EPA 200.7
Manganese	0.24	0.02		mg/L	06/27/2018 0235 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

TRD 6 2/25

RECD 10-25-18

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578420-AL-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578420-AL-1 Date Sampled 7 / 11 / 18 Time 1515 am (pm)

Describe Sampling Point GW monitoring Well

Well Depth 17.40 ft below MP Depth to Water (below MP) 8.24 ft Casing Diameter 2 in

Date 7 / 11 / 18 Time 1440 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method : Submersible pump (Bladder)

Tap Bailer Grab

Pump intake or bailer set at 16 ft below MP

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1505	7.62	785	22.3	163	↓	150mL/30sec
1515	7.61	770	21.0	113	~3.0	↓

Pumping Start Time 1445 WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF (Stick up = 1.95')

COC# 177611

Form completed by: Bob Fuller Witnessed by: _____

DEQ 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
INTER-MOUNTAIN LABS
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/24/2018
Report ID: S1807175001

Work Order: S1807175
Collection Date: 7/11/2018 3:15:00 PM
Date Received: 7/11/2018 3:58:00 PM
Sampler: RF
Matrix: Water
COC: 177611

Project: Ramaco-2014163-98
Lab ID: S1807175-004
Client Sample ID: 578420-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.61			s.u.	07/11/2018 1515	Field
Conductivity	770			µmhos/cm	07/11/2018 1515	Field
Turbidity	113			NTU	07/11/2018 1515	Field
Depth To Water	8.24			ft	07/11/2018 1515	Field
Temperature	21.0			°C	07/11/2018 1515	Field
General Parameters						
pH	8.3	0.1		s.u.	07/12/2018 2216 IBS	SM 4500 H B
Electrical Conductivity	845	5		µmhos/cm	07/12/2018 2216 IBS	SM 2510B
Total Dissolved Solids (180)	540	10		mg/L	07/12/2018 1618 NLG	SM 2540
Solids, Total Dissolved (Calc)	490	10		mg/L	07/24/2018 1146 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	316	5		mg/L	07/12/2018 2216 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	360	1		mg/L	07/24/2018 1146 JJ	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	07/17/2018 1055 AMB	EPA 350.1
dium Adsorption Ratio	0.88	0.01			07/24/2018 1146 JJ	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	386	5		mg/L	07/12/2018 2216 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/12/2018 2216 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/12/2018 2216 IBS	SM 2320B
Chloride	3	1		mg/L	07/12/2018 1819 AB	EPA 300.0
Fluoride	0.3	0.1		mg/L	07/12/2018 2216 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/13/2018 1450 AMB	EPA 353.2
Sulfate	135	1		mg/L	07/12/2018 1819 AB	EPA 300.0
Cations						
Calcium	88	1		mg/L	07/19/2018 1352 DG	EPA 200.7
Magnesium	34	1		mg/L	07/19/2018 1352 DG	EPA 200.7
Potassium	2	1		mg/L	07/16/2018 1749 DG	EPA 200.7
Sodium	38	1		mg/L	07/19/2018 1352 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TRN G 2/[illegible]
DEQ 10-23-18

DEQ Ex. 3-711

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/24/2018
Report ID: S1807175001

Work Order: S1807175
Collection Date: 7/11/2018 3:15:00 PM
Date Received: 7/11/2018 3:58:00 PM
Sampler: RF
Matrix: Water
COC: 177611

Project: Ramaco-2014163-98
Lab ID: S1807175-004
Client Sample ID: 578420-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	6.32	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Chloride	0.09	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Sulfate	2.81	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Calcium	4.38	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Magnesium	2.81	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Potassium	0.05	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Sodium	1.67	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	8.92	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
ion Sum	9.26	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
ation-Anion Balance	1.86	0.01		%	07/24/2018 1146 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/18/2018 1105 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/14/2018 0224 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/14/2018 0224 MS	EPA 200.8
Boron	ND	0.1		mg/L	07/18/2018 1105 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/14/2018 0224 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/18/2018 1105 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/14/2018 0224 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/18/2018 1105 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/14/2018 0224 MS	EPA 200.8
Manganese	0.21	0.02		mg/L	07/18/2018 1105 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 1129 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/14/2018 0224 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/18/2018 1105 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/14/2018 0224 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/18/2018 1105 DG	EPA 200.7
Total Metals						
Iron	2.18	0.05		mg/L	07/18/2018 2023 DG	EPA 200.7
Manganese	0.26	0.02		mg/L	07/18/2018 2023 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TPH G 2/235
DEQ 10-22-18

DEQ Ex. 3-712

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578524-CRN-PUMP Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578524-CRN-PUMP Date Sampled 6/7/18 Time 1530 am (pm)

Describe Sampling Point Coal aquifer pump test well

Well Depth 75 ft below MP Depth to Water (below MP) 13.66 ft Casing Diameter 5 in

Date 6/7/18 Time 1145 am pm Casing Volume ~~62.57~~ 62.57 gal

At least 3+ bore volumes have been evacuated before sampling

Sampling method (Submersible pump) Bladder

Tap Bailer

Pump intake or bailer set at 70 ft below MP.

Tubing (type: steel pipe). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for pump test

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1530	7.68	1033	14.5	22.5	400	4.0

75.00
13.66
61.34 x 1.02 = 62.57 x 3 = 187.7

Pumping Start Time 1350 WL _____ Pumping End Time _____ WL _____

Comments: 1450 1530 Water slightly turbid - ~~[illegible]~~ slight sulfer smell
LCF
COC# 176239

Form completed by: Rod Fuller Witnessed by: _____

RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
INTER-MOUNTAIN LABS
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/21/2018
Report ID: S1806121001

Work Order: S1806121
Collection Date: 6/7/2018 3:30:00 PM
Date Received: 6/7/2018 4:44:00 PM
Sampler: RF
Matrix: Water
COC: 176239

Project: Ramaco-2014163-98
Lab ID: S1806121-001
Client Sample ID: 578524-CRN-PUMP

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.68			s.u.	06/07/2018 1530	Field
Conductivity	1033			µmhos/cm	06/07/2018 1530	Field
Turbidity	22.5			NTU	06/07/2018 1530	Field
Temperature	14.5			°C	06/07/2018 1530	Field
General Parameters						
pH	8.4	0.1		s.u.	06/08/2018 1745 IBS	SM 4500 H B
Electrical Conductivity	1150	5		µmhos/cm	06/08/2018 1745 IBS	SM 2510B
Total Dissolved Solids (180)	700	10		mg/L	06/08/2018 1242 NLG	SM 2540
Solids, Total Dissolved (Calc)	690	10		mg/L	06/21/2018 1543 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	588	5		mg/L	06/08/2018 1745 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	53	1		mg/L	06/21/2018 1543 JJ	SM 2340B
Nitrogen, Ammonia (as N)	4.1	0.1		mg/L	06/14/2018 1519 AMB	EPA 350.1
Sodium Adsorption Ratio	16.5	0.01			06/21/2018 1543 JJ	Calculation
ns						
lkalinity, Bicarbonate as HCO3	685	5		mg/L	06/08/2018 1745 IBS	SM 2320B
Alkalinity, Carbonate as CO3	16	5		mg/L	06/08/2018 1745 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/08/2018 1745 IBS	SM 2320B
Chloride	5	1		mg/L	06/08/2018 1016 AB	EPA 300.0
Fluoride	1.9	0.1		mg/L	06/08/2018 1745 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	06/15/2018 1008 AMB	EPA 353.2
Sulfate	33	1		mg/L	06/08/2018 1016 AB	EPA 300.0
Cations						
Calcium	8	1		mg/L	06/08/2018 1548 DG	EPA 200.7
Magnesium	8	1		mg/L	06/08/2018 1548 DG	EPA 200.7
Potassium	9	1		mg/L	06/08/2018 1548 DG	EPA 200.7
Sodium	276	1		mg/L	06/08/2018 1548 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

DEQ Ex. 3-714

Scanned, 02/28/2020

TRAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/21/2018
Report ID: S1806121001

Project: Ramaco-2014163-98
Lab ID: S1806121-001
Client Sample ID: 578524-CRN-PUMP

Work Order: S1806121
Collection Date: 6/7/2018 3:30:00 PM
Date Received: 6/7/2018 4:44:00 PM
Sampler: RF
Matrix: Water
COC: 176239

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	11.22	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Carbonate as CO3	0.53	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Chloride	0.12	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Fluoride	0.10	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Sulfate	0.68	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Calcium	0.37	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Magnesium	0.68	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Potassium	0.23	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Sodium	11.99	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	13.58	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
ion Sum	12.67	0.01		meq/L	06/21/2018 1543 JJ	SM 1030E
ation-Anion Balance	3.46	0.01		%	06/21/2018 1543 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	06/08/2018 1548 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	06/12/2018 0034 MS	EPA 200.8
Barium	0.1	0.1		mg/L	06/12/2018 0034 MS	EPA 200.8
Boron	ND	0.1		mg/L	06/08/2018 1548 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	06/12/2018 0034 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/08/2018 1548 DG	EPA 200.7
Copper	ND	0.01		mg/L	06/12/2018 0034 MS	EPA 200.8
Iron	ND	0.05		mg/L	06/08/2018 1548 DG	EPA 200.7
Lead	ND	0.02		mg/L	06/12/2018 0034 MS	EPA 200.8
Manganese	0.02	0.02		mg/L	06/08/2018 1548 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/12/2018 0958 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	06/12/2018 0034 MS	EPA 200.8
Nickel	ND	0.01		mg/L	06/08/2018 1548 DG	EPA 200.7
Selenium	0.038	0.005		mg/L	06/12/2018 0034 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/08/2018 1548 DG	EPA 200.7
Total Metals						
Iron	0.41	0.05		mg/L	06/12/2018 1706 DG	EPA 200.7
Manganese	0.02	0.02		mg/L	06/12/2018 1706 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

FEB 6 2020
WCCD 10-25-18

Addendum D6-10-225

DEQ Ex. 3-715

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578420-CRN-PUMP Project Ramaco

Location ~~578420~~ W.O.# 2014163-98

Sample ID# 578420-CRN-PUMP Date Sampled 7 / 3 / 18 Time 1310 am (pm)

Describe Sampling Point GW monitoring well for Pump test

Well Depth _____ ft below MP Depth to Water (below MP) _____ ft Casing Diameter 5 in

Date / / Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method : (Submersible pump) Bladder

Tap Bailer Grab

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0920	7.72	841	15.3			0.5
0925	7.77	848	15.4			↓
0935	7.88	873	16.0			↓
0945	7.83	881	16.1	Pump Dry @ 0947 - Let Recharge	(13.5 GAL)	↓
1300	Started pump					0.5
1310	7.85	880	16.6	148	18.5	↓

Pumping Start Time 0910 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor - could not get DTW due to pump - slow recharge and could not get 3 casing volumes

HCF - COC# 171835

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-716 TFN 6 2/023
RECD 10-25-18

Scanned, 02/28/2020

IML INTER-MOUNTAIN LABS
RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/18/2018
Report ID: S1807054001

Work Order: S1807054
Collection Date: 7/3/2018 1:10:00 PM
Date Received: 7/3/2018 2:10:00 PM
Sampler: RF
Matrix: Water
COC: 171835

Project: Ramaco-2014163-98
Lab ID: S1807054-001
Client Sample ID: 578420-CRN-Pump

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.85			s.u.	07/03/2018 1310	Field
Conductivity	980			µmhos/cm	07/03/2018 1310	Field
Turbidity	148			NTU	07/03/2018 1310	Field
Temperature	16.6			°C	07/03/2018 1310	Field
General Parameters						
pH	8.3	0.1		s.u.	07/05/2018 1637 IBS	SM 4500 H B
Electrical Conductivity	1030	5		µmhos/cm	07/05/2018 1637 IBS	SM 2510B
Total Dissolved Solids (180)	640	10		mg/L	07/05/2018 1330 NLG	SM 2540
Solids, Total Dissolved (Calc)	610	10		mg/L	07/18/2018 0758 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	363	5		mg/L	07/05/2018 1637 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	252	1		mg/L	07/18/2018 0758 JJ	SM 2340B
Nitrogen, Ammonia (as N)	2.6	0.1		mg/L	07/06/2018 1001 AMB	EPA 350.1
Sodium Adsorption Ratio	3.13	0.01			07/18/2018 0758 JJ	Calculation
ns						
Jkalinity, Bicarbonate as HCO3	440	5		mg/L	07/05/2018 1637 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/05/2018 1637 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/05/2018 1637 IBS	SM 2320B
Chloride	4	1		mg/L	07/06/2018 0042 AB	EPA 300.0
Fluoride	0.6	0.1		mg/L	07/05/2018 1637 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/05/2018 1057 AMB	EPA 353.2
Sulfate	182	1		mg/L	07/06/2018 0042 AB	EPA 300.0
Cations						
Calcium	48	1		mg/L	07/06/2018 1532 DG	EPA 200.7
Magnesium	32	1		mg/L	07/06/2018 1532 DG	EPA 200.7
Potassium	14	1		mg/L	07/06/2018 1532 DG	EPA 200.7
Sodium	114	1		mg/L	07/06/2018 1532 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

DEQ Ex. 3-717

Addendum D6-10-227

Scanned, 02/28/2020

1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/18/2018
Report ID: S1807054001

Work Order: S1807054
Collection Date: 7/3/2018 1:10:00 PM
Date Received: 7/3/2018 2:10:00 PM
Sampler: RF
Matrix: Water
COC: 171835

Project: Ramaco-2014163-98
Lab ID: S1807054-001
Client Sample ID: 578420-CRN-Pump

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	7.20	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Chloride	0.12	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Sulfate	3.77	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Calcium	2.40	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Magnesium	2.63	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Potassium	0.35	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Sodium	4.97	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	10.55	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
ıion Sum	11.19	0.01		meq/L	07/18/2018 0758 JJ	SM 1030E
ation-Anion Balance	2.94	0.01		%	07/18/2018 0758 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/06/2018 1532 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/12/2018 2251 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/12/2018 2251 MS	EPA 200.8
Boron	ND	0.1		mg/L	07/06/2018 1532 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/12/2018 2251 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/06/2018 1532 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/12/2018 2251 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/06/2018 1532 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/12/2018 2251 MS	EPA 200.8
Manganese	0.21	0.02		mg/L	07/06/2018 1532 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 0931 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/12/2018 2251 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/06/2018 1532 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/12/2018 2251 MS	EPA 200.8
Zinc	0.07	0.01		mg/L	07/06/2018 1532 DG	EPA 200.7
Total Metals						
Iron	1.21	0.05		mg/L	07/06/2018 1029 DG	EPA 200.7
Manganese	0.24	0.02		mg/L	07/06/2018 1029 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager
October 2018

TFN 6 2/223
DEQ 10-26-18

DEQ Ex. 3-718

Addendum D6-10-228

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578420 - [redacted] CRN-PUMP Project Ramaco

Location _____ W.O.# 2014165-98

Sample ID# 578420-CRN-PUMP Date Sampled 7 / 11 / 18 Time 1420 am (pm)

Describe Sampling Point GW Monitoring well

Well Depth 30.02 ft below MP Depth to Water (below MP) 7.81 ft Casing Diameter 5 in

Date 7 / 11 / 18 Time 1340 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

DISCHARGE RATE

Sampling method : Submersible pump (Bladder) _____ gpm

Tap Bailer Grab x 0.00223

Pump intake or bailer set at 25 ft below MP. cfs

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1410	7.72	971	21.3	8.21	↓	150mL/30sec
1420	7.71	999	21.4	6.61	~3.0	↓

Pumping Start Time 1350 WL _____ Pumping End Time _____ WL _____

Comments: water clear - no odor

LCF
COC# 177611

Stick up = 1.65'

Form completed by: Rod Fuller Witnessed by: _____

JAN 6 2020
RECD 10-25-18

Scanned, 02/28/2020

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/24/2018
Report ID: S1807175001

Work Order: S1807175
Collection Date: 7/11/2018 2:20:00 PM
Date Received: 7/11/2018 3:58:00 PM
Sampler: RF
Matrix: Water
COC: 177611

Project: Ramaco-2014163-98
Lab ID: S1807175-003
Client Sample ID: 578420-CRN-PUMP

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.71			s.u.	07/11/2018 1420	Field
Conductivity	999			µmhos/cm	07/11/2018 1420	Field
Turbidity	6.61			NTU	07/11/2018 1420	Field
Depth To Water	7.81			ft	07/11/2018 1420	Field
Temperature	21.4			°C	07/11/2018 1420	Field
General Parameters						
pH	8.3	0.1		s.u.	07/12/2018 2205 IBS	SM 4500 H B
Electrical Conductivity	1090	5		µmhos/cm	07/12/2018 2205 IBS	SM 2510B
Total Dissolved Solids (180)	680	10		mg/L	07/12/2018 1617 NLG	SM 2540
Solids, Total Dissolved (Calc)	630	10		mg/L	07/24/2018 1146 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	379	5		mg/L	07/12/2018 2205 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	279	1		mg/L	07/24/2018 1146 JJ	SM 2340B
Nitrogen, Ammonia (as N)	1.9	0.1		mg/L	07/17/2018 1054 AMB	EPA 350.1
ıdium Adsorption Ratio	2.89	0.01			07/24/2018 1146 JJ	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	450	5		mg/L	07/12/2018 2205 IBS	SM 2320B
Alkalinity, Carbonate as CO3	6	5		mg/L	07/12/2018 2205 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/12/2018 2205 IBS	SM 2320B
Chloride	4	1		mg/L	07/12/2018 1805 AB	EPA 300.0
Fluoride	0.7	0.1		mg/L	07/12/2018 2205 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/13/2018 1448 AMB	EPA 353.2
Sulfate	186	1		mg/L	07/12/2018 1805 AB	EPA 300.0
Cations						
Calcium	54	1		mg/L	07/16/2018 1746 DG	EPA 200.7
Magnesium	35	1		mg/L	07/16/2018 1746 DG	EPA 200.7
Potassium	12	1		mg/L	07/16/2018 1746 DG	EPA 200.7
Sodium	111	1		mg/L	07/16/2018 1746 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager
October 2018

TFN 6 21035
DEQ 10-25-18

DEQ Ex. 3-720

Scanned, 02/28/2020

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/24/2018
Report ID: S1807175001

Work Order: S1807175
Collection Date: 7/11/2018 2:20:00 PM
Date Received: 7/11/2018 3:58:00 PM
Sampler: RF
Matrix: Water
COC: 177611

Project: Ramaco-2014163-98
Lab ID: S1807175-003
Client Sample ID: 578420-CRN-PUMP

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	7.38	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Carbonate as CO3	0.19	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Chloride	0.10	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Sulfate	3.87	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Calcium	2.68	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Magnesium	2.89	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Potassium	0.31	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Sodium	4.83	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	10.86	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
ıion Sum	11.59	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
ation-Anion Balance	3.24	0.01		%	07/24/2018 1146 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/18/2018 1103 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/14/2018 0201 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/14/2018 0201 MS	EPA 200.8
Boron	ND	0.1		mg/L	07/18/2018 1103 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/14/2018 0201 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/18/2018 1103 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/14/2018 0201 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/18/2018 1103 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/14/2018 0201 MS	EPA 200.8
Manganese	0.26	0.02		mg/L	07/18/2018 1103 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 1121 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/14/2018 0201 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/18/2018 1103 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/14/2018 0201 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/18/2018 1103 DG	EPA 200.7
Total Metals						
Iron	0.18	0.05		mg/L	07/18/2018 2013 DG	EPA 200.7
Manganese	0.27	0.02		mg/L	07/18/2018 2013 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
DEQ 10-25-18

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578415-SPL-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578415-SPL-1 Date Sampled 6 / 4 / 18 Time 1510 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 41.32 ft below MP Depth to Water (below MP) 15.88 ft Casing Diameter 2 in

Date 6 / 4 / 18 Time 1350 am (pm) Casing Volume 4.15 gal

At least 3 bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap (Bailer)

Pump intake or bailer set at NA ft below MP

Tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1510	6.88	3970	16.2	34.6	15	—

41.32
- 15.88 = 25.44' x 0.163 = 4.15 x 3 = 12.44 GAL

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water Clear - no odor

HCF
COC# 176172

Form completed by: Rod Fuller Witnessed by: _____

October 2018

RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/15/2018
Report ID: S1806031001

Work Order: S1806031
Collection Date: 6/4/2018 3:10:00 PM
Date Received: 6/4/2018 3:17:00 PM
Sampler: RF
Matrix: Water
COC: 176172

Project: 2014163-98-Ramaco
Lab ID: S1806031-002
Client Sample ID: 578415-SPL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.88			s.u.	06/04/2018 1510	Field
Conductivity	3970			µmhos/cm	06/04/2018 1510	Field
Turbidity	34.6			NTU	06/04/2018 1510	Field
Temperature	16.2			°C	06/04/2018 1510	Field
Static Water Level	15.88			ft	06/04/2018 1510	Field
General Parameters						
pH	7.7	0.1		s.u.	06/05/2018 1940 IBS	SM 4500 H B
Electrical Conductivity	4640	5		µmhos/cm	06/05/2018 1940 IBS	SM 2510B
Total Dissolved Solids (180)	3960	10		mg/L	06/05/2018 1324 NLG	SM 2540
Solids, Total Dissolved (Calc)	3870	10		mg/L	06/15/2018 1125 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	941	5		mg/L	06/05/2018 1940 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2210	1		mg/L	06/15/2018 1125 JJ	SM 2340B
Nitrogen, Ammonia (as N)	5.4	0.1		mg/L	06/07/2018 1358 AMB	EPA 350.1
›dium Adsorption Ratio	3.23	0.01			06/15/2018 1125 JJ	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	1150	5		mg/L	06/05/2018 1940 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	06/05/2018 1940 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/05/2018 1940 IBS	SM 2320B
Chloride	15	1		mg/L	06/05/2018 1915 AB	EPA 300.0
Fluoride	0.5	0.1		mg/L	06/05/2018 1940 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.3	0.1		mg/L	06/06/2018 1445 AMB	EPA 353.2
Sulfate	2200	1		mg/L	06/06/2018 1007 AB	EPA 300.0
Cations						
Calcium	375	1		mg/L	06/05/2018 1536 DG	EPA 200.7
Magnesium	310	1		mg/L	06/05/2018 1536 DG	EPA 200.7
Potassium	52	1		mg/L	06/05/2018 1536 DG	EPA 200.7
Sodium	350	1		mg/L	06/05/2018 1536 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

DEQ Ex. 3-723

Addendum D6-10-233

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/15/2018
Report ID: S1806031001

Work Order: S1806031
Collection Date: 6/4/2018 3:10:00 PM
Date Received: 6/4/2018 3:17:00 PM
Sampler: RF
Matrix: Water
COC: 176172

Project: 2014163-98-Ramaco
Lab ID: S1806031-002
Client Sample ID: 578415-SPL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	18.81	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Chloride	0.41	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Nitrate + Nitrite as N	0.02	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Sulfate	45.89	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Calcium	18.70	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Magnesium	25.47	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Potassium	1.31	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Sodium	15.21	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	61.10	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
ıion Sum	65.17	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
ation-Anion Balance	3.22	0.01		%	06/15/2018 1125 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	06/05/2018 1536 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	06/05/2018 2232 MS	EPA 200.8
Barium	ND	0.1		mg/L	06/05/2018 2232 MS	EPA 200.8
Boron	0.1	0.1		mg/L	06/05/2018 1536 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	06/05/2018 2232 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/05/2018 1536 DG	EPA 200.7
Copper	ND	0.01		mg/L	06/05/2018 2232 MS	EPA 200.8
Iron	0.13	0.05		mg/L	06/05/2018 1536 DG	EPA 200.7
Lead	ND	0.02		mg/L	06/05/2018 2232 MS	EPA 200.8
Manganese	1.00	0.02		mg/L	06/05/2018 1536 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/06/2018 1331 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	06/05/2018 2232 MS	EPA 200.8
Nickel	0.02	0.01		mg/L	06/05/2018 1536 DG	EPA 200.7
Selenium	ND	0.005		mg/L	06/05/2018 2232 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/05/2018 1536 DG	EPA 200.7
Total Metals						
Iron	0.54	0.05		mg/L	06/07/2018 1835 DG	EPA 200.7
Manganese	1.16	0.02		mg/L	06/07/2018 1835 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

TRK G 2/2020

RECD 10-25-18

October 2018

DEQ Ex. 3-724

Addendum D6-10-234

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578415-SPL-1 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578415-SPL-1 Date Sampled 7 / 11 / 18 Time 1120 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 41.31 ft below MP Depth to Water (below MP) 16.09 ft Casing Diameter 2 in

Date 7 / 11 / 18 Time 1040 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method: Submersible pump (Bladder) Tap Bailer Grab

Pump intake or bailer set at 38 ft below MP.

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1120	6.83	4150	22.2	52.8	↓	150mL/30sec
1130	6.85	4180	21.3	45.0	~3.0	↓

Pumping Start Time 1050 WL _____ Pumping End Time _____ WL _____

Comments: water slightly turbid - no odor

HCF

Stick up = 1.65'

COC# 177611

Form completed by: Rod Fuller Witnessed by: _____

October 2018

TEK 2/2025

RECD 10-25-18

Addendum D6-10-235

Scanned, 02/28/2020

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Project: Ramaco-2014163-98
Lab ID: S1807175-002
Client Sample ID: 578415-SPL-1

Date Reported: 7/24/2018
Report ID: S1807175001

Work Order: S1807175
Collection Date: 7/11/2018 11:30:00 AM
Date Received: 7/11/2018 3:58:00 PM
Sampler: RF
Matrix: Water
COC: 177611

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	6.85			s.u.	07/11/2018 1130	Field
Conductivity	4180			µmhos/cm	07/11/2018 1130	Field
Turbidity	45.0			NTU	07/11/2018 1130	Field
Depth To Water	16.09			ft	07/11/2018 1130	Field
Temperature	21.3			°C	07/11/2018 1130	Field
General Parameters						
pH	7.7	0.1		s.u.	07/12/2018 2153 IBS	SM 4500 H B
Electrical Conductivity	4760	5		µmhos/cm	07/12/2018 2153 IBS	SM 2510B
Total Dissolved Solids (180)	4570	10		mg/L	07/12/2018 1616 NLG	SM 2540
Solids, Total Dissolved (Calc)	3860	10		mg/L	07/24/2018 1146 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	964	5		mg/L	07/12/2018 2153 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	2270	1		mg/L	07/24/2018 1146 JJ	SM 2340B
Nitrogen, Ammonia (as N)	4.2	0.1		mg/L	07/17/2018 1054 AMB	EPA 350.1
ıdium Adsorption Ratio	2.80	0.01			07/24/2018 1146 JJ	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	1180	5		mg/L	07/12/2018 2153 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/12/2018 2153 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/12/2018 2153 IBS	SM 2320B
Chloride	15	1		mg/L	07/12/2018 1751 AB	EPA 300.0
Fluoride	0.5	0.1		mg/L	07/12/2018 2153 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/13/2018 1447 AMB	EPA 353.2
Sulfate	2200	1		mg/L	07/13/2018 1103 AB	EPA 300.0
Cations						
Calcium	395	1		mg/L	07/16/2018 1740 DG	EPA 200.7
Magnesium	313	1		mg/L	07/16/2018 1740 DG	EPA 200.7
Potassium	46	1		mg/L	07/16/2018 1740 DG	EPA 200.7
Sodium	307	1		mg/L	07/16/2018 1740 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager
October 2018

TFN 6 2/035
DEQ 10-25-18

DEQ Ex. 3-726

Scanned, 02/28/2020

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/24/2018
Report ID: S1807175001

Work Order: S1807175
Collection Date: 7/11/2018 11:30:00 AM
Date Received: 7/11/2018 3:58:00 PM
Sampler: RF
Matrix: Water
COC: 177611

Project: Ramaco-2014163-98
Lab ID: S1807175-002
Client Sample ID: 578415-SPL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	19.27	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Chloride	0.41	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Sulfate	45.90	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Calcium	19.73	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Magnesium	25.76	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Potassium	1.17	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Sodium	13.37	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	60.34	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
ıion Sum	65.61	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
ation-Anion Balance	4.17	0.01		%	07/24/2018 1146 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/18/2018 1056 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/14/2018 0133 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/14/2018 0133 MS	EPA 200.8
Boron	0.1	0.1		mg/L	07/18/2018 1056 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/14/2018 0133 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/18/2018 1056 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/14/2018 0133 MS	EPA 200.8
Iron	0.06	0.05		mg/L	07/18/2018 1056 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/14/2018 0133 MS	EPA 200.8
Manganese	1.06	0.02		mg/L	07/18/2018 1056 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 1108 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/14/2018 0133 MS	EPA 200.8
Nickel	0.02	0.01		mg/L	07/18/2018 1056 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/14/2018 0133 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/18/2018 1056 DG	EPA 200.7
Total Metals						
Iron	0.50	0.05		mg/L	07/18/2018 2010 DG	EPA 200.7
Manganese	1.04	0.02		mg/L	07/18/2018 2010 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager
October 2018

TEU C 2/023

DEQ Ex. 3-727 5-25-18

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578415-SPL-2 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578415-SPL-2 Date Sampled 6 / 4 / 18 Time 1330 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 108.50 ft below MP Depth to Water (below MP) 64.30 ft Casing Diameter 2 in

Date 6 / 4 / 18 Time 1110 (am) pm Casing Volume 7.20 gal

At least 3 bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap (Bailer)

Pump intake or bailer set at NA ft below MP.

Tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1120	7.78	1719	15.0	761	8.0	
1230	7.92	1745	15.0	Over Limit	16.0	
1330	7.93	1782	15.1	O.L.	22.0	
		108.50				
		−64.30	= 44.20 x 0.163 = 7.20 x 3 =		21.6 GAL	

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC # 176172

Form completed by: [signature] Witnessed by: _____

DEQ Ex. 3-728

DEQ 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Brook Mine
Your Environmental Monitoring Partner

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/15/2018
Report ID: S1806031001

Work Order: S1806031
Collection Date: 6/4/2018 1:30:00 PM
Date Received: 6/4/2018 3:17:00 PM
Sampler: RF
Matrix: Water
COC: 176172

Project: 2014163-98-Ramaco
Lab ID: S1806031-001
Client Sample ID: 578415-SPL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.93			s.u.	06/04/2018 1330	Field
Conductivity	1782			µmhos/cm	06/04/2018 1330	Field
Turbidity	over limit			NTU	06/04/2018 1330	Field
Temperature	15.1			°C	06/04/2018 1330	Field
Static Water Level	64.30			ft	06/04/2018 1330	Field
General Parameters						
pH	8.4	0.1		s.u.	06/05/2018 1927 IBS	SM 4500 H B
Electrical Conductivity	1970	5		µmhos/cm	06/05/2018 1927 IBS	SM 2510B
Total Dissolved Solids (180)	1240	10		mg/L	06/05/2018 1323 NLG	SM 2540
Solids, Total Dissolved (Calc)	1230	10		mg/L	06/15/2018 1125 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	1080	5		mg/L	06/05/2018 1927 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	88	1		mg/L	06/15/2018 1125 JJ	SM 2340B
Nitrogen, Ammonia (as N)	5.7	0.1		mg/L	06/14/2018 1649 AMB	EPA 350.1
odium Adsorption Ratio	22.9	0.01			06/15/2018 1125 JJ	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	1270	5		mg/L	06/05/2018 1927 IBS	SM 2320B
Alkalinity, Carbonate as CO3	25	5		mg/L	06/05/2018 1927 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	06/05/2018 1927 IBS	SM 2320B
Chloride	16	1		mg/L	06/05/2018 1806 AB	EPA 300.0
Fluoride	1.4	0.1		mg/L	06/05/2018 1927 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	06/06/2018 1435 AMB	EPA 353.2
Sulfate	26	1		mg/L	06/05/2018 1806 AB	EPA 300.0
Cations						
Calcium	18	1		mg/L	06/05/2018 1532 DG	EPA 200.7
Magnesium	11	1		mg/L	06/05/2018 1532 DG	EPA 200.7
Potassium	15	1		mg/L	06/05/2018 1532 DG	EPA 200.7
Sodium	494	1		mg/L	06/05/2018 1532 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager
October 2018

DEQ Ex. 3-729

Addendum D6-10-239

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/15/2018
Report ID: S1806031001

Work Order: S1806031
Collection Date: 6/4/2018 1:30:00 PM
Date Received: 6/4/2018 3:17:00 PM
Sampler: RF
Matrix: Water
COC: 176172

Project: 2014163-98-Ramaco
Lab ID: S1806031-001
Client Sample ID: 578415-SPL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	20.87	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Carbonate as CO3	0.82	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Chloride	0.45	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Fluoride	0.07	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Sulfate	0.53	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Calcium	0.87	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Magnesium	0.87	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Potassium	0.39	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Sodium	21.49	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	24.04	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
ion Sum	22.76	0.01		meq/L	06/15/2018 1125 JJ	SM 1030E
ation-Anion Balance	2.74	0.01		%	06/15/2018 1125 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.3	0.1		mg/L	06/05/2018 1532 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	06/05/2018 2227 MS	EPA 200.8
Barium	0.3	0.1		mg/L	06/05/2018 2227 MS	EPA 200.8
Boron	ND	0.1		mg/L	06/05/2018 1532 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	06/05/2018 2227 MS	EPA 200.8
Chromium	ND	0.01		mg/L	06/05/2018 1532 DG	EPA 200.7
Copper	ND	0.01		mg/L	06/05/2018 2227 MS	EPA 200.8
Iron	0.10	0.05		mg/L	06/05/2018 1532 DG	EPA 200.7
Lead	ND	0.02		mg/L	06/05/2018 2227 MS	EPA 200.8
Manganese	0.16	0.02		mg/L	06/05/2018 1532 DG	EPA 200.7
Mercury	ND	0.001		mg/L	06/06/2018 1329 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	06/05/2018 2227 MS	EPA 200.8
Nickel	ND	0.01		mg/L	06/05/2018 1532 DG	EPA 200.7
Selenium	ND	0.005		mg/L	06/05/2018 2227 MS	EPA 200.8
Zinc	ND	0.01		mg/L	06/05/2018 1532 DG	EPA 200.7
Total Metals						
Iron	37.7	0.05		mg/L	06/07/2018 1830 DG	EPA 200.7
Manganese	1.19	0.02		mg/L	06/07/2018 1830 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

RECEIVED
OCT 24 2025
WQD 10-25-18

Scanned, 02/28/2020

RAMACO
WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578415-SPL-2 Project Ramaco

Location _____ W.O.# 2014163-98

Sample ID# 578415-SPL-2 Date Sampled 7 / 11 / 18 Time 0930 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 108.57 ft below MP Depth to Water (below MP) 70.80 ft Casing Diameter 2 in

Date 7 / 11 / 18 Time 0840 (am) pm Casing Volume _____ gal

At least NA bore volumes have been evacuated before sampling

Sampling method: Submersible pump (Bladder) Tap Bailer Grab

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Pump intake or bailer set at 105 ft below MP.

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0920	7.79	~~1776~~ [176]	24.0	30.3	↓	150 mL/30 sec
0930	7.81	1786	24.6	31.1	~3.0	↓

Pumping Start Time 0905 WL _____ Pumping End Time _____ WL _____

Comments: Water slightly turbid - no odor

HCF (Stick up = 1.83')

COC# 177611

Form completed by: Rod Fuller Witnessed by: _____

TFR 0 2/025

RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Brook Mine
Your Environmental Monitoring Partner

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/24/2018
Report ID: S1807175001

Work Order: S1807175
Collection Date: 7/11/2018 9:30:00 AM
Date Received: 7/11/2018 3:58:00 PM
Sampler: RF
Matrix: Water
COC: 177611

Project: Ramaco-2014163-98
Lab ID: S1807175-001
Client Sample ID: 578415-SPL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.81			s.u.	07/11/2018 0930	Field
Conductivity	1786			µmhos/cm	07/11/2018 0930	Field
Turbidity	31.3			NTU	07/11/2018 0930	Field
Depth To Water	70.80			ft	07/11/2018 0930	Field
Temperature	24.6			°C	07/11/2018 0930	Field
General Parameters						
pH	8.5	0.1		s.u.	07/12/2018 2140 IBS	SM 4500 H B
Electrical Conductivity	1950	5		µmhos/cm	07/12/2018 2140 IBS	SM 2510B
Total Dissolved Solids (180)	1210	10		mg/L	07/12/2018 1615 NLG	SM 2540
Solids, Total Dissolved (Calc)	1190	10		mg/L	07/24/2018 1146 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	1100	5		mg/L	07/12/2018 2140 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	84	1		mg/L	07/24/2018 1146 JJ	SM 2340B
Nitrogen, Ammonia (as N)	5.6	0.1		mg/L	07/17/2018 1157 AMB	EPA 350.1
ıdium Adsorption Ratio	22.2	0.01			07/24/2018 1146 JJ	Calculation
ons						
Alkalinity, Bicarbonate as HCO3	1280	5		mg/L	07/12/2018 2140 IBS	SM 2320B
Alkalinity, Carbonate as CO3	33	5		mg/L	07/12/2018 2140 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/12/2018 2140 IBS	SM 2320B
Chloride	17	1		mg/L	07/12/2018 1737 AB	EPA 300.0
Fluoride	1.4	0.1		mg/L	07/12/2018 2140 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.1	0.1		mg/L	07/13/2018 1445 AMB	EPA 353.2
Sulfate	7	1		mg/L	07/12/2018 1737 AB	EPA 300.0
Cations						
Calcium	17	1		mg/L	07/19/2018 1349 DG	EPA 200.7
Magnesium	10	1		mg/L	07/19/2018 1349 DG	EPA 200.7
Potassium	14	1		mg/L	07/19/2018 1349 DG	EPA 200.7
Sodium	467	1		mg/L	07/19/2018 1349 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager
October 2018

TFN 6 2/025
RECD 10-25-18

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
INTER-MOUNTAIN LABS
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

IENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/24/2018
Report ID: S1807175001

Work Order: S1807175
Collection Date: 7/11/2018 9:30:00 AM
Date Received: 7/11/2018 3:58:00 PM
Sampler: RF
Matrix: Water
COC: 177611

Project: Ramaco-2014163-98
Lab ID: S1807175-001
Client Sample ID: 578415-SPL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	20.91	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Carbonate as CO3	1.10	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Chloride	0.47	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Fluoride	0.07	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Sulfate	0.14	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Calcium	0.83	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Magnesium	0.84	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Potassium	0.36	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Sodium	20.33	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	22.76	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
ıion Sum	22.71	0.01		meq/L	07/24/2018 1146 JJ	SM 1030E
ation-Anion Balance	0.10	0.01		%	07/24/2018 1146 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/18/2018 1044 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/14/2018 0127 MS	EPA 200.8
Barium	0.3	0.1		mg/L	07/14/2018 0127 MS	EPA 200.8
Boron	ND	0.1		mg/L	07/18/2018 1044 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/14/2018 0127 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/18/2018 1044 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/14/2018 0127 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/18/2018 1044 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/14/2018 0127 MS	EPA 200.8
Manganese	ND	0.02		mg/L	07/18/2018 1044 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/17/2018 1106 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/14/2018 0127 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/18/2018 1044 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/14/2018 0127 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/18/2018 1044 DG	EPA 200.7
Total Metals						
Iron	0.72	0.05		mg/L	07/18/2018 2008 DG	EPA 200.7
Manganese	0.03	0.02		mg/L	07/18/2018 2008 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs

John Jacobs, Project Manager

October 2018

2/025

10-25-18

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578433-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578433-AL-1 Date Sampled 9/11/15 Time 0840 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 16.58 ft below MP Depth to Water (below MP) 7.20 ft Casing Diameter 2 in

Date 9/11/15 Time 0805 (am) pm Casing Volume 1.56 gal

At least 6+ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder Tap (Bailer)

Pump intake or bailer set at _____ ft below MP.

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no) and all field measurements (yes or no). Tubing used only for _____

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0840	7.41	1301	13.1	623	10	—

16.58
- 7.20
9.38' x 0.163 = 1.56 x 3 = 4.68 GAL

* used bucket to measure water volume

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor - Light brown in color.

HCF

COC# 131159

Form completed by: Bob Fuller Witnessed by: _____

April 2019

TFNS 2/025
RECD MAY 23, 2019

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/25/2015
Report ID: S1509203001

Work Order: S1509203
Collection Date: 9/11/2015 8:40:00 AM
Date Received: 9/11/2015 4:15:00 PM
Sampler: RF
Matrix: Water
COC: 131159

Project: Ramaco-2014163-07
Lab ID: S1509203-004
Client Sample ID: 578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.41			s.u.	09/11/2015 0840	Field
Conductivity	1301			µmhos/cm	09/11/2015 0840	Field
Turbidity	623			NTU	09/11/2015 0840	Field
Temperature	13.1			°C	09/11/2015 0840	Field
Static Water Level	7.20			ft	09/11/2015 0840	Field
General Parameters						
pH	8.2	0.1		s.u.	09/17/2015 1719 MRL	SM 4500 H B
Electrical Conductivity	1440	5		µmhos/cm	09/17/2015 1719 MRL	SM 2510B
Total Dissolved Solids (180)	1020	10		mg/L	09/14/2015 1557 IR	SM 2540
Solids, Total Dissolved (Calc)	930	10		mg/L	09/23/2015 0930 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	547	5		mg/L	09/17/2015 1719 MRL	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	641	1		mg/L	09/23/2015 0930 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.1	0.1		mg/L	09/18/2015 1517 AMB	EPA 350.1
Sodium Adsorption Ratio	1.7	0.1			09/23/2015 0930 JJ	Calculation
nions						
Alkalinity, Bicarbonate as HCO3	667	5		mg/L	09/17/2015 1719 MRL	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	09/17/2015 1719 MRL	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	09/17/2015 1719 MRL	SM 2320B
Chloride	12	1		mg/L	09/20/2015 2201 AB	EPA 300.0
Fluoride	0.6	0.1		mg/L	09/17/2015 1719 MRL	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	09/17/2015 1207 AMB	EPA 353.2
Sulfate	291	1		mg/L	09/20/2015 2201 AB	EPA 300.0
Cations						
Calcium	103	1		mg/L	09/14/2015 1929 DG	EPA 200.7
Magnesium	94	1		mg/L	09/14/2015 1929 DG	EPA 200.7
Potassium	5	1		mg/L	09/14/2015 1929 DG	EPA 200.7
Sodium	97	1		mg/L	09/14/2015 1929 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/225
RECD MAY 23, 2019

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/25/2015
Report ID: S1509203001

Work Order: S1509203
Collection Date: 9/11/2015 8:40:00 AM
Date Received: 9/11/2015 4:15:00 PM
Sampler: RF
Matrix: Water
COC: 131159

Project: Ramaco-2014163-07
Lab ID: S1509203-004
Client Sample ID: 578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	10.93	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Chloride	0.34	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Sulfate	6.05	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Calcium	5.12	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Magnesium	7.70	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Potassium	0.13	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Sodium	4.20	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	17.17	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Anion Sum	17.36	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Cation-Anion Balance	0.54	0.01		%	09/23/2015 0930 JJ	SM 1030E
Dissolved Metals						
Aluminum	0.5	0.1		mg/L	09/14/2015 1929 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	09/14/2015 1404 MS	EPA 200.8
Barium	ND	0.1		mg/L	09/14/2015 1404 MS	EPA 200.8
Boron	0.3	0.1		mg/L	09/14/2015 1929 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	09/14/2015 1404 MS	EPA 200.8
Chromium	ND	0.01		mg/L	09/14/2015 1929 DG	EPA 200.7
Copper	ND	0.01		mg/L	09/14/2015 1404 MS	EPA 200.8
Iron	1.97	0.05		mg/L	09/14/2015 1929 DG	EPA 200.7
Lead	ND	0.02		mg/L	09/14/2015 1404 MS	EPA 200.8
Manganese	1.19	0.02		mg/L	09/14/2015 1929 DG	EPA 200.7
Mercury	ND	0.001		mg/L	09/18/2015 0908 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	09/14/2015 1404 MS	EPA 200.8
Nickel	ND	0.01		mg/L	09/14/2015 1929 DG	EPA 200.7
Selenium	ND	0.005		mg/L	09/14/2015 1404 MS	EPA 200.8
Zinc	ND	0.01		mg/L	09/14/2015 1929 DG	EPA 200.7
Total Metals						
Iron	17.8	0.05		mg/L	09/17/2015 1129 DG	EPA 200.7
Manganese	1.37	0.02		mg/L	09/17/2015 1129 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by another laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/025
RECD MAY 23, 2016

DEQ Ex. 3-736

Scanned, 02/28/2020

RAMACO

* Field Duplicate

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point FD-578433-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# FD-578433-AL-1 Date Sampled 9 / 11 / 15 Time 0850 (am) pm

Describe Sampling Point 2" GW monitoring well

Well Depth _____ ft below MP Depth to Water (below MP) _____ ft Casing Diameter _____ in

Date / / Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap Bailer

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
_____	cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0850	7.41	1301	13.1	623	10	—

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Field Duplicate

COC# 131159

Form completed by: Rod Fuller Witnessed by: _____

April 2019

Addendum D6-10-247

C:\Fuller Files\Monitor Well Sample Form RF.doc

TENS 2/825

RECD MAY 23, 2019

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/25/2015
Report ID: S1509203001

Work Order: S1509203
Collection Date: 9/11/2015 8:50:00 AM
Date Received: 9/11/2015 4:15:00 PM
Sampler: RF
Matrix: Water
COC: 131159

Project: Ramaco-2014163-07
Lab ID: S1509203-005
Client Sample ID: FD-578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.41			s.u.	09/11/2015 0850	Field
Conductivity	1301			µmhos/cm	09/11/2015 0850	Field
Turbidity	623			NTU	09/11/2015 0850	Field
Temperature	13.1			°C	09/11/2015 0850	Field
Static Water Level	7.20			ft	09/11/2015 0850	Field
General Parameters						
pH	8.1	0.1		s.u.	09/17/2015 1742 MRL	SM 4500 H B
Electrical Conductivity	1450	5		µmhos/cm	09/17/2015 1742 MRL	SM 2510B
Total Dissolved Solids (180)	1020	10		mg/L	09/14/2015 1558 IR	SM 2540
Solids, Total Dissolved (Calc)	930	10		mg/L	09/23/2015 0930 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	547	5		mg/L	09/17/2015 1742 MRL	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	625	1		mg/L	09/23/2015 0930 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.3	0.1		mg/L	09/18/2015 1518 AMB	EPA 350.1
Sodium Adsorption Ratio	1.7	0.1			09/23/2015 0930 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	667	5		mg/L	09/17/2015 1742 MRL	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	09/17/2015 1742 MRL	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	09/17/2015 1742 MRL	SM 2320B
Chloride	12	1		mg/L	09/20/2015 2215 AB	EPA 300.0
Fluoride	0.6	0.1		mg/L	09/17/2015 1742 MRL	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	09/17/2015 1209 AMB	EPA 353.2
Sulfate	294	1		mg/L	09/20/2015 2215 AB	EPA 300.0
Cations						
Calcium	95	1		mg/L	09/14/2015 1932 DG	EPA 200.7
Magnesium	95	1		mg/L	09/14/2015 1932 DG	EPA 200.7
Potassium	6	1		mg/L	09/14/2015 1932 DG	EPA 200.7
Sodium	100	1		mg/L	09/14/2015 1932 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/025
RECD MAY 23, 2016

DEQ Ex. 3-738

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/25/2015
Report ID: S1509203001

Work Order: S1509203
Collection Date: 9/11/2015 8:50:00 AM
Date Received: 9/11/2015 4:15:00 PM
Sampler: RF
Matrix: Water
COC: 131159

Project: Ramaco-2014163-07
Lab ID: S1509203-005
Client Sample ID: FD-578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	10.93	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Chloride	0.34	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Sulfate	6.12	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Calcium	4.71	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Magnesium	7.79	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Potassium	0.14	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Sodium	4.33	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	17.01	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Anion Sum	17.44	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Cation-Anion Balance	1.23	0.01		%	09/23/2015 0930 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	09/14/2015 1932 DG	EPA 200.7
Arsenic	0.009	0.005		mg/L	09/14/2015 1410 MS	EPA 200.8
Barium	ND	0.1		mg/L	09/14/2015 1410 MS	EPA 200.8
Boron	0.3	0.1		mg/L	09/14/2015 1932 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	09/14/2015 1410 MS	EPA 200.8
Chromium	ND	0.01		mg/L	09/14/2015 1932 DG	EPA 200.7
Copper	ND	0.01		mg/L	09/14/2015 1410 MS	EPA 200.8
Iron	0.74	0.05		mg/L	09/14/2015 1932 DG	EPA 200.7
Lead	ND	0.02		mg/L	09/14/2015 1410 MS	EPA 200.8
Manganese	1.09	0.02		mg/L	09/14/2015 1932 DG	EPA 200.7
Mercury	ND	0.001		mg/L	09/18/2015 0910 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	09/14/2015 1410 MS	EPA 200.8
Nickel	ND	0.01		mg/L	09/14/2015 1932 DG	EPA 200.7
Selenium	ND	0.005		mg/L	09/14/2015 1410 MS	EPA 200.8
Zinc	ND	0.01		mg/L	09/14/2015 1932 DG	EPA 200.7
Total Metals						
Iron	11.9	0.05		mg/L	09/17/2015 1131 DG	EPA 200.7
Manganese	1.32	0.02		mg/L	09/17/2015 1131 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/825
RECD MAY 23, 2019

DEQ Ex. 3-739

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578434-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578434-AL-1 Date Sampled 9 / 11 / 15 Time 1000 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 13.88 ft below MP Depth to Water (below MP) 5.36 ft Casing Diameter 2 in

Date 9 / 11 / 15 Time 0938 (am) pm Casing Volume 1.39 gal

At least 6+ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap (Bailer)

Pump intake or bailer set at NA ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

Tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1000	7.34	1431	16.7	OVER LIMIT	10	—

13.88
-5.36
8.52 x 0.163 = 1.39 x 3 = 4.17

* used bucket to measure water volume

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor - not clearing up after 6 bore volumes - Dark brown in color

HCF

COC # 131159

Form completed by: Rod Fuller Witnessed by: _____

April 2019

TFNS 2/825

C:\Fuller Files\WWC\Well Sample Form 4-19.doc

Addendum D6-10-250

DEQ Ex. 3-740

RECD MAY 23, 2019

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/25/2015
Report ID: S1509203001

Work Order: S1509203
Collection Date: 9/11/2015 10:00:00 AM
Date Received: 9/11/2015 4:15:00 PM
Sampler: RF
Matrix: Water
COC: 131159

Project: Ramaco-2014163-07
Lab ID: S1509203-006
Client Sample ID: 578434-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.34			s.u.	09/11/2015 1000	Field
Conductivity	1431			µmhos/cm	09/11/2015 1000	Field
Turbidity	Over Limit			NTU	09/11/2015 1000	Field
Temperature	16.7			°C	09/11/2015 1000	Field
Static Water Level	5.36			ft	09/11/2015 1000	Field
General Parameters						
pH	8.0	0.1		s.u.	09/17/2015 1802 MRL	SM 4500 H B
Electrical Conductivity	1650	5		µmhos/cm	09/17/2015 1802 MRL	SM 2510B
Total Dissolved Solids (180)	1110	10		mg/L	09/14/2015 1559 IR	SM 2540
Solids, Total Dissolved (Calc)	1070	10		mg/L	09/23/2015 0930 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	784	5		mg/L	09/17/2015 1802 MRL	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	831	1		mg/L	09/23/2015 0930 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.5	0.1		mg/L	09/18/2015 1519 AMB	EPA 350.1
Sodium Adsorption Ratio	1.5	0.1			09/23/2015 0930 JJ	Calculation
nions						
Alkalinity, Bicarbonate as HCO3	956	5		mg/L	09/17/2015 1802 MRL	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	09/17/2015 1802 MRL	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	09/17/2015 1802 MRL	SM 2320B
Chloride	11	1		mg/L	09/22/2015 2119 AB	EPA 300.0
Fluoride	0.9	0.1		mg/L	09/17/2015 1802 MRL	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	09/17/2015 1210 AMB	EPA 353.2
Sulfate	246	1		mg/L	09/22/2015 2119 AB	EPA 300.0
Cations						
Calcium	91	1		mg/L	09/22/2015 2140 DG	EPA 200.7
Magnesium	147	1		mg/L	09/22/2015 2140 DG	EPA 200.7
Potassium	4	1		mg/L	09/22/2015 2140 DG	EPA 200.7
Sodium	102	1		mg/L	09/14/2015 1934 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/025
RECD MAY 23, 2019

DEQ Ex. 3-741

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/25/2015
Report ID: S1509203001

Work Order: S1509203
Collection Date: 9/11/2015 10:00:00 AM
Date Received: 9/11/2015 4:15:00 PM
Sampler: RF
Matrix: Water
COC: 131159

Project: Ramaco-2014163-07
Lab ID: S1509203-006
Client Sample ID: 578434-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	15.67	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Chloride	0.29	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Fluoride	0.04	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Sulfate	5.12	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Calcium	4.54	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Magnesium	12.08	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Potassium	0.11	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Sodium	4.45	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	21.23	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Anion Sum	21.14	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Cation-Anion Balance	0.20	0.01		%	09/23/2015 0930 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	09/14/2015 1934 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	09/14/2015 1415 MS	EPA 200.8
Barium	0.1	0.1		mg/L	09/14/2015 1415 MS	EPA 200.8
Boron	0.3	0.1		mg/L	09/14/2015 1934 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	09/14/2015 1415 MS	EPA 200.8
Chromium	ND	0.01		mg/L	09/14/2015 1934 DG	EPA 200.7
Copper	ND	0.01		mg/L	09/14/2015 1415 MS	EPA 200.8
Iron	0.70	0.05		mg/L	09/14/2015 1934 DG	EPA 200.7
Lead	ND	0.02		mg/L	09/14/2015 1415 MS	EPA 200.8
Manganese	1.06	0.02		mg/L	09/14/2015 1934 DG	EPA 200.7
Mercury	ND	0.001		mg/L	09/18/2015 0912 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	09/14/2015 1415 MS	EPA 200.8
Nickel	ND	0.01		mg/L	09/14/2015 1934 DG	EPA 200.7
Selenium	ND	0.005		mg/L	09/14/2015 1415 MS	EPA 200.8
Zinc	ND	0.01		mg/L	09/14/2015 1934 DG	EPA 200.7
Total Metals						
Iron	94.3	0.05		mg/L	09/18/2015 1109 DG	EPA 200.7
Manganese	3.68	0.02		mg/L	09/17/2015 1134 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by another laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/825
RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578434-AL-2 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578434-AL-2 Date Sampled 9 / 11 / 15 Time 1130 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 17.24 ft below MP Depth to Water (below MP) 5.84 ft Casing Diameter 2 in

Date 9 / 11 / 15 Time 1050 (am) pm Casing Volume 1.86 gal

At least 6+ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap (Bailer)

Pump intake or bailer set at NA ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

Tubing (type: NA). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1130	7.74	663	19.2	513	12	—

17.24
- 5.84
11.40 X 0.163 = 1.86 X 3 = 5.57GAL
* used bucket to measure water volume

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: water turbid (light brown) - no odor

HCE
COC# 131159

Form completed by: Bob Fuller Witnessed by: _____

April 2019 C:\Fuller Files\Monitor Well Sample Form-RR.doc

TENS 2/825
RECD MAY 23, 2019

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/25/2015
Report ID: S1509203001

Work Order: S1509203
Collection Date: 9/11/2015 11:30:00 AM
Date Received: 9/11/2015 4:15:00 PM
Sampler: RF
Matrix: Water
COC: 131159

Project: Ramaco-2014163-07
Lab ID: S1509203-007
Client Sample ID: 578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.74			s.u.	09/11/2015 1130	Field
Conductivity	663			µmhos/cm	09/11/2015 1130	Field
Turbidity	513			NTU	09/11/2015 1130	Field
Temperature	19.2			°C	09/11/2015 1130	Field
Static Water Level	5.84			ft	09/11/2015 1130	Field
General Parameters						
pH	8.3	0.1		s.u.	09/17/2015 1812 MRL	SM 4500 H B
Electrical Conductivity	689	5		µmhos/cm	09/17/2015 1812 MRL	SM 2510B
Total Dissolved Solids (180)	440	10		mg/L	09/14/2015 1600 IR	SM 2540
Solids, Total Dissolved (Calc)	420	10		mg/L	09/23/2015 0930 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	271	5		mg/L	09/17/2015 1812 MRL	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	338	1		mg/L	09/23/2015 0930 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	09/18/2015 1521 AMB	EPA 350.1
Sodium Adsorption Ratio	0.6	0.1			09/23/2015 0930 JJ	Calculation
Ions						
Alkalinity, Bicarbonate as HCO3	331	5		mg/L	09/17/2015 1812 MRL	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	09/17/2015 1812 MRL	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	09/17/2015 1812 MRL	SM 2320B
Chloride	9	1		mg/L	09/22/2015 2132 AB	EPA 300.0
Fluoride	0.3	0.1		mg/L	09/17/2015 1812 MRL	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.3	0.1		mg/L	09/17/2015 1221 AMB	EPA 353.2
Sulfate	108	1		mg/L	09/22/2015 2132 AB	EPA 300.0
Cations						
Calcium	64	1		mg/L	09/22/2015 2143 DG	EPA 200.7
Magnesium	43	1		mg/L	09/22/2015 2143 DG	EPA 200.7
Potassium	4	1		mg/L	09/22/2015 2143 DG	EPA 200.7
Sodium	24	1		mg/L	09/22/2015 2143 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/625
FEBRUARY 28, 2019

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 9/25/2015
Report ID: S1509203001

Work Order: S1509203
Collection Date: 9/11/2015 11:30:00 AM
Date Received: 9/11/2015 4:15:00 PM
Sampler: RF
Matrix: Water
COC: 131159

Project: Ramaco-2014163-07
Lab ID: S1509203-007
Client Sample ID: 578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	5.42	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Chloride	0.24	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Nitrate + Nitrite as N	0.02	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Sulfate	2.23	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Calcium	3.20	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Magnesium	3.55	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Potassium	0.09	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Sodium	1.02	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	7.88	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Anion Sum	7.95	0.01		meq/L	09/23/2015 0930 JJ	SM 1030E
Cation-Anion Balance	0.41	0.01		%	09/23/2015 0930 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	09/14/2015 1936 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	09/14/2015 1421 MS	EPA 200.8
Barium	ND	0.1		mg/L	09/14/2015 1421 MS	EPA 200.8
Boron	0.4	0.1		mg/L	09/14/2015 1936 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	09/14/2015 1421 MS	EPA 200.8
Chromium	ND	0.01		mg/L	09/14/2015 1936 DG	EPA 200.7
Copper	ND	0.01		mg/L	09/14/2015 1421 MS	EPA 200.8
Iron	2.24	0.05		mg/L	09/14/2015 1936 DG	EPA 200.7
Lead	ND	0.02		mg/L	09/14/2015 1421 MS	EPA 200.8
Manganese	ND	0.02		mg/L	09/23/2015 1343 DG	EPA 200.7
Mercury	ND	0.001		mg/L	09/18/2015 0914 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	09/14/2015 1421 MS	EPA 200.8
Nickel	ND	0.01		mg/L	09/14/2015 1936 DG	EPA 200.7
Selenium	ND	0.005		mg/L	09/14/2015 1421 MS	EPA 200.8
Zinc	ND	0.01		mg/L	09/14/2015 1936 DG	EPA 200.7
Total Metals						
Iron	9.19	0.05		mg/L	09/17/2015 1136 DG	EPA 200.7
Manganese	0.32	0.02		mg/L	09/17/2015 1136 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by another laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/625

DEQ Ex. 3-745

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578433-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578433-AL-1 Date Sampled 12 / 1 / 15 Time 1240 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 16.6 ft below MP Depth to Water (below MP) 6.89 ft Casing Diameter 2 in

Date 12 / 1 / 15 Time 1205 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

Pump intake or bailer set at 15.5 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1230	7.59	1540	11.3	439	↓	150 mL/30 sec
1240	7.61	1515	10.8	210	~3.0	↓

Pumping Start Time 1215 WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF

COC # 162106

Form completed by: Rod Fuller Witnessed by: _____

April 2019

C:\Fuller Files\Monitor Well Sample Form 4R.doc

Addendum D6-10-256

DEQ Ex. 3-746

TENS 2/525

RECD MAY 23, 2019

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RAMACO
INTER-MOUNTAIN LABS
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512028001

Work Order: S1512028
Collection Date: 12/1/2015 12:40:00 PM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162106

Project: Ramaco-2014163-07
Lab ID: S1512028-003
Client Sample ID: 578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.61			s.u.	12/01/2015 1240	Field
Conductivity	1515			µmhos/cm	12/01/2015 1240	Field
Turbidity	210			NTU	12/01/2015 1240	Field
Temperature	10.8			°C	12/01/2015 1240	Field
Static Water Level	6.89			ft	12/01/2015 1240	Field
General Parameters						
pH	8.0	0.1		s.u.	12/02/2015 1646 SFF	SM 4500 H B
Electrical Conductivity	1590	5		µmhos/cm	12/02/2015 1646 SFF	SM 2510B
Total Dissolved Solids (180)	1170	10		mg/L	12/02/2015 1440 IR	SM 2540
Solids, Total Dissolved (Calc)	1050	10		mg/L	12/08/2015 1116 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	586	5		mg/L	12/02/2015 1646 SFF	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	713	1		mg/L	12/08/2015 1116 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.2	0.1		mg/L	12/07/2015 1002 AMB	EPA 350.1
Sodium Adsorption Ratio	1.8	0.1			12/08/2015 1116 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	715	5		mg/L	12/02/2015 1646 SFF	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/02/2015 1646 SFF	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/02/2015 1646 SFF	SM 2320B
Chloride	16	1		mg/L	12/02/2015 1859 AB	EPA 300.0
Fluoride	0.6	0.1		mg/L	12/02/2015 1646 SFF	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/07/2015 1118 AMB	EPA 353.2
Sulfate	348	1		mg/L	12/02/2015 1859 AB	EPA 300.0
Cations						
Calcium	111	1		mg/L	12/02/2015 1456 DG	EPA 200.7
Magnesium	106	1		mg/L	12/02/2015 1456 DG	EPA 200.7
Potassium	5	1		mg/L	12/02/2015 1456 DG	EPA 200.7
Sodium	114	1		mg/L	12/02/2015 1456 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

A	Check MSA specifications
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/025
RECEIVED MAY 23, 2019

DEQ Ex. 3-747

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512028001

Work Order: S1512028
Collection Date: 12/1/2015 12:40:00 PM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162106

Project: Ramaco-2014163-07
Lab ID: S1512028-003
Client Sample ID: 578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	11.71	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Chloride	0.45	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Sulfate	7.24	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Calcium	5.52	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Magnesium	8.72	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Potassium	0.13	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Sodium	4.94	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	19.35	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Anion Sum	19.44	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Cation-Anion Balance	0.23	0.01		%	12/08/2015 1116 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/02/2015 1456 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/02/2015 2056 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/02/2015 2056 MS	EPA 200.8
Boron	0.2	0.1		mg/L	12/02/2015 1456 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/02/2015 2056 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/02/2015 1456 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/02/2015 2056 MS	EPA 200.8
Iron	0.90	0.05		mg/L	12/02/2015 1456 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/02/2015 2056 MS	EPA 200.8
Manganese	1.30	0.02		mg/L	12/02/2015 1456 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/04/2015 1007 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/02/2015 2056 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/02/2015 1456 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/02/2015 2056 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/02/2015 1456 DG	EPA 200.7
Total Metals						
Iron	11.7	0.05		mg/L	12/03/2015 1617 DG	EPA 200.7
Manganese	1.45	0.02		mg/L	12/03/2015 1617 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

A	Check MSA specifications
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/025
RECD MAY 23, 2019

DEQ Ex. 3-748

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578434-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578434-AL-1 Date Sampled 12 / 1 / 15 Time 1350 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 13.88 ft below MP Depth to Water (below MP) 5.04 ft Casing Diameter 2 in

Date 12 / 1 / 15 Time 1315 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

Pump intake or bailer set at 13 ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
_____	cfs

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1340	7.61	1661	10.4	443	↓	↓
1350	7.63	1624	10.2	175	~3.0	150ML/30sec

Pumping Start Time 1325 WL _____ Pumping End Time _____ WL _____

Comments: Water turbid - no odor

HCF

COC# 162106

Form completed by: Bob Fulton Witnessed by: _____

April 2019

C:\Forms\Field\Monitor Well Sample Form-Rev1.doc

Addendum D6-10-259

DEQ Ex. 3-749

TENR 2/625
RECD MAY 23, 2019

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512028001

Work Order: S1512028
Collection Date: 12/1/2015 1:50:00 PM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162106

Project: Ramaco-2014163-07
Lab ID: S1512028-004
Client Sample ID: 578434-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.63			s.u.	12/01/2015 1350	Field
Conductivity	1624			µmhos/cm	12/01/2015 1350	Field
Turbidity	175			NTU	12/01/2015 1350	Field
Temperature	10.2			°C	12/01/2015 1350	Field
Static Water Level	5.04			ft	12/01/2015 1350	Field
General Parameters						
pH	8.0	0.1		s.u.	12/02/2015 1656 SFF	SM 4500 H B
Electrical Conductivity	1730	5		µmhos/cm	12/02/2015 1656 SFF	SM 2510B
Total Dissolved Solids (180)	1260	10		mg/L	12/02/2015 1441 IR	SM 2540
Solids, Total Dissolved (Calc)	1150	10		mg/L	12/08/2015 1116 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	735	5		mg/L	12/02/2015 1656 SFF	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	867	1		mg/L	12/08/2015 1116 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.3	0.1		mg/L	12/07/2015 1004 AMB	EPA 350.1
Sodium Adsorption Ratio	1.5	0.1			12/08/2015 1116 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	897	5		mg/L	12/02/2015 1656 SFF	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/02/2015 1656 SFF	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/02/2015 1656 SFF	SM 2320B
Chloride	9	1		mg/L	12/02/2015 1912 AB	EPA 300.0
Fluoride	0.8	0.1		mg/L	12/02/2015 1656 SFF	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	12/07/2015 1120 AMB	EPA 353.2
Sulfate	345	1		mg/L	12/02/2015 1912 AB	EPA 300.0
Cations						
Calcium	91	1		mg/L	12/02/2015 1459 DG	EPA 200.7
Magnesium	156	1		mg/L	12/02/2015 1459 DG	EPA 200.7
Potassium	3	1		mg/L	12/02/2015 1459 DG	EPA 200.7
Sodium	101	1		mg/L	12/02/2015 1459 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- A Check MSA specifications
- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by another laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/825
RECD MAY 23, 2019

DEQ Ex. 3-750

Scanned, 02/28/2020

RAMACO
INTER-MOUNTAIN LABS
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512028001

Work Order: S1512028
Collection Date: 12/1/2015 1:50:00 PM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162106

Project: Ramaco-2014163-07
Lab ID: S1512028-004
Client Sample ID: 578434-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	14.70	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Chloride	0.24	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Sulfate	7.17	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Calcium	4.52	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Magnesium	12.81	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Potassium	0.07	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Sodium	4.39	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	21.83	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Anion Sum	22.16	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Cation-Anion Balance	0.75	0.01		%	12/08/2015 1116 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/02/2015 1459 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/02/2015 2102 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/02/2015 2102 MS	EPA 200.8
Boron	0.3	0.1		mg/L	12/02/2015 1459 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/02/2015 2102 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/02/2015 1459 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/02/2015 2102 MS	EPA 200.8
Iron	6.28	0.05		mg/L	12/02/2015 1459 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/02/2015 2102 MS	EPA 200.8
Manganese	0.57	0.02		mg/L	12/02/2015 1459 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/04/2015 1021 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/02/2015 2102 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/02/2015 1459 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/02/2015 2102 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/02/2015 1459 DG	EPA 200.7
Total Metals						
Iron	19.3	0.05		mg/L	12/03/2015 1626 DG	EPA 200.7
Manganese	0.66	0.02		mg/L	12/03/2015 1626 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

A	Check MSA specifications
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

April 2019

TFNS 2/025
2020 MAY 23, 2019

Addendum D6-10-261

DEQ Ex. 3-751

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578434-AL-2 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578434-AL-2 Date Sampled 12 / 1 / 15 Time 1110 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 17.24 ft below MP Depth to Water (below MP) 5.63 ft Casing Diameter 2 in

Date 12 / 1 / 15 Time 1035 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

Pump intake or bailer set at 15 ft below MP.

DISCHARGE RATE	
_____	gpm
x	0.00223
	cfs

Tubing (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1100	7.99	699	9.4	153	↓	150 ML/30 Sec.
1110	7.96	692	8.8	43.2	~3.0	↓

Pumping Start Time 1045 WL _____ Pumping End Time _____ WL _____

Comments: water slightly turbid - no odor

HCF
COC # 162106

Form completed by: Rod Fuller Witnessed by: _____

April 2019

TFNS 2/C25

Addendum D6.10-262

DEQ Ex. 3-752

RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO
INTER-MOUNTAIN LABS
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512028001

Work Order: S1512028
Collection Date: 12/1/2015 11:10:00 AM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162106

Project: Ramaco-2014163-07
Lab ID: S1512028-001
Client Sample ID: 578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.96			s.u.	12/01/2015 1110	Field
Conductivity	692			µmhos/cm	12/01/2015 1110	Field
Turbidity	43.2			NTU	12/01/2015 1110	Field
Temperature	8.8			°C	12/01/2015 1110	Field
Static Water Level	5.63			ft	12/01/2015 1110	Field
General Parameters						
pH	8.2	0.1		s.u.	12/02/2015 1616 SFF	SM 4500 H B
Electrical Conductivity	690	5		µmhos/cm	12/02/2015 1616 SFF	SM 2510B
Total Dissolved Solids (180)	440	10		mg/L	12/02/2015 1438 IR	SM 2540
Solids, Total Dissolved (Calc)	410	10		mg/L	12/08/2015 1116 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	270	5		mg/L	12/02/2015 1616 SFF	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	337	1		mg/L	12/08/2015 1116 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	12/07/2015 0952 AMB	EPA 350.1
Sodium Adsorption Ratio	0.6	0.1			12/08/2015 1116 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	330	5		mg/L	12/02/2015 1616 SFF	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/02/2015 1616 SFF	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/02/2015 1616 SFF	SM 2320B
Chloride	8	1		mg/L	12/02/2015 1833 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	12/02/2015 1616 SFF	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.5	0.1		mg/L	12/07/2015 1115 AMB	EPA 353.2
Sulfate	102	1		mg/L	12/02/2015 1833 AB	EPA 300.0
Cations						
Calcium	63	1		mg/L	12/02/2015 1452 DG	EPA 200.7
Magnesium	43	1		mg/L	12/02/2015 1452 DG	EPA 200.7
Potassium	3	1		mg/L	12/02/2015 1452 DG	EPA 200.7
Sodium	23	1		mg/L	12/02/2015 1452 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

A	Check MSA specifications
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/025

April 2019

RECD MAY 23, 2019

Addendum D6-10-263

DEQ Ex. 3-753

Scanned, 02/28/2020

RAMACO
INTER-MOUNTAIN LABS
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512028001

Work Order: S1512028
Collection Date: 12/1/2015 11:10:00 AM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162106

Project: Ramaco-2014163-07
Lab ID: S1512028-001
Client Sample ID: 578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	5.40	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Chloride	0.23	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Nitrate + Nitrite as N	0.03	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Sulfate	2.11	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Calcium	3.15	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Magnesium	3.57	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Potassium	0.08	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Sodium	1.01	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	7.82	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Anion Sum	7.79	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Cation-Anion Balance	0.20	0.01		%	12/08/2015 1116 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/02/2015 1452 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/02/2015 2030 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/02/2015 2030 MS	EPA 200.8
Boron	ND	0.1		mg/L	12/02/2015 1452 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/02/2015 2030 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/02/2015 1452 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/02/2015 2030 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/02/2015 1452 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/02/2015 2030 MS	EPA 200.8
Manganese	0.03	0.02		mg/L	12/02/2015 1452 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/04/2015 1004 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/02/2015 2030 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/02/2015 1452 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/02/2015 2030 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/02/2015 1452 DG	EPA 200.7
Total Metals						
Iron	2.51	0.05		mg/L	12/03/2015 1612 DG	EPA 200.7
Manganese	0.32	0.02		mg/L	12/03/2015 1612 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

A	Check MSA specifications
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/825

DEQ Ex. 3-754

Scanned, 02/28/2020

RAMACO

* Field Duplicate

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point FD-578434-AL-2 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# FD-578434-AL-2 Date Sampled 12 / 1 / 15 Time 1115 (am) pm

Describe Sampling Point GW monitoring Well

Well Depth _____ ft below MP Depth to Water (below MP) 5.63 ft Casing Diameter _____ in

Date / / Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method Submersible pump Bladder

Tap Bailer

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1115	7.96	692	8.8	43.2		

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Field duplicate

COC # 162106

Form completed by: Rod Fuller Witnessed by: _____

April 2019

TFNS 2/825

RECD MAY 23, 2019

Addendum D6.10-265

C:\Fuller Files\Monitor Well Sample Form-AP.doc

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512028001

Work Order: S1512028
Collection Date: 12/1/2015 11:15:00 AM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162106

Project: Ramaco-2014163-07
Lab ID: S1512028-002
Client Sample ID: FD-578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.96			s.u.	12/01/2015 1115	Field
Conductivity	692			µmhos/cm	12/01/2015 1115	Field
Turbidity	43.2			NTU	12/01/2015 1115	Field
Temperature	8.8			°C	12/01/2015 1115	Field
Static Water Level	5.63			ft	12/01/2015 1115	Field
General Parameters						
pH	8.2	0.1		s.u.	12/02/2015 1626 SFF	SM 4500 H B
Electrical Conductivity	698	5		µmhos/cm	12/02/2015 1626 SFF	SM 2510B
Total Dissolved Solids (180)	440	10		mg/L	12/02/2015 1439 IR	SM 2540
Solids, Total Dissolved (Calc)	410	10		mg/L	12/08/2015 1116 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	269	5		mg/L	12/02/2015 1626 SFF	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	334	1		mg/L	12/08/2015 1116 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	12/07/2015 1001 AMB	EPA 350.1
Sodium Adsorption Ratio	0.6	0.1			12/08/2015 1116 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	328	5		mg/L	12/02/2015 1626 SFF	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	12/02/2015 1626 SFF	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	12/02/2015 1626 SFF	SM 2320B
Chloride	8	1		mg/L	12/02/2015 1846 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	12/02/2015 1626 SFF	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.6	0.1		mg/L	12/07/2015 1117 AMB	EPA 353.2
Sulfate	102	1		mg/L	12/02/2015 1846 AB	EPA 300.0
Cations						
Calcium	63	1		mg/L	12/02/2015 1454 DG	EPA 200.7
Magnesium	43	1		mg/L	12/02/2015 1454 DG	EPA 200.7
Potassium	3	1		mg/L	12/02/2015 1454 DG	EPA 200.7
Sodium	23	1		mg/L	12/02/2015 1454 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

A	Check MSA specifications
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFWS 2/625
RECEIVED MAY 23, 2019

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 12/9/2015
Report ID: S1512028001

Work Order: S1512028
Collection Date: 12/1/2015 11:15:00 AM
Date Received: 12/1/2015 3:00:00 PM
Sampler: RF
Matrix: Water
COC: 162106

Project: Ramaco-2014163-07
Lab ID: S1512028-002
Client Sample ID: FD-578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	5.37	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Chloride	0.22	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Nitrate + Nitrite as N	0.04	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Sulfate	2.13	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Calcium	3.12	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Magnesium	3.55	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Potassium	0.08	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Sodium	1.00	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	7.76	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Anion Sum	7.79	0.01		meq/L	12/08/2015 1116 JJ	SM 1030E
Cation-Anion Balance	0.19	0.01		%	12/08/2015 1116 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	12/02/2015 1454 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	12/02/2015 2051 MS	EPA 200.8
Barium	ND	0.1		mg/L	12/02/2015 2051 MS	EPA 200.8
Boron	ND	0.1		mg/L	12/02/2015 1454 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	12/02/2015 2051 MS	EPA 200.8
Chromium	ND	0.01		mg/L	12/02/2015 1454 DG	EPA 200.7
Copper	ND	0.01		mg/L	12/02/2015 2051 MS	EPA 200.8
Iron	ND	0.05		mg/L	12/02/2015 1454 DG	EPA 200.7
Lead	ND	0.02		mg/L	12/02/2015 2051 MS	EPA 200.8
Manganese	0.03	0.02		mg/L	12/02/2015 1454 DG	EPA 200.7
Mercury	ND	0.001		mg/L	12/04/2015 1006 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	12/02/2015 2051 MS	EPA 200.8
Nickel	ND	0.01		mg/L	12/02/2015 1454 DG	EPA 200.7
Selenium	ND	0.005		mg/L	12/02/2015 2051 MS	EPA 200.8
Zinc	ND	0.01		mg/L	12/02/2015 1454 DG	EPA 200.7
Total Metals						
Iron	4.03	0.05		mg/L	12/03/2015 1615 DG	EPA 200.7
Manganese	0.36	0.02		mg/L	12/03/2015 1615 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

A	Check MSA specifications
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

RL - Reporting Limit

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/S25
RECD MAY 23, 2019

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578433-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578433-AL-1 Date Sampled 3 / 1 / 16 Time 1245 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 16.6 ft below MP Depth to Water (below MP) 7.15 ft Casing Diameter 2 in

Date 3 / 1 / 16 Time 1210 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

Pump intake or bailer set at 15 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1235	7.63	1796	13.1	250	↓	150ML/30sec
1245	7.69	1776	13.3	86.1	3.0	↓

Pumping Start Time 1220 WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF

CCC# 165160

Form completed by: Rod Fuller Witnessed by: _____

TENS 2/825
RECD MAY 23, 2019

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2016
Report ID: S1603020001

Work Order: S1603020
Collection Date: 3/1/2016 12:45:00 PM
Date Received: 3/1/2016 4:06:00 PM
Sampler: RF
Matrix: Water
COC: 165160

Project: Ramaco-2014163-07
Lab ID: S1603020-004
Client Sample ID: 578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.69			s.u.	03/01/2016 1245	Field
Conductivity	1776			µmhos/cm	03/01/2016 1245	Field
Turbidity	86.1			NTU	03/01/2016 1245	Field
Temperature	13.3			°C	03/01/2016 1245	Field
Static Water Level	7.15			ft	03/01/2016 1245	Field
General Parameters						
pH	8.1	0.1		s.u.	03/02/2016 1853 LAB	SM 4500 H B
Electrical Conductivity	1690	5		µmhos/cm	03/02/2016 1853 LAB	SM 2510B
Total Dissolved Solids (180)	1330	10		mg/L	03/02/2016 0947 NLG	SM 2540
Solids, Total Dissolved (Calc)	1200	10		mg/L	03/08/2016 1550 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	671	5		mg/L	03/02/2016 1853 LAB	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	803	1		mg/L	03/08/2016 1550 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.3	0.1		mg/L	03/04/2016 1507 AMB	EPA 350.1
Sodium Adsorption Ratio	2.0	0.1			03/08/2016 1550 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	819	5		mg/L	03/02/2016 1853 LAB	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/02/2016 1853 LAB	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/02/2016 1853 LAB	SM 2320B
Chloride	17	1		mg/L	03/02/2016 1604 AB	EPA 300.0
Fluoride	0.6	0.1		mg/L	03/02/2016 1853 LAB	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/03/2016 1310 AMB	EPA 353.2
Sulfate	402	1		mg/L	03/02/2016 1604 AB	EPA 300.0
Cations						
Calcium	122	1		mg/L	03/02/2016 1436 DG	EPA 200.7
Magnesium	121	1		mg/L	03/02/2016 1436 DG	EPA 200.7
Potassium	5	1		mg/L	03/02/2016 1436 DG	EPA 200.7
Sodium	130	1		mg/L	03/02/2016 1436 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/025
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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2016
Report ID: S1603020001

Work Order: S1603020
Collection Date: 3/1/2016 12:45:00 PM
Date Received: 3/1/2016 4:06:00 PM
Sampler: RF
Matrix: Water
COC: 165160

Project: Ramaco-2014163-07
Lab ID: S1603020-004
Client Sample ID: 578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.42	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Chloride	0.48	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Sulfate	8.37	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Calcium	6.10	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Magnesium	9.94	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Potassium	0.13	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Sodium	5.65	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	21.86	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Anion Sum	22.31	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Cation-Anion Balance	1.02	0.01		%	03/08/2016 1550 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/02/2016 1436 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/02/2016 1731 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/02/2016 1731 MS	EPA 200.8
Boron	0.2	0.1		mg/L	03/02/2016 1436 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/02/2016 1731 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/02/2016 1436 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/02/2016 1731 MS	EPA 200.8
Iron	0.78	0.05		mg/L	03/02/2016 1436 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/02/2016 1731 MS	EPA 200.8
Manganese	1.53	0.02		mg/L	03/02/2016 1436 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/04/2016 0955 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/02/2016 1731 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/02/2016 1436 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/02/2016 1731 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/02/2016 1436 DG	EPA 200.7
Total Metals						
Iron	4.86	0.05		mg/L	03/04/2016 1639 DG	EPA 200.7
Manganese	1.60	0.02		mg/L	03/04/2016 1639 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/625
RECD MAY 23, 2019

April 2019

Addendum D6-10-270

DEQ Ex. 3-760

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578434-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578434-AL-1 Date Sampled 3 / 1 / 16 Time 1350 am/pm

Describe Sampling Point GW monitoring well

Well Depth 13.88 ft below MP Depth to Water (below MP) 5.20 ft Casing Diameter 2 in

Date 3 / 1 / 16 Time 1320 am/pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

Pump intake or bailer set at 12 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1340	7.68	1526	11.0	202	↓	150 ML/30 sec
1350	7.72	1513	10.5	111	~3.0	↓

Pumping Start Time 1325 WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF

COC # 165160

Form completed by: Rod Fuller Witnessed by: _____

April 2019

TFNS 2/025

C:\Fuller Files\Monitor Well Sample Form-NT.doc

Addendum D6-10-271

DEQ Ex. 3-761

RECEIVED MAY 23, 2019

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2016
Report ID: S1603020001

Work Order: S1603020
Collection Date: 3/1/2016 1:50:00 PM
Date Received: 3/1/2016 4:06:00 PM
Sampler: RF
Matrix: Water
COC: 165160

Project: Ramaco-2014163-07
Lab ID: S1603020-005
Client Sample ID: 578434-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.72			s.u.	03/01/2016 1350	Field
Conductivity	1513			µmhos/cm	03/01/2016 1350	Field
Turbidity	111			NTU	03/01/2016 1350	Field
Temperature	10.5			°C	03/01/2016 1350	Field
Static Water Level	5.20			ft	03/01/2016 1350	Field
General Parameters						
pH	8.2	0.1		s.u.	03/02/2016 1904 LAB	SM 4500 H B
Electrical Conductivity	1420	5		µmhos/cm	03/02/2016 1904 LAB	SM 2510B
Total Dissolved Solids (180)	1030	10		mg/L	03/02/2016 0948 NLG	SM 2540
Solids, Total Dissolved (Calc)	930	10		mg/L	03/08/2016 1550 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	683	5		mg/L	03/02/2016 1904 LAB	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	735	1		mg/L	03/08/2016 1550 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.3	0.1		mg/L	03/04/2016 1508 AMB	EPA 350.1
Sodium Adsorption Ratio	1.3	0.1			03/08/2016 1550 JJ	Calculation
nions						
Alkalinity, Bicarbonate as HCO3	833	5		mg/L	03/02/2016 1904 LAB	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/02/2016 1904 LAB	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/02/2016 1904 LAB	SM 2320B
Chloride	9	1		mg/L	03/02/2016 1616 AB	EPA 300.0
Fluoride	0.7	0.1		mg/L	03/02/2016 1904 LAB	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	03/03/2016 1311 AMB	EPA 353.2
Sulfate	219	1		mg/L	03/02/2016 1616 AB	EPA 300.0
Cations						
Calcium	78	1		mg/L	03/02/2016 1438 DG	EPA 200.7
Magnesium	131	1		mg/L	03/02/2016 1438 DG	EPA 200.7
Potassium	3	1		mg/L	03/02/2016 1438 DG	EPA 200.7
Sodium	83	1		mg/L	03/02/2016 1438 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/025
RECD MAY 23, 2019

DEQ Ex. 3-762

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2016
Report ID: S1603020001

Work Order: S1603020
Collection Date: 3/1/2016 1:50:00 PM
Date Received: 3/1/2016 4:06:00 PM
Sampler: RF
Matrix: Water
COC: 165160

Project: Ramaco-2014163-07
Lab ID: S1603020-005
Client Sample ID: 578434-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.65	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Chloride	0.24	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Sulfate	4.56	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Calcium	3.88	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Magnesium	10.81	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Potassium	0.07	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Sodium	3.62	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	18.42	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Anion Sum	18.50	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Cation-Anion Balance	0.22	0.01		%	03/08/2016 1550 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/02/2016 1438 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/02/2016 1737 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/02/2016 1737 MS	EPA 200.8
Boron	0.2	0.1		mg/L	03/02/2016 1438 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/02/2016 1737 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/02/2016 1438 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/02/2016 1737 MS	EPA 200.8
Iron	5.99	0.05		mg/L	03/02/2016 1438 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/02/2016 1737 MS	EPA 200.8
Manganese	0.37	0.02		mg/L	03/02/2016 1438 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/04/2016 0957 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/02/2016 1737 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/02/2016 1438 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/02/2016 1737 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/02/2016 1438 DG	EPA 200.7
Total Metals						
Iron	13.8	0.05		mg/L	03/04/2016 1641 DG	EPA 200.7
Manganese	0.43	0.02		mg/L	03/04/2016 1641 DG	EPA 200.7

These results apply only to the samples tested. **RL - Reporting Limit**

Qualifiers:
- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by another laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/C25
RECD MAY 22, 2019

DEQ Ex. 3-763

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578434-AL-2 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578434-AL-2 Date Sampled 3 / 1 / 16 Time 1515 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 17.24 ft below MP Depth to Water (below MP) 5.69 ft Casing Diameter 2 in

Date 3 / 1 / 16 Time 1445 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

Pump intake or bailer set at 15 ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1505	8.07	687	8.1	81.4	↓	150ML/30Sec
1515	8.19	684	7.2	39.8	~3.0	↓

Pumping Start Time 1450 WL _____ Pumping End Time _____ WL _____

Comments: water slightly turbid - no odor

HCF

COC # 165160

Form completed by: Rod Fuller Witnessed by: _____

April 2019

TFNS 2/625

RECEIVED MAY 23, 2019

Addendum D6-10-274

C:\Fuller Files\Water Well Sampling Form 4r.doc

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2016
Report ID: S1603020001

Work Order: S1603020
Collection Date: 3/1/2016 3:15:00 PM
Date Received: 3/1/2016 4:06:00 PM
Sampler: RF
Matrix: Water
COC: 165160

Project: Ramaco-2014163-07
Lab ID: S1603020-006
Client Sample ID: 578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	8.19			s.u.	03/01/2016 1515	Field
Conductivity	684			µmhos/cm	03/01/2016 1515	Field
Turbidity	39.8			NTU	03/01/2016 1515	Field
Temperature	7.2			°C	03/01/2016 1515	Field
Static Water Level	5.69			ft	03/01/2016 1515	Field
General Parameters						
pH	8.3	0.1		s.u.	03/02/2016 1916 LAB	SM 4500 H B
Electrical Conductivity	647	5		µmhos/cm	03/02/2016 1916 LAB	SM 2510B
Total Dissolved Solids (180)	430	10		mg/L	03/02/2016 0949 NLG	SM 2540
Solids, Total Dissolved (Calc)	380	10		mg/L	03/08/2016 1550 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	245	5		mg/L	03/02/2016 1916 LAB	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	309	1		mg/L	03/08/2016 1550 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	03/04/2016 1509 AMB	EPA 350.1
Sodium Adsorption Ratio	0.6	0.1			03/08/2016 1550 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	292	5		mg/L	03/02/2016 1916 LAB	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	03/02/2016 1916 LAB	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	03/02/2016 1916 LAB	SM 2320B
Chloride	8	1		mg/L	03/02/2016 1629 AB	EPA 300.0
Fluoride	0.2	0.1		mg/L	03/02/2016 1916 LAB	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.6	0.1		mg/L	03/03/2016 1313 AMB	EPA 353.2
Sulfate	98	1		mg/L	03/02/2016 1629 AB	EPA 300.0
Cations						
Calcium	60	1		mg/L	03/02/2016 1443 DG	EPA 200.7
Magnesium	39	1		mg/L	03/02/2016 1443 DG	EPA 200.7
Potassium	3	1		mg/L	03/02/2016 1443 DG	EPA 200.7
Sodium	22	1		mg/L	03/02/2016 1443 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/625

DEQ Ex. 3-765

Scanned, 02/28/2020

RAMACO
INTER-MOUNTAIN LABS
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 3/11/2016
Report ID: S1603020001

Work Order: S1603020
Collection Date: 3/1/2016 3:15:00 PM
Date Received: 3/1/2016 4:06:00 PM
Sampler: RF
Matrix: Water
COC: 165160

Project: Ramaco-2014163-07
Lab ID: S1603020-006
Client Sample ID: 578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	4.78	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Chloride	0.22	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Nitrate + Nitrite as N	0.03	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Sulfate	2.04	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Calcium	2.96	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Magnesium	3.20	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Potassium	0.07	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Sodium	0.97	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	7.21	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Anion Sum	7.22	0.01		meq/L	03/08/2016 1550 JJ	SM 1030E
Cation-Anion Balance	0.04	0.01		%	03/08/2016 1550 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	03/02/2016 1443 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	03/02/2016 1742 MS	EPA 200.8
Barium	ND	0.1		mg/L	03/02/2016 1742 MS	EPA 200.8
Boron	ND	0.1		mg/L	03/02/2016 1443 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	03/02/2016 1742 MS	EPA 200.8
Chromium	ND	0.01		mg/L	03/02/2016 1443 DG	EPA 200.7
Copper	ND	0.01		mg/L	03/02/2016 1742 MS	EPA 200.8
Iron	ND	0.05		mg/L	03/02/2016 1443 DG	EPA 200.7
Lead	ND	0.02		mg/L	03/02/2016 1742 MS	EPA 200.8
Manganese	ND	0.02		mg/L	03/02/2016 1443 DG	EPA 200.7
Mercury	ND	0.001		mg/L	03/04/2016 1007 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	03/02/2016 1742 MS	EPA 200.8
Nickel	ND	0.01		mg/L	03/02/2016 1443 DG	EPA 200.7
Selenium	ND	0.005		mg/L	03/02/2016 1742 MS	EPA 200.8
Zinc	ND	0.01		mg/L	03/02/2016 1443 DG	EPA 200.7
Total Metals						
Iron	1.72	0.05		mg/L	03/04/2016 1644 DG	EPA 200.7
Manganese	0.46	0.02		mg/L	03/04/2016 1644 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- C Calculated Value
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- L Analyzed by another laboratory
- M Value exceeds Monthly Ave or MCL or is less than LCL
- ND Not Detected at the Reporting Limit
- O Outside the Range of Dilutions
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/625
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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578433-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578433-AL-1 Date Sampled 5 / 20 / 16 Time 1215 am pm

Describe Sampling Point GW monitoring well

Well Depth _____ ft below MP Depth to Water (below MP) 6.29 ft Casing Diameter 2 in

Date 5 / 20 / 16 Time 1142 (am) pm Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE

_____ gpm

x 0.00223

cfs

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1205	7.53	1761	23.8	526	↓	150 mL / 30 sec
1215	7.56	1764	19.7	254	23.0	↓

Pumping Start Time 1150 WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF

COC# 162125

Form completed by: Rod Fuller Witnessed by: _____

April 2019

TFN 5 2/025

Addendum D6-10-277

C:\Fuller Files\Monitor Well Sample Form-RF.doc

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RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/1/2016
Report ID: S1605394001

Work Order: S1605394
Collection Date: 5/20/2016 12:15:00 PM
Date Received: 5/20/2016 2:52:00 PM
Sampler: RF
Matrix: Water
COC: 162125

Project: Ramaco 2014163-07
Lab ID: S1605394-004
Client Sample ID: 578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.56			s.u.	05/20/2016 1215	Field
Conductivity	1764			µmhos/cm	05/20/2016 1215	Field
Turbidity	254			NTU	05/20/2016 1215	Field
Temperature	19.7			°C	05/20/2016 1215	Field
Static Water Level	6.29			ft	05/20/2016 1215	Field
General Parameters						
pH	8.0	0.1		s.u.	05/24/2016 1727 IBS	SM 4500 H B
Electrical Conductivity	1970	5		µmhos/cm	05/24/2016 1727 IBS	SM 2510B
Total Dissolved Solids (180)	1180	10		mg/L	05/20/2016 1703 NLG	SM 2540
Solids, Total Dissolved (Calc)	1200	10		mg/L	05/31/2016 1449 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	669	5		mg/L	05/24/2016 1727 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	776	1		mg/L	05/31/2016 1449 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.2	0.1		mg/L	05/27/2016 1613 AMB	EPA 350.1
Sodium Adsorption Ratio	1.9	0.1			05/31/2016 1449 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	817	5		mg/L	05/24/2016 1727 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/24/2016 1727 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/24/2016 1727 IBS	SM 2320B
Chloride	18	1		mg/L	05/24/2016 2358 AB	EPA 300.0
Fluoride	0.5	0.1		mg/L	05/24/2016 1727 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/25/2016 1322 AMB	EPA 353.2
Sulfate	422	1		mg/L	05/24/2016 2358 AB	EPA 300.0
Cations						
Calcium	115	1		mg/L	05/23/2016 1513 DG	EPA 200.7
Magnesium	119	1		mg/L	05/23/2016 1513 DG	EPA 200.7
Potassium	6	1		mg/L	05/23/2016 1513 DG	EPA 200.7
Sodium	124	1		mg/L	05/23/2016 1513 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/625
TODAY 23, 2019

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Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/1/2016
Report ID: S1605394001

Work Order: S1605394
Collection Date: 5/20/2016 12:15:00 PM
Date Received: 5/20/2016 2:52:00 PM
Sampler: RF
Matrix: Water
COC: 162125

Project: Ramaco 2014163-07
Lab ID: S1605394-004
Client Sample ID: 578433-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	13.38	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Chloride	0.50	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Fluoride	0.02	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Sulfate	8.78	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Calcium	5.72	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Magnesium	9.78	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Potassium	0.14	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Sodium	5.39	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	21.06	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Anion Sum	22.70	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Cation-Anion Balance	3.72	0.01		%	05/31/2016 1449 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/23/2016 1513 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/23/2016 1742 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/23/2016 1742 MS	EPA 200.8
Boron	0.2	0.1		mg/L	05/23/2016 1513 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/23/2016 1742 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/23/2016 1513 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/23/2016 1742 MS	EPA 200.8
Iron	0.78	0.05		mg/L	05/23/2016 1513 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/23/2016 1742 MS	EPA 200.8
Manganese	1.43	0.02		mg/L	05/23/2016 1513 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/26/2016 1410 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/23/2016 1742 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/23/2016 1513 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/23/2016 1742 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/23/2016 1513 DG	EPA 200.7
Total Metals						
Iron	12.6	0.05		mg/L	05/25/2016 1703 DG	EPA 200.7
Manganese	1.70	0.02		mg/L	05/25/2016 1703 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- X Matrix Effect
- C Calculated Value
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/025
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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578434-AL-1 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578434-AL-1 Date Sampled 5/20/16 Time 1305 am (pm)

Describe Sampling Point GW monitoring well

Well Depth _____ ft below MP Depth to Water (below MP) 4.59 ft Casing Diameter 2 in

Date 5/20/16 Time 1233 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

DISCHARGE RATE

_____ gpm

x 0.00223

Pump intake or bailer set at _____ ft below MP. cfs

Tubing (type: Plastic). (New or (previously used)) was used to collect all samples ((yes) or no)

and all field measurements ((yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1255	7.56	1735	18.2	334	↓	150 mL/30sec
1305	7.56	1692	18.7	131	~3.0	↓

Pumping Start Time 1240 WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF
COC # 162125

Form completed by: Bob Fuller Witnessed by: _____

April 2019

TENS 2/625
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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/1/2016
Report ID: S1605394001

Work Order: S1605394
Collection Date: 5/20/2016 1:05:00 PM
Date Received: 5/20/2016 2:52:00 PM
Sampler: RF
Matrix: Water
COC: 162125

Project: Ramaco 2014163-07
Lab ID: S1605394-005
Client Sample ID: 578434-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.56			s.u.	05/20/2016 1305	Field
Conductivity	1692			µmhos/cm	05/20/2016 1305	Field
Turbidity	131			NTU	05/20/2016 1305	Field
Temperature	18.7			°C	05/20/2016 1305	Field
Static Water Level	4.59			ft	05/20/2016 1305	Field
General Parameters						
pH	8.0	0.1		s.u.	05/24/2016 1737 IBS	SM 4500 H B
Electrical Conductivity	1880	5		µmhos/cm	05/24/2016 1737 IBS	SM 2510B
Total Dissolved Solids (180)	1240	10		mg/L	05/20/2016 1704 NLG	SM 2540
Solids, Total Dissolved (Calc)	1150	10		mg/L	05/31/2016 1449 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	601	5		mg/L	05/24/2016 1737 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	815	1		mg/L	05/31/2016 1449 JJ	SM 2340B
Nitrogen, Ammonia (As N)	0.2	0.1		mg/L	05/27/2016 1614 AMB	EPA 350.1
Sodium Adsorption Ratio	1.4	0.1			05/31/2016 1449 JJ	Calculation
nions						
Alkalinity, Bicarbonate as HCO3	733	5		mg/L	05/24/2016 1737 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/24/2016 1737 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/24/2016 1737 IBS	SM 2320B
Chloride	11	1		mg/L	05/25/2016 0011 AB	EPA 300.0
Fluoride	0.7	0.1		mg/L	05/24/2016 1737 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/25/2016 1324 AMB	EPA 353.2
Sulfate	456	1		mg/L	05/25/2016 0011 AB	EPA 300.0
Cations						
Calcium	83	1		mg/L	05/23/2016 1515 DG	EPA 200.7
Magnesium	148	1		mg/L	05/23/2016 1515 DG	EPA 200.7
Potassium	3	1		mg/L	05/23/2016 1515 DG	EPA 200.7
Sodium	90	1		mg/L	05/23/2016 1515 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/025
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DEQ Ex. 3-771

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/1/2016
Report ID: S1605394001

Work Order: S1605394
Collection Date: 5/20/2016 1:05:00 PM
Date Received: 5/20/2016 2:52:00 PM
Sampler: RF
Matrix: Water
COC: 162125

Project: Ramaco 2014163-07
Lab ID: S1605394-005
Client Sample ID: 578434-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	12.02	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Chloride	0.32	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Fluoride	0.03	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Sulfate	9.49	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Calcium	4.11	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Magnesium	12.17	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Potassium	0.08	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Sodium	3.93	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	20.33	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Anion Sum	21.87	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Cation-Anion Balance	3.65	0.01		%	05/31/2016 1449 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/23/2016 1515 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/23/2016 1747 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/23/2016 1747 MS	EPA 200.8
Boron	0.2	0.1		mg/L	05/23/2016 1515 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/23/2016 1747 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/23/2016 1515 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/23/2016 1747 MS	EPA 200.8
Iron	6.65	0.05		mg/L	05/23/2016 1515 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/23/2016 1747 MS	EPA 200.8
Manganese	0.37	0.02		mg/L	05/23/2016 1515 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/26/2016 1412 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/23/2016 1747 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/23/2016 1515 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/23/2016 1747 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/23/2016 1515 DG	EPA 200.7
Total Metals						
Iron	16.8	0.05		mg/L	05/25/2016 1712 DG	EPA 200.7
Manganese	0.50	0.02		mg/L	05/25/2016 1712 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFNS 2/625
RECD MAY 23, 2016

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578434-AL-2 Project Ramaco

Location _____ W.O.# 2014163-07

Sample ID# 578434-AL-2 Date Sampled 5 / 20 / 16 Time 1410 am (pm)

Describe Sampling Point GW monitoring well

Well Depth _____ ft below MP Depth to Water (below MP) 4.76 ft Casing Diameter 2 in

Date 5 / 20 / 16 Time 1340 am (pm) Casing Volume NA gal

At least NA bore volumes have been evacuated before sampling

Sampling method Submersible pump (Bladder)

Tap Bailer

Pump intake or bailer set at _____ ft below MP.

Tubing (type: Plastic). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for NA

DISCHARGE RATE

_____ gpm

x 0.00223

_____ cfs

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1400	7.90	427	18.0	122	↓	150ML/30Sec
1410	7.93	409	16.5	34.4	~3.0	↓

Pumping Start Time 1345 WL _____ Pumping End Time _____ WL _____

Comments: water slightly turbid - no odor

HCF

COC# 162125

Form completed by: Bob Fuller Witnessed by: _____

April 2019

TENS 2/825

RECD MAY 23, 2016

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Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/1/2016
Report ID: S1605394001

Work Order: S1605394
Collection Date: 5/20/2016 2:10:00 PM
Date Received: 5/20/2016 2:52:00 PM
Sampler: RF
Matrix: Water
COC: 162125

Project: Ramaco 2014163-07
Lab ID: S1605394-006
Client Sample ID: 578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.93			s.u.	05/20/2016 1410	Field
Conductivity	409			µmhos/cm	05/20/2016 1410	Field
Turbidity	34.4			NTU	05/20/2016 1410	Field
Temperature	16.5			°C	05/20/2016 1410	Field
Static Water Level	4.76			ft	05/20/2016 1410	Field
General Parameters						
pH	8.3	0.1		s.u.	05/26/2016 1723 IBS	SM 4500 H B
Electrical Conductivity	432	5		µmhos/cm	05/24/2016 1756 IBS	SM 2510B
Total Dissolved Solids (180)	250	10		mg/L	05/20/2016 1705 NLG	SM 2540
Solids, Total Dissolved (Calc)	220	10		mg/L	05/31/2016 1449 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	169	5		mg/L	05/26/2016 1723 IBS	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	187	1		mg/L	05/31/2016 1449 JJ	SM 2340B
Nitrogen, Ammonia (As N)	ND	0.1		mg/L	05/27/2016 1615 AMB	EPA 350.1
Sodium Adsorption Ratio	0.4	0.1			05/31/2016 1449 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	203	5		mg/L	05/26/2016 1723 IBS	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	05/26/2016 1723 IBS	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	05/26/2016 1723 IBS	SM 2320B
Chloride	3	1		mg/L	05/25/2016 0024 AB	EPA 300.0
Fluoride	0.3	0.1		mg/L	05/24/2016 1756 IBS	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	05/25/2016 1325 AMB	EPA 353.2
Sulfate	41	1		mg/L	05/25/2016 0024 AB	EPA 300.0
Cations						
Calcium	38	1		mg/L	05/27/2016 1335 DG	EPA 200.7
Magnesium	22	1		mg/L	05/27/2016 1335 DG	EPA 200.7
Potassium	3	1		mg/L	05/27/2016 1335 DG	EPA 200.7
Sodium	13	1		mg/L	05/23/2016 1518 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
X	Matrix Effect
C	Calculated Value
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/625

April 2019

ERROR: MAY 23, 2019

Addendum D6-10-284

Scanned, 02/28/2020

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 6/1/2016
Report ID: S1605394001

Work Order: S1605394
Collection Date: 5/20/2016 2:10:00 PM
Date Received: 5/20/2016 2:52:00 PM
Sampler: RF
Matrix: Water
COC: 162125

Project: Ramaco 2014163-07
Lab ID: S1605394-006
Client Sample ID: 578434-AL-2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	3.32	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Chloride	0.09	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Sulfate	0.86	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Calcium	1.90	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Magnesium	1.83	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Potassium	0.07	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Sodium	0.55	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	4.36	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Anion Sum	4.35	0.01		meq/L	05/31/2016 1449 JJ	SM 1030E
Cation-Anion Balance	0.20	0.01		%	05/31/2016 1449 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	05/23/2016 1518 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	05/23/2016 1753 MS	EPA 200.8
Barium	ND	0.1		mg/L	05/23/2016 1753 MS	EPA 200.8
Boron	ND	0.1		mg/L	05/23/2016 1518 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	05/23/2016 1753 MS	EPA 200.8
Chromium	ND	0.01		mg/L	05/23/2016 1518 DG	EPA 200.7
Copper	ND	0.01		mg/L	05/23/2016 1753 MS	EPA 200.8
Iron	ND	0.05		mg/L	05/23/2016 1518 DG	EPA 200.7
Lead	ND	0.02		mg/L	05/23/2016 1753 MS	EPA 200.8
Manganese	0.07	0.02		mg/L	05/23/2016 1518 DG	EPA 200.7
Mercury	ND	0.001		mg/L	05/26/2016 1414 AW	EPA 245.1
Molybdenum	ND	0.02		mg/L	05/23/2016 1753 MS	EPA 200.8
Nickel	ND	0.01		mg/L	05/23/2016 1518 DG	EPA 200.7
Selenium	ND	0.005		mg/L	05/23/2016 1753 MS	EPA 200.8
Zinc	ND	0.01		mg/L	05/23/2016 1518 DG	EPA 200.7
Total Metals						
Iron	1.76	0.05		mg/L	05/25/2016 1715 DG	EPA 200.7
Manganese	0.44	0.02		mg/L	05/25/2016 1715 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

B	Analyte detected in the associated Method Blank	C	Calculated Value
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	L	Analyzed by another laboratory
M	Value exceeds Monthly Ave or MCL or is less than LCL	ND	Not Detected at the Reporting Limit
O	Outside the Range of Dilutions	S	Spike Recovery outside accepted recovery limits
X	Matrix Effect		

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TENS 2/625
RECD MAY 23, 2019

DEQ Ex. 3-775

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point LAYA #1 Project Ramaco

Location 44.90635/-107.08013 W.O.# ~~20144163-98~~ 2013139-98

Sample ID# LAYA #1 Date Sampled 4 / 9 / 19 Time 1120 (am) pm

Describe Sampling Point Frost free hydrant - sample point (44.90602/ -107.08088

Well Depth unknown ft below MP Depth to Water (below MP) unknown ft Casing Diameter 5 in

Date / / Time am pm Casing Volume gal

At least bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap Bailer (Grab)

Pump intake or bailer set at ft below MP.

DISCHARGE RATE	
	gpm
x	0.00223
	cfs

g (type:). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1120	7.95	1954	7.2	3.02	~400	20

Pumping Start Time WL Pumping End Time WL

Comments: Water clear - no odor - Well by Laya house, which is piped to a storage tank. Water sampled at frost free hydrant by house. Let water run at 20GPM for 20 minutes before sampled. See photos

LCF COC# 180753

Form completed by: Josh Fuller Witnessed by:

DEQ Ex. 3-776
RECD 09-20-19

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/15/2019
Report ID: S1904165001

Work Order: S1904165
Collection Date: 4/9/2019 11:20:00 AM
Date Received: 4/9/2019 4:14:00 PM
Sampler: RF
Matrix: Water
COC: 180753

Project: Ramaco-2014163-98
Lab ID: S1904165-001
Client Sample ID: LAYA #1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.95			s.u.	04/09/2019 1120	Field
Conductivity	1954			µmhos/cm	04/09/2019 1120	Field
Turbidity	3.02			NTU	04/09/2019 1120	Field
Temperature	7.2			℃	04/09/2019 1120	Field
General Parameters						
pH	8.4	0.1		s.u.	04/10/2019 1613 AB	SM 4500 H B
Electrical Conductivity	1840	5		µmhos/cm	04/10/2019 1613 AB	SM 2510B
Total Dissolved Solids (180)	1270	10		mg/L	04/10/2019 1244 IJQ	SM 2540
Solids, Total Dissolved (Calc)	1260	10		mg/L	04/15/2019 1142 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	1140	5		mg/L	04/10/2019 1613 AB	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	90	1		mg/L	04/15/2019 1142 JJ	SM 2340B
Nitrogen, Ammonia (as N)	4.7	0.1		mg/L	04/12/2019 1041 AMB	EPA 350.1
Sodium Adsorption Ratio	22.5	0.01			04/15/2019 1142 JJ	Calculation
nions						
Alkalinity, Bicarbonate as HCO3	1350	5		mg/L	04/10/2019 1613 AB	SM 2320B
Alkalinity, Carbonate as CO3	24	5		mg/L	04/10/2019 1613 AB	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/10/2019 1613 AB	SM 2320B
Chloride	36	1		mg/L	04/11/2019 2243 AB	EPA 300.0
Fluoride	2.0	0.1		mg/L	04/10/2019 1613 AB	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/11/2019 1016 AMB	EPA 353.2
Sulfate	ND	1		mg/L	04/10/2019 1606 AB	EPA 300.0
Cations						
Calcium	13	1		mg/L	04/10/2019 1908 DG	EPA 200.7
Magnesium	14	1		mg/L	04/10/2019 1908 DG	EPA 200.7
Potassium	19	1		mg/L	04/10/2019 1908 DG	EPA 200.7
Sodium	491	1		mg/L	04/10/2019 1908 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD 09-20-19

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/15/2019
Report ID: S1904165001

Work Order: S1904165
Collection Date: 4/9/2019 11:20:00 AM
Date Received: 4/9/2019 4:14:00 PM
Sampler: RF
Matrix: Water
COC: 180753

Project: Ramaco-2014163-98
Lab ID: S1904165-001
Client Sample ID: LAYA #1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	22.05	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Carbonate as CO3	0.80	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Chloride	1.0	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Fluoride	0.10	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Sulfate	ND	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Calcium	0.63	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Magnesium	1.16	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Potassium	0.47	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Sodium	21.33	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	23.94	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Anion Sum	23.96	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Cation-Anion Balance	0.04	0.01		%	04/15/2019 1142 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/10/2019 1908 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/11/2019 0624 MS	EPA 200.8
Barium	0.4	0.1		mg/L	04/11/2019 0624 MS	EPA 200.8
Boron	0.1	0.1		mg/L	04/10/2019 1908 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/11/2019 0624 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/10/2019 1908 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/11/2019 0624 MS	EPA 200.8
Iron	ND	0.05		mg/L	04/10/2019 1908 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/11/2019 0624 MS	EPA 200.8
Manganese	0.03	0.02		mg/L	04/10/2019 1908 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/12/2019 1026 AEF	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/11/2019 0624 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/10/2019 1908 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/11/2019 0624 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/10/2019 1908 DG	EPA 200.7
Total Metals						
Iron	0.15	0.05		mg/L	04/11/2019 1850 DG	EPA 200.7
Manganese	0.03	0.02		mg/L	04/11/2019 1850 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
DEQ 09-20-19

September 2019

Addendum D6-10-288

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578420-CRN-PUMP Project Ramaco

Location _____ W.O.# 2013139-98

Sample ID# 578420-CRN-Pump Date Sampled 4/9/19 Time 1455 am (pm)

Describe Sampling Point GW monitoring well

Well Depth 30 ft below MP Depth to Water (below MP) 8.94 ft Casing Diameter 5 in

Date 4/9/19 Time 1335 am (pm) Casing Volume _____ gal

At least NA bore volumes have been evacuated before sampling

Sampling method : Submersible pump (Bladder)

Tap Bailer Grab

Pump intake or bailer set at 27 ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

g (type: Plastic). (New or (previously used) was used to collect all samples (yes) or no)

and all field measurements (yes) or no). Tubing used only for NA

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1445	7.83	1115	12.5	18.3	↓	150 ML/30 Sec
1455	7.81	1098	12.8	20.7	3.0	↓

Pumping Start Time 1430 WL _____ Pumping End Time _____ WL _____

Comments: Water slightly turbid - no odor

LCF

COC# 180753

Form completed by: Rod Fuller Witnessed by: _____

September 2019

TFN 6 2/025

Addendum D6-10-289

C:\Fuller Files\Monitor Well Sample Form-RF.doc

DEQ Ex. 3-779

RECD 09-20-19

Scanned, 02/28/2020

RAMCO
INTER-MOUNTAIN LABS
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/15/2019
Report ID: S1904165001

Work Order: S1904165
Collection Date: 4/9/2019 2:55:00 PM
Date Received: 4/9/2019 4:14:00 PM
Sampler: RF
Matrix: Water
COC: 180753

Project: Ramaco-2014163-98
Lab ID: S1904165-002
Client Sample ID: 578420-CRN-PUMP

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.81			s.u.	04/09/2019 1455	Field
Conductivity	1098			µmhos/cm	04/09/2019 1455	Field
Turbidity	20.7			NTU	04/09/2019 1455	Field
Depth To Water	8.94			ft	04/09/2019 1455	Field
Temperature	12.8			℃	04/09/2019 1455	Field
General Parameters						
pH	8.3	0.1		s.u.	04/10/2019 1625 AB	SM 4500 H B
Electrical Conductivity	1040	5		µmhos/cm	04/10/2019 1625 AB	SM 2510B
Total Dissolved Solids (180)	690	10		mg/L	04/10/2019 1245 IJQ	SM 2540
Solids, Total Dissolved (Calc)	680	10		mg/L	04/15/2019 1142 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	421	5		mg/L	04/10/2019 1625 AB	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	220	1		mg/L	04/15/2019 1142 JJ	SM 2340B
Nitrogen, Ammonia (as N)	2.9	0.1		mg/L	04/12/2019 1044 AMB	EPA 350.1
Sodium Adsorption Ratio	4.94	0.01			04/15/2019 1142 JJ	Calculation
nions						
Alkalinity, Bicarbonate as HCO3	510	5		mg/L	04/10/2019 1625 AB	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	04/10/2019 1625 AB	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	04/10/2019 1625 AB	SM 2320B
Chloride	4	1		mg/L	04/11/2019 2256 AB	EPA 300.0
Fluoride	1.1	0.1		mg/L	04/10/2019 1625 AB	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	04/11/2019 1018 AMB	EPA 353.2
Sulfate	168	1		mg/L	04/10/2019 1619 AB	EPA 300.0
Cations						
Calcium	38	1		mg/L	04/10/2019 1910 DG	EPA 200.7
Magnesium	30	1		mg/L	04/10/2019 1910 DG	EPA 200.7
Potassium	14	1		mg/L	04/10/2019 1910 DG	EPA 200.7
Sodium	169	1		mg/L	04/10/2019 1910 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

IFR 5 2/025
0500 09-20-19

Scanned, 02/28/2020

Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 4/15/2019
Report ID: S1904165001

Work Order: S1904165
Collection Date: 4/9/2019 2:55:00 PM
Date Received: 4/9/2019 4:14:00 PM
Sampler: RF
Matrix: Water
COC: 180753

Project: Ramaco-2014163-98
Lab ID: S1904165-002
Client Sample ID: 578420-CRN-PUMP

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.35	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Chloride	0.11	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Fluoride	0.05	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Sulfate	3.50	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Calcium	1.90	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Magnesium	2.49	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Potassium	0.34	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Sodium	7.33	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	12.29	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Anion Sum	12.10	0.01		meq/L	04/15/2019 1142 JJ	SM 1030E
Cation-Anion Balance	0.79	0.01		%	04/15/2019 1142 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	04/10/2019 1910 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	04/11/2019 0703 MS	EPA 200.8
Barium	ND	0.1		mg/L	04/11/2019 0703 MS	EPA 200.8
Boron	ND	0.1		mg/L	04/10/2019 1910 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	04/11/2019 0703 MS	EPA 200.8
Chromium	ND	0.01		mg/L	04/10/2019 1910 DG	EPA 200.7
Copper	ND	0.01		mg/L	04/11/2019 0703 MS	EPA 200.8
Iron	ND	0.05		mg/L	04/10/2019 1910 DG	EPA 200.7
Lead	ND	0.02		mg/L	04/11/2019 0703 MS	EPA 200.8
Manganese	0.37	0.02		mg/L	04/10/2019 1910 DG	EPA 200.7
Mercury	ND	0.001		mg/L	04/12/2019 1033 AEF	EPA 245.1
Molybdenum	ND	0.02		mg/L	04/11/2019 0703 MS	EPA 200.8
Nickel	ND	0.01		mg/L	04/10/2019 1910 DG	EPA 200.7
Selenium	ND	0.005		mg/L	04/11/2019 0703 MS	EPA 200.8
Zinc	ND	0.01		mg/L	04/10/2019 1910 DG	EPA 200.7
Total Metals						
Iron	1.10	0.05		mg/L	04/11/2019 1859 DG	EPA 200.7
Manganese	0.36	0.02		mg/L	04/11/2019 1859 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 8 2/025
RECD 09-20-19

September 2019

Addendum D6-10-291

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RAMACO

* no sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point LAYA #2 Project Ramaco

Location 44.91290/-107.08254 W.O.# ~~2014463-98~~ 2013139-98

Sample ID# _____ Date Sampled 4/9/19 Time 1210 am (pm)

Describe Sampling Point _____

Well Depth _____ ft below MP Depth to Water (below MP) _____ ft Casing Diameter _____ in

Date / / Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap Bailer Grab

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

g (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well not functioning - see photo - Land-owner indicated that well ~~was~~ has not been used for quite some time.

TEN 8 2/025

RECD 09-20-19

Form completed by: Rod Fuller Witnessed by: _____

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RAMACO x No Sample

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578513-OVB-1 Project Ramaco

Location _____ W.O.# ~~2014163-98~~ 2013134-98

Sample ID# _____ Date Sampled ___/___/___ Time _____ am pm

Describe Sampling Point _____

Well Depth _____ ft below MP Depth to Water (below MP) DRY ft Casing Diameter _____ in

Date 4 / 9 / 19 Time 1535 am (pm) Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap Bailer Grab

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
_____	cfs

g (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Well is Dry

TFN 8 2/025
REC'D 09-20-19

Form completed by: Rod Fuller Witnessed by: _____

DEQ Ex. 3-783

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RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point Taylor Domestic Alluvial well Project Ramaco

Location 44.90700/-107.06536 W.O.# 2013139-98

Sample ID# TDAW-01 Date Sampled 7 / 11 / 19 Time 1600 am (pm)

Describe Sampling Point LeRoy Taylor's domestic alluvial well - Well in facility yard - Frost free hydrant in house yard - photos of both.

Well Depth _____ ft below MP Depth to Water (below MP) _____ ft Casing Diameter 5 in

Date / / Time _____ am pm Casing Volume _____ gal

At least _____ bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap Bailer Grab

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1525	7.40	1073	18.0			2.5
1535	7.46	1085	12.8			↓
1545	7.47	1084	11.4			
1600	7.47	1093	11.5	0.65	88	

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: Could not get water level or TD because of pump and wires in well - Hydrant max flow = 8GPM - Well is used continuously - water clear - no odor

LCF/ COC # 180757

TFN 8 2/025

RECD 09-20-19

Form completed by: Rod Fuller Witnessed by: _____

September 2019

Addendum D6-10-294
C:\Fuller Files\Monitor Well Sample Form-RF.doc

Scanned, 02/28/2020

RAMCO
Inter-Mountain Labs
INTER-MOUNTAIN LABS
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/25/2019
Report ID: S1907203001

Work Order: S1907203
Collection Date: 7/11/2019 4:00:00 PM
Date Received: 7/11/2019 4:39:00 PM
Sampler: RF
Matrix: Water
COC: 180757

Project: RAMACO-2013139-98
Lab ID: S1907203-001
Client Sample ID: TDAW-01

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.47			s.u.	07/11/2019 1600	Field
Conductivity	1093			µmhos/cm	07/11/2019 1600	Field
Turbidity	0.65			NTU	07/11/2019 1600	Field
Temperature	11.5			℃	07/11/2019 1600	Field
General Parameters						
pH	8.2	0.1		s.u.	07/13/2019 0030 KMG	SM 4500 H B
Electrical Conductivity	1140	5		µmhos/cm	07/13/2019 0030 KMG	SM 2510B
Total Dissolved Solids (180)	730	10		mg/L	07/15/2019 0926 IJQ	SM 2540
Solids, Total Dissolved (Calc)	660	10		mg/L	07/25/2019 0930 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	431	5		mg/L	07/13/2019 0030 KMG	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	524	1		mg/L	07/25/2019 0930 JJ	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	07/19/2019 0944 AMB	EPA 350.1
Sodium Adsorption Ratio	0.85	0.01			07/25/2019 0930 JJ	Calculation
Ions						
Alkalinity, Bicarbonate as HCO3	526	5	B	mg/L	07/13/2019 0030 KMG	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/13/2019 0030 KMG	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/13/2019 0030 KMG	SM 2320B
Chloride	5	1		mg/L	07/12/2019 1957 KMG	EPA 300.0
Fluoride	0.3	0.1		mg/L	07/13/2019 0030 KMG	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/15/2019 1032 AMB	EPA 353.2
Sulfate	178	1		mg/L	07/12/2019 1957 KMG	EPA 300.0
Cations						
Calcium	98	1		mg/L	07/16/2019 1652 DG	EPA 200.7
Magnesium	68	1		mg/L	07/16/2019 1652 DG	EPA 200.7
Potassium	4	1		mg/L	07/16/2019 1652 DG	EPA 200.7
Sodium	45	1		mg/L	07/16/2019 1652 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

September 2019

TFN 8 2/025
DEQ 09-20-19

Addendum D6-10-295

Scanned, 02/28/2020

RAMCO
INTER-MOUNTAIN LABS Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 7/25/2019
Report ID: S1907203001

Work Order: S1907203
Collection Date: 7/11/2019 4:00:00 PM
Date Received: 7/11/2019 4:39:00 PM
Sampler: RF
Matrix: Water
COC: 180757

Project: RAMACO-2013139-98
Lab ID: S1907203-001
Client Sample ID: TDAW-01

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.62	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Chloride	0.13	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Sulfate	3.69	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Calcium	4.88	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Magnesium	5.60	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Potassium	0.10	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Sodium	1.95	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	12.54	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Anion Sum	12.47	0.01		meq/L	07/25/2019 0930 JJ	SM 1030E
Cation-Anion Balance	0.27	0.01		%	07/25/2019 0930 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/16/2019 1652 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/12/2019 1825 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/12/2019 1825 MS	EPA 200.8
Boron	0.1	0.1		mg/L	07/16/2019 1652 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/12/2019 1825 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/16/2019 1652 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/12/2019 1825 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/16/2019 1652 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/12/2019 1825 MS	EPA 200.8
Manganese	0.41	0.02		mg/L	07/16/2019 1652 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/19/2019 1440 AEF	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/12/2019 1825 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/16/2019 1652 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/12/2019 1825 MS	EPA 200.8
Zinc	0.04	0.01		mg/L	07/16/2019 1652 DG	EPA 200.7
Total Metals						
Iron	0.07	0.05		mg/L	07/16/2019 2050 DG	EPA 200.7
Manganese	0.41	0.02		mg/L	07/16/2019 2050 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

TFN 6 2/025
RECD 09-20-19

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578415-AL-1 Project Ramaco

Location 44.91278/W106.97832 W.O.# 2013139-98

Sample ID# 578415-AL-1 Date Sampled 7/26/19 Time 1310 am (pm)

Describe Sampling Point 2" GW monitoring well

Well Depth 36.70 ft below MP Depth to Water (below MP) 30.21 ft Casing Diameter 2 in

Date 7/26/19 Time 1225 am pm Casing Volume 1.06 gal

At least 5 bore volumes have been evacuated before sampling

Sampling method : Submersible pump Bladder

Tap (Bailer) Grab

Pump intake or bailer set at _____ ft below MP.

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1310	7.10	2270	12.6	OVERLIMIT	5	
	36.70					
	− 30.21					
	6.49 X 0.163	= 1.06 X 3 = 3.17 GAL				

Pumping Start Time — WL — Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF

COC # 180758

TFN 6 2/025

RECD 09-20-19

Form completed by: Rod Fuller Witnessed by: _____

September 2019

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RAMCO
IML Inter-Mountain Labs
INTER-MOUNTAIN LABS
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 8/2/2019
Report ID: S1907400001

Work Order: S1907400
Collection Date: 7/26/2019 1:10:00 PM
Date Received: 7/26/2019 1:59:00 PM
Sampler: RF
Matrix: Water
COC: 180758

Project: RAMACO-2013104-98
Lab ID: S1907400-003
Client Sample ID: 578415-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.10			s.u.	07/26/2019 1310	Field
Conductivity	2270			µmhos/cm	07/26/2019 1310	Field
Turbidity	over Limit			NTU	07/26/2019 1310	Field
Depth To Water	30.21			ft	07/26/2019 1310	Field
Temperature	12.6			°C	07/26/2019 1310	Field
General Parameters						
pH	7.9	0.1		s.u.	07/29/2019 1539 KMG	SM 4500 H B
Electrical Conductivity	2430	5		µmhos/cm	07/29/2019 1539 KMG	SM 2510B
Total Dissolved Solids (180)	2030	10		mg/L	07/26/2019 1446 IJQ	SM 2540
Solids, Total Dissolved (Calc)	1790	10		mg/L	08/02/2019 0950 IBS	SM 1030E
Alkalinity, Total (As CaCO3)	734	5		mg/L	07/29/2019 1539 KMG	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1350	1		mg/L	08/02/2019 0950 IBS	SM 2340B
Nitrogen, Ammonia (as N)	0.2	0.1		mg/L	07/29/2019 0949 AMB	EPA 350.1
Sodium Adsorption Ratio	0.80	0.01			08/02/2019 0950 IBS	Calculation
..nions						
Alkalinity, Bicarbonate as HCO3	895	5		mg/L	07/29/2019 1539 KMG	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/29/2019 1539 KMG	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/29/2019 1539 KMG	SM 2320B
Chloride	10	1		mg/L	07/29/2019 2250 KMG	EPA 300.0
Fluoride	0.3	0.1		mg/L	07/29/2019 1539 KMG	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/29/2019 1221 AMB	EPA 353.2
Sulfate	845	1		mg/L	07/29/2019 2250 KMG	EPA 300.0
Cations						
Calcium	224	1		mg/L	07/29/2019 1516 DG	EPA 200.7
Magnesium	192	1		mg/L	07/29/2019 1516 DG	EPA 200.7
Potassium	16	1		mg/L	07/29/2019 1516 DG	EPA 200.7
Sodium	68	1		mg/L	07/29/2019 1516 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by:
Ian Scofield, Project Manager

TFN 6 2/025
RECD 09-20-19

DEQ Ex. 3-788

Scanned, 02/28/2020

RAMCO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 8/2/2019
Report ID: S1907400001

Work Order: S1907400
Collection Date: 7/26/2019 1:10:00 PM
Date Received: 7/26/2019 1:59:00 PM
Sampler: RF
Matrix: Water
COC: 180758

Project: RAMACO-2013104-98
Lab ID: S1907400-003
Client Sample ID: 578415-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	14.67	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Chloride	0.27	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Fluoride	0.01	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Sulfate	17.58	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Calcium	11.17	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Magnesium	15.76	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Potassium	0.41	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Sodium	2.94	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Cation / Anion Balance						
Cation Sum	30.31	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Anion Sum	32.54	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Cation-Anion Balance	3.55	0.01		%	08/02/2019 0950 IBS	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/29/2019 1516 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/30/2019 0157 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/30/2019 0157 MS	EPA 200.8
Boron	0.3	0.1		mg/L	07/29/2019 1516 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/30/2019 0157 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/29/2019 1516 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/30/2019 0157 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/29/2019 1516 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/30/2019 0157 MS	EPA 200.8
Manganese	1.51	0.02		mg/L	07/29/2019 1516 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/30/2019 1050 JJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/30/2019 0157 MS	EPA 200.8
Nickel	0.01	0.01		mg/L	07/29/2019 1516 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/30/2019 0157 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/29/2019 1516 DG	EPA 200.7
Total Metals						
Iron	111	0.05		mg/L	07/30/2019 1602 DG	EPA 200.7
Manganese	3.95	0.02		mg/L	07/30/2019 1559 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by:
Ian Scofield, Project Manager

September 2019

TFN 6 2/025
REGD 09-20-19

Addendum D6-10-299

DEQ Ex. 3-789

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point LAYA #2 Project Ramaco

Location 44.91290/-107.08254 W.O.# 2013139-98

Sample ID# LAYA #2 Date Sampled 7/26/19 Time 1005 (am) pm

Describe Sampling Point Gas monitoring well 5" stack & irrigation well

Well Depth NA ft below MP Depth to Water (below MP) NA ft Casing Diameter 5 in

Date — / — / — Time — am pm Casing Volume — gal

At least NA bore volumes have been evacuated before sampling

Sampling method : Submersible pump – landowner – used Niles Veals generator Bladder

Tap Bailer Grab

Pump intake or bailer set at — ft below MP.

DISCHARGE RATE	
	gpm
x	0.00223
	cfs

Tubing (type: used pumps drop pipe) (New or previously used) was used to collect all samples (yes or no) and all field measurements (yes or no). Tubing used only for —

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
0925	7.23	3520	11.0			14
0935	7.21	3610	10.7			↓
0945	7.18	3640	10.9			
0955	7.21	3670	10.8			
1005	7.20	3670	10.7	47.8	~840	

Pumping Start Time 0915 WL — Pumping End Time — WL —

Comments: Could not measure Total depth and DTW due to pump and wire in well – Well cap sealed – no casing volume – water slightly turbid · no odor –

H&F / COC # 180758 See photo

Form completed by: Rob Fuller Witnessed by: —

September 2019

TFN 6 2/025

RECD 09-20-19

Addendum D6-10-300
C:\Fuller Files\Monitor Well Sample Form-RF.doc

Scanned, 02/28/2020

RAMACO
IML Inter-Mountain Labs
INTER-MOUNTAIN LABS
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 8/2/2019
Report ID: S1907400001

Work Order: S1907400
Collection Date: 7/26/2019 10:05:00 AM
Date Received: 7/26/2019 1:59:00 PM
Sampler: RF
Matrix: Water
COC: 180758

Project: RAMACO-2013104-98
Lab ID: S1907400-001
Client Sample ID: LAYA #2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.28			s.u.	07/26/2019 1005	Field
Conductivity	3670			µmhos/cm	07/26/2019 1005	Field
Turbidity	47.8			NTU	07/26/2019 1005	Field
Temperature	10.7			°C	07/26/2019 1005	Field
General Parameters						
pH	7.9	0.1		s.u.	07/29/2019 1513 KMG	SM 4500 H B
Electrical Conductivity	3530	5		µmhos/cm	07/29/2019 1513 KMG	SM 2510B
Total Dissolved Solids (180)	3480	10		mg/L	07/26/2019 1444 IJQ	SM 2540
Solids, Total Dissolved (Calc)	3020	10		mg/L	08/02/2019 0950 IBS	SM 1030E
Alkalinity, Total (As CaCO3)	537	5		mg/L	07/29/2019 1513 KMG	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1800	1		mg/L	08/02/2019 0950 IBS	SM 2340B
Nitrogen, Ammonia (as N)	0.3	0.1		mg/L	07/29/2019 0948 AMB	EPA 350.1
Sodium Adsorption Ratio	2.73	0.01			08/02/2019 0950 IBS	Calculation
nions						
Alkalinity, Bicarbonate as HCO3	655	5		mg/L	07/29/2019 1513 KMG	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/29/2019 1513 KMG	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/29/2019 1513 KMG	SM 2320B
Chloride	18	1		mg/L	07/29/2019 2107 KMG	EPA 300.0
Fluoride	0.8	0.1		mg/L	07/29/2019 1513 KMG	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	07/29/2019 1218 AMB	EPA 353.2
Sulfate	1870	1		mg/L	07/29/2019 2107 KMG	EPA 300.0
Cations						
Calcium	248	1		mg/L	07/29/2019 1512 DG	EPA 200.7
Magnesium	288	1		mg/L	08/01/2019 1309 DG	EPA 200.7
Potassium	14	1		mg/L	08/01/2019 1309 DG	EPA 200.7
Sodium	267	1		mg/L	07/29/2019 1512 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by:
Ian Scofield, Project Manager

TFN 6 2/025
WCCD 09-20-19

September 2019

Addendum D6-10-301

DEQ Ex. 3-791

Scanned, 02/28/2020

RAMCO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 8/2/2019
Report ID: S1907400001

Work Order: S1907400
Collection Date: 7/26/2019 10:05:00 AM
Date Received: 7/26/2019 1:59:00 PM
Sampler: RF
Matrix: Water
COC: 180758

Project: RAMACO-2013104-98
Lab ID: S1907400-001
Client Sample ID: LAYA #2

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	10.73	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Chloride	0.51	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Fluoride	0.04	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Sulfate	38.87	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Calcium	12.35	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Magnesium	23.71	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Potassium	0.34	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Sodium	11.59	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Cation / Anion Balance						
Cation Sum	48.03	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Anion Sum	50.17	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Cation-Anion Balance	2.17	0.01		%	08/02/2019 0950 IBS	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/29/2019 1512 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/30/2019 0127 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/30/2019 0127 MS	EPA 200.8
Boron	0.5	0.1		mg/L	07/29/2019 1512 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/30/2019 0127 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/29/2019 1512 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/30/2019 0127 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/29/2019 1512 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/30/2019 0127 MS	EPA 200.8
Manganese	0.34	0.02		mg/L	07/29/2019 1512 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/30/2019 1046 JJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/30/2019 0127 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/29/2019 1512 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/30/2019 0127 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/29/2019 1512 DG	EPA 200.7
Total Metals						
Iron	1.65	0.05		mg/L	07/30/2019 1542 DG	EPA 200.7
Manganese	0.49	0.02		mg/L	07/30/2019 1542 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by:
Ian Scofield, Project Manager

TFN 8 2/025

DEQ Ex. 3-792
09-20-19

Scanned, 02/28/2020

RAMACO

WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point LAYA #3 Project Ramaco

Location N44.91259 W107.00634 W.O.# ~~201139-98~~ 201339-98

Sample ID# LAYA#3 Date Sampled 7/26/19 Time 1100 (am) pm

Describe Sampling Point 5" stock and irrigation well

Well Depth NA ft below MP Depth to Water (below MP) NA ft Casing Diameter 5 in

Date —/—/— Time — am pm Casing Volume — gal

At least NA bore volumes have been evacuated before sampling

Sampling method : (Submersible pump) Bladder — landowner - used Niles Veal generator to run pump.

Tap Bailer Grab

Pump intake or bailer set at — ft below MP.

DISCHARGE RATE	
—	gpm
x 0.00223	
	cfs

Tubing (type: used well's drop pipe to collect sample). (New or previously used) was used to collect all samples (yes or no) and all field measurements (yes or no). Tubing used only for —

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1030	7.56	1085	11.5			20
1040	7.56	1069	11.3			↓
1050	7.57	1068	11.0		↓	
1100	7.57	1071	11.0	1.71	~800	↓

Pumping Start Time 1020 WL — Pumping End Time — WL —

Comments: Could not measure total depth and DTW due to well cap, pump, and wires. - no casing volume - water clear - no odor - See photo

LCF/COC# 180758

TFN 6 21025

Form completed by: Rod Suder Witnessed by: RECD 09-20-19

September 2019

Addendum D6-10-303

C:\Fuller Files\Monitor Well Sample Form-RF.doc

Scanned, 02/28/2020

RAMCO
IML Inter-Mountain Labs
INTER-MOUNTAIN LABS
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 8/2/2019
Report ID: S1907400001

Work Order: S1907400
Collection Date: 7/26/2019 11:00:00 AM
Date Received: 7/26/2019 1:59:00 PM
Sampler: RF
Matrix: Water
COC: 180758

Project: RAMACO-2013104-98
Lab ID: S1907400-002
Client Sample ID: LAYA #3

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.57			s.u.	07/26/2019 1100	Field
Conductivity	1071			µmhos/cm	07/26/2019 1100	Field
Turbidity	1.71			NTU	07/26/2019 1100	Field
Temperature	11.0			°C	07/26/2019 1100	Field
General Parameters						
pH	8.2	0.1		s.u.	07/29/2019 1527 KMG	SM 4500 H B
Electrical Conductivity	1070	5		µmhos/cm	07/29/2019 1527 KMG	SM 2510B
Total Dissolved Solids (180)	720	10		mg/L	07/26/2019 1445 IJQ	SM 2540
Solids, Total Dissolved (Calc)	650	10		mg/L	08/02/2019 0950 IBS	SM 1030E
Alkalinity, Total (As CaCO3)	418	5		mg/L	07/29/2019 1527 KMG	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	516	1		mg/L	08/02/2019 0950 IBS	SM 2340B
Nitrogen, Ammonia (as N)	ND	0.1		mg/L	07/29/2019 0948 AMB	EPA 350.1
Sodium Adsorption Ratio	0.59	0.01			08/02/2019 0950 IBS	Calculation
nions						
Alkalinity, Bicarbonate as HCO3	510	5		mg/L	07/29/2019 1527 KMG	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	07/29/2019 1527 KMG	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	07/29/2019 1527 KMG	SM 2320B
Chloride	4	1		mg/L	07/29/2019 2120 KMG	EPA 300.0
Fluoride	0.7	0.1		mg/L	07/29/2019 1527 KMG	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	0.3	0.1		mg/L	07/29/2019 1219 AMB	EPA 353.2
Sulfate	203	1		mg/L	07/29/2019 2120 KMG	EPA 300.0
Cations						
Calcium	92	1		mg/L	07/29/2019 1514 DG	EPA 200.7
Magnesium	70	1		mg/L	07/29/2019 1514 DG	EPA 200.7
Potassium	2	1		mg/L	07/29/2019 1514 DG	EPA 200.7
Sodium	31	1		mg/L	07/29/2019 1514 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by:
Ian Scofield, Project Manager

TFN 8 2/025
RECD 09-20-19

Scanned, 02/28/2020

RAMACO
Inter-Mountain Labs
1673 Terra Avenue, Sheridan, Wyoming 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 8/2/2019
Report ID: S1907400001

Work Order: S1907400
Collection Date: 7/26/2019 11:00:00 AM
Date Received: 7/26/2019 1:59:00 PM
Sampler: RF
Matrix: Water
COC: 180758

Project: RAMACO-2013104-98
Lab ID: S1907400-002
Client Sample ID: LAYA #3

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	8.35	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Chloride	0.12	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Fluoride	0.03	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Nitrate + Nitrite as N	0.01	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Sulfate	4.22	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Calcium	4.60	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Magnesium	5.72	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Potassium	0.04	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Sodium	1.35	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Cation / Anion Balance						
Cation Sum	11.72	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Anion Sum	12.76	0.01		meq/L	08/02/2019 0950 IBS	SM 1030E
Cation-Anion Balance	4.26	0.01		%	08/02/2019 0950 IBS	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	07/29/2019 1514 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	07/30/2019 0151 MS	EPA 200.8
Barium	ND	0.1		mg/L	07/30/2019 0151 MS	EPA 200.8
Boron	0.2	0.1		mg/L	07/29/2019 1514 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	07/30/2019 0151 MS	EPA 200.8
Chromium	ND	0.01		mg/L	07/29/2019 1514 DG	EPA 200.7
Copper	ND	0.01		mg/L	07/30/2019 0151 MS	EPA 200.8
Iron	ND	0.05		mg/L	07/29/2019 1514 DG	EPA 200.7
Lead	ND	0.02		mg/L	07/30/2019 0151 MS	EPA 200.8
Manganese	ND	0.02		mg/L	07/29/2019 1514 DG	EPA 200.7
Mercury	ND	0.001		mg/L	07/30/2019 1048 JJB	EPA 245.1
Molybdenum	ND	0.02		mg/L	07/30/2019 0151 MS	EPA 200.8
Nickel	ND	0.01		mg/L	07/29/2019 1514 DG	EPA 200.7
Selenium	ND	0.005		mg/L	07/30/2019 0151 MS	EPA 200.8
Zinc	ND	0.01		mg/L	07/29/2019 1514 DG	EPA 200.7
Total Metals						
Iron	ND	0.05		mg/L	07/30/2019 1553 DG	EPA 200.7
Manganese	ND	0.02		mg/L	07/30/2019 1553 DG	EPA 200.7

These results apply only to the samples tested.

RL - Reporting Limit

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect
- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by:
Ian Scofield, Project Manager

September 2019

TFN 6 2/025

Addendum D6-10-305

RECD 09-20-19

Scanned, 02/28/2020

RAMAC WWC ENGINEERING

Brook Mine
1849 Terra Avenue
Sheridan, Wyoming 82801
(307) 672-0761

SAMPLING INFORMATION

Sampling Point 578415-AL-1 Project Ramaco

Location _____ W.O.# 20131139-98

Sample ID# 578415-AL-1 Date Sampled 11/8/19 Time 1020 (am) pm

Describe Sampling Point GW monitoring well

Well Depth 36.32 ft below MP Depth to Water (below MP) 31.12 ft Casing Diameter 2 in

Date 11/8/19 Time 1020 (am) pm Casing Volume NA gal

At least 3+ bore volumes have been evacuated before sampling

Sampling method : Submersible pump ~~Bladder~~ Tap (Bailer) Grab

DISCHARGE RATE	
_____	gpm
x 0.00223	
	cfs

Pump intake or bailer set at _____ ft below MP.

Tubing (type: _____). (New or previously used) was used to collect all samples (yes or no)

and all field measurements (yes or no). Tubing used only for _____

EVACUATION / STABILIZATION TEST DATA

Time	PH (units)	Temperature Corrected Conductance (µmhos/cm)	Temperature (°C)	Turbidity (NTU)	Cumulative Volume of Water Removed from Well (gallons)	Pumping Rate (gpm)
1020	7.00	2430	10.7	OVER LIMIT	5.0	
	36.32					
	-31.12					
	5.20 x 0.163 = 0.85 x 3 = 2.54 Gallons					

Pumping Start Time _____ WL _____ Pumping End Time _____ WL _____

Comments: water turbid - no odor

HCF
COC# 182525

Form completed by: Rod Fuller Witnessed by: _____

December 2019

Addendum D6-10-306
C:\Fuller Files\Monitor Well Sample Form-RF.doc

TEMP 2/025
RECD DEC 13, 2019

Scanned, 02/28/2020

RAMACO Pace Analytical • Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 11/26/2019
Report ID: S1911126001

Work Order: S1911126
Collection Date: 11/8/2019 10:20:00 AM
Date Received: 11/8/2019 2:30:00 PM
Sampler: RF
Matrix: Water
COC: 182525

Project: RAMACO-2013139-98
Lab ID: S1911126-001
Client Sample ID: 578415-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Field						
pH	7.0			s.u.	11/08/2019 1020	Field
Conductivity	2430			µmhos/cm	11/08/2019 1020	Field
Turbidity	Over Limit			NTU	11/08/2019 1020	Field
Depth To Water	31.12			ft	11/08/2019 1020	Field
Temperature	10.7			℃	11/08/2019 1020	Field
General Parameters						
pH	8.0	0.1		s.u.	11/09/2019 0812 AB	SM 4500 H B
Electrical Conductivity	2500	5		µmhos/cm	11/09/2019 0812 AB	SM 2510B
Total Dissolved Solids (180)	2190	10		mg/L	11/11/2019 0824 IJQ	SM 2540
Solids, Total Dissolved (Calc)	1950	10		mg/L	11/26/2019 1118 JJ	SM 1030E
Alkalinity, Total (As CaCO3)	768	5		mg/L	11/09/2019 0812 AB	SM 2320B
Hardness, Calcium/Magnesium (As CaCO3)	1560	1		mg/L	11/26/2019 1118 JJ	SM 2340B
Nitrogen, Ammonia (as N)	0.2	0.1		mg/L	11/25/2019 1044 AMB	EPA 350.1
Sodium Adsorption Ratio	0.98	0.01			11/26/2019 1118 JJ	Calculation
Anions						
Alkalinity, Bicarbonate as HCO3	937	5		mg/L	11/09/2019 0812 AB	SM 2320B
Alkalinity, Carbonate as CO3	ND	5		mg/L	11/09/2019 0812 AB	SM 2320B
Alkalinity, Hydroxide as OH	ND	5		mg/L	11/09/2019 0812 AB	SM 2320B
Chloride	10	1		mg/L	11/16/2019 0732 AB	EPA 300.0
Fluoride	0.3	0.1		mg/L	11/09/2019 0812 AB	SM 4500FC
Nitrogen, Nitrate-Nitrite (as N)	ND	0.1		mg/L	11/21/2019 1706 AMB	EPA 353.2
Sulfate	900	1		mg/L	11/16/2019 0732 AB	EPA 300.0
Cations						
Calcium	245	1		mg/L	11/11/2019 1633 DG	EPA 200.7
Magnesium	230	1		mg/L	11/11/2019 1633 DG	EPA 200.7
Potassium	15	1		mg/L	11/11/2019 1633 DG	EPA 200.7
Sodium	89	1		mg/L	11/11/2019 1633 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- L Analyzed by another laboratory
- ND Not Detected at the Reporting Limit
- S Spike Recovery outside accepted recovery limits
- X Matrix Effect

RL - Reporting Limit

- C Calculated Value
- G Analyzed at IML Gillette laboratory
- J Analyte detected below quantitation limits
- M Value exceeds Monthly Ave or MCL or is less than LCL
- O Outside the Range of Dilutions
- U Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

December 2019

TFNB 2/025

Addendum D6-10-307

DEQ Ex. 3-797

RECD DEC 13, 2019

Scanned, 02/28/2020

RAMACO Pace Analytical • Formerly Inter-Mountain Laboratories
1673 Terra Avenue Sheridan, WY 82801 ph: (307) 672-8945

Sample Analysis Report

CLIENT: Western Water Consultants
1849 Terra
Sheridan, WY 82801

Date Reported: 11/26/2019
Report ID: S1911126001

Work Order: S1911126
Collection Date: 11/8/2019 10:20:00 AM
Date Received: 11/8/2019 2:30:00 PM
Sampler: RF
Matrix: Water
COC: 182525

Project: RAMACO-2013139-98
Lab ID: S1911126-001
Client Sample ID: 578415-AL-1

Analyses	Result	RL	Qual	Units	Date Analyzed/Init	Method
Cation/Anion-Milliequivalents						
Bicarbonate as HCO3	15.36	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Carbonate as CO3	ND	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Hydroxide as OH	ND	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Chloride	0.27	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Fluoride	0.01	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Nitrate + Nitrite as N	ND	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Sulfate	18.73	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Calcium	12.20	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Magnesium	18.90	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Potassium	0.37	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Sodium	3.87	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Cation / Anion Balance						
Cation Sum	35.37	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Anion Sum	34.39	0.01		meq/L	11/26/2019 1118 JJ	SM 1030E
Cation-Anion Balance	1.40	0.01		%	11/26/2019 1118 JJ	SM 1030E
Dissolved Metals						
Aluminum	ND	0.1		mg/L	11/11/2019 1633 DG	EPA 200.7
Arsenic	ND	0.005		mg/L	11/12/2019 0143 MS	EPA 200.8
Barium	ND	0.1		mg/L	11/12/2019 0143 MS	EPA 200.8
Boron	0.4	0.1		mg/L	11/11/2019 1633 DG	EPA 200.7
Cadmium	ND	0.001		mg/L	11/12/2019 0143 MS	EPA 200.8
Chromium	ND	0.01		mg/L	11/11/2019 1633 DG	EPA 200.7
Copper	ND	0.01		mg/L	11/12/2019 0143 MS	EPA 200.8
Iron	0.13	0.05		mg/L	11/11/2019 1633 DG	EPA 200.7
Lead	ND	0.02		mg/L	11/12/2019 0143 MS	EPA 200.8
Manganese	1.20	0.02		mg/L	11/11/2019 1633 DG	EPA 200.7
Mercury	ND	0.001		mg/L	11/15/2019 1030 HCZ	EPA 245.1
Molybdenum	ND	0.02		mg/L	11/12/2019 0143 MS	EPA 200.8
Nickel	0.01	0.01		mg/L	11/11/2019 1633 DG	EPA 200.7
Selenium	ND	0.005		mg/L	11/12/2019 0143 MS	EPA 200.8
Zinc	ND	0.01		mg/L	11/11/2019 1633 DG	EPA 200.7
Total Metals						
Iron	114	0.05		mg/L	11/15/2019 1338 DG	EPA 200.7
Manganese	3.07	0.02		mg/L	11/14/2019 1925 DG	EPA 200.7

These results apply only to the samples tested.

Qualifiers:

B	Analyte detected in the associated Method Blank
E	Value above quantitation range
H	Holding times for preparation or analysis exceeded
L	Analyzed by another laboratory
ND	Not Detected at the Reporting Limit
S	Spike Recovery outside accepted recovery limits
X	Matrix Effect

RL - Reporting Limit

C	Calculated Value
G	Analyzed at IML Gillette laboratory
J	Analyte detected below quantitation limits
M	Value exceeds Monthly Ave or MCL or is less than LCL
O	Outside the Range of Dilutions
U	Analysis reported under the reporting limit

Reviewed by: John M. Jacobs
John Jacobs, Project Manager

December 2019

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ADDENDUM D6-11

2016 Tongue River Watershed Interim Monitoring Project Final Report

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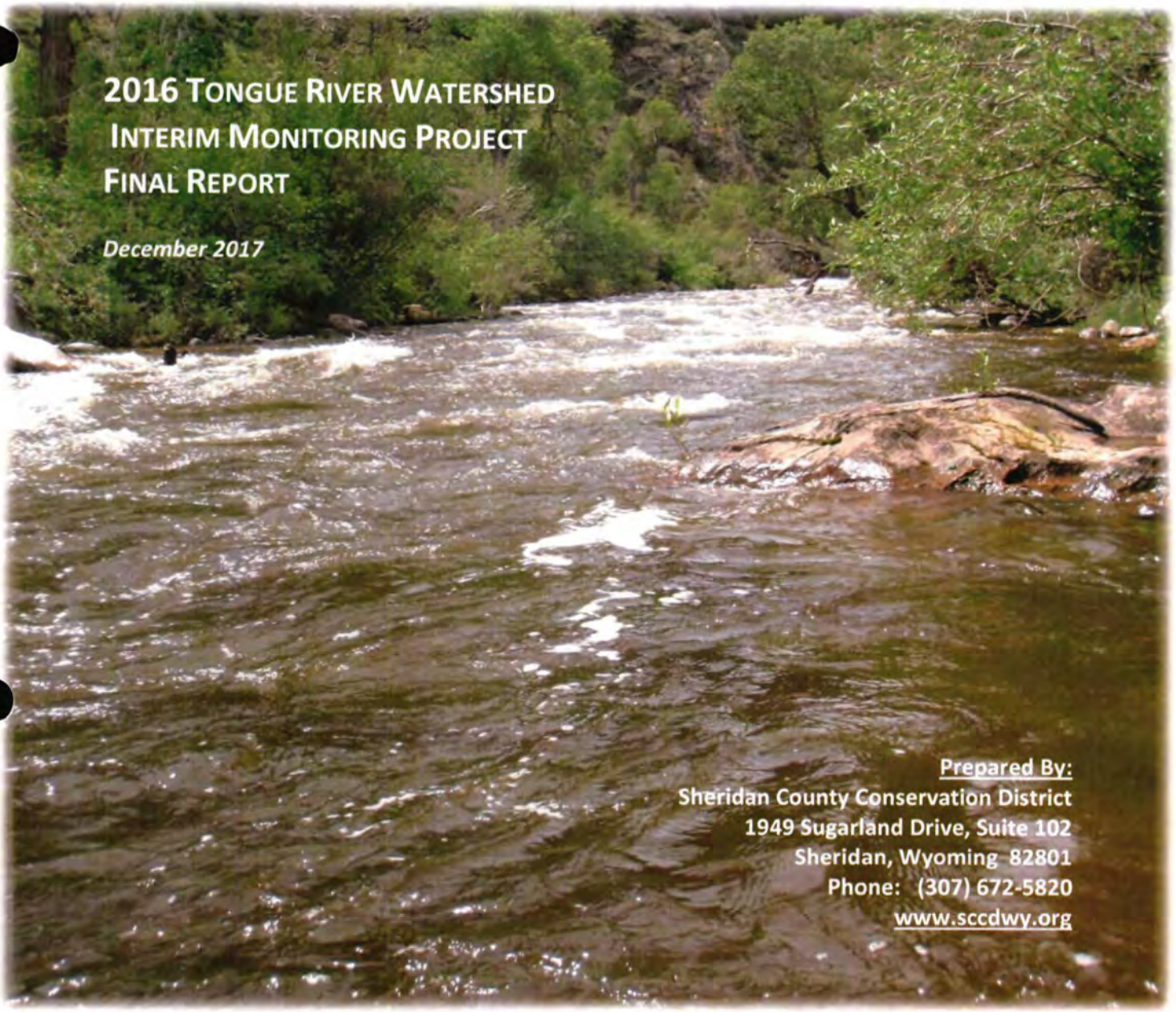

2016 Tongue River Watershed Interim Monitoring Project Final Report

December 2017

Prepared By:
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EXECUTIVE SUMMARY

The Tongue River originates in Wyoming on the eastern side of the Big Horn Mountains and flows through the Towns of Dayton and Ranchester east and north into Montana. The project area, which begins at the Wyoming-Montana state line, consists of approximately 463,990 acres. Annual precipitation ranges from 32 inches in the headwaters to 12 inches near the state line. Major tributaries of the Tongue River above the Town of Ranchester include Little Tongue River, Smith Creek, Columbus Creek, Five Mile Creek, and Wolf Creek. Goose Creek and Prairie Dog Creek are the primary perennial tributaries in the lower portion of the project area, however intermittent draws may contribute stormwater run-off during precipitation or snowmelt events. Tributaries provide irrigation water and make up a portion of the water supply to rural residents in the watershed. The project area includes a combination of private, State, and Federal lands, with private lands dominating the portion of the watershed downstream of the Bighorn National Forest (BNF). Land uses include irrigated and non-irrigated hay and crop lands, pasture, livestock grazing, energy development, recreation, the Towns of Dayton and Ranchester, and wildlife habitat. The Tongue River and major tributaries are perennial waterbodies expected to support drinking water supplies (when treated), fish and aquatic life, recreation, wildlife, industry and agriculture uses. Five Mile Creek and other draws are not expected to support fish populations or drinking water supplies. The State of Wyoming has identified the Tongue River and several tributaries as impaired for recreational use because of bacteria concentrations. Some lower Tongue River segments have also been identified as impaired for Cold Water fisheries because of high water temperatures.

The Sheridan County Conservation District (SCCD) initiated water quality monitoring on the Tongue River Watershed in 1996. The original 1996 Tongue River project area consisted of eight sites in approximately 313,121 acres upstream of the Town of Ranchester. The 1996-1999 Tongue River Watershed Assessment Final Report was completed in September 2000 and resulted in the development of the Tongue River Watershed Plan. The Plan outlined the goals, objectives, and action items for addressing bacteria concerns within the watershed.

The project boundary was expanded twice since the Tongue River Watershed Assessment, but still includes the initial eight sites. The first expansion, in 2006, included two new sites on the Tongue River between the Town of Ranchester and the confluence with Goose Creek. The section from Goose Creek to the Montana State Line was added in 2013 to tie into existing efforts on adjacent watersheds. In the 2013 expansion, four sites on the Tongue River were added, along with the lowermost sites on Goose Creek and Prairie Dog Creek.

There have been five rounds of interim water quality monitoring since 1999; one in 2003, 2006, 2010, 2013, and the most recent in 2016. Interim monitoring includes water quality monitoring along with benthic macroinvertebrates and habitat assessments at a limited number of stations. Interim monitoring evaluates trends in bacteria and other water quality parameters. Benthic macroinvertebrate populations and habitat assessments are evaluated at a limited

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number of stations. The water quality parameters include: water temperature, pH, conductivity, dissolved oxygen, discharge, turbidity, and *E. coli* bacteria.

Implementation of the Tongue River Watershed Plan resulted in the development and administration of a water resources improvement program, which included cost-share funding for projects with the potential to benefit water quality. Despite improvement efforts, bacteria concerns continued to exist and the initial watershed plan was updated in 2007. In 2012, the plan was updated again to meet the nine essential elements of a Watershed Based Plan, required by the U.S. Environmental Protection Agency. Ongoing interim water quality monitoring influenced the decisions, priority areas, and action items within the plan.

Water quality monitoring for 2016 was performed at 13 stations; six sites on the mainstem of the Tongue River, and seven sites on the major tributaries that flow into the Tongue River. These seven tributaries included Smith Creek, Little Tongue River, Columbus Creek, Five Mile Creek, Wolf Creek, Goose Creek, and Prairie Dog Creek. Stations were equipped with a SCCD calibrated staff gauge or located at USGS gauging stations. Grab samples for bacteria and turbidity were collected five times in the early season from May-July and five times in the late season from July-September. Instantaneous temperature, pH, conductivity, dissolved oxygen (% and mg/L), and gauge height were measured on-site during sampling events. Continuous temperature loggers were used to monitor water temperature at the seven mainstem stations. Macroinvertebrate collections and habitat assessments were conducted on five mainstem sites of the Tongue River during the month of September. All monitoring methods, standard operating procedures, and QA/QC protocols used for this project were described in the 2016 Quality Assurance Project Plan 2015 Update and the 2016 Tongue River Watershed Interim Monitoring Sampling and Analysis Plan.

Data Quality Objectives (DQOs) were established for each monitoring parameter for precision, accuracy, and completeness at levels sufficient to allow SCCD to recognize project goals and objectives. With few exceptions, all parameters met the DQO's and data were accepted. Meter malfunction resulted in discarding all dissolved oxygen measurements for one sample day. In addition, one-set of *E. coli* and turbidity samples on Five Mile Creek were discarded because of non-representative sample conditions.

Summary statistics and geometric mean values were calculated for instantaneous monitoring parameters on accepted data. Instantaneous water temperature measurements were recorded above the maximum 20°C instream temperature standard at 12 of the 13 sites on at least one occasion; the uppermost station (TR09) did not have any temperature measurements above 20°C. Continuous temperature loggers reported temperatures above 20°C at all but the uppermost station in Tongue River Canyon. Conductivity and pH were within the expected ranges during 2016. Turbidity values were considered normal for the watershed with occasional high values occurring during late-spring, early summer precipitation and run-off events. All sites met the minimum instantaneous dissolved oxygen concentration for early and other life stages. Four tributary stations and four mainstem stations had one or more samples

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that were below the 8.0 mg/L water column concentration recommended to achieve the inter-gravel concentrations for early life stages.

Bacteria geometric mean concentrations in the early season were typically higher than in the late season on tributary sites. In contrast, mainstem sites had higher bacteria concentrations in the late season except on TR03 and TR09. While some mainstem sites did not meet Wyoming Water Quality Standards, the highest bacteria concentration observed at a mainstem site was 169 cfu/100 mL or 25% above the standard. Bacteria concentrations at tributary stations appeared to contribute to bacteria increases on the Tongue River at adjacent downstream stations in the upper portion of the watershed during the early season. Except for Wolf Creek during the late season, bacteria concentrations at all tributary stations exceeded Wyoming Water Quality standards in both the early season and the late season.

For the most part, bacteria concentrations decreased from 2003-2016 and from 2013-2016 at all mainstem sites in the early season but increased in the late season. In contrast, bacteria concentrations at TR09 in the early season increased since 2003, but were still well below Wyoming Water Quality standards.

The collection and analysis of stream benthic macroinvertebrate samples during 2016 revealed similar trends in biological condition observed during previous monitoring at Tongue River mainstem stations. No Tongue River tributary stations were sampled during this 2016 report period. Biological condition scores at reference station TR09 varied little over the years. With the exception of 1995 and 2007, the biological condition scores indicated full support for aquatic life use. The slightly positive trendline indicating improvement in biological condition at station TR09 over the years indicated stability in the biological community and confirmed that station TR09 was a representative reference station. The biological condition of the benthic macroinvertebrate community at Tongue River TR07 station varied little from the period of 1996 through 1999 and indicated indeterminate or full support for aquatic life use each year. However, a negative trendline indicated a general decline in biological condition since sampling began in 1996. The biological condition scores at station TR05 in from 1995 to 2004 indicated full support for aquatic life use. Sampling from 2006 to 2016 indicated indeterminate support for aquatic life use. The negative trendline for biological condition at TR05 indicated a gradual downward trend in biological condition since sampling in 1995. Biological condition scores at the most downstream station TR01 located near the Montana border indicated full support for aquatic life use during each year since 1998. However, a graph of biological condition scores indicated that biological condition has declined over time. Full support for aquatic life use may change should the decline in biological condition continue. No threatened or endangered benthic macroinvertebrate taxa or fish species have been identified since sampling began in the Tongue River watershed in 1993. The generally widespread occurrence of indicator taxa indicated that water contained no toxic substances in sufficient concentration to prevent the establishment and survival of these taxa. The disappearance of stoneflies since the latter 1990's noted at some mainstem Tongue River stations continued. The general disappearance of stoneflies at Tongue River stations downstream of TR09 since the 1990's indicates that water

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quality and habitat change have negatively affected this pollution intolerant group of aquatic insects. Monitoring of aquatic benthic macroinvertebrate communities in the Tongue River watershed have not identified the presence of aquatic invasive species of concern to the Wyoming Game and Fish Department. No zebra mussel (*Dreissena polymorpha)*, quagga mussel (*Dreissena rostriformis bugensis),* New Zealand Mudsnail (*Potamopyrgus antipodarum)* and the Asian Clam (*Corbicula fluminea*) have been identified in the Tongue River watershed. Recommended future benthic macroinvertebrate monitoring by SCCD will be attentive to the presence of aquatic invasive species.

Tubifex tubifex, a species of aquatic worm, involved in the whirling disease life cycle that may decimate trout populations, have not been collected at Tongue River stations since monitoring began indicating a low probability for the occurrence of whirling disease. However, the presence of the genus *Tubifex* and immature Tubificid worms in samples collected in the Tongue River watershed suggest the future potential occurrence of *T. tubifex*. Whirling disease has not been detected in the Tongue River watershed or nearby Little Goose Creek and Big Goose Creek watersheds.

Attempts to determine if improvements in overall water quality have been achieved are often difficult, especially when comparing water quality data that has been collected during seasons with different hydrological and meteorological conditions. Although normal flow conditions cannot be anticipated nor expected during monitoring, these varying conditions do make water quality comparisons more difficult. Bacteria concentrations, in particular, are known to vary in response to a number of different water quality and water quantity factors, including changes in water temperature, water quantity, and suspended sediment loads. Higher *E. coli* bacteria concentrations in May can be associated with precipitation events in the spring, including run-off from snowmelt, that contribute surface contaminants. Increased stream discharge can also disturb bed sediment containing high concentrations of bacteria. From 2000 through 2006, the local area was in a prolonged drought and below average stream discharge conditions were experienced. Years 2001 and 2002 lacked adequate peak flows during May and June which normally "flush" stream channel sediment accumulated during the previous year. During 2003 and 2010, the Tongue River experienced higher than normal peak flows, which may have had the ability to "flush" streambed sediment that had accumulated during previous drought years. Flows in 2013 and 2016 were generally below normal at most stations, especially during the early season.

The positive effects that improvement projects have on water quality may not be immediately determined due to factors such as the bacteria storage capacity of bed sediment, which is normally suspended during bankfull flows. Bacteria "storage" in bed sediments and their annual release during high flows may cause a delay in observing quantifiable changes in bacteria currently entering the system. The data provided by the 1996 – 1999 watershed assessment and subsequent interim monitoring indicate the need for additional improvement projects as well as additional future monitoring to create and measure positive water quality changes. The SCCD anticipates that voluntary, incentive based watershed planning and

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implementation will be successful; however, it may require several years to measure these achievements. Nonetheless, each improvement project that has been implemented or is currently being implemented on the watershed certainly induces positive water quality changes, whether they are immediately apparent or not.

SCCD will continue to monitor water quality in the Tongue River Watershed on a three-year rotation, pending available funding sources. Planning and implementation of remedial measures to restore full aquatic life use support in the streams in the Tongue River watershed should continue. Continued benthic macroinvertebrate sampling should be conducted at stations in the watershed to track potential changes in biological condition.

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CHAPTER 1 PROJECT AREA DESCRIPTION

1.1 WATERSHED DESCRIPTION

The Tongue River originates in the Bighorn National Forest (BNF) on the eastern side of the Big Horn Mountains, flows east and north through the towns of Dayton and Ranchester, and eventually into the Yellowstone River in Montana. The project area, which begins at the Wyoming-Montana state line, consists of approximately 463,990 acres in northern Sheridan County, in north-central Wyoming and Big Horn County in south-east Montana (Appendix A-1). Of the 463,990 acres, 81,207 acres (17.5 %) are located in Montana adjacent to smaller, ephemeral tributaries and draws and are not included in the following project area description. This area did not include the entire Goose Creek and Prairie Dog Creek Watershed areas, which have separate monitoring and improvement efforts. The designated project area, including the project area description, includes only a small area above the sampling site at those stations.

Elevation of the Tongue River within the project area starts at 4,160 feet in the Tongue River canyon (TR09) and drops to 3,420 feet just below the confluence with Prairie Dog Creek at TR01. Total elevation difference is 740 feet over a distance of approximately 53.01 miles (13.96 ft/mile or 0.07% slope). The annual precipitation is 28 to 32 inches at the headwaters in the BNF. At the uppermost monitoring station in Tongue River Canyon (TR09), the annual precipitation is 16 to 18 inches. Downstream of the Town of Ranchester, the watershed transitions to a drier precipitation zone; near the Wyoming-Montana state line, at TR01, the precipitation is only 12 to 14 inches (Appendix A-2). The watershed is comprised of three ecological site groups (Appendix A-3). Sites within the lower watershed, below the Town of Ranchester to the State Line, are in the 10-14" Northern Plains Ecological Site Group. The middle to upper portion of the watershed, including Tongue River Sites TR07 and TR08, are within the 15-19" Northern Plains Ecological Site Group. The 20+" Mountains Ecological Site Group, encompasses the remaining portion of the watershed, including all of the area within the BNF and the uppermost sample station (TR09).

Major tributaries of the Tongue River above the Town of Ranchester include Little Tongue River, Smith Creek, Columbus Creek, Five Mile Creek, and Wolf Creek. Goose Creek and Prairie Dog Creek are the primary perennial tributaries below the Town of Ranchester, however intermittent draws may contribute stormwater run-off during precipitation or snowmelt events. The largest of these draws include Six-mile Creek, Earley Creek, North Dry Creek, Slater Creek, South Dry Creek, and Hidden Water Creek. Tributaries provide irrigation water to ranches and make up a portion of the water supply to rural residents in the watershed. Diversions result in the transferring and mixing of waters from different areas of the watershed.

1.2 LAND OWNERSHIP AND USES

Descriptions of land ownership and uses are limited to the 382,783 acres within the State of Wyoming. The project area includes a combination of private, State, and Federal lands with private lands dominating the portion of the watershed downstream of the BNF (Appendix A-4).

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Nearly 177,127 acres (46%) are privately owned. State lands comprise approximately 24,664 acres (6%) and include the Amsden Creek Big Game Winter Range. Federal lands constitute approximately 180,993 (47%) of the total acres, including:

- 174,111 acres managed by the BNF,
- 5207 acres managed by the Bureau of Land Management (BLM),
- 1150 managed by the Department of Defense, and
- 525 acres managed by the United States Fish and Wildlife Service (USFWS).

Land uses within the watershed include irrigated and non-irrigated hay and crop lands, dry land pasture, livestock grazing, energy development, various types of recreation, the urban areas of Dayton and Ranchester, and prime wildlife habitat that is concentrated along stream bottoms and brushy draws where riparian zones are intact (Appendix A-5). Sensitive species including warm water game and non-game fish, sage grouse and prairie dog populations occur within the project area. The headwaters, located in the BNF, supports wildlife habitat, livestock grazing, logging, recreation, including angling, camping, hiking, ATV trails, and other uses. The historic coal mining community of Monarch, as well as others, has been almost entirely removed, with some remnant homesites, a church (converted into a residence), and a water tower remaining. A railroad, local highway, and the interstate run parallel to the Tongue River between the Town of Ranchester and Acme. The lower portion of the project area has more coal bed methane, mining, and other energy development than other areas of the watershed.

There are five permitted point source discharges (not including storm drains) within the upper portion of the project area; four are from sanitary wastewater facilities (including the Towns of Dayton and Ranchester), and one from a Concentrated Animal Feeding Operation (CAFO). The lower portion of the project area contains point source discharges from coal bed methane production, although some of these are inactive. The City of Sheridan Wastewater Treatment Plant discharges into Goose Creek approximately 7 miles upstream of the GC01 site. Approximately 5 miles upstream of the GC 01 site, the KOA campground also had a permitted discharge from a small wastewater facility; however, that system is being replaced with a connection to the City of Sheridan sanitary sewer system in 2017.

The mainstem of the Tongue River and major tributaries contain numerous small to very large ranches. Status for domestic wastewater treatment at ranches and rural subdivisions is unknown. Agriculture related land use dominates the watershed. Agricultural operations center on cattle and hay production enhanced by irrigation water from the Tongue River and its tributaries during the summer growing season. Livestock tend to be fed and wintered along the creek bottoms since these areas provide the necessary shelter and water. A more comprehensive, detailed description of the project area has been previously provided in the 1996-1999 Tongue River Watershed Assessment Final Report (SCCD, 2000), which includes narrative descriptions of water uses, land uses, surface geology, soil types, and other factors.

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1.3 Stream Classifications and Beneficial Uses

The Wyoming Department of Environmental Quality (WDEQ) is charged with implementing the policies of the Clean Water Act and providing for the "highest possible water quality" for activities on a waterbody (WDEQ, 2013). Depending upon its classification, a waterbody is expected to be suitable for certain uses (Table 1-1).

Table 1-1. Wyoming surface water classes and use designations (WDEQ, 2013)

Class	Drinking Water[2]	Game Fish[3]	Non-Game Fish[3]	Fish Consumption[4]	Other Aquatic Life[5]	Recreation[6]	Wildlife[7]	Agriculture[8]	Industry[9]	Scenic Value[10]
1[1]	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	Yes	Yes	Yes	Yes	Yes
2AB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2A	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2B	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2D	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3A	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3B	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3C	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4A	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4B	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4C	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

[1] Class 1 waters are not protected for all uses in all circumstances. For example, all waters in the National Parks and Wilderness areas are Class 1, however, all do not support fisheries or other aquatic life uses (e.g. hot springs, ephemeral waters, wet meadows, etc.).

[2]The drinking water use involves maintaining a level of water quality that is suitable for potable water or intended to be suitable after receiving conventional drinking water treatment.

[3]The fisheries use includes water quality, habitat conditions, spawning and nursery areas, and food sources necessary to sustain populations of game and non-game fish. This does not include the protection of exotic species which are designated "undesirable" by the Wyoming Game and Fish Department or the U.S. Fish and Wildlife Service with their appropriate jurisdictions.

[4]The fish consumption use involves maintaining a level of water quality that will prevent any unpalatable flavor and/or accumulation of harmful substances in fish tissue.

[5]Aquatic life other than fish includes water quality and habitat necessary to sustain populations of organisms other than fish in proportions which make up diverse aquatic communities common to waters of the state. This does not include the protection of insect pests or exotic species which are designated "undesirable" by the Wyoming Game and Fish Department or the U.S. Fish and Wildlife Service with their appropriate jurisdictions.

[6]Recreational use protection involves maintaining a level of water quality that is safe for human contact. It does not guarantee the availability of water for any recreational purpose. Both primary and secondary contact recreation are protected in Class 2AB waters.

[7]The wildlife use designation involves protection of water quality to a level that is safe for contact and consumption by avian and terrestrial wildlife species.

[8]For purposes of water pollution control, agricultural uses include irrigation or stock watering.

[9]Industrial use protection involves maintaining a level of water quality useful for industrial purposes.

[10]Scenic value involves the aesthetics of the aquatic systems themselves (odor, color, taste, settleable solids, floating solids, suspended solids, and solid waste) and is not necessarily related to general landscape appearance.

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Stream classifications are assigned by WDEQ and identified on the Wyoming Surface Water Classification List (WDEQ, 2013a) or in subsequent reports. Chapter 1 of the Wyoming Water Quality Rules and Regulations (WDEQ, 2013) describes the surface water classes, and designated uses, and the water quality standards that must be achieved for a Wyoming waterbody to support its designated uses (WDEQ, 2013).

Streams within the Tongue River Watershed project area are classified as either 2AB or 3B (Table 1-2). Class 2AB waters are perennial waterbodies expected to support drinking water supplies (when treated), fish and aquatic life, recreation, wildlife, industry, and agriculture uses (WDEQ, 2013). Five Mile Creek and other draws, which are Class 3B surface waters, are not expected to support fish populations or drinking water supplies.

Table 1-2. Stream classifications of waterbodies in the Tongue River watershed

Stream Classifications	
Class 2AB	**Class 3B**
Tongue River (below BNF boundary)	Ash Creek
Amsden Creek	Earley Creek
Columbus Creek	Five Mile Creek
Little Tongue River	Six Mile Creek
Sheep Creek	Slater Creek
Smith Creek	South Dry Creek
Wolf Creek	Squirrel Creek
Goose Creek	Youngs Creek
Prairie Dog Creek	

1.4 Stream Impairments and Listings

States are required to summarize water quality conditions in the state through section 305(b) of the Clean Water Act; this report is commonly known as the 305(b) report and is published every two years. If a waterbody exceeds narrative or numeric water quality standards, it is considered "impaired" or not meeting its designated uses. Section 303(d) of the Clean Water Act requires states to identify waters that are not supporting their designated uses and/or need to have a Total Maximum Daily Load (TMDL) established to support the designated uses. A TMDL describes the amount of a given pollutant a waterbody can receive and still meet water quality standards. Currently, impaired waterbodies are first included on the Wyoming 303(d) list of Waters Requiring TMDLS under Category 5 (WDEQ, 2016). Once a TMDL is completed, a waterbody is moved from Category 5 to Category 4, which includes the list of waterbodies with TMDLs.

Some streams within Tongue River Watershed were listed as early as 1996, but were removed or included in the list of waterbodies requiring further monitoring in the 1998 list. Subsequent monitoring by SCCD, USGS, WDEQ, and others resulted in impairment designations on the Tongue River and several tributaries (Table 1-3). These waterbodies were assigned a low priority for TMDL development because of local watershed improvement efforts.

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Table 1-3. Impaired stream segments within the Tongue River watershed (WDEQ, 2016)

Name	Class	Location	Miles	Uses	Impairment	List Date
Tongue River	2AB	From Monarch Road upstream to Wolf Creek Road	13.5	Recreation	*E. coli*	2010
Tongue River	2AB	From Goose Creek downstream to the Montana border	22.1	Cold Water Fishery	Temperature	2002
Prairie Dog Creek	2AB	From I-90 to a point 47.2 miles downstream	47.2	Recreation	Fecal Coliform	2004
Prairie Dog Creek	2AB	From I-90 to a point 47.2 miles downstream	47.2	Drinking Water	Manganese	2012
Prairie Dog Creek	2AB	From I-90 to a point 47.2 miles downstream	47.2	Cold Water Fishery	Temperature	2012
Prairie Dog Creek	2AB	From Tongue River to a point 6.7 miles upstream	6.7	Recreation	Fecal Coliform	2004
Prairie Dog Creek	2AB	From Tongue River a point 6.7 miles upstream	6.7	Drinking Water	Manganese	2002
Prairie Dog Creek	2AB	From Tongue River a point 6.7 miles upstream	6.7	Cold Water Fishery	Temperature	2012
Goose Creek	2AB	From Little Goose Creek downstream to the Tongue River	12.7	Aquatic life, Cold Water Fishery	Habitat Alterations, Sediment	2006
Goose Creek	2AB	From Little Goose Creek downstream to the Tongue River	12.7	Recreation	Fecal Coliform	2000
Wolf Creek	2AB	From Tongue River upstream to East Wolf Creek	10.6	Recreation	Fecal Coliform	2002
Five Mile Creek	3B	From Tongue River upstream to Hanover Ditch	2.1	Recreation	Fecal Coliform	2002
Columbus Creek	2AB	From Tongue River to a point 3.1 miles upstream	3.1	Recreation	Fecal Coliform	2002
Little Tongue River	2AB	From Tongue River upstream to Frisbee Ditch	4.8	Recreation	*E. coli*	2002
Smith Creek	2AB	From Tongue River to a point 5.8 miles upstream	5.8	Recreation	Fecal Coliform	2002
North Tongue River (Bighorn National Forest)	1	From Road 171 upstream to Pole Creek	11.1	Recreation	Fecal Coliform	2004

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CHAPTER 2 PROJECT BACKGROUND

2.1 PREVIOUS SCCD MONITORING EFFORTS

The Sheridan County Conservation District (SCCD) initiated water quality monitoring in the Tongue River Watershed in 1996, in partnership with the USDA Natural Resources Conservation Service (NRCS) and the Tongue River Watershed steering committee. The original 1996 project area consisted of approximately 313,121 acres and contained eight water quality monitoring sites; three mainstem sites and five tributary sites. The 1996-1999 Tongue River Watershed Assessment Final Report was completed in September 2000 and identified fecal coliform impairments on Five Mile Creek, Columbus Creek, Smith Creek, Little Tongue River, and Wolf Creek (SCCD, 2000). The Lower Tongue River station, near the Ranchester Water Treatment Plant intake, also exceeded the fecal coliform standard on some occasions. Other water quality parameters monitored during this assessment (including nutrients and pesticides) were found at low or non-detectable levels, suggesting fertilizers and pesticides appeared well managed within the watershed.

Previous interim water quality monitoring was conducted in 2003, 2006, 2010, and 2013 utilizing many of the same monitoring sites, water quality parameters, and sampling periods (SCCD, 2004; SCCD, 2007; SCCD, 2012; and SCCD, 2015). Interim monitoring includes water quality monitoring along with benthic macroinvertebrates and habitat assessments at a limited number of stations. In 2003 and 2006, SCCD collected fecal coliform and *E. coli* samples to correspond with changes in WDEQ water quality standards. The water quality parameters include: water temperature, pH, conductivity, dissolved oxygen, discharge, turbidity, and *E. coli* bacteria. Upper tributary stations were not monitored in subsequent years because no water quality impairments were identified at these stations during the initial assessment. In addition, SCCD did not collect nutrient, pesticide, or herbicide data because these parameters were found at low or non-detectable levels during the initial assessment.

The project boundary was expanded in 2006 and again in 2013. The 2006 expansion included two new sites on the Tongue River between the Town of Ranchester and the confluence with Goose Creek. The section from Goose Creek to the Montana State Line was added in 2013 to tie into existing efforts on adjacent watersheds. SCCD added four new Tongue River sites, along with sites on Goose Creek (GC01) and Prairie Dog Creek (PD01), which are the primary tributaries in the lower watershed. Two of the Tongue River sites were retained for monitoring in 2016; the other two were discontinued due to limited staff and funding resources.

The general trend in bacteria concentrations on Tongue River stations were typically higher in the early season than in the late season; while tributaries are much more variable. Relatively high bacteria concentrations in May of 2010 were followed by sharp decreases in 2013 at most stations, which may have resulted from higher than normal precipitation and early season flows in 2010. Extremes in short and long-term weather conditions have produced bacteria data that are not directly comparable among years. Nonetheless, values that exceed bacteria standards were observed on essentially the same stream reaches year after year and indicate water quality impairments continue to exist, regardless of hydrologic conditions.

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Biological condition trends are relatively stable for most years through 2013 at the uppermost station in Tongue River Canyon (TR09) and stations below the Town of Ranchester, including, the station near Kleenburn (TR05) and near Decker Highway (TR03). While the lowermost station (TR01) continued to show full support for aquatic life use, biological condition declined from 2004-2013. The site within the Town of Ranchester downstream of the confluences with Wolf Creek and Five Mile Creek (TR07) declined from full support of aquatic life use from 1996-1999 to partial or non-support in 2010 and 2013.

2.2 Watershed Planning and Implementation

The 1996-1999 Tongue River assessment served as the foundation of a local watershed planning and improvement effort. The Tongue River Watershed steering committee, which consisted of stakeholders representing rural, urban, and other local interests, recognized bacteria levels as a major concern. Wildlife, livestock and other domestic animals, and humans were identified as possible bacteria sources. The Tongue River Watershed Plan was developed to address these concerns and was approved by WDEQ in 2000 (SCCD, 2000a). The plan outlined the goals, objectives, and action items for improving water quality with the Tongue River Watershed, along with prioritizing best management practices, and providing future recommendations. This initial plan included recommendations for continued monitoring, information and education, and improvement projects.

Since the completion of the original *Tongue River Watershed Management Plan*, there have been two updates. The *Tongue River Watershed Management Plan, Revision 1* (SCCD, 2007a) recommended continuation of improvement efforts and monitoring. Although excess sediment was not identified as a source of impairment in the Tongue River watershed, it was a concern for watershed residents. As a result, sediment contributions related to unstable channels and irrigation diversions were included in the 2007 Plan. In 2012, the SCCD and steering committee developed the *Tongue River Watershed Plan, Revision 2* (SCCD, 2012a) to include the nine essential elements required by the USEPA. The 2012 Plan identifies impaired waters; designates and characterizes distinct subwatersheds; quantifies existing pollutant loads from previous monitoring efforts; develops estimates of the load reductions required to meet water quality standards; and develops effective management action items to reduce pollutant loads. Ongoing interim water quality monitoring influenced the decisions, priority areas, and action items within the *Tongue River Watershed Plan, Revision 2* (SCCD, 2012a). As part of the *Tongue River Watershed Plan, Revision 2*, SCCD/NRCS will implement the following recommendations:

- Continue a watershed improvement effort by providing leadership and project oversight;
- Reduce bacteria contributions by an average of 18% by 2017;
- Continue mitigation efforts in the highest priority reaches, which include Smith Creek, Little Tongue River, Columbus Creek, and Five Mile Creek, along with their tributaries.
- Reduce water quality impacts, other than bacteria, such as nutrient concentrations, organic matter, temperature, and sediment loads;
- Increase awareness and encourage participation in the watershed improvement efforts; and
- Increase awareness and understanding about water quality impacts and relationships among water quality parameters.

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As of December 2016, there have been several improvement projects completed within the Tongue River Watershed, including: 10 septic system replacements; 3 riparian fencing/stockwater developments, 7 corral relocation projects; 6 irrigation diversion replacements; 10 stinger/tree cutting sites; and 9 stream/channel stabilization projects. In addition, riparian buffers on four tributaries and a reservoir restoration project have been done without financial assistance from the SCCD. Some of the buffers included contracts under USDA programs while others were completed by the landowner without assistance from SCCD or USDA. These and other watershed improvement projects are documented on a progress register map for the watershed (Appendix A-6).

The Tongue River Watershed improvement effort has helped to increase awareness about several important resource issues and has led to more public interest in the watershed. The SCCD anticipates that voluntary, incentive based watershed planning and implementation efforts will eventually be successful; however, it may require several years to measure these achievements. Continued monitoring can provide information on water quality changes over the long-term.

2.3 Project Purpose and Objectives

The purpose of this project was to complete the 2016 interim milestone in the *Tongue River Watershed Plan, Revision 2* (SCCD, 2012a). The 2015 monitoring is within a three-year monitoring rotation currently conducted by SCCD on the Tongue River, Goose Creek, and Prairie Dog Creek watersheds and is funded through the Sheridan County Watershed Improvements #4 Project funded by WDEQ through Section 319 of the Clean Water Act.

The project was consistent with the goals and overarching principles outlined in the Wyoming Nonpoint Source Management Plan Update (WDEQ, 2013b). The monitoring is part of a locally-led collaborative process that includes information and education programs and project implementation through the organization and facilitation of local stakeholder groups.
The specific objectives of this project were to use water quality monitoring information/trends:

- to identify and prioritize areas affected by nonpoint source pollution and
- to evaluate effectiveness of implementation of improvement projects and other activities.

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CHAPTER 3 HISTORICAL AND CURRENT DATA

Historical data, for the purposes of this project, are defined as data greater than five years old from the start of the 1996-1999 Assessment. The 1996-1999 Tongue River Watershed Assessment Final Report included a comprehensive compilation of known water quality data for the watershed and contained historical and current data through 1999 (SCCD, 2000). Data collected by SCCD, government agencies, and various other sources were provided in tabular form and are not repeated in this document.

Summaries of current water quality data collected after the 1996-1999 Assessment were provided in the reports for the 2003, 2006, 2010, and 2013 interim monitoring (SCCD, 2004, 2007, 2012, and 2015). USGS collected water quality and/or discharge data from seven stations within the expanded watershed boundary through 2016 (Table 3-1). Among other things, the USGS collected temperature, pH, dissolved oxygen, specific conductivity, and flow throughout the period (Appendix Tables C-17 through C-20). USGS did collect water quality samples for other parameters, but they are not included here. It was not the purpose of the interim monitoring to conduct a comprehensive review of data from other sources.

Table 3-1. Active USGS stations in the Tongue River watershed project area during 2016.

Site ID	Drainage Area (miles^2)	"Real-time: Current Observations	Field Lab Water Quality Samples	Daily/Monthly/Annual Statistics
06306300 Tongue River, at State Line Near Decker, MT	1451	10/1994-Cirremt Discharge Conductivity	10/16/1985-Current	7/1960-Current Discharge Conductance SAR
06306250 Prairie Dog Creek, Near Acme, WY	358	6/15/2000-6/30/2016 Discharge Conductivity SAR	6/23/1986-6/24/2016 Field Discharge 5/15/2000-7/7/2016	10/1970-6/2016 Temperature Discharge Conductance SAR
06305700 Goose Creek Near Acme	413	10/01/1990-Current Discharge	10/1983-8/2008 Field Discharge 5/1984-10/2017	5/1984-Current Discharge
06299980 Tongue River, at Monarch, WY	478	5/1/2004-Current Discharge Conductivity	4/3/1974-Current	5/2004-Current Discharge Conductance SAR
06306020 Tongue River BL Youngs Creek, NR Acme	Not identified		3/26/2009-6/24/2016	
06298000 Tongue River Near Dayton, WY	206	9/1987-Current Discharge	10/10/1966-08/14/2002	11/1918-Current Discharge
06297500 Highline Ditch near Dayton	NA	10/1996-Current Discharge	Field Discharge 9/1979-Current	6/1920-Current Discharge

USGS has not reported any field/laboratory data from Station No. 06298000 (Tongue River Near Dayton) since August 2002; discharge information from this station is included in this report. USGS Station 06297500 Highline Ditch near Dayton, which collected discharge information, is not located on one of the contributing tributaries or mainstem of the Tongue River. Therefore,

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no information from this station is included in this report. Station 06305700 (Goose Creek near Acme) has intermittently collected hydrologic information since 1983; "real-time" flow observations began again in June 2015.

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CHAPTER 4 MONITORING DESIGN

4.1 KEY PROJECT PERSONNEL AND RESPONSIBILITIES

This project involved various individuals from the SCCD, NRCS, WDEQ, and others (Table 4-1). The District Manager served as the Project Coordinator and Field Supervisor and was responsible for the implementation of the Quality Assurance/Quality Control (QA/QC) procedures. The Program Specialist was responsible for data entry and initial QA/QC procedures through mid-July 2016. These duties were assumed by the Program Assistant after that time. Other SCCD Supervisors and NRCS personnel assisted with the project as needed. WDEQ provided assistance and oversight as well as administration of the funds provided through Section 319 of the Clean Water Act. Progress updates were provided to the SCCD Board of Supervisors, steering committee, and cooperating stakeholders and landowners who provided site access for sampling and other information.

Table 4-1. Key personnel and organizations involved in the project

Personnel/Organization	Project Role
Carrie Rogaczewski, District Manager	Project management/oversight; field monitoring; QA/QC protocol and oversight; data validation; reporting
Amy Doke, Program Specialist	Assistance with field data collection, data management, QA/QC protocols, and reporting through July 2016
Theresa Shaw, Program Assistant	Assistance with field data collection, data management, QA/QC protocols, and reporting after July 2016
SCCD Board of Supervisors	Project review; field monitoring assistance
NRCS Sheridan Field Office Staff	Field monitoring assistance
Wyoming Department of Environmental Quality	Project review; QA/QC review; report review, funding administration
Inter-Mountain Laboratories	Laboratory analyses of water quality samples
Aquatic Assessments, Inc.	Macroinvertebrate sample sorting and midge identification; macroinvertebrate data interpretation
Aquatic Biology Associates	Macroinvertebrate sample identification and analyses
Landowners/ Steering Committee	Project and data review; sampling access

4.2 MONITORING PARAMETERS

Water quality parameters monitored in 2016 included: water temperature, pH, conductivity, dissolved oxygen, discharge, turbidity, and *E. coli* bacteria. Monitoring was performed at 13 stations; six sites on the mainstem of the Tongue River and seven sites on the major tributaries (Appendix A-1). Samples were collected 5 times in May-July and 5 times in July-September. Continuous data loggers recorded water temperature at five stations at 15-minute intervals from May through November. Macroinvertebrate sampling and habitat assessments were performed at five mainstem stations in September-October.

4.3 SITE DESCRIPTIONS

Sites were selected based on a review of the historical data, historical SCCD sampling sites, availability, and access (Table 4-2). During the initial site reconnaissance and site set-up SCCD identified land uses and other site characteristics. Considerations for site selection included the ability to reveal types and regions of non-point source pollution at a level that would

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optimize landowner participation in the watershed planning process and would allow SCCD to direct remediation assistance in the most cost-effective and environmentally sound ways.

All of the sites used in this project were previously monitored in the 1996-1999 assessment and/or subsequent monitoring years. In total, there were 13 water quality sampling stations; six sites on the mainstem of the Tongue River and seven tributary stations. These seven tributaries include Smith Creek, Little Tongue River, Columbus Creek, Five Mile Creek, Wolf Creek, Goose Creek and Prairie Dog Creek. Macroinvertebrates were collected from five Tongue River stations. Detailed site and watershed descriptions were provided in the 1996-1999 Tongue River Assessment Final Report (SCCD, 2000) and/or subsequent SAPs and Reports.

Historically, SCCD requested and documented verbal permission to collect water quality samples and publish the data in a report. On July 1, 2012, changes to the Wyoming Public Records Act (W.S. 16-4-291 through 16-4-205) required written permission to release any information collected on agricultural operations. In addition, Wyoming Statute W.S. 6-3-414 through the 2015 Enrolled Act #61 (The Trespass Bill), requires written permission to access for the purpose of collecting data. Signed consent forms were maintained for all sample sites; all sites were accessed using public highways/roads or private driveways/parking areas where consent forms had been received.

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Table 4-2. Tongue River watershed 2016 sample site descriptions

Site ID	1996-2010 Site Name	Sample Site Description	UTM Zone 13 (NAD83)	Latitude Longitude	HUC	Elevation (ft)	Land use(s)
Water Quality Stations							
TR01	____	On Tongue River, approximately 200 meters downstream of river bend off of well pad road from County Road 1211	4983391N 0356301E	44.989417N 106.822851W	100901010407 Beatty Gulch-Tongue River	3,435	Cattle grazing, irrigated haylands, and wildlife habitat.
PD01	____	On Prairie Dog Creek approximately 150 meters downstream USGS station 06306250.	4982905N 0354974E	44.984773N 106.839612W	100901010307 Lwr Prairie Dog Creek	3,484	Cattle grazing, irrigated haylands, and wildlife habitat.
TR03	____	On Tongue River, approximately 20 meters downstream of Hwy 338 bridge crossing	4978645N 0346783E	44.944777N 106.941805W	100901010407 Beatty Gulch-Tongue River	3,544	Primarily wildlife habitat. Winter cattle grazing only.
GC01	____	On Goose Creek between USGS Station No. 06305700 and HWY 339 bridge crossing.	4971855N 0343017E	44.882964N 106.987587W	100901010109 Soldier Creek-Goose Creek	3,630	Cattle grazing, irrigated hayland, and wildlife habitat. Parallel to railroad.
TR05	TR1	On Tongue River at Kleenburn Road Recreational Picnic Area approximately 0.7 miles downstream of USGS Station 06306250	4974512N 0341266E	44.906308N 107.010622W	100901010211 Slater Creek-Tongue River	3,595	Primarily wildlife habitat. Reclaimed mining lands made into recreational picnic area.
TR07	TRL	On Tongue River, approximately 3 meters downstream of the Ranchester Water Treatment Plant intake	4974826N 0329210E	44.9063314N 107.163592W	100901010210 Five Mile Creek-Tongue River	3747	Urban: Ranchester City limits. Site of City water intake.
WC01	WCL	On Wolf Creek, upstream of the County Road 67 bridge crossing	4973980N 0328613E	44.898278N 107.172225W	100901010209 Lower Wolf Creek	3763	Rural residential, wildlife habitat, cattle grazing, and irrigated haylands.
FMC01	FMCL	On Five Mile Creek upstream of the Hwy 14 Bridge in Ranchester	4975024N 0328635E	44.908068N 107.170918W	100901010210 Five Mile Creek-Tongue River	3748	Urban, Ranchester City limits. Rural residential livestock.
TR08	TRM	On Tongue River, downstream of the Halfway Lane County Road bridge	4973244N 0325508E	44.891483N 107.209832W	100901010210 Five Mile Creek-Tongue River	3778	Cattle grazing, irrigated haylands, and wildlife habitat. Some rural residential.
CC01	CCL	On Columbus Creek downstream of the Hwy 14 bridge crossing	4973511N 0323346E	44.892859N 107.237026W	100901010207 Columbus Creek-Tongue River	3707	Cattle grazing, feedlot, irrigated hay and wildlife.

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Table 4-2 (continued). Tongue River Watershed 2016 Monitoring Sample Site Descriptions

Site ID	1996-2010 Site Name	Sample Site Description	UTM Zone 13 (NAD83)	Latitude Longitude	HUC	Elevation (ft)	Land use(s)
LTR01	LTRL	On Little Tongue River, approximately 300 meters upstream of Tongue River confluence	4971707N 0321031E	44.877175N 107.265394W	100901010206 Little Tongue River	3726	Urban: Dayton city limits. Occasional wildlife habitat.
SC01	SCL	On Smith Creek downstream of County Road 92 bridge crossing	4971970N 0321164E	44.878043N 107.268177W	100901010207 Columbus Creek-Tongue River	3885	Urban: Dayton city limits.
TR09	TRU	At the USGS Station No. 06298000	4968747N 0317895E	44.849105N 107.304038W	100901010205 Sheep Creek-Tongue River	4060	Primarily wildlife habitat. Recreational camping. Parallel to County Road.
Macroinvertebrate Stations							
TR01	____	On Tongue River, approximately 50 meters downstream of river bend off of well pad road from County Road 1211	4983391N 0356301E	44.989417N 106.822851W	100901010407 Beatty Gulch-Tongue River	3,435	Cattle grazing, irrigated haylands, and wildlife habitat.
TR03	____	On Tongue River, approximately 500 meters upstream of Hwy 338 bridge crossing	4978650N 0346809E	44.944778N 106.941806W	100901010407 Beatty Gulch-Tongue River	3,530	Primarily wildlife habitat. Winter cattle grazing only. BLM recreation area.
TR05	TR1	On Tongue River at Kleenburn Road Recreational Picnic Area approximately 0.7 miles downstream of USGS Station 06306250	4974512N 0341266E	44.906308N 107.010622W	100901010211 Slater Creek-Tongue River	3,595	Primarily wildlife habitat. Reclaimed mining lands made into recreational area.
TR07	TRL	On Tongue River upstream County Road bridge crossing	4974822N 0329198E	44.9063314N 107.163592W	100901010210 Five Mile Creek-Tongue River	3750	Wildlife habitat, irrigated haylands, rural residential.
TR09	TRU	On Tongue River at USGS Station No. 06298000	4968747N 0317895E	44.849105N 107.304038W	100901010205 Sheep Creek-Tongue River	4060	Primarily wildlife habitat. Recreational camping. Parallel to County Road.

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4.4 Sampling and Analysis Methods

Water quality sample collection, discharge measurements, macroinvertebrate sampling, and habitat assessments were performed according to the methods described in the project Sampling Analysis Plan (SCCD, 2016) and the SCCD Water Quality Monitoring Program Quality Assurance Project Plan, 2015 Update (SCCD, 2015a), according to the WDEQ Manual of Standard Operating Procedures for Sample Collection and Analysis (WDEQ, 2015) and accepted analytical methods (Table 4-3). Samples were obtained from representative riffles.

Table 4-3. Standard field and laboratory methods applicable to 2016 monitoring

Parameter	Units	Method / Reference[1,2]	Location of Analyses	Preservative	Holding Time
Temperature	ºC	grab/USEPA 170.1 SM2550	On-site	n/a	n/a
Temperature	ºC	continuous recorder	On-site	n/a	n/a
pH	SU	grab/USEPA 150.2	On-site	n/a	n/a
Conductivity	µS/cm	grab/USEPA 120.1	On-site	n/a	n/a
Dissolved Oxygen-Probe	mg/l	grab/USEPA 360.1	On-site	n/a	n/a
E. coli	col/100 ml	grab/SM9223B, CFR136[3]	IML[4]	Cool to 10°C	8 hours
Turbidity	NTU	grab/ SM2130	IML[4]	Cool to 6°C	48 hours
Stage Height	cfs	Calibrated staff gauge	On-site	n/a	n/a
Discharge	cfs	Mid-Section Method	On-site	n/a	n/a
Macroinvertebrates	Metrics	King 1993	AA[5] ABA[6]	99% ethyl alcohol or isopropanol	n/a
Habitat (Reach level)	n/a	King 1993	On-site	n/a	n/a

[1]USEPA Method references from Methods for Chemical Analysis of Water and Wastes (USEPA, 1983)
[2] SM Method references from Standard Methods for the examination of water and wastewater (APHA, 1998 & 2005).
[3] CFR reference from 40 CFR Part 136. Guidelines Establishing Test Procedures (Federal Register, 2012)
[4]IML refers to Inter-Mountain Laboratories in Sheridan, Wyoming.
[5]AA refers to Aquatic Assessments, Inc. in Sheridan, Wyoming.
[6]ABA refers to Aquatic Biology Associates, Inc. in Corvallis, Oregon.

Sample sites were equipped with a staff gauge for flow measurements. Initially, two sample sites were already equipped with USGS gauges (station 06298000 in Tongue River Canyon and 06306250 on Prairie Dog Creek). The USGS gauge on Prairie Dog Creek was scheduled to be discontinued in July 2016 and a staff gauge was installed. During site reconnaissance, staff gauges were inspected, surveyed, and replaced if needed. Upon installation and/or inspection, gauges were surveyed and compared with a permanent bench mark; this confirmed the stability of the gauge to ensure consistent measurement. Staff gauge calibrations were performed by measuring instantaneous discharge with a Marsh-McBirney 2000 current meter using the mid-section method (WDEQ, 2015). The resulting stage-discharge relationships were used to estimate flow during sampling events.

Grab samples for *E. coli* and turbidity were collected within two separate 60-day periods in May-July and July-September. Gauge height, pH, conductivity, dissolved oxygen, and instantaneous water temperature were also measured during these sampling events. Continuous temperature data were collected by anchoring data loggers to the bottom of the staff gauges and downloading

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the recorded information. Benthic macroinvertebrates were collected and habitat assessments were performed at five stations in September.

Sample containers for bacteria and turbidity were provided by the contract laboratory and left unopened until sample collection. Bacteria containers were sealed, clear, cylindrical, IDEXX bottles that contained the sample preservative. The turbidity containers were 125 mL plastic, opaque bottles. All containers had blank labels, which were completed in the field. Containers for macroinvertebrate samples were 32 oz, pre-cleaned, HDPE wide mouth bottles. Labels were completed and affixed in the field with packing tape.

Turbidity and *E. coli* samples were hand delivered to Inter-Mountain Laboratories (IML) in Sheridan, Wyoming for analysis. Macroinvertebrate samples were sorted by Aquatic Assessments, Inc. (AA) in Sheridan, Wyoming and analyzed by Aquatic Biology Associates, Inc. (ABA) in Corvallis, Oregon.

4.5 Monitoring Schedule

The 2016 monitoring schedule included sampling to determine the geometric means of *E. coli*, based on 5 samples collected within a 60-day period in May-July and 5 samples collected within a 60-day period in July-September (Table 4-4). Other field water chemistry parameters were also measured. A total of ten water quality samples were collected at each site.

Sample dates were based on random numbers generated for Monday-Thursday due to lab availability and sampling holding times. Continuous temperature data loggers were deployed to measure instream temperatures from May 18th through October 3rd. Macroinvertebrate collections and habitat assessments were completed in September-October.

Table 4-4. Sample schedule for 2016 Tongue River watershed monitoring

Date(s)	Sites	Parameters
May 18th – October 3rd	TR01, TR03, TR05, TR07, TR09	Continuous Temperature
May 18th	TR01, TR03, TR05, TR07, TR08, TR09, PD01, GC01, WC01, FMC01, CC01, SC01, LTR01	Instantaneous temperature, pH, Conductivity, Dissolved Oxygen, Stage Height/Discharge, Turbidity, and *E. coli*. *Early Season upstream and downstream photos were taken on 6/13/16
May 31st		
*June 13th		
June 27th		
July 13th		
July 28th	TR01, TR03, TR05, TR07, TR08, TR09, PD01, GC01, WC01, FMC01, CC01, SC01, LTR01	Instantaneous temperature, pH, Conductivity, Dissolved Oxygen, Stage Height/Discharge, Turbidity, and *E. coli*. *Late Season upstream and downstream photos were taken on 8/10/16
*August 10th		
August 22nd		
September 7th		
September 20th		
September 22nd – October 4th	TR01, TR03, TR05, TR07, TR09	Macroinvertebrates, Habitat, Photo

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CHAPTER 5 QUALITY ASSURANCE/QUALITY CONTROL

5.1 FUNCTION OF QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance (QA) may be defined as an integrated system of management procedures designed to evaluate the quality of data and to verify that the quality control system is operating within acceptable limits (Friedman and Erdmann, 1982; USEPA, 1995). Quality control (QC) may be defined as the system of technical procedures designed to ensure the integrity of data by adhering to proper field sample collection methods, operation and maintenance of equipment and instruments. Together, QA/QC functions to ensure that all data generated are consistent, valid and of known quality (USEPA, 1980). QA/QC should not be viewed as an obscure notion to be tolerated by monitoring and assessment personnel, but as a critical, deeply ingrained concept followed through each step of the monitoring process. Data quality must be assured before the results can be accepted with any scientific study. Project QA/QC is fully described in the SCCD QAPP (SCCD, 2015a) and the Project SAP (SCCD, 2016).

5.2 SAMPLING PERSONNEL QUALIFICATIONS

Water quality monitoring, data management, and reporting were performed by SCCD personnel, which had the appropriate training and qualifications to implement the project (Table 5-1). SCCD Supervisors and NRCS Field office staff assisted with site set-up, surveys, discharge measurements, water quality monitoring, and macroinvertebrate collection. During monitoring activities, SCCD personnel collected the samples/measurements, while the other staff recorded the information on the appropriate data sheets. Assisting personnel were under the direct supervision of SCCD staff. The SAP defined all necessary field protocols and was available to the sampling team for every sampling event.

Table 5-1. SCCD sampling personnel and qualifications

Personnel	Qualifications
Carrie Rogaczewski District Manager	M.S. University of Wyoming in Rangeland Ecology and Watershed Management with an emphasis in Water Resources; BKS Environmental; 17+ years of experience with the SCCD; WACD Water Quality training
Amy Doke Program Specialist	B.A. University of Wyoming in Environment and Natural Resources with an emphasis in international studies and ecology; 10+ years of experience with SCCD, assisting in other watershed efforts
Theresa Shaw Program Assistant	B.S. Montana State University in Sociology, Social and Criminal Justice; United States Air Force Special Investigations Officer and Special Agent; joined SCCD in August 2016 and under supervision of District Manager

5.3 SAMPLE COLLECTION, PRESERVATION, ANALYSIS, AND CUSTODY

Accepted referenced methods for the collection, preservation and analysis of samples were adhered to as described in the SAP. In addition to field data sheets, samplers carried a field log book to document conditions, weather, and other information for each sample day and/or site. Calibration logs were completed for each instrument every time a calibration was performed.

Project field measurements were recorded on field data sheets. Water samples requiring laboratory analysis were immediately preserved (if required), placed on ice, and hand delivered to

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the laboratory. A Chain of Custody (COC) form was prepared and signed by the sampler before samples entered laboratory custody. A laboratory employee would then sign and date the COC form after receiving custody of the samples. After samples changed custody, laboratory internal procedures were implemented according to their Quality Assurance Plans.

Benthic macroinvertebrate samples were preserved in the field, placed in a cooler, and transported to the SCCD office in Sheridan. A project specific macroinvertebrate COC form was completed. After all macroinvertebrate samples were collected, samples and COC forms were hand delivered to the contractor for initial sorting. COC forms were signed by SCCD and the contractor receiving the samples. Sorted samples, COC forms, and lab bench sheets were hand delivered to SCCD and then shipped to the contract laboratory for identification. Upon receipt, the contract laboratory performed a visual check for the number and general condition of samples, and signed the COC form. The completed COC form was returned to SCCD.

5.4 Calibration and Operation of Field Equipment

The project SAP outlined requirements for calibration and maintenance of field equipment; calibration instructions and manuals were carried on sampling days. On every sampling day, before leaving the office, the pH meter, conductivity meter, and dissolved oxygen meter were calibrated according to the manufacturer's instructions. The Hanna 9025 pH meter was calibrated using a two-point calibration method with pH 7.01 and pH 10.01 buffer solutions. The Hanna 9033 conductivity meter was calibrated using a 1413 µS/cm calibration standard. All calibration solutions were discarded after each use. The YSI Pro20 dissolved oxygen meter did not require a calibration solution; the meter was calibrated by inserting the probe into the moist calibration chamber. The barometric pressure on the meter was cross referenced to the barometric pressure at the Sheridan County airport to check calibration accuracy. Calibration of each meter was documented on the corresponding calibration logbook.

The Marsh-McBirney flow meter was factory calibrated and did not require field calibration; however, SCCD conducted a "zero check" prior to the beginning of the field season using a five-gallon plastic bucket of water. However, the meter began to malfunction and provide erratic readings in September. Another Marsh McBirney flow meter was obtained from the Sheridan WDEQ field office for some of the final discharge calibrations and velocity measurements during macroinvertebrate sample collection. Factory calibration of Onset HOBO data loggers, used for continuous temperature monitoring, was checked by performing a crushed-ice test at the beginning and end of the season to validate the loggers' accuracy.

Equipment used for benthic macroinvertebrate sample collection and reach level habitat assessments did not require calibration; however, surber sampler nets and other equipment were checked for damage prior to entering the field. Equipment maintenance, to include replacement of the dissolved oxygen meter membrane cap before each sampling day and battery replacement as needed, was performed according to the SAP and manufacturer's instructions. All maintenance activities were documented on the maintenance log.

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5.5 SUMMARY OF QA/QC RESULTS

Data Quality Objectives (DQO's) are qualitative and quantitative specifications used by water quality monitoring programs to limit data uncertainty to an acceptable level. DQO's were established for each monitoring parameter for precision, accuracy, and completeness at levels sufficient to allow SCCD to realize project goals and objectives (Table 5-2). SCCD evaluated collected data according to the DQOs in the SAP (SCCD, 2016) and WDEQ protocols (WDEQ, 2015).

Table 5-2. Data Quality Objectives for 2016 Tongue River watershed monitoring (SCCD, 2016)

Parameter	Precision (%)		Accuracy** (%)	Completeness (%)	Minimum Detection Limit
	SCCD*	WDEQ*			
Temperature	10	10	10	95	0.2 °C
pH	5	±0.3 SU	5	95	0.01 S.U.
Conductivity	10	10	10	95	1 µS/cm
Dissolved Oxygen	20	10	20	95	0.2 mg/L
Turbidity	20	20	10	95	0.1 NTU
E. coli	50	50 if >100 NA if <100	NA	95	1 CFU/100 mL
Macroinvertebrates	NA		NA	95	NA
Total Taxa	15		NA	95	NA
Total Abundance	50		NA	95	NA
Habitat Assessment	NA		NA	95	NA
Intra-Crew	15		NA	10	NA
Discharge	NA		NA	95	NA
Stage-Discharge Relationships	NA		NA	95	Minimum $r^2 = 0.95$

** SCCD Precision DQOs were from the Tongue River 2016 Sampling Analysis Plan and the SCCD Quality Assurance Project Plan, 2015 update; WDEQ precision DQOs were from the 2015 Manual of Standard Operating Procedures.*

*** Accuracy values shown are acceptable departures from 100% accuracy. A 10 percent accuracy value means accuracy values of 90 to 110 percent are acceptable.*

5.5.1 COMPARABILITY

Comparability refers to the degree to which data collected during this Project were comparable to data collected during other past or present studies. This was an important factor because future water quality monitoring will occur within the watershed and current project data must be comparable to future data in order to detect water quality change with confidence. Recognizing that periodic adjustments to locations, parameters, and/or sampling methods are needed, several steps were taken to assure data comparability including:

- Collection of samples at previously used monitoring stations;
- Collection of samples during the same time of year;
- Collection of samples using the same field sampling methods and sampling gear;
- Analysis of samples using the same laboratory analytical methods and equipment;
- Use of the same reporting units and significant figures;
- Use of the same data handling and reduction methods (rounding and censoring); and
- Use of similar QA/QC processes.

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Chemical, physical, biological, and habitat data collected during this project were highly comparable because of close coordination prior to initiation of sampling. Where possible, each step identified above was implemented to assure comparability.

Prior to 2014, *E. coli* standards were based on a geometric mean of 5 samples collected within a 30-day period. SCCD collected water quality parameters on the same schedule as the *E. coli* samples; 5-sample geometric means were calculated for all water quality parameters for the 30-day periods. During revisions to water quality standards and methods in 2014, WDEQ changed the basis for the *E. coli* standard to a geometric mean of 5 of more samples collected within a 60-day period (WDEQ, 2014). As a result, SCCD incorporated 60-day geometric means into the 2016 schedule. Comparisons among years are still valuable for evaluating water quality trends; both the 30-day geometric means and the 60-day geometric means capture samples collected during early season (May-June/July) and late season (July-August/September) conditions.

5.5.2 *Continuous Temperature Data Loggers*

The continuous temperature data loggers, Onset's HOBO Pendent Temperature 64 Data Logger, were used at TR01, TR03, TR05, TR07, and TR09 during the 2016 monitoring project. These loggers were factory calibrated, encapsulated devices that cannot be re-calibrated.

To verify the accuracy of the factory calibration, SCCD performed a crushed-ice test before and after the sampling season. A seven-pound bag of crushed ice was emptied into a 2.5 gallon bucket. Distilled water was added to just below the top level of the ice and the mixture was stirred. The data loggers were submerged in the bath and placed in a refrigerator to minimize temperature gradients. If the ice bath was prepared properly and if the loggers maintained their accuracy, the loggers should read the temperature of the ice bath as 0°C ±0.232°C. The pre-season ice bath temperature on 4/5/2016 was reported to be between 0.01°C to 0.232°C, which was within the manufacturer's predicted range. The post-season ice bath temperature on 12/15/2016 also reported temperatures between 0.1°C to 0.232°C (Appendix Table B-3).

Onset suggests the loggers should maintain their accuracy unless they have been utilized outside their range of intended use (-20°C to 50°C). None of the data loggers were used outside of this range and returned the expected results in the crushed ice tests. All of the temperature loggers were considered to have maintained their accuracy and have provided valid water temperature data for the 2016 monitoring project.

5.5.3 *Stage-Discharge Relationships*

The relationship between stage height and discharge for a given location yields an equation that allows the calculation of discharge at various stage heights recorded on a staff gauge. A correlation coefficient (R^2 value) of at least 0.95 (95%) is desirable for proper calibration of the gauge. Stage-discharge relationships were established for all staff gauges installed by SCCD (Table 5-3). These relationships were developed by recording the stage height and measuring discharge using the mid-section method (WDEQ, 2015) on at least three occasions with varying flow conditions.

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Staff gauges installed by SCCD were surveyed against established benchmarks upon installation and at the end of the season. The difference between the height of the gauge and the height of the benchmark were compared to verify gauge stability (Table 5-3).

Table 5-3. Summary of R^2 values for 2016 stage-discharge relationships

Site	Pre-Season Survey	Post-Season Survey	Pre/Post Survey Difference	Stage-Discharge Relationship R^2 Value
TR01	1.24	1.24	0.00	0.9775
PD01	6.09	6.08	0.01	0.9931
TR03	7.81	7.82	0.01	0.9988
GC01	1.96	1.98	0.02	0.9999
TR05	8.05	8.04	0.01	0.9992
TR07	1.53	1.53	0.00	0.9643
WC01	6.04	6.04	0.00	1.0000
FMC01	1.18	1.18	0.00	0.9926
TR08	4.84	4.84	0.00	0.9987
CC01	3.95	3.98	0.03	***0.9383***
LTR01	2.70	2.70	0.00	0.9995
SC01	3.40	3.42	0.02	0.9877
TR09	NA-USGS	NA-USGS	NA-USGS	NA-USGS

A gauge was not installed at TR09; flow information was obtained from USGS Station 06298000. None of the gauge surveys resulted in differences greater 0.05 between the pre-season and post-season surveys. Only CC01 had a coefficient value (0.9383) below the DQO of 0.95. Because the value approached the DQO and represented the best, and in some cases the only, flow information available, the value was used in the calculation of summary statistics and in the development of load estimates, where appropriate.

5.5.4 *Blanks*

Trip blanks were prepared to determine whether samples might be contaminated by the sample container, preservative, or during transport and storage conditions. One blank for every 10 samples for each parameter is required. Two *E. coli* and turbidity trip blanks were prepared for every sampling event. Prior to sampling, the contract laboratory filled sample containers with laboratory de-ionized water and the appropriate preservative. The trip blanks were maintained in the cooler with the collected samples and returned to the laboratory for analysis. No trip blanks used during the project contained detectable levels of *E. coli* or turbidity (Appendix Table B-4).

Field blanks were prepared to determine whether samples might be contaminated by conditions associated with sample collection procedures. One blank for every 10 samples for every parameter is required. *E. coli* and turbidity field blanks were prepared at two separate sites during every sampling event. At the designated sites, sample bottles were labeled, rinsed (if turbidity), and filled with de-ionized water provided by the contract laboratory. The bottles were then placed in the cooler and delivered to the contract laboratory with the other samples. No field blanks prepared during the project contained detectable levels of *E. coli*; one sample had a turbidity value of 0.6

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NTU (Appendix Table B-4). Because the value approached the detection limit and the other blank sample for the day was below the detection limit, all bacteria and turbidity results were accepted.

5.5.5 *Sample Holding Times*

All laboratory data sheets were reviewed to ensure all samples were analyzed before their holding times had expired. This review found that all *E. coli* samples were analyzed within their required 8-hour holding time and all turbidity samples were analyzed within the required 48 hour holding time. All water quality field samples were analyzed on-site immediately following sample collection. Benthic macroinvertebrate samples were preserved on-site upon sample collection; there is no holding time for benthic macroinvertebrate samples.

5.5.6 *Duplicates*

The project SAP specified that duplicate chemical, physical, biological, and habitat samples be obtained for at least 10% of all field samples. Duplicate water quality samples were obtained by collecting consecutive water quality samples from a representative stream riffle. Duplicate macroinvertebrate samples were collected by two field samplers, each equipped with a surber net, collecting samples simultaneously and adjacent to one another. Intra-crew habitat duplicates were conducted simultaneously by each observer performing independent assessments without communication, at the same site and same time. All DQOs for duplicates were met (Table 5-4).

Table 5-4. Summary of 2016 Tongue River watershed monitoring duplicates

Parameter	No. of samples	No. of Duplicates	% Duplicated	DQO (%)
Water Quality Samples in 2016 (13 sites X 10 samples)	130	20	15.4	10
Macroinvertebrate Samples in 2016	5	1	20.0	10
Habitat Assessments in 2016	5	1	20.0	10

5.5.7 *Precision*

Precision was defined as the degree of agreement of a measured value as the result of repeated application under the same condition. The Relative Percent Difference (RPD) statistic was used, because the determination of precision is affected by changes in relative concentration for certain chemical parameters. Precision was determined for water quality samples by conducting duplicate samples at 10 percent of the sample sites. RPD is calculated by the formula: RPD = [(A-B) / (A+B)] X 200 where A is the value for duplicate 1 and B is the value for duplicate 2. With few exceptions, all parameters met the DQO's for precision (Table 5-5).

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Table 5-5. Precision of 2016 Tongue River Watershed water quality monitoring data

Date	Duplicate Sample ID	Site Duplicated	TEMP RPD (%)	pH RPD (%)	COND RPD (%)	DO mg/L RPD (%)	DO % RPD (%)	TURB RPD (%)	E. coli RPD (%)
SCCD DQO Relative Percent Difference:			10	5	10	20	20	20	50
WDEQ DQO Relative Percent Difference or Other:			10	±0.3SU	10	10	10	20	50 if >100 NA if <100
5/18/16	Dup1	TR01	1.5	1.5	2.3	ND	ND	***79.0***	36.2
	Dup2	TR09	1.1	0.0	9.5	ND	ND	***20.7***	***66.7 <100***
5/31/16	Dup1	PD01	0.8	0.1	1.8	0.2	0.2	7.7	15.6
	Dup2	SC01	0.0	0.2	0.0	0.3	0.2	4.2	***77.5***
6/13/16	Dup 1	TR03	0.6	0.1	8.9	0.2	0.1	9.8	48.0
	Dup2	LTR01	0.6	0.0	1.3	0.8	0.7	3.8	21.6
6/27/16	Dup 1	GC01	0.5	0.2	0.2	1.0	0.7	14.0	42.1
	Dup 2	CC01	0.5	0.2	0.4	0.5	0.3	***32.0***	11.5
7/13/16	Dup 1	TR05	0.5	0.1	0.8	1.1	1.1	7.7	0.0
	Dup 2	TR08	0.0	0.1	1.4	0.6	0.6	8.0	9.0
7/28/16	Dup 1	TR07	0.0	0.2	0.5	2.6	1.9	2.7	***59.3***
	Dup 2	FMC01	0.0	0.3	1.7	***14.6***	***17.4***	***111.6***	7.5
8/10/16	Dup 1	WC01	0.5	0.2	0.2	0.4	0.1	0.0	18.3
	Dup 2	TR09	0.5	0.6	1.3	2.7	2.0	0.0	35.9
8/22/16	Dup 1	TR01	0.5	0.0	0.1	0.7	0.4	0.8	25.7
	Dup 2	SC01	1.9	0.1	2.1	1.3	0.9	3.4	10.7
9/7/16	Dup 1	PD01	0.6	0.1	0.3	0.3	0.2	4.3	17.1
	Dup 2	LTR01	0.7	0.1	1.2	0.6	0.5	9.5	7.3
9/20/16	Dup 1	TR03	0.6	0.5	0.8	1.0	1.0	8.0	***66.7<100***
	Dup 2	CC01	0.7	0.1	0.0	0.8	0.7	8.6	11.1
AVERAGE RPD FOR ALL SAMPLES			*0.61*	*0.25*	*1.73*	*1.64*	*1.61*	*16.79*	*29.04*

All temperature, pH, and conductivity samples met the appropriate DQO for precision. In addition to meeting the DQO of 5% RPD, all pH samples were within ±0.3 SU as required by WDEQ. One dissolved oxygen measurement (mg/L and percent saturation) exceeded the WDEQ precision DQO of 10% on 7/28/16. These samples were within the SCCD DQO of 20% and the other duplicate sample for the day was within 10%. All reported dissolved oxygen measurements, based on RPD, were accepted. However, all dissolved oxygen measurements from 5/18/16, including duplicates, were discarded because of meter malfunction.

Four turbidity samples exceeded the DQO of 20%. Because turbidity values can be relatively low, small variations can result in high RPDs. Samples from 7/28/16 and 6/27/16 were accepted because values were confirmed by the contract laboratory and RPDs from other duplicates collected on the same day were within the DQO of 20%. Both duplicates collected on 5/18/16 exceeded 20%; however, the RPD for one of the duplicates was only slightly over 20% and was calculated on very small values (3.2 and 2.6). All turbidity sample results were accepted based on RPD.

Four *E. coli* samples exceeded the SCCD precision DQO of 50%. Two of the samples, occurring on 5/18/16 at TR09 and 9/20/16 at TR03, were calculated on reported values that were less than 100. According to WDEQ requirements, the DQO of 50% would not apply to these samples. The RPDs for the sample from TR07 on 7/28/16, which was 59.3, was calculated on one sample that was less

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than 100 (76 col/100 mL) and one that was above 100 (140 col/100 mL). The duplicate sample for the sample collected at SC01 on 5/31/16 was reported as >2419.6 col/100 mL, which was converted to 2420 for calculation of the RPD statistic. This was a conservative estimate and may be closer to the sample site value, which was reported as 5480 col/100 mL. In addition, the RPDs for the other duplicate samples collected on the same sample day were within the DQOs. All of the data for bacteria samples, based on RPD, were accepted.

Duplicate macroinvertebrate samples and habitat assessments were collected at greater than 10% of the macroinvertebrate and habitat assessment sites. The RPD for total macroinvertebrate abundance was 8 percent, which was within the DQO of 50 percent (Table 5.6). The RPD for total macroinvertebrate taxa was 28 percent, which exceeded the DQO of 15 percent. The higher RPD for total taxa was due primarily to the presence of 8 taxa present in the duplicate 2 sample that were not present in the duplicate 1 sample. Each of the 8 taxa present in the duplicate 2 sample was represented by a single organism (Appendix Table E-2). Although a single organism was present for each of the 8 taxa, the abundance was reported as 2 organisms in Appendix Table E- 2 after adjustment by the correction factor of 1.429. The difference in total taxa between duplicate samples based upon the presence of several taxa each represented by a single organism should be considered an anomaly especially considering the RPD for total macroinvertebrate abundance was only 8 percent. The macroinvertebrate data was determined to be valid and of known quality based upon those considerations. The RPD for the duplicate habitat assessment was 6 percent (Appendix Table D-5), which was within the established DQO of 15 percent.

Table 5-6. Precision of 2016 Tongue River benthic macroinvertebrate and habitat data

Parameter	TR01 Duplicate 1	TR01 Duplicate 2	(% - RPD)	DQO (%)
Total Abundance	997	924	8	50
Total Taxa	31	41	28	15
Intra-Crew Habitat Assessment Score	152	162	6	15

5.5.8 *Accuracy*

Accuracy is the degree of agreement of a measured value with the true or actual value. Accuracy for water quality parameters measured in the field was assured by calibration of equipment to known standards. Conductivity, dissolved oxygen, and pH meters were calibrated on the morning of every sampling event. A "crushed ice test" was used to verify the accuracy of the continuous temperature data loggers. There are no current laboratory methods to determine the accuracy of biological samples; therefore, the accuracy of *E. coli* samples could not be determined. Accuracy for macroinvertebrate sampling and habitat assessment could not be determined since the true or actual value for macroinvertebrate populations or habitat parameters was unknown. Precision served as the primary QA check for *E. coli* bacteria, benthic macroinvertebrates, and habitat assessments.

5.5.9 *Completeness*

Completeness refers to the percentage of measurements determined to be valid and acceptable compared to the number of samples scheduled for collection. This DQO is achieved by avoiding

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loss of samples due to accidents, inadequate preservation, holding time exceedances, and proper access to sample sites for collection of samples as scheduled. DQOs for most parameters were met with the exception of dissolved oxygen measurements (Table 5.7). The dissolved oxygen meter malfunctioned on one sample day, which resulted in all of the measurements for that day being discarded. One set of *E. Coli* and turbidity samples on Five Mile Creek were discarded because of non-representative sample conditions.

Table 5-7. Completeness of 2016 Tongue River monitoring data

Parameter	# Samples Planned	# Samples Collected	% 2016 Completeness*	DQO (%)
Water Temperature	130	130	100.0	95
pH	130	130	100.0	95
Conductivity	130	130	100.0	95
Dissolved Oxygen	130	117	90.0	95
Discharge	130	130	100.0	95
Turbidity	130	129	99.2	95
E. coli	130	129	99.2	95
Total Abundance of Marcroinvertebrates	5	5	100	95
Total Taxa	5	5	100	95
Intra-Crew Habitat Assessments	5	5	100	10

*Bold values are below the DQO's percentage.

5.6 Data Validation

Data generated by the contract laboratories was subject to the internal contract laboratory QA/QC process before it was released. Data are assumed to be valid because the laboratory adhered to its internal QA/QC plan. Field data generated by SCCD were considered valid and usable only after defined QA/QC procedures and processes were applied, evaluated, and determined acceptable. Questionable data were rechecked by the contract laboratory and either confirmed or corrected. Data determined to be invalid were rejected and not used in preparation of this report.

Low flow values and lab results reported below the detection limit were to be reported as ½ the detection limit for the purpose of summary statistics, as specified in the SAP for this project (Gilbert, 1987 and SCCD, 2016). With the exception of field and trip blanks, there were no samples reported below the detection limit in 2016. Blank data were not used in the calculation of summary statistics, so no reporting adjustments were necessary.

One *E. coli* sample from SC01 on 5/31/16 was reported as >2419.6; SCCD used 2420 for calculation of relative percent difference for precision.

5.7 Documentation and Records

All water quality field data were recorded on data sheets prepared for the appropriate waterbody and monitoring station. After each sampling day, water quality field data sheets are scanned and filed electronically on SCCD's computer; hard copies were duplicated and maintained in a binder. Macroinvertebrate and habitat assessment data were recorded onto data sheets that were in a similar format to those used by WDEQ in the past. WDEQ now uses a more comprehensive

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protocol for macroinvertebrate and habitat assessments, but SCCD decided to continue with their existing data sheets for consistency and simplicity. Equipment checklists, COC forms, and calibration and maintenance logs were documented on the appropriate forms and are maintained on file and/or electronically in the SCCD office. Photographs and photograph descriptions were organized by station, maintained in digital format in the SCCD office (Appendix F).

Water quality and supporting QA/QC data were received electronically from the contract laboratory. Printed hard copies are maintained on file in the SCCD office. Macroinvertebrate sample results were received from the contract laboratory electronically and printed. All electronic data are maintained in a database on the SCCD server in Sheridan, Wyoming.

5.8 Database Construction and Data Reduction

The project database consists of a series of electronic computer files. Each project database file was constructed with reportable data (accepted after QA/QC checks) by entering into Microsoft Excel® spreadsheets. Electronic files for water quality, discharge, continuous water temperature, macroinvertebrate, and habitat data were constructed. All computer data entries were checked for possible mistakes made during data entry. If a mistake was suspected, the original field or laboratory data sheet was re-examined and the data entry corrected. SCCD also maintains an ACCESS® Database for all reportable water quality data collected by SCCD; validated data are copied into the ACCESS Database only after approval of the monitoring report by WDEQ.

After data validation and database construction, data were statistically summarized for the following calculations (Appendix C):

- Number of samples;
- Maximum;
- Minimum;
- Median;
- Mean;
- Geometric mean; and
- Coefficient of variation.

These statistics and analyses provided insight for temporal and spatial water quality changes within the watershed. Microsoft Excel® was used to generate the statistical tables, geometric means, and graphics for this report. Geometric means were calculated for all water quality parameters for three reporting periods of 60 days each, including May 18-July 13, June 13-August 10, and July 28-September 20. Summary statistics did not include discarded data or instances where the staff gauge was submerged.

5.9 Data Reconciliation

Data collected by SCCD were evaluated before being accepted and entered into the project database. Obvious outliers were flagged after consideration of "expected" values based upon evaluation of historical and current data. Field data sheets were re-checked and if no calibration or field note anomalies or excursions were identified, the data were accepted as presented. Otherwise, data were rejected and not included in the project database.

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5.10 Data Reporting

Data collected by SCCD for this project are presented in tabular, narrative, and graphical formats throughout this report. This report will be submitted to WDEQ and other interested parties as necessary. Copies of this report will be available through the SCCD office. Compact disks containing the Microsoft Excel®, Microsoft Word®, Adobe Reader X®, and Arc Map 10® files used to construct this document will also be available.

In addition to this report, the SCCD will submit a separate data package to WDEQ. The complete data package will include copies of all field and laboratory data sheets, field and equipment calibration logs, survey notes, and QA/QC documentation. Other information may be submitted as requested by WDEQ.

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CHAPTER 6 WATER QUALITY STANDARDS AND DISCUSSION OF RESULTS

6.1 WATER QUALITY STANDARDS

Wyoming's surface waters are protected through application of numeric and narrative (descriptive) water quality standards. The applicable water quality standards and other recommendations were used in interpretation of results and included in this report (Table 6-1).

Table 6-1. Standards applicable for 2016 Tongue River watershed monitoring (WDEQ, 2013)

NUMERIC STANDARDS		
Parameter	**Reference**	**Standard / Description**
Dissolved Oxygen	Chapter 1 Sections 21 & 30 Appendix D	For Class 1, 2AB, 2B, and 2C waters 1 day minima Early life stages: 5.0 mg/L intergravel concentration 8.0 mg/L water column Other life stages: 4.0 mg/L
E. coli	Chapter 1 Section 27	Geometric mean of a consecutive 60 day period shall not exceed 126 organisms per 100 ml for primary contact recreation waters/seasons (May 1-Sept 30) and shall not exceed 630 organisms per 100 ml for secondary contact recreation waters/seasons.
pH	Chapter 1 Sections 21 & 26 Appendix B	6.5-9.0 standard units
Temperature	Chapter 1 Section 25	Discharge shall not increase temperature by more than 2 degrees F; maximum allowable temperature is 68 degrees F/20 degrees C (cold water fisheries) except on Class 2D, 3 and 4 waters.
Turbidity	Chapter 1 Section 23	For cold water fisheries and drinking water supplies, discharge shall not create increase of 10 NTU's.
NARRATIVE STANDARDS		
Settleable Solids	Section 15	Shall not be present in quantities that could degrade aquatic life habitat, affect public water supplies, agricultural or industrial use, or plant and wildlife.
Floating and Suspended Solids	Section 16	Shall not be present in quantities that could degrade aquatic life habitat, affect public water supplies, agricultural or industrial use, or plant and wildlife.
Taste, Odor, Color	Section 17	Substances shall not be present in quantities that would produce taste, odor, or color in: fish flesh, skin, clothing, vessels, structures, or public water supplies.
Macroinvertebrates	Chapter 1 Section 32 Hargett (2011)	Score for Full, Indeterminate, or Partial/Non Support *Sedimentary Mountains Bioregion: >52.3, 34.8-52.3; <34.8;* *High Valleys Bioregion: >48.8, 32.5-48.8, <32.5;* *Northeast Plains Bioregion: >58.4, 38.9-58.4, <38.9*
ADDITIONAL PARAMETERS AND RECOMMENDED STANDARDS		
Habitat	King (1993); Stribling et al. (2000)	Habitat condition no less than 50 percent of reference; total habitat score >100 to qualify as reference
Conductivity	King (1990)	Concentrations greater than 6900 µmhos/cm may affect aquatic organisms in ponds in NE Wyoming.

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6.2 Field Water Chemistry and Physical Parameters

Water quality data were collected from May 18 through September 20, 2016 at 13 stations (Appendix Tables C-3 through C-15). Summary statistics were calculated for all instantaneous monitoring parameters on accepted data (Appendix Table C-16). Geometric means for three 60-day periods were calculated for bacteria samples; arithmetic means for all other parameters were established for the same 60-day periods as well as for the season.

In addition, USGS collected water quality data from four stations from 2013-2016:

- Station 06306300 Tongue River at State Line Near Decker, MT;
- Station 06306250 Prairie Dog Creek, Near Acme, WY;
- Station 06306020 Tongue River Below Youngs Creek Near Acme, WY; and
- Station No. 06299980, Tongue River near Monarch, WY.

For the most part, measurements were collected monthly from USGS Station 06299980 (Tongue River at Monarch), USGS 06306020 (Tongue River Below Youngs Creek) and USGS Station 06306250 (Prairie Dog Creek) and anywhere from zero to two times per month from USGS station 06306300 (Tongue River Near State Line). Among other things, the USGS collected temperature, pH, dissolved oxygen, specific conductivity, nutrients, and metals throughout the period. For these stations, only data similar in scope to the parameters collected by SCCD during 2016 are discussed.

6.2.1 Instantaneous Water Temperature

Instantaneous water temperature measurements were recorded above the maximum 20°C instream temperature standard at 12 of the 13 sites on at least one occasion (Table 6-2). The uppermost station (TR09) had a maximum instantaneous temperature of 18.6°C. Instantaneous temperature measurements do not necessarily represent daily minimum, maximum, or average water temperatures.

All stations reported the highest instantaneous temperature on July 28, 2016. The maximum instantaneous temperature for the season was recorded at TR05 (24.6°C). Average instantaneous temperature was higher in June-August period than in the May-July and July-September periods at all stations; however, there was very little difference in the June-August and July-September periods at station TR05 near Acme (20.5°C and 20.4°C, respectively).

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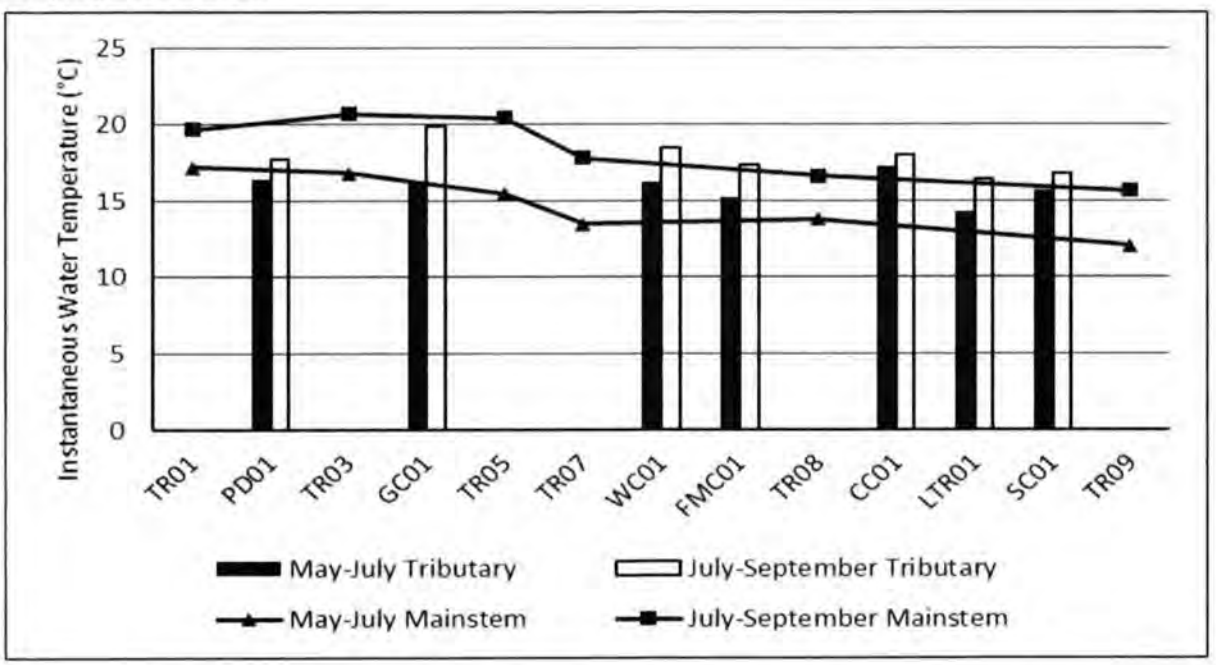
Table 6-2. Instantaneous temperature measurements exceeding 20°C in 2016

Site	Temperature (°C)				
	6/27/2016	7/13/2016	7/28/2016	8/10/2016	8/22/2016
Tongue River (TR01)	21.6	20.4	23.6	22.2	
Prairie Dog Creek (PD01)			21.1	20.0	
Tongue River (TR03)	21.3	21.0	24.1	23.9	20.3
Goose Creek (GC01)	21.6	21.1	23.3	22.1	
Tongue River (TR05)			24.6	22.9	20.7
Tongue River (TR07)			22.5		
Wolf Creek (WC01)	21.4		23.5		
Five Mile Creek (FMC01)			21.2		
Tongue River (TR08)			20.5		
Columbus Creek (CC01)	20.9	20.4	22.7		
Little Tongue River (LTR01)			20.5		
Smith Creek (SC01)			21.1		

For Tongue River sites, average instantaneous water temperatures generally increased from upstream to downstream (Figure 6-1) and were higher at sites located downstream of the Interstate-90 crossing near Acme.

Figure 6-1. Average instantaneous water temperature in the Tongue River watershed by site and sample period in 2016



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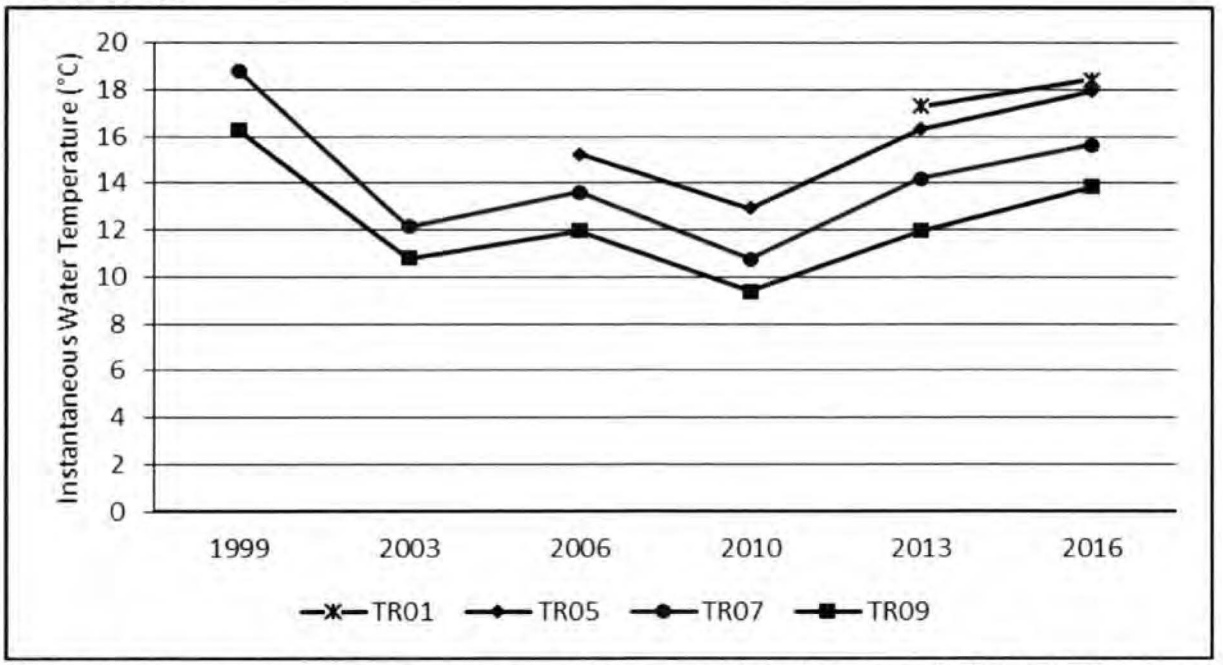
Changes in seasonal average instantaneous water temperatures were relatively consistent among sites (Figure 6-2). Seasonal average temperatures have increased since 2010. This could be attributed to higher than normal air temperatures, lower streamflows, or fewer samples being collected earlier in the season. Direct comparisons among years are difficult because of variations in water quantity and temperatures.

Figure 6-2. Seasonal average instantaneous water temperature at select Tongue River stations from 1999-2016



All USGS Stations reported instantaneous water temperatures that exceeded 20°C during certain periods (Appendix Tables C-17 through C-20). USGS 06306300 (Tongue River Near State Line) had the highest number of measurements over 20°C, including measurements in August 2014, July 2015, and June and July in 2016. The highest instantaneous measurement of 25.7 °C was observed at USGS Station 06299980 (Tongue River at Monarch) in July 2016.

6.2.2 *Continuous Water Temperature*

Continuous temperature data loggers were deployed at five Tongue River stations. Two loggers were found out of water at some point during the season and only have partial datasets. The data from the time the logger was discovered on the bank or out of water back to the previous sample date, when the logger was known to be in the water, was considered suspect and discarded. Data at TR05 is unavailable from 7/13 to 7/28; data at TR09 is unavailable from 7/28-8/10. All but one station reported temperatures that exceeded the temperature standard of 20° C. The uppermost station in Tongue River Canyon (TR09) was the only station that did not have any measurements above 20°C.

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Temperatures at the three stations below the Town of Ranchester (TR01, TR03, and TR05) stayed above the standard for extended periods from late June through the middle of August. During the same period, temperatures at TR07 had daily maximum temperatures that exceeded 20°C, but daily minimums were below the standard. Maximum temperatures for each station occurred in late July or early August (Table 6-3). The loggers at TR05 and TR09 did not have full datasets; reported maximum temperatures may not represent the actual maximum daily temperature for those sites.

Table 6-3. Maximum daily water temperatures recorded by continuous data loggers in 2016

Site	Maximum Temperature (°C)		Maximum Temperature on Select Dates			
	Date	Temp	7/21	7/27	7/30	8/2
TR01	7/21	31.268	31.268	30.154	30.054	30.356
TR03	7/27	30.862	30.255	30.862	29.953	30.457
TR05*	7/30	30.054	ND*	ND*	30.054	29.953
TR07	8/2	25.513	24.158	24.448	25.319	25.513
TR09*	7/27	18.996	11.041	18.996	ND*	ND*

*Loggers at these stations were washed onto the bank for certain periods, which resulted in incomplete datasets.

Yearly comparisons for 2003, 2006, 2010 and 2016 at TR07 showed that daily average temperatures for 2016 were similar to 2003 and 2006 (Appendix Figure C-6). Daily average temperatures were generally lower in 2010 than in the other years from May-July.

6.2.3 pH

Ranging from 7.88 SU (FMC01) to 8.70 SU (TR01), all pH values were within the Wyoming water quality standard of 6.5-9.0 SU. There was little variability among samples in 2016; only three samples were below 8.00 SU (Appendix Tables C-3 through C-15). In addition, average pH values have remained relatively consistent since 1999 (Table 6-4).

USGS stations reported similar pH values, which ranged from 7.5 to 8.9 from October 2013 through October 2016 (Appendix Tables C-17 through C-20). Measurements were collected monthly from USGS Station 06299980 (Tongue River at Monarch), USGS 06306020 (Tongue River Below Youngs Creek) and USGS Station 06306250 (Prairie Dog Creek) and anywhere from zero to two times per month from USGS station 06306300 (Tongue River Near State Line).

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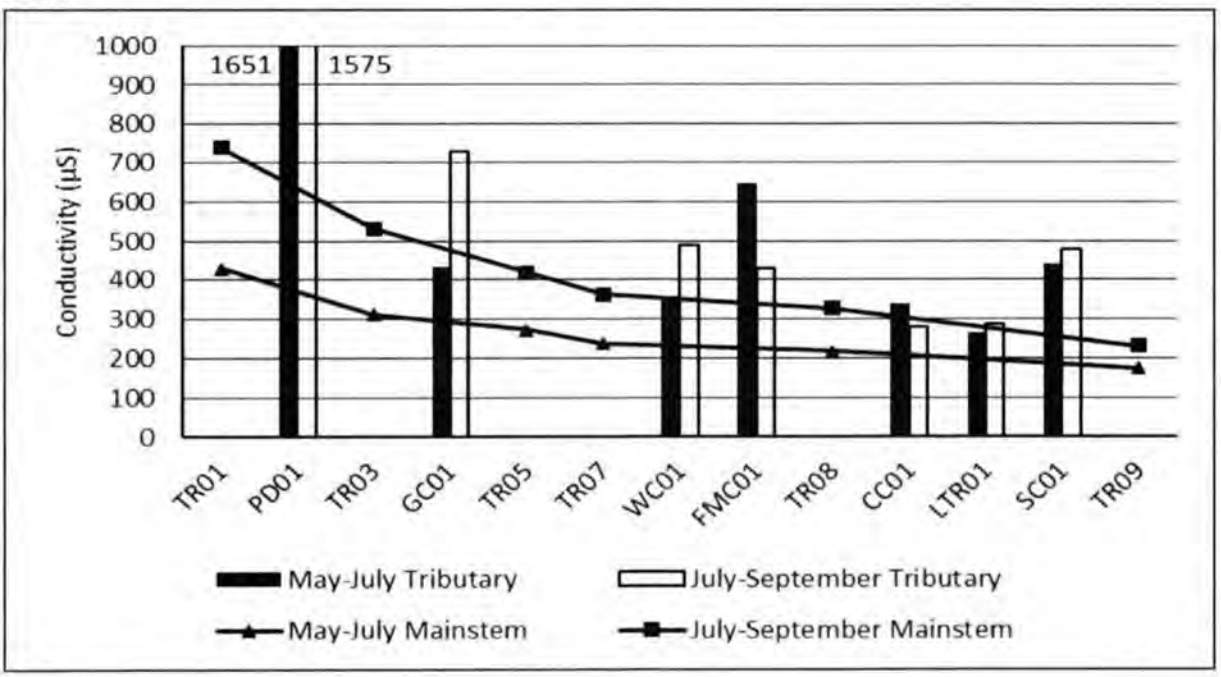
Table 6-4. Average seasonal pH within the Tongue River watershed from 1999-2016

Site	1999	2003	2006	2010	2013	2016
TR01					8.35	8.34
PD01					8.14	8.33
TR03					8.36	8.43
GC01					8.31	8.36
TR05			8.13	8.17	8.38	8.43
TR07	8.31	8.09	8.06	8.26	8.33	8.34
WC01	8.09	8.08	8.05	8.17	8.24	8.33
FMC01	8.08	7.95	7.98	8.19	8.15	8.13
TR08	8.23	8.14	8.04	8.38	8.44	8.47
CC01	7.97	8.06	8.09	8.24	8.32	8.20
LTR01	8.28	8.16	8.15	8.35	8.41	8.48
SC01	8.18	8.27	8.29	8.32	8.52	8.44
TR09	8.36	8.30	8.27	8.60	8.58	8.49

6.2.4 *Conductivity*

The average conductivity increased from upstream to downstream on Tongue River stations in 2016 (Figure 6-3) and was higher in July-September than in May-July. Tributary stations were typically higher than the adjacent mainstem stations. Prairie Dog Creek (PD01) had the highest conductivity with a May-July average of 1651 µS and a July-September average of 1575 µS.

Figure 6-3. Average conductivity in the Tongue River watershed by site and sample period in 2016



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Prairie Dog Creek and Five Mile Creek were the only stations with conductivity values over 1000 µS, with maximum values of 2800 µS and 1221 µS, respectively. All 2016 conductivity measurements from Prairie Dog Creek were above 1000 µS; values ranged from 1046 µS to 2800 µS.

With some exceptions, conductivity values were relatively consistent among years at most stations. For mainstem sites, yearly variability was greater in the downstream sites. Variability at all stations appeared to be higher in the early monitoring periods than in the later periods (Table 6-5).

Table 6-5. Average conductivity on the Tongue River Watershed from 1999-2016

Site	May					August					
	2003	2006	2010	2013	2016	1999	2003	2006	2010	2013	2016
TR01				595	431					831	739
PD01				1646	1651					2265	1575
TR03				369	313					577	532
GC01				436	432					718	729
TR05		224	349	314	273			548	426	505	420
TR07	275	206	336	287	239	327	372	433	375	407	364
WC01	354	268	383	373	358	490	616	661	573	628	491
FMC01	926	663	793	1080	647	679	584	440	415	442	429
TR08	270	191	302	263	218	285	341	384	325	374	328
CC01	1030	586	655	561	338	299	312	312	331	321	281
LTR01	420	442	476	664	263	454	330	407	426	412	289
SC01	900	548	620	565	441	495	619	567	621	506	479
TR09	193	157	202	192	174	219	224	237	252	245	230

Conductivity values reported by USGS from 2013-2016 ranged from 199 to 902 µS at mainstem stations; both the highest and lowest were observed at USGS 06299980, Tongue River at Monarch. USGS Station 06306250 (Prairie Dog Creek) reported the highest conductivity values, which ranged from 710 to 2020 µS; all but three of the values were above 1000 µS. USGS also reported Dissolved Solids, which followed a similar pattern. The highest values were reported from USGS Station 06306250 (Prairie Dog Creek) and ranged from 468-1500 mg/L. Values for the other USGS Stations ranged from 117-604 mg/L.

There is no standard for conductivity in the state of Wyoming; however, because conductivity is highly dependent on the amount of dissolved solids (such as salts), high values could become a concern for agricultural operations related to crop/hayland production. Quality standards are established for Wyoming groundwater such that concentrations of total dissolved solids (TDS) for domestic, agricultural, or livestock use shall not exceed 500 mg/L, 2000 mg/L, or 5000 mg/L,

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respectively (WDEQ, 2005). While conductivity is not directly proportional to the TDS concentration, conductivity can be used to estimate the relative concentration of TDS.

6.2.5 *Dissolved Oxygen*

All sites met the minimum instantaneous DO concentration standard of 4.0 mg/L for other life stages and the 5.0 mg/L for early life stages (Table 6-6). Because of meter issues on the first sample day, only nine measurements were collected per site. Four tributary stations and four mainstem stations had at least one sample below the 8.0 mg/L water column concentration recommended to achieve the 5.0 mg/L inter-gravel concentration for early life stages.

Table 6-6. Dissolved oxygen ranges and number of samples below 8.0 mg/L in 2016

Mainstem Sites			Tributary Sites		
Site	# of samples below 8.0 mg/L	Range (mg/L)	Site	# of samples below 8.0 mg/L	Range (mg/L)
TR01	4	6.35-10.10	PD1	2	6.83-9.80
TR03	1	7.32-9.31	GC1	1	6.10-12.10
TR05	1	7.03-10.19	WC1	0	8.30-12.08
TR07	1	7.10-10.91	FMC1	3	5.70-9.52
TR08	0	9.46-11.78	CC1	2	7.52-9.55
TR09	0	9.16-11.20	LTR1	0	8.50-10.84
			SC1	0	8.12-10.42

The uppermost mainstem stations (TR08 and TR09) and the uppermost tributaries (Little Tongue River and Smith Creek) did not have any values below 8.0 mg/L. Dissolved Oxygen on mainstem sites ranged from a minimum of 6.35 at TR01 to a maximum of 11.78 at TR08; on tributary sites, values ranged from 5.70 (FMC01) to 12.10 (GC01). The lowest dissolved oxygen measurement was on Five Mile Creek (5.70 mg/L), which had three measurements below 8.0 mg/L. The lowermost sample site, TR01, had the highest number of values below 8.0 mg/L with four values between 6.35 and 7.91 mg/L.

Dissolved Oxygen concentrations at USGS stations were above 5.0 mg/L from 2013-2016 (Appendix Tables C-17 through C-20), with the lowest value of 6.8 mg/L reported at two stations: USGS 06306300 (Tongue River at State Line) in July 2015 and USGS Station 06306020 (Tongue River Below Youngs Creek). In most cases, Dissolved Oxygen concentrations were above the 8.0 mg/L recommended water column concentration. The USGS station on Prairie Dog Creek (06306250), USGS 06306300 (Tongue River at State Line), and USGS Station 06306020 (Tongue River Below Youngs Creek) each had two occasions where dissolved oxygen concentrations were below 8.0 mg/L. All dissolved oxygen concentrations were above 8.0 mg/L at USGS Station 06299980 (Tongue River at Monarch).

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Early and late season averages were above 4.0 mg/L and 5.0 mg/L at all sites during all sampling years (Table 6-7). Overall, there were more dissolved oxygen average values below 8.0 mg/L in the late season than in the early season, which had no averages below 8.0 mg/L. In 2013, five sites had late season averages below 8.0 mg/L.

Table 6-7. Average yearly comparisons of dissolved oxygen (mg/L) from 1999-2016

Site	May					August					
	2003	2006	2010	2013	2016	1999	2003	2006	2010	2013	2016
TR01				8.48	8.79					6.99	7.78
PD01				9.24	9.40					7.98	8.58
TR03				8.53	9.03					7.23	8.49
GC01				9.43	9.65					8.13	9.53
TR05		10.30	10.35	9.56	9.74			8.73	7.60	8.40	9.11
TR07	11.10	10.92	11.29	10.54	10.50	9.97	8.63	9.59	9.02	9.03	9.28
WC01	10.22	10.23	10.65	9.46	10.66	9.30	6.14	8.20	7.96	7.34	10.29
FMC01	9.18	10.64	10.01	9.70	8.90	9.88	7.46	8.49	8.06	6.98	8.02
TR08	11.61	11.02	11.76	11.00	10.26	9.53	9.07	9.71	9.42	9.10	10.33
CC01	9.62	10.12	9.94	8.98	8.52	8.67	7.77	9.35	8.27	7.84	8.44
LTR01	11.38	10.42	11.46	9.80	9.67	9.88	9.11	9.68	9.38	8.52	9.24
SC01	10.54	10.11	11.15	9.87	9.09	9.23	8.57	10.03	9.20	10.39	9.06
TR09	11.88	11.18	11.95	10.86	10.03	9.64	9.07	9.97	9.22	8.45	9.52

6.3 DISCHARGE

SCCD installed and used calibrated staff gauges to estimate discharge during water sampling events (Appendix Tables C3-C15). SCCD used a USGS gauge and "real-time" flow information at TR09 (Station 06298000 Tongue River Near Dayton). USGS Station PD01 (Station 06306250 Prairie Dog Creek, Near Acme, WY) was discontinued in July 2016 and a staff gauge was needed.

On mainstem sites, the highest flows occurred on 6/13/2016 for the lowermost sites (TR01 and TR03) followed by 5/31/16 (Table 6-8). For all other mainstem sites, these were reversed; the highest flows occurred on 5/13/16 followed by 6/13/16. A similar pattern was observed for the lowest flows. The lowest flows were on 7/28/16 followed by 8/10/16 for the two lower stations. With the exception of TR09, the remaining mainstem sites had the lowest flow on 8/10/16 followed by 7/28/16. The lowest flow observed at TR09 occurred on 8/22/16.

Discharge at tributary stations was much more variable. For the most part, the highest flows occurred in the early season and the lower flows occurred later in the summer/fall. However, the highest or 2nd highest flows were observed during the late season on Prairie Dog Creek (9/20) and Columbus Creek (8/22 and 8/10). On one occasion, the lowest flow was observed in the early season; the lowest observed flow on Five Mile Creek occurred on 5/18.

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Table 6-8. Highest and lowest instantaneous discharge measurements in 2016

Site	Highest Discharge		2nd Highest Discharge		Lowest Discharge		2nd Lowest Discharge	
	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
MAINSTEM SITES								
TR01	6/13	1192.10	5/31	917.39	7/28	30.43	8/10	80.67
TR03	6/13	549.76	5/31	508.88	7/28	36.01	8/10	59.43
TR05	5/31	423.61	6/13	332.35	8/10	30.56	7/28	44.08
TR07	5/31	208.66	6/13	182.95	8/10	23.95	7/28	41.68
TR08	5/31	271.21	6/13	242.87	8/10	29.27	7/28	39.52
TR09	5/31	383.00	6/13	373.00	8/22	55.00	8/10	57.00
TRIBUTARY SITES								
PD1	5/18	48.83	9/20	24.18	7/13	1.4	7/28	2.16
GC1	6/13	694.43	5/31	343.83	7/28	17.02	8/10	21.85
WC01	5/31	58.70	6/13	35.18	8/10	0.5	7/28	0.64
FMC01	6/27	4.32	6/13	3.02	5/18	1.02	8/10 & 9/20	2.37
CC01	8/22	13.53	5/31 & 8/10	7.16	7/13	0.42	7/28	1.77
LTR01	5/18	19.92	5/31	19.47	8/22	1.23	8/10	1.32
SC01	6/27	11.38	5/31	10.14	9/20	1.27	8/10	3.26

High flow values in 2016 correspond to high instantaneous discharge measurements reported by the USGS at mainstem sites on in May and June 2016; the highest instantaneous discharge measured at USGS stations on the Tongue River occurred on 5/26 followed by 6/22 and 6/24 (Appendix Tables C-17 through C20). Low discharge measurements on mainstem stations were reported by USGS on 7/27 and 8/25 at Stations 06306300 (Tongue River at State Line) and 06299980 (Tongue River at Monarch). USGS Station 06306020 (Tongue River Below Youngs Creek) did not report any discharge measurements after 6/24/16. USGS Station 06306250 on Prairie Dog Creek reported an instantaneous discharge of 116 cfs on 4/27/16, which was followed by 24 cfs on 5/26/17 and 11 cfs on 6/24/16. The gauge was discontinued after 6/24/216. USGS mean daily flows within the watershed for 2016 were typically below the normal mean daily flow, with a few exceptions (Appendix Figures C-7 through C-11).

6.4 TURBIDITY

Average early season and late season turbidity generally increased from upstream to downstream (Figure 6-4). Samples collected in the early season had higher average turbidity than samples collected later in the season at all stations except TR07 and TR08. Tributary sites were typically higher than adjacent mainstem stations in the early season. Five Mile Creek was the only tributary with higher average turbidity in the late season than in the early season.

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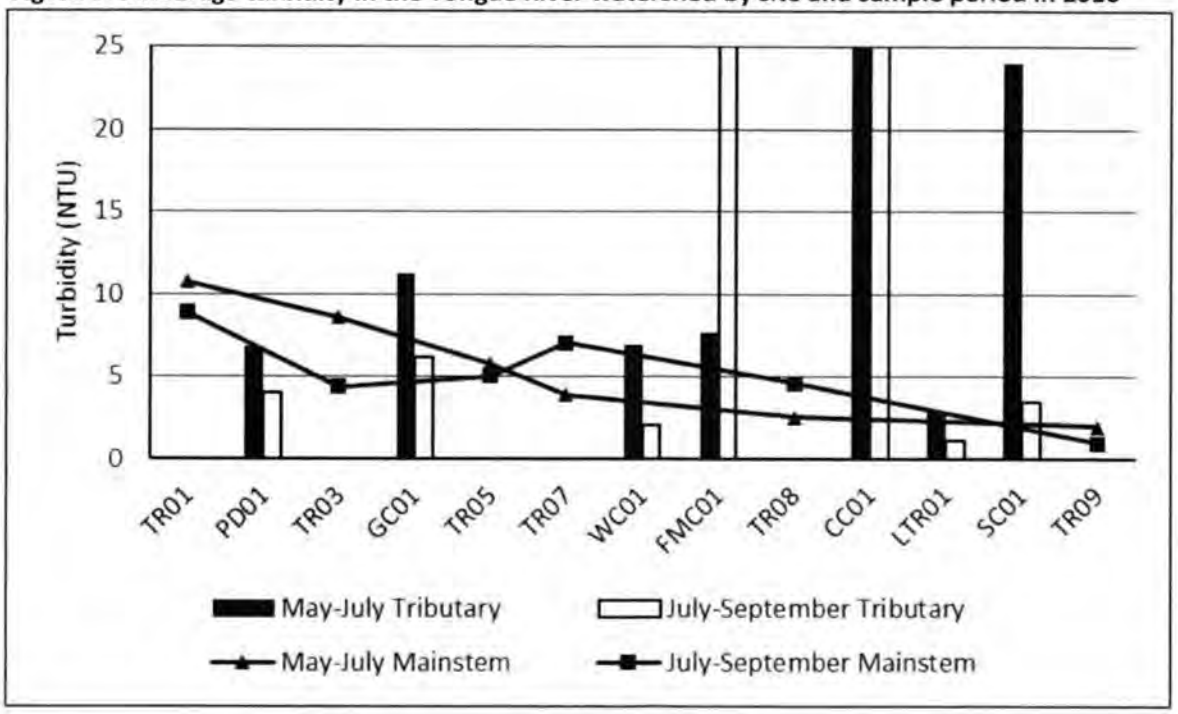
Figure 6-4. Average turbidity in the Tongue River watershed by site and sample period in 2016



Average turbidity was typically lower in 2016 than in previous years in both the early season and late season samples (Table 6-9). In the early season, only Smith Creek had higher turbidity in 2016 than in 2013 and 2006 and Columbus Creek had higher turbidity in 2016 than in 2006.

Table 6-9. Yearly comparisons of Average Turbidity (NTU) from 1999-2016

	May-July 2016					July-September 2016					
Site	2003	2006	2010	2013	2016	1999	2003	2006	2010	2013	2016
PD1				50.32	10.74					14.48	8.90
TR01				33.82	6.82					6.40	4.02
TR03				41.24	8.60					5.10	4.40
GC1				26.72	11.22					6.02	6.16
TR05		49.63	128.92	42.22	5.82			10.56	11.04	8.94	5.06
TR07	29.60	18.30	43.08	16.78	3.94	3.73	4.00	4.76	4.16	7.06	7.06
WC01	37.40	37.13	25.72	18.26	6.98	5.80	5.60	2.76	4.98	3.28	2.12
FMC01	684.80	31.23	96.62	152.88	7.66	43.48	36.00	24.80	15.74	19.02	40.50
TR08	15.20	10.85	31.48	11.30	2.58	3.50	3.80	2.76	2.52	4.74	4.64
CC01	79.00	24.58	182.02	76.22	34.52	64.50	57.40	18.64	23.50	18.52	33.24
LTR01	29.20	4.50	57.84	6.16	2.92	0.60	1.20	0.72	0.74	1.04	1.18
SC01	66.60	9.28	56.36	16.12	24.00	24.28	10.20	1.52	3.24	2.00	3.46
TR09	5.00	9.68	6.48	6.18	2.04	1.27	1.40	0.63	1.34	0.76	1.00

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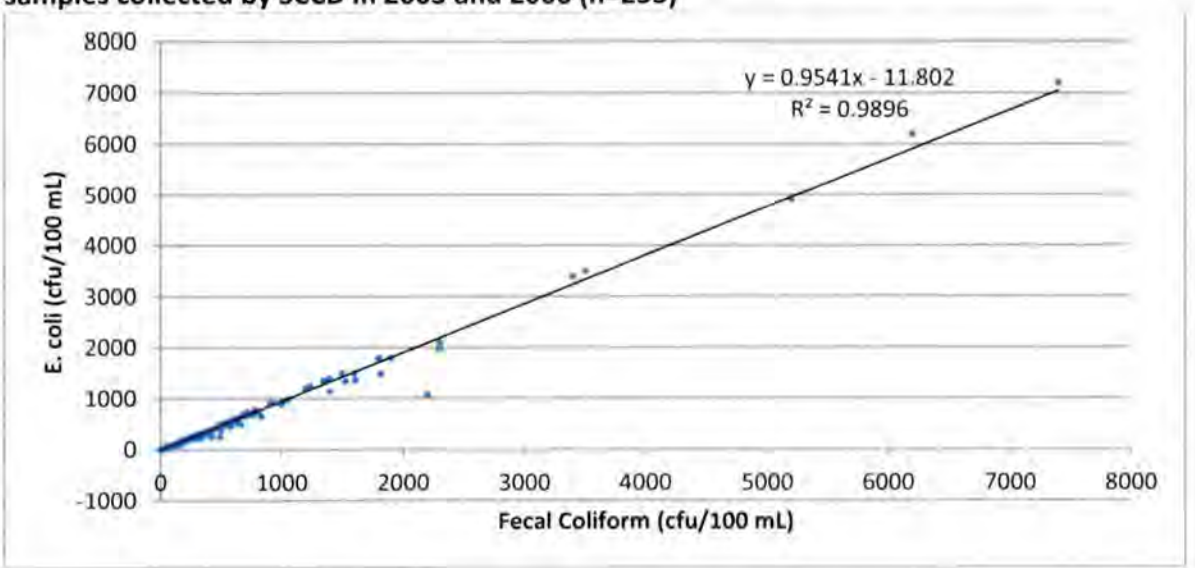
For late season samples, average turbidity on Five Mile Creek was higher in 2016 than all other sampling years except 1999. Turbidity on Columbus Creek was higher in 2016 than all years except 1999 and 2003. Turbidity in 2016 was only slightly higher than previous sampling years on Goose Creek and Smith Creek.

6.5 BACTERIA

In 1996-1999, 2003, and 2006 fecal coliform bacteria were the indicator for pathogen impairments under Wyoming Water Quality Standards. During a 2007 revision, *E. coli* became the indicator. In anticipation of this change, SCCD collected both *E. coli* and fecal coliform in 2003 and 2006 so *E. coli* samples could be compared to fecal coliform data from previous years. While there is no standard conversion from fecal coliform to *E. coli*, it is possible to find a relatively consistent relationship within an individual watershed (Rasmussen, 2003). Within the Tongue River watershed, the R^2 value of this comparison was 0.99, which SCCD determined was sufficient for looking at long-term trends (Figure 6-5). Using the results of the comparison, SCCD converted fecal coliform values from 1999 to *E. coli* so comparisons among years could be made. Fecal coliform data collected from 1996-1998 were not converted, because samples were collected monthly and no geometric means were calculated. These converted data were not used in any listing determination or other regulatory action. Only one site (WCL) that did not exceed the fecal coliform bacteria standard in 1999 did exceed the *E. coli* standard when *E. coli* concentrations were calculated.

Figure 6-5. Tongue River watershed fecal coliform and *E. coli* bacteria comparison from samples collected by SCCD in 2003 and 2006 (n=233)



Ten *E. coli* bacteria samples were obtained from each of the 13 monitoring stations within two 60-day periods in May-July and July-September (Appendix Tables C-3 through C-15). Bacteria

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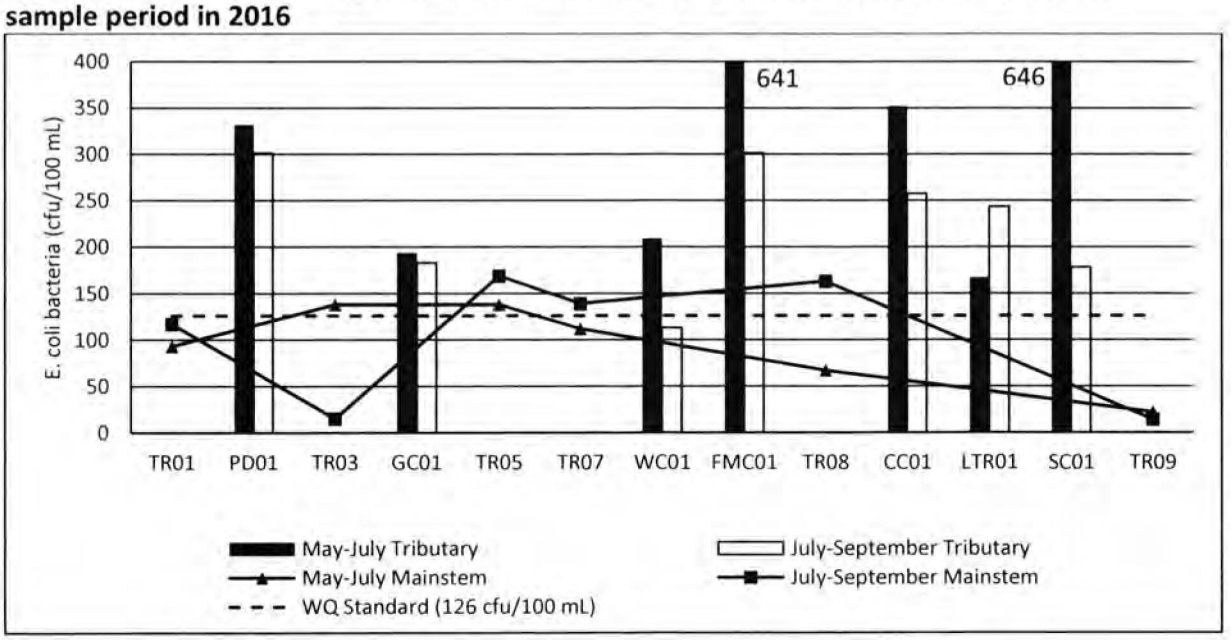
geometric mean concentrations in the early season were higher than in the late season on all tributaries except Little Tongue River (Figure 6-6). In contract, mainstem sites had higher bacteria concentrations in the late season with two exceptions; bacteria concentrations in the early season were higher at TR03 and TR09. Early season geometric means were within Wyoming Water Quality Standards at all mainstem sites except TR05 and TR03, both of which were 138 cfu/100 mL. While some mainstem sites did not meet Wyoming Water Quality standards during the late season, the highest bacteria concentration observed on mainstem site was 169 cfu/100 mL or 25% above the standard. Bacteria concentrations at tributary stations appeared to contribute to bacteria increases on the Tongue River at adjacent downstream stations in the upper portion of the watershed during the early season. With one exception, bacteria concentrations exceeded Wyoming Water Quality standards at all tributary stations in both the early season and the late season; late season bacteria concentrations on Wolf Creek were below 126 cfu/100 mL.

Figure 6-6. *E. coli* Bacteria geometric means in the Tongue River watershed by site and sample period in 2016



Comparisons among years could be made from 2003-2016 at the stations within and above the Town of Ranchester, which were within the original assessment boundary. The original assessment included sites TR07, TR08, and TR09 on the Tongue River. Tributary stations included Wolf Creek, Five Mile Creek, Columbus Creek, Little Tongue River, and Smith Creek. Comparisons between 2013 and 2016 could be made at all stations sampled in 2016.

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Table 6-10. Bacteria geometric means and percent change among years at comparable stations in the Tongue River watershed

	Site	May-July *E. Coli* geometric means (cfu/100 mL)						2016 percent above/below WQ Standard	Percent Change	
		1999*	2003	2006	2010	2013	2016		2003-2016	2013-2016
Mainstem Stations	TR01					154	93	-35%		-40%
	TR03					162	138	9%		-15%
	TR05			299	440	153	138	9%		-10%
	TR07		189	176	248	166	112	-13%	-41%	-33%
	TR08		113	68	97	139	67	-88%	-41%	-52%
	TR09		13	11	5	14	22	-473%	67%	57%
Tributary Stations	Prairie Dog Creek (PD01)					144	332	62%		131%
	Goose Creek (GC01)					260	194	35%		-26%
	Wolf Creek (WC01)		339	145	427	197	209	40%	-38%	6%
	Fivemile Creek (FMC01)		2713	640	861	2399	641	80%	-76%	-73%
	Columbus Creek (CC01)		89	176	572	659	352	64%	295%	-47%
	Little Tongue River (LTR01)		74	72	136	126	167	25%	127%	33%
	Smith Creek (SC01)		768	163	516	319	646	80%	-16%	103%

	Site	July-September *E. coli* geometric means (cfu/100mL)						2016 % above/below WQ Standard	Percent Change	
		1999*	2003	2006	2010	2013	2016		2003-2016	2013-2016
Mainstem Stations	TR01					43	117	-8%		170%
	TR03					8	15	-740%		85%
	TR05			86	50	41	169	25%		315%
	TR07	48	104	112	95	116	139	9%	33%	20%
	TR08	74	124	67	82	141	163	23%	32%	15%
	TR09	1	45	14	31	16	14	-800%	-69%	-11%
Tributary Stations	Prairie Dog Creek (PD01)					136	301	58%		121%
	Goose Creek (GC01)					92	183	31%		99%
	Wolf Creek (WC01)	128	253	145	257	143	113	-12%	-55%	-21%
	Fivemile Creek (FMC01)	519	689	250	378	463	301	58%	-56%	-35%
	Columbus Creek (CC01)	373	377	128	291	214	257	51%	-32%	20%
	Little Tongue River (LTR01)	261	1191	308	273	283	243	48%	-80%	-14%
	Smith Creek (SC01)	495	598	298	1337	209	178	29%	-70%	-15%

*1999 E. coli values were calculated using the conversion from Fecal Coliform concentrations

With one exception, early season bacteria concentrations decreased from 2003-2016 and from 2013-2016 at all mainstem sites. Bacteria concentrations at TR09 increased since 2003; however, concentrations in 2016 were still well below Wyoming Water Quality Standards at 22 cfu/100 mL (Table 6-10 and Figure 6-7). Bacteria concentrations later in the season increased at all mainstem stations except TR09.

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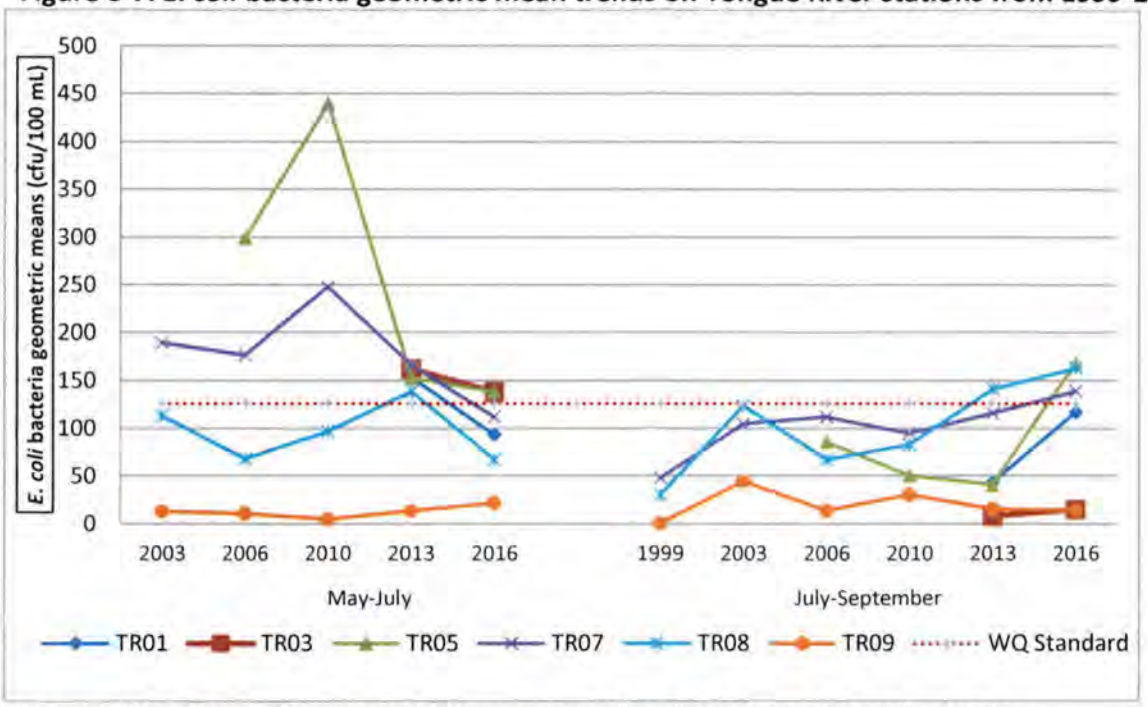
Figure 6-7. *E. coli* bacteria geometric mean trends on Tongue River stations from 1999-2016



*August 1999 *E. coli* values were based on the conversion from fecal coliform to *E. coli* calculation

Three tributary stations, Goose Creek, Columbus Creek, and Five Mile Creek had decreases in early season bacteria concentrations (Table 6-10 and Figure 6-8) from 2013-2016. The decrease on Five Mile Creek represented a change from 2399 cfu/100 mL in 2013 to 641 cfu/100 mL in 2016. All tributary stations showed decreases in late season bacteria concentrations from 2003-2016. However, increases were observed from 2013-2016 at Prairie Dog Creek, Goose Creek and Columbus Creek. All tributary stations continued to exceed Wyoming Water Quality standards in the early season and in the late season except for late season bacteria concentrations on Wolf Creek, which were 113 cfu/100 mL.

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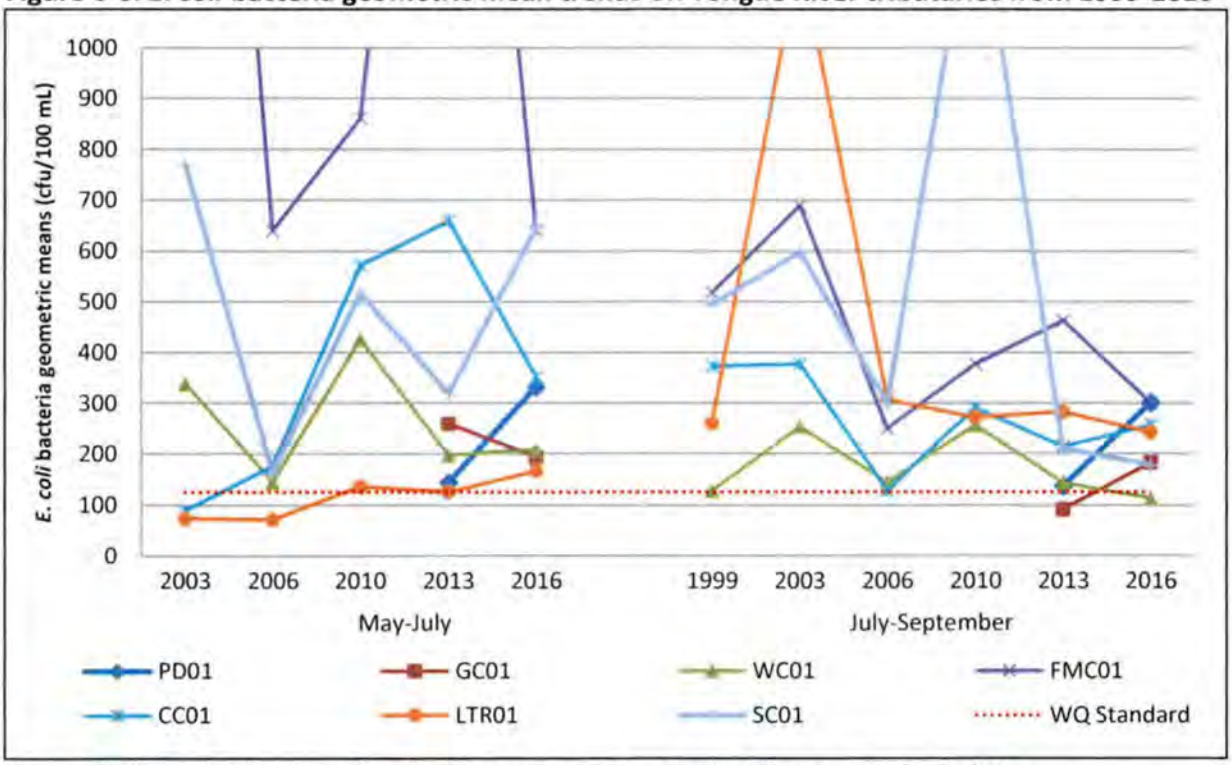
Figure 6-8. *E. coli* bacteria geometric mean trends on Tongue River tributaries from 1999-2016



*August 1999 *E. coli* values were based on the conversion from fecal coliform to *E. coli* calculation

6.6 Meteorological Data and Supporting Information

Mean daily air temperatures were above normal for most of May through July 2016 and below normal for most of September and October 2013 (Appendix Figure C-12). National Weather Service data at the Sheridan County Airport show normal mean daily air temperatures from May through October average 59.4°F while 2016 temperatures averaged 62.1°F. Monthly averages for air temperature were 0.42°F – 7.3°F higher in 2016 than normal (Table 6-11).

Cumulative precipitation through October 2016 was 13.95 inches, which was 1.61 inches higher than normal precipitation (Appendix Figure C-13). The higher than normal cumulative precipitation was largely due to higher than normal precipitation in January-April. Monthly precipitation for September 2016 was 0.07 inches higher than normal (Table 6-11).

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Table 6-11. Air Temperature and Precipitation data collected by the National Weather Service from the Sheridan County Airport in 2016

	Average Daily Air Temperature (°F)		Precipitation (inches)			
	2016	Normal	2016	Normal	2016 Cumulative	Normal Cumulative
January-April					6.4	3.83
May	53.45	52.74	0.03	0.08	6.87	4.97
June	69.17	61.87	0.01	0.07	7.68	7.31
July	73.10	70.20	0.01	0.04	7.97	8.82
August	69.13	68.71	0.05	0.02	8.93	9.72
September	59.57	57.46	0.12	0.05	10.79	10.78
October	47.90	45.13	0.05	0.04	13.95	12.34

6.7 Benthic Macroinvertebrates

Benthic macroinvertebrates reside on and in the bottom substrate of streams and provide a valuable tool for the assessment of water quality in the Tongue River watershed. They are small but visible to the naked eye and large enough to be retained in a U.S. Standard Number 30 sieve.

Water chemistry sampling provides information for the quality of water at the time of sample collection. In contrast, macroinvertebrates serve as continuous monitors of stream water quality since they live in the water during the majority of their life cycle and are exposed to often variable concentrations of pollutants over extended periods of time. This is an important concept because water quality sampling may miss important changes in water quality due to normal seasonal and spatial variability, changes in land use, water management, or accidental pollutant spills. An optimal water quality monitoring program involves both water chemistry sampling and biological monitoring (Rosenberg and Resh 1993).

Wyoming Water Quality Standards for chemical and physical water quality parameters (WDEQ, 2013) were established to protect aquatic life and human health. Instead of using sampling results from individual chemical and physical water quality parameters, evaluation of benthic macroinvertebrate populations may serve as a direct measure for the attainment of the Aquatic Life beneficial use in addition to validating the effectiveness of individual numeric water quality chemical and physical standards. Benthic macroinvertebrates also serve to integrate water quality and habitat quality interaction, and evaluate potential synergistic effects from multiple chemical and physical water pollutants not measured during routine water quality monitoring. Wyoming has developed biological criteria for streams statewide, but they have not been adopted as numeric, enforceable standards (Stribling et al., 2000; Jessup and Stribling, 2002; Hargett and ZumBerge, 2006; Hargett, 2011). As such, they may be used as narrative standards to determine beneficial use for aquatic life and the protection and propagation of fish and

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wildlife. The Biological Criteria in Section 32 of the Wyoming Water Quality Standards provide a narrative standard for protection of indigenous or intentionally introduced aquatic communities (i.e. brown, brook, and rainbow trout species). In addition, Section 4 in the Wyoming Water Quality Standards relates the presence of food sources (e.g. benthic macroinvertebrates) for game and non-game fish as a criterion for Surface Water Classes and (beneficial) uses (WDEQ, 2013).

6.7.1 Previous Benthic Macroinvertebrate Sampling

The historic benthic macroinvertebrate data for forty (N = 40) samples collected in the Tongue River watershed from 1993 through 1999 were presented and discussed in the *Tongue River Watershed Assessment 1996-1999: Final Report* (SCCD, 2000). SCCD collected nine (N = 9) benthic macroinvertebrate samples from eight stations in 2003. The data from the 2003 sampling were presented and discussed in SCCD (2004). In 2006, a total of three benthic macroinvertebrate samples were collected by SCCD from two mainstem Tongue River monitoring stations (stations TRL (renamed TR07 in 2013) and TR1 (renamed TR05 in 2013)). These data were presented and discussed in the *2006 Tongue River Monitoring Project report* (SCCD, 2007). No benthic macroinvertebrate samples were collected in the Tongue River watershed by SCCD from 2007 through 2009. SCCD then collected a total of eleven (N = 11) benthic macroinvertebrate samples in 2010 from ten stations. Six of the samples were collected from Tongue River mainstem stations and five of the samples were collected from tributaries to the Tongue River. These data were presented and discussed in the *2010 Tongue River Watershed Interim Monitoring Project report* (SCCD, 2012).

A total of six (N = 6) benthic macroinvertebrate samples were collected by SCCD in 2013 from five stations. Two of the monitoring stations were new and included TR03 near the Decker Highway bridge crossing, and TR01 near the Wyoming/Montana state line. WDEQ previously collected a total of two (N = 2) benthic macroinvertebrate samples at station TR03 in 1998 and 2004 (see Appendix Tables C-7 through C-8 *in* SCCD, 2015). In addition, WDEQ collected a total of four (N = 4) samples from a location just downstream from SCCD station TR01 during 1998, 2003 and 2004 (see Appendix Tables C-9 through C-12 *in* SCCD, 2015).

Field benthic macroinvertebrate sample collection methods and laboratory analytical methods employed by both SCCD and WDEQ have been the same since sampling began by WDEQ in 1993 and SCCD in 1996 (i.e. 8 random composite Surber samples with 500-micron net, 500-600 organisms identified in the laboratory, and similar Standard Taxonomic Effort). This resulted in comparable benthic macroinvertebrate data sets generated by SCCD and WDEQ, and allowed all data to be used in the evaluation of biological condition for water bodies sampled within the project area.

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6.7.2 *Benthic Macroinvertebrate Sampling In 2016*

A total of six (N = 6) benthic macroinvertebrate samples were collected by SCCD in 2016 from five stations (Appendix D). All samples were collected from Tongue River mainstem stations TR09, TR07, TR05, TR03 and TR01. Tongue River stations TR03 and TR01 were newer SCCD benthic macroinvertebrate monitoring sites established in 2013. No samples were collected from tributaries to the Tongue River. Included in the total number of samples was a duplicate benthic macroinvertebrate sample collected from station TR09. The duplicate sample was used only for QA/QC purposes, construction of taxa lists and for general discussion of macroinvertebrate results. The duplicate sample was not used for the determination of biological condition.

A series of metrics were calculated for each sample. A metric is a characteristic of the macroinvertebrate community that changes in a predictable way to increased human influence. (Table 6-12). The change in certain macroinvertebrate metrics at a sample station over time, or between sample stations, can indicate change in water quality at or among stations. The metrics for macroinvertebrate samples collected in 2016 and for previous macroinvertebrate samples are presented in Appendix Tables D-7 through D-12.

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Table 6-12. Definition of select macroinvertebrate metrics and expected response to perturbation including water quality and habitat change (from King, 1993 and Barbour et al., 1999)

Metric	Definition	Expected Response
Total Number Taxa	Measures the overall variety of the macroinvertebrate assemblage	Decrease
Total Number EPT Taxa	Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies, and Trichoptera (caddisflies)	Decrease
Total Number Ephemeroptera Taxa	Total Number of mayfly taxa	Decrease
% Ephemeroptera	Percent of mayfly nymphs	Decrease
Total Number Plecoptera Taxa	Total Number of stonefly taxa	Decrease
% Plecoptera	Percent of stonefly nymphs	Decrease
Total Number Insect Taxa	Total Number taxa in the Class Insecta	Decrease
Total Number Non - Insect Taxa	Total Number taxa not in the Class Insecta	Increase
% Non - Insects	Percent of Non - Insects	Increase
% Chironomidae	Percent of midge larvae	Increase
% Oligochaeta	Percent of worms	Increase
% 5 Dominant	Total Percent of the 5 most dominant taxa	Increase
% 10 Dominant	Total Percent of the 10 most dominant taxa	Increase
Number Predator Taxa	Number of taxa that feed upon other organisms or themselves in some instances	Variable, but appears to decrease in most regions of Wyoming
Total Number Scraper Taxa	Total Number of taxa that scrape periphyton for food	Decrease
% Scrapers	Percent organisms that scrape periphyton for food	Decrease
% Collector - Filterers	Percent organisms that filter Fine Particulate Organic Material from either the water column or sediment	Increase in most Wyoming ecoregions
% Collector - Gatherers	Percent organisms that either collect or gather food particles	Increase
Modified HBI	Uses tolerance values to weight abundance in an estimate of overall pollution. Originally designed to evaluate organic pollution.	Increase
BCI CTQa	Tolerance classification based on nonpoint source impact of sedimentation and velocity alteration	Increase
Shannon H (Log base 2)	Incorporates both richness and evenness in a measure of general diversity and composition	Decrease
% Multivoltine	Percent of organisms having short (several per year) life cycle	Increase
% Univoltine	Percent of organisms relatively long-lived (life cycles of 1 or more years)	Decrease

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6.7.3 Benthic Invertebrate Taxa

Taxa lists for Tongue River watershed benthic macroinvertebrate samples collected by SCCD in 2016 are presented in Appendix Tables D-1 through D-6. The list of benthic macroinvertebrate metrics for historic and current study samples collected at stations TR09, TR07, TR05, TR03 and TR01 from 1993 to 2016 is presented in Appendix Tables D-7 through D-12.

The benthic community at Tongue River TR09 station was generally dominated by cool water taxa indicative of good water quality and good habitat. A mixture of cool water and warm water taxa were present at stations TR07 and TR05. A shift to primarily warm water taxa dominated the benthic community at stations TR03 and TR01. Worms, leeches and other organisms indicating degraded water quality have comprised less than 1 percent of the macroinvertebrate community at TR09. A higher frequency of occurrence and number of worm and leech taxa were observed at downstream stations TR07, TR05, TR03 and TR01.

No threatened or endangered benthic macroinvertebrate taxa or fish species (incidentally captured during macroinvertebrate sampling) have been identified since sampling began in the Tongue River watershed in 1993. Two new taxa were identified during sampling in 2016. The genus *Musculium*, a clam in the family Pisidiidae, and the genus *Galba*, a snail in the genus Lymnaeidae have not been previously identified in the Tongue River watershed or north-central Wyoming waterbodies. Two specimens of *Musculium* were identified at station TR09 and numerous specimens of *Galba* were identified at station TR05. Smith (2001) reported that *Musculium* occurs throughout the United States. The occurrence of *Galba* was due to a change in nomenclature where the genus *Fossaria* was changed to the genus *Galba* (Johnson et al., 2013). *Fossaria* has been previously identified in samples from the Tongue River watershed.

The generally widespread occurrence of the freshwater shrimp genera *Gammarus* and *Hyalella*, and the freshwater shrimp species group *Hyalella azteca* (commonly used in laboratory toxicity tests) in the Tongue River watershed indicated that water in Tongue River and Tongue River tributaries contained no toxic substances in sufficient concentration to prevent the establishment and survival of these organisms.

The disappearance of stoneflies since the latter 1990's was noted at some mainstem Tongue River stations. Plecoptera (stoneflies) are considered one of the most pollution sensitive groups of aquatic organisms. At station TR07, from 3 to 5 Plecoptera taxa were collected each year from 1996 through 1999, but were absent from collections in 2003, 2004, 2006, and 2013. One immature stonefly in the family Perlidae was present in 2010 and one *Isoperla* was identified in the 2016 sample. No stoneflies have been collected at station TR05 since sampling began in 1995. The stonefly genus *Isoperla* was present at station TR03 in 1998, but has not been collected since then. At TR01, stonefly genera *Isoperla* and *Acroneuria* were present in 1998, but neither has been collected in samples since then. The general disappearance of stoneflies at Tongue River mainstem stations downstream of TR09 since the 1990's indicates

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that water quality and habitat change have negatively affected this pollution intolerant group of aquatic insects.

Whirling disease is caused by a destructive parasite that may decimate trout populations. Whirling disease has not been detected in the Tongue River watershed or nearby Little Goose Creek and Big Goose Creek watersheds. However, the disease has been detected at six locations in the adjacent Powder River watershed. *Tubifex tubifex* (a species of aquatic worm), is significantly involved in the whirling disease life cycle caused by a parasite (*Myxobolus cerebralis*) that penetrates the head and spinal cartilage of fingerling trout. Whirling disease may eventually cause death in trout. No *T. tubifex* have been collected at Tongue River stations since monitoring began indicating a low probability for the occurrence of whirling disease. However, the presence of the genus *Tubifex* in a 2006 sample at TR07 and the presence of immature Tubificid worms in samples collected at TR01 suggest the future potential occurrence of *T. tubifex* at those locations.

Wyoming Game and Fish Department implemented an aquatic invasive species monitoring program throughout Wyoming including mandatory aquatic invasive species check stations. The program is designed to prevent the establishment of the zebra mussel (*Dreissena polymorpha)* and the quagga mussel (*Dreissena rostriformis bugensis)* in Wyoming waterbodies. The two clam species may produce serious negative impact to aquatic resources, ecological functions of waterbodies, drinking water intakes and water distribution systems. Although the mussels have been identified in Utah, Colorado, eastern South Dakota and eastern Nebraska, they are not present in Wyoming to date. No zebra or quagga mussels have been identified by SCCD sampling in the Tongue River watershed.

Other aquatic invasive species of significant concern currently in Wyoming include the New Zealand Mudsnail species (*Potamopyrgus antipodarum*) and the Asian Clam species (*Corbicula fluminea*). The New Zealand Mudsnail is present in Yellowstone National Park, the Snake River, Shoshone River and the Bighorn River. The distribution of the Asian Clam in Wyoming is restricted to a few locations in south-east Wyoming. Historic benthic macroinvertebrate sampling and current monitoring by SCCD have not identified the New Zealand Mudsnail or the Asian clam in the Tongue River watershed or adjacent Little Goose Creek and Big Goose Creek watersheds.

6.8 BIOLOGICAL CONDITION

The biological condition based on the benthic macroinvertebrate community was determined for each station sampled in 2016 and for those comparable stations sampled by WDEQ in 1998, 2003 and 2004. A total of forty-four (N = 44) biological condition calculations were completed and listed in Table 6-15.

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Biological condition scores were derived using the Wyoming Stream Integrity Index (WSII) initially developed by Jessup and Stribling (2002), updated by Hargett and ZumBerge (2006) and Hargett (2011). The WSII is based on the analysis of benthic macroinvertebrate monitoring data collected by WDEQ from 1993 through 2009 from 1,488 reference and non-reference quality streams statewide. The WSII identified eleven bioregions for Wyoming. Each bioregion used different scoring criteria because the biological communities naturally differ between bioregions. Based on classifications provided by Hargett (2011), biological condition scoring criteria for three bioregions were used to evaluate biological condition (Table 6-13) as follows:

- Sedimentary Mountains bioregion for Tongue River locations TR09;
- High Valleys bioregion for Tongue River locations TR07 and TR05; and
- Northeastern Plains bioregion for Tongue River locations TR03 and TR01.

Table 6-13. Wyoming Stream Integrity Index (WSII) metrics and scoring criteria for benthic macroinvertebrate communities in the Sedimentary Mountains, High Valleys and Northeastern Plains bioregions (from Hargett, 2011)

Sedimentary Mountains Bioregion (TR09)		
Macroinvertebrate Metric	**Metric Scoring Formulae**	**5th or 95th %ile (as per formula)**
No. of EPT Taxa (less Arctopsychidae and Hydropsychidae)	100*X / 95th%ile	24
% Ephemeroptera (less Baetidae and *Tricorythodes*)	100*X / 95th%ile	43.7
% Collector-gatherer	100*(88.3-X) / (88.3-5th%ile)	14
% Scraper	100*X / 95th%ile	71.5
Number of Scraper Taxa	100*X / 95th%ile	8
HBI	100*X / 95th%ile	100
High Valleys Bioregion (TR07 and TR05)		
Macroinvertebrate Metric	**Metric Scoring Formulae**	**5th or 95th %ile (as per formula)**
% Chironomidae Taxa of Total Taxa	100*(33.3-X) / (33.3-5th%ile)	0
% Ephemeroptera Taxa of Total Taxa	100*X / 95th%ile	24
No. EPT Taxa	100*X / 95th%ile	23
% EPT (less Arctopsychidae and Hydropsychidae)	100*X / 95th%ile	81.3
% Scraper	100*X / 95th%ile	52
BCICTQa	100*(79.9-X) / (79.9-5th%ile)	54.2
Northeastern Plains Bioregion (TR03 and TR01)		
Macroinvertebrate Metric	**Metric Scoring Formulae**	**25th or 75th %ile (as per formula)**
Number of Ephemeroptera Taxa	100*X / 75th%ile	4
Number of Univoltine Taxa	100*X / 75th%ile	16
HBI	100*(6.8-X) / (6.8-25th%ile)	5.7

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Metric values for the sample benthic macroinvertebrate community were compared to optimal benthic macroinvertebrate metric values (WSII) and expressed as a percent. The percentages were summed for each sample metric to provide a biological condition rating (Table6-14).

Table 6-14. Assessment rating criteria for benthic macroinvertebrate communities based on the Wyoming Stream Integrity Index (WSII); (from Hargett, 2011) in the Sedimentary Mountains, High Valleys and Northeastern bioregions of Wyoming

Rating of Biological Condition (Aquatic Life Use Support)	Sedimentary Mountains bioregion	High Valleys bioregion	Northeastern Plains bioregion
Full Support	>52.25	>48.77	>58.42
Indeterminate Support	34.83-52.24	32.51 – 48.76	38.95-58.41
Partial/ (Non - Support)	0-34.82	0 – 32.50	0-38.94

The calculated biological condition rating was used to rate the biological community as Full-Support, Indeterminate, or Partial/Non-Support (Table 6-15). A biological condition rating of Full-support indicates full support for narrative aquatic life use. The Indeterminate biological classification is not an attainment category, but rather a designation requiring the use of ancillary information and/or additional data in a weight of evidence evaluation to determine a narrative assignment such as full support or partial/non-support (Hargett, 2011). The Partial/Non-support classification indicates the resident aquatic community is subjected to substantial anthropogenic stressors. Water quality and/or habitat improvements are required to restore the stream to full support for narrative aquatic life use.

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TABLE 6-15. Biological condition score and rating for benthic macroinvertebrate samples collected from 1993 through 2016 from Tongue River stations based on the Wyoming Stream Integrity Index (WSII; from Hargett, 2011)

	Sedimentary Mountains Bioregion		High Valleys Bioregion		Northeastern Plains Bioregion	
Sampling Station and Year	**Score**	**Rating**	**Score**	**Rating**	**Score**	**Rating**
Tongue River - TR09 - Canyon (1993)[A]	70.3	Full	NA[B]	NA	NA[B]	NA
Tongue River - TR09 - Canyon (1994)[A]	58.5	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (1995)[A]	52.0	Indeterminate	NA	NA	NA	NA
Tongue River - TR09 - Canyon (1996)[A]	64.3	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (1997)[A]	61.9	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (1998)[A]	56.9	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (1999)[A]	62.9	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (1999)[C]	63.1	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2000)[A]	55.2	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2001)[A]	66.5	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2002)[A]	72.5	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2003)	63.0	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2003)[A]	75.2	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2004)[A]	71.5	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2007)[A]	51.9	Indeterminate	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2009)[A]	59.4	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2010)	55.4	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2013)	71.6	Full	NA	NA	NA	NA
Tongue River - TR09 - Canyon (2016)	68.4	Full	NA	NA	NA	NA
Tongue River - TR07 - Co. Rd 67 (1996)	NA[B]	NA	46.6	Indeterminate	NA[B]	NA
Tongue River - TR07 - Co. Rd 67 (1997)	NA	NA	52.7	Full	NA	NA
Tongue River - TR07 - Co. Rd 67 (1998)	NA	NA	45.5	Indeterminate	NA	NA

[A] = Sample collected by WDEQ.
[B] = NA = WSII Score or Rating not applicable since sample was not collected in the bioregion.
[C] = Sample collected by USGS.

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TABLE 6-15 (continued). Biological condition score and rating for benthic macroinvertebrate samples collected from 1993 through 2016 from Tongue River stations based on the Wyoming Stream Integrity Index (WSII; from Hargett, 2011)

	Sedimentary Mountains Bioregion		High Valleys Bioregion		Northeastern Plains Bioregion	
Sampling Station and Year	**Score**	**Rating**	**Score**	**Rating**	**Score**	**Rating**
Tongue River - TR07 - Co. Rd 67 (1999)	NA[B]	NA	48.2	Indeterminate	NA[B]	NA
Tongue River - TR07 - Co. Rd 67 (2003)	NA	NA	47.8	Indeterminate	NA	NA
Tongue River - TR07 - Co. Rd 67 (2004)[A]	NA	NA	41.7	Indeterminate	NA	NA
Tongue River - TR07 - Co. Rd 67 (2010)	NA	NA	29.8	Partial or Non	NA	NA
Tongue River - TR07 - Co. Rd 67 (2013)	NA	NA	30.4	Partial or Non	NA	NA
Tongue River - TR07 - Co. Rd 67 (2016)	NA	NA	47.9	Indeterminate	NA	NA
Tongue River - TR05 - Kleenburn (1995)[A]	NA	NA	63.6	Full	NA	NA
Tongue River - TR05 - Kleenburn (1998)[A]	NA	NA	56.0	Full	NA	NA
Tongue River - TR05 - Kleenburn (2004)[A]	NA	NA	58.0	Full	NA	NA
Tongue River - TR05 - Kleenburn (2006)	NA	NA	46.2	Indeterminate	NA	NA
Tongue River - TR05 - Kleenburn (2010)	NA	NA	48.5	Indeterminate	NA	NA
Tongue River - TR05 - Kleenburn (2013)	NA	NA	46.0	Indeterminate	NA	NA
Tongue River - TR05 - Kleenburn (2016)	NA	NA	34.0	Indeterminate	NA	NA
Tongue River - TR03 - Decker Hwy (1998)[A]	NA	NA	NA	NA	100.0	Full
Tongue River - TR03 - Decker Hwy (2004)[A]	NA	NA	NA	NA	66.7	Full
Tongue River - TR03 - Decker Hwy (2013)	NA	NA	NA	NA	73.2	Full
Tongue River - TR03 - Decker Hwy (2016)	NA	NA	NA	NA	62.7	Full
Tongue River - TR01 - State Line (1998)[A]	NA	NA	NA	NA	97.0	Full
Tongue River - TR01 - State Line (2003)[A]	NA	NA	NA	NA	75.9	Full
Tongue River - TR01 - State Line (2004)[A]	NA	NA	NA	NA	70.4	Full
Tongue River - TR01 - State Line (2013)	NA	NA	NA	NA	87.1	Full
Tongue River - TR01 - State Line (2016)	NA	NA	NA	NA	79.4	Full

[A] = Sample collected by WDEQ.
[B] = NA = WSII Score or Rating not applicable since sample was not collected in the bioregion.
[C] = Sample collected by USGS.

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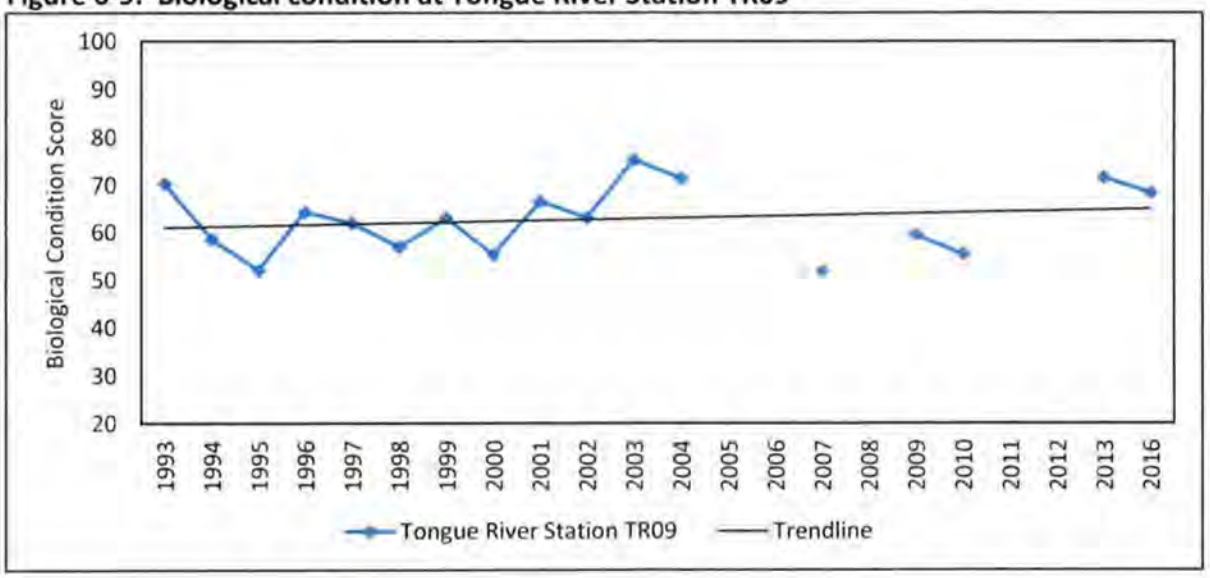
6.8.1 TONGUE RIVER TR09

The Tongue River TR09 station represents the most upstream monitoring site on the mainstem Tongue River and is located in the Sedimentary Mountains bioregion. The station is identified as the reference, or control station, for macroinvertebrate monitoring on the mainstem Tongue River. The Tongue River TR09 station has been sampled annually for benthic macroinvertebrates from 1993 through 2004, and in 2007, 2009, 2010, 2013 and 2016 (Table 6-15). This station has been sampled by SCCD, WDEQ, USGS and EPA over the years and represents the most frequently sampled benthic macroinvertebrate station in north central Wyoming. It should be noted that data collected by EPA was not used to determine biological condition for this report since sampling and analysis methods were not directly comparable to those methods used by SCCD and WDEQ.

Biological condition scores have varied little over the years ranging from a score of 75.2 in 2003 to a score of 51.9 in 2007 (Table 6-15; Figure 6-9). With the exception of 1995 and 2007, the biological condition scores consistently indicated full support for aquatic life use. It should be noted that the biological condition scores in 1995 (52.0) and 2007 (51.9) were very close to achieving the full support score of 52.2. The slightly positive trendline shown in Figure 6-9 for biological condition indicates stability in the biological community and confirms that station TR09 is a representative reference station. The general stability in biological condition over the years indicated that despite variable stream flows and likely variable water temperature among years, water quality and habitat remained consistently good.

Figure 6-9. Biological condition at Tongue River Station TR09



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The benthic community at Tongue River TR09 station was generally dominated by cool water taxa indicative of good water quality and good habitat. Worms, leeches and other organisms indicating degraded water quality comprised less than 1 percent of the macroinvertebrate community over the years. No *Tubifex tubifex* (a species of worm) have been collected at Tongue River TR09 since monitoring began in 1993 indicating a low probability for the occurrence of whirling disease.

The benthic macroinvertebrate data indicated that land use occurring upstream in the Bighorn National Forest (BNF) had no measurable effect on the Tongue River TR09 benthic macroinvertebrate community. Potential pollutants that may enter the Tongue River from BNF are apparently removed by natural stream processes resulting in good year-round water quality and healthy biological communities. The high biological condition scores confirmed the overall good water quality shown through water quality sampling, habitat assessment, and the resultant general full support for aquatic life use.

6.8.2 Tongue River TR07

The Tongue River TR07 station is located just upstream of the County Road 67 bridge near Ranchester, WY and is placed in the High Valleys bioregion near the lower boundary of the Sedimentary Mountains bioregion. The Tongue River TR07 station has been sampled annually for benthic macroinvertebrates from 1996 through 1999, and in 2003, 2004, 2006, 2010, 2013 and 2016 (Table 6-15). The sample collected by WDEQ in 2004 was comparable to samples collected by SCCD at TR07 since the WDEQ sampled in Conner Park about 250 yards downstream of SCCD location TR07.

The biological condition of the benthic macroinvertebrate community at Tongue River TR07 station varied little from the period of 1996 through 1999 (Table 6-15; Figure 6-10). Biological condition scores ranged from 46.6 in 1996 to 52.0 in 1997. The biological condition scores indicated indeterminate or full support for aquatic life use each year.

In 2003, the biological condition score dropped to 47.8 with further declines to 41.7 in 2004, 29.8 in 2010 and 30.4 in 2013 (Figure 6-10). The biological condition increased to 47.9 in 2016. Aquatic life use dropped from full support in 1997 to indeterminate or partial or non-support during subsequent years (Table 6-15). Although the improvement in biological condition from 2013 to 2016 was encouraging, the negative trendline shown in Figure 6-10 indicated a general decline in the biological condition since sampling began in 1996.

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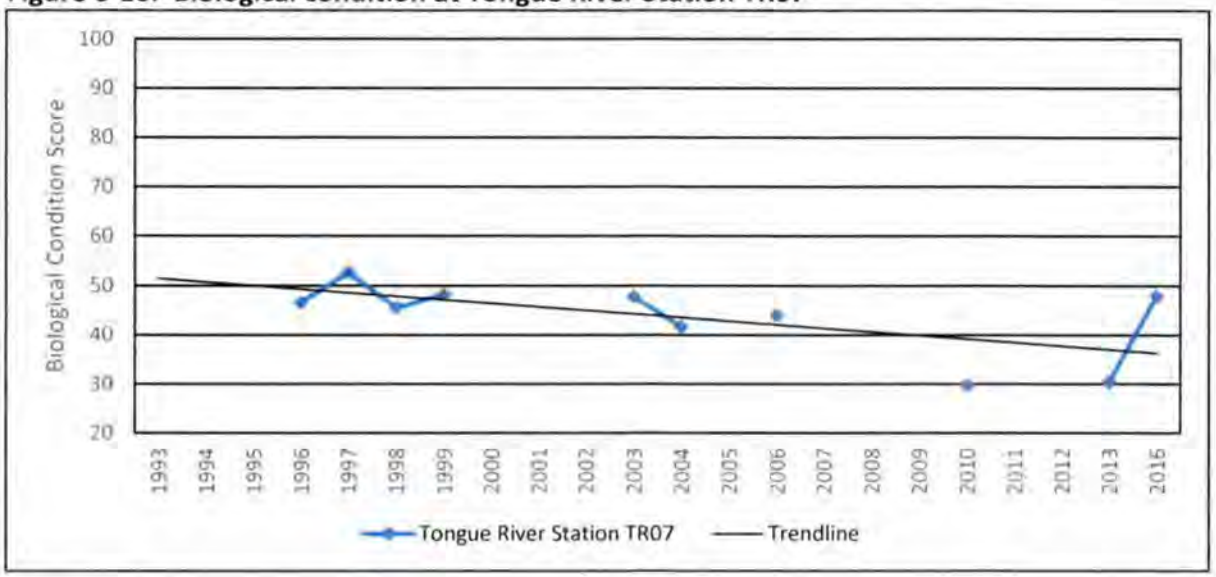
Figure 6-10. Biological condition at Tongue River Station TR07



The decline in biological condition was due to an increase in pollution tolerant organisms and a decrease in organisms sensitive to pollution. The total number of Non-Insect Taxa (generally more tolerant of pollution than Insect Taxa) and the HBI value (general community measure of pollution tolerant organisms) has been relatively high (Appendix Table C-9). Further, the number of Chironomidae taxa has generally increased since 1996. As previously noted was the near disappearance of Plecoptera (stoneflies) at Tongue River TR07 after 1999. Plecoptera are considered to be the most pollution sensitive group of aquatic organisms. From 3 to 5 Plecoptera taxa were collected each year from 1996 through 1999, but were absent from collections in 2003, 2004, and 2006 and 2013. One immature stonefly in the family Perlidae was present in 2010. Some Ephemeroptera (mayfly) taxa including the genera *Drunella* and *Ephemerella* (both indicative of good water quality and cooler water temperature) have nearly disappeared at Tongue River TR07 station since 1999.

The highest number of worm and leech taxa (N = 8 taxa) comprising 2.48% of the total benthic community occurred at Tongue River TR07 during 2006. In 2013 there were 5 worm and leech taxa comprising 4.19% of the total benthic community. Increase in the density of worms may be associated with organic pollution (Klemm, 1985), pollution from feedlots (Prophet and Edwards, 1973), and pollutants contained in urban storm water runoff (Lenat et al., 1979; Lenat and Eagleson, 1981). The number of worm taxa and percent contribution of worms in 2006 and 2013 did not indicate a severe pollution problem, but rather a moderate amount of pollution indicative of animal waste from agricultural, wildlife or urban sources.

Tubifex tubifex (a species of worm) has not been collected at Tongue River TR07 station since monitoring began in 1996. However, the presence of the genus *Tubifex* in the 2006 sample

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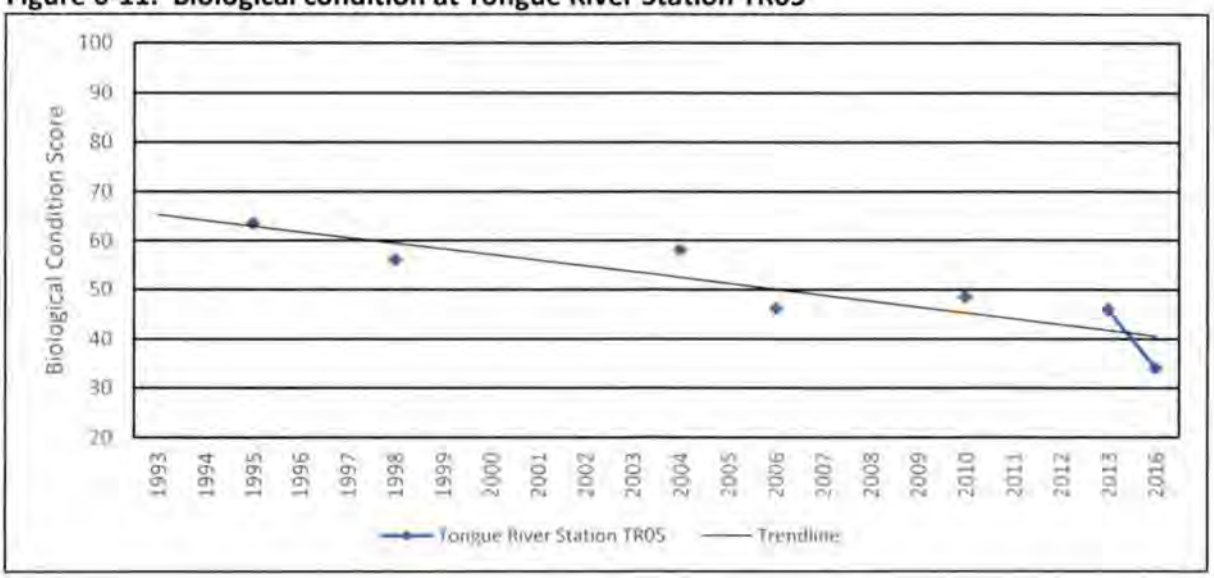
suggests the future potential occurrence of *T. tubifex* at Tongue River TR07.
The reasons for the general reduction in biological condition and the loss of cool water macroinvertebrate taxa at Tongue River TR07 since 1999 are unknown. An increase in the amount of sand in the stream substrate and relatively high embeddedness (amount of silt covering cobble and gravel) noted during 2006 in Section 7.6 in SCCD (2007) may produce adverse effects on the river benthic macroinvertebrate community and other aquatic organisms including fish. However, the combined amount of sand and silt at Tongue River TR07 station was low (1%) in 2010 suggesting that the lower biological condition rating in 2010 was not due to combined silt and sand or embeddedness. The combined amount of sand and silt in the substrate increased in 2013 (10%) (Appendix Table E2). The ongoing drought in northeast Wyoming from approximately 2000 to 2009 undoubtedly produced a negative effect on the aquatic communities in the Tongue River by reducing stream flow and likely increasing water temperature.

6.8.3 Tongue River TR05

The Tongue River TR05 station at the Kleenburn County Park was formerly known as Tongue River TR1 station. SCCD sampled TR05 for benthic macroinvertebrates in 2006, 2010, 2013 and 2016. WDEQ previously established a site identified as Tongue River at Kleenburn in 1995. WDEQ sampled this site in 1995, 1998 and 2004. The station is located in the High Valleys bioregion.

Figure 6-11. Biological condition at Tongue River Station TR05



The biological condition scores at station TR05 ranged from a low of 34.0 in 2016 to a high of 63.6 in 1995 (Table 6-15). Sampling in 1995, 1998 and 2004 indicated full support for aquatic life use. Sampling in 2006, 2010, 2013 and 2016 indicated indeterminate support for aquatic life use. The trendline shown in Figure 6-11 indicates a gradual downward trend in biological

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condition since sampling in 1995. The downward trend in biological condition was primarily due to a reduction percentage of mayfly taxa to the total number of taxa in the benthic community, a reduction in the number of EPT taxa and a reduction in the percent of scrapers.

The benthic macroinvertebrate community was dominated by warm water taxa each year. The mayfly genus *Tricorythodes* dominated the community in 1998, 2006 and 2016, and was the second most dominant taxon in the community in 1995. The riffle beetle genus *Microcylloepus* co-dominated the community in 2006, and was the second most dominant taxon in the community in 2010. Trichoptera (caddisflies) were well represented in the benthic community each year. The genera *Helicopsyche, Hydropsyche* and *Cheumatopsyche* were the most common caddisfly taxa. *Helicopsyche* dominated the benthic community in 2004 and 2013. Several specimens in the stonefly genus *Isoperla* and one immature stonefly in the family Capniidae was present in 1998, but no stoneflies have been collected in samples since then. The disappearance of stoneflies since the latter 1990's was noted at other mainstem Tongue River stations.

6.8.4 TONGUE RIVER TR03

The Tongue River TR03 station located upstream of the Decker Highway bridge crossing was established and first sampled by SCCD in 2013. WDEQ previously established a site identified as Tongue River at Decker Highway in 1998. WDEQ sampled that site in 1998 and 2004. The station is located in the Northeastern Plains bioregion. The biological condition scores ranged from a low of 62.7 in 2016 to a high of 100.0 in 1998 (Table 6-15). Sampling in 1998, 2004, 2013 and 2016 indicated full support for aquatic life use. However, Figure 6-12 shows that there has been a downward trend in biological condition.

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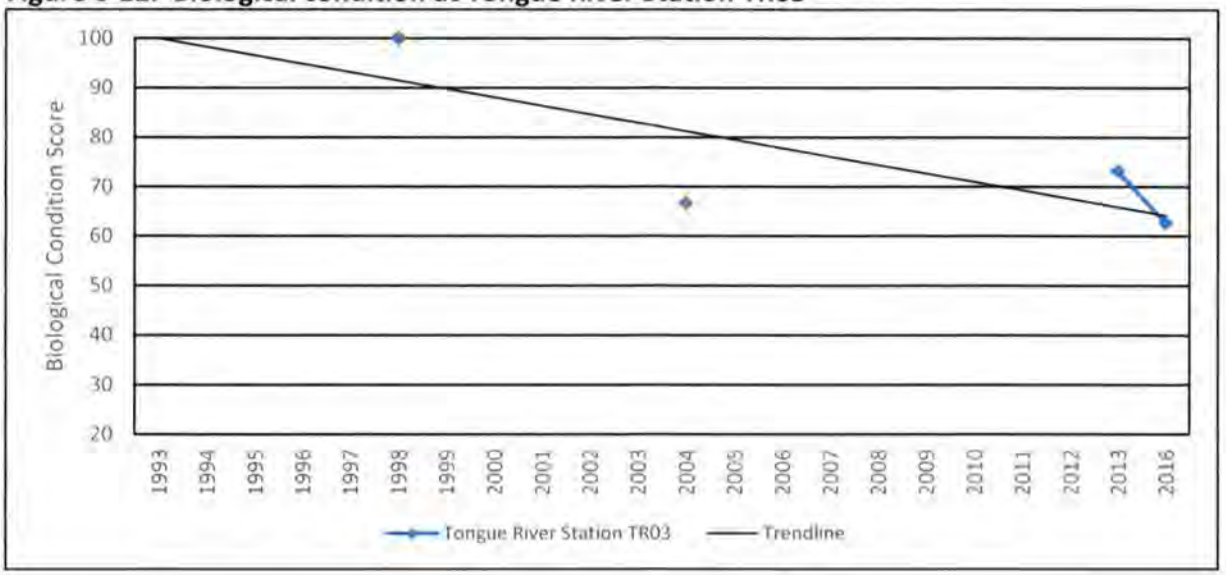
Figure 6-12. Biological condition at Tongue River Station TR03



The benthic macroinvertebrate community was dominated by warm water taxa each year. The mayfly genus *Tricorythodes* dominated the community in 1998 and 2016, and was the second most dominant taxon in the community in 2004 and 2013. The riffle beetle genus *Microcylloepus* dominated the community in 2004 and 2013, and was the second most dominant taxon in the community in 1998 and 2016. Trichoptera (caddisflies) were well represented in the benthic community each year. The genera *Hydropsyche*, *Helicopsyche* and *Oecetis* were the most common caddisfly taxa in 1998, 2004, 2013 and 2014. The stonefly genus Isoperla was present in 1998, but has not been collected in samples since then. The disappearance of stoneflies since the latter 1990's was noted at other mainstem Tongue River stations.

6.8.5 Tongue River TR01

The Tongue River TR01 station near the Wyoming – Montana border in the Northeastern Plains bioregion is the lowermost sampling station on the mainstem Tongue River within the project area. SCCD established and first sampled this station in 2013. WDEQ previously established a site identified as Tongue River – State Line in 1998. WDEQ sampled that site in 1998, 2003 and 2004. The WDEQ station is located near U.S. Geological Survey Station 06306300 downstream of SCCD station TR01. Biological condition at Tongue River TR01 was relatively stable from 1998 to 2003, but declined from 2003 to 2014 and from 2014 to 2016 (Figure 6-13).

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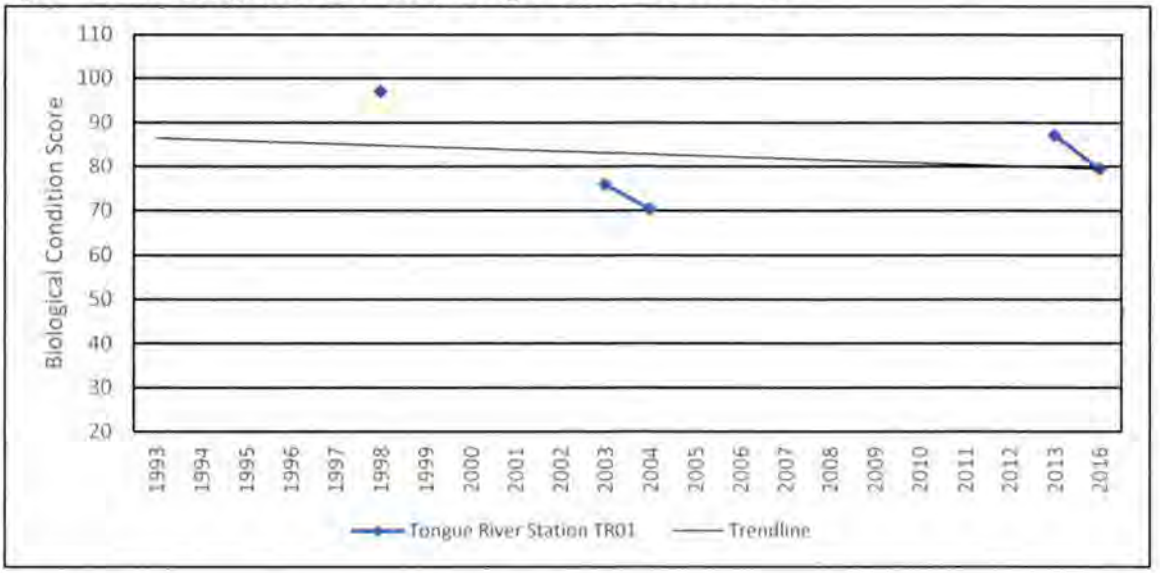
Figure 6-13. Biological condition at Tongue River Station TR01



The biological condition scores ranged from a low of 70.4 in 2004 to a high of 97.0 in 1998 (Table 6-15). Sampling during each year indicated full support for aquatic life use. WDEQ concurred with this finding, but added that effects due to stressors such as temperature, sulfates, nutrients, and sediment were present (WDEQ, 2002). These stressors appeared to affect the mainstem Tongue River system below the confluence with Goose Creek (between Tongue River stations TR05 and TR03). The biological condition trendline shown in Figure 6-13 indicated that biological condition has declined over time. Full support for aquatic life use may change should the decline in biological condition continue.

The benthic macroinvertebrate community was dominated by warm water taxa each year. No one taxon has dominated the benthic community over the years. The mayfly genera *Tricorythodes* and *Fallceon* were abundant at times along with the caddisfly genera *Hydroptila* and *Oecetis*, and the chironomid genus *Rheotanytarsus*. The riffle beetle genus *Microcylloepus* was the second most abundant taxon in 2016. Immature Tubificid worms were abundant in 1998. The stonefly genera *Isoperla* and *Acroneuria* were present in 1998, but have not been collected in samples since then. The disappearance of stoneflies since 1998 was noted at other mainstem Tongue River stations upstream of TR01.

Tubifex tubifex (a species of worm) has not been collected at Tongue River TR01 station since monitoring began in 1998. However, the presence of immature Tubificid worms in all samples collected over the years suggests the potential occurrence of *T. tubifex* at Tongue River TR01.

6.8.6 Summary of Biological Condition

The collection and analysis of stream benthic macroinvertebrate samples during 2016 revealed similar trends in biological condition observed during previous monitoring at Tongue River

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mainstem stations. No Tongue River tributary stations were sampled during this 2016 report period.

Biological condition scores at reference station TR09 varied little over the years. With the exception of 1995 and 2007, the biological condition scores consistently indicated full support for aquatic life use. It should be noted that the biological condition scores in 1995 (52.0) and 2007 (51.9) were very close to achieving the full support score of 52.2. The slightly positive trendline at station TR09 for biological condition indicated stability in the biological community and confirmed that station TR09 was a representative reference station.
The biological condition of the benthic macroinvertebrate community at Tongue River TR07 station varied little from the period of 1996 through 1999. Biological condition scores ranged from 46.6 in 1996 to 52.0 in 1997. The biological condition scores indicated indeterminate or full support for aquatic life use each year. There was an improvement in biological condition from 2013 to 2016; however, a negative trendline indicated a general decline in the biological condition since sampling began in 1996.

The biological condition scores at station TR05 in 1995, 1998 and 2004 indicated full support for aquatic life use. Sampling in 2006, 2010, 2013 and 2016 indicated indeterminate support for aquatic life use. The negative trendline graph for biological condition indicated a gradual downward trend in biological condition since sampling in 1995.

Biological condition scores at the most downstream station TR01 located near the Montana border indicated full support for aquatic life use during each year since 1998. However, a graph of biological condition scores indicated that biological condition has declined over time. Full support for aquatic life use may change should the decline in biological condition continue.

Those stations that have the partial or non-support classification for biological condition indicated the aquatic communities were stressed and water quality or habitat improvements were required to restore the stream to full support for the narrative WDEQ standard for aquatic life use. Planning and implementation of remedial measures must continue to restore full aquatic life use support in the streams in the Tongue River watershed. Continued benthic macroinvertebrate sampling should be conducted at stations in the watershed to track changes in biological condition.

No threatened or endangered benthic macroinvertebrate taxa or fish species have been identified since sampling began in the Tongue River watershed in 1993. The generally widespread occurrence of freshwater shrimp genera indicated that water in Tongue River contained no toxic substances in sufficient concentration to prevent the establishment and survival of these organisms.

The disappearance of stoneflies since the latter 1990's noted at some mainstem Tongue River stations continued. The general disappearance of stoneflies at Tongue River stations

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downstream of TR09 since the 1990's indicates that water quality and habitat change have negatively affected this pollution intolerant group of aquatic insects.

Historic and SCCD monitoring of aquatic benthic macroinvertebrate communities in the Tongue River watershed have not identified the presence of aquatic invasive species of concern to the WGFD. No zebra mussel (*Dreissena polymorpha)*, quagga mussel (*Dreissena rostriformis bugensis),* New Zealand Mudsnail (*Potamopyrgus antipodarum)* and the Asian Clam (*Corbicula fluminea*) have been identified in the Tongue River watershed or adjacent Little Goose Creek and Big Goose Creek watersheds. Recommended future benthic macroinvertebrate monitoring by SCCE will be attentive to the presence of aquatic invasive species.

Tubifex tubifex, a species of aquatic worm, involved in the whirling disease life cycle that may decimate trout populations, have not been collected at Tongue River stations since monitoring began in 1993 indicating a low probability for the occurrence of whirling disease. However, the presence of the genus *Tubifex* and immature Tubificid worms in samples collected in the Tongue River watershed suggest the future potential occurrence of *T. tubifex*. Whirling disease has not been detected in the Tongue River watershed or nearby Little Goose Creek and Big Goose Creek watersheds. However, the disease has been detected at six locations in the adjacent Powder River watershed to the east. *Tubifex tubifex* (a species of aquatic worm), is significantly involved in the whirling disease life cycle caused by a parasite (*Myxobolus cerebralis*) that penetrates the head and spinal cartilage of fingerling trout. Whirling disease may eventually cause death in trout.

6.9 HABITAT ASSESSMENTS

Qualitative habitat assessments were conducted by SCCD during 2016 at mainstem Tongue River stations TR09, TR07, TR05, TR03 and TR01. WDEQ used the same habitat assessment method as that used by SCCD through 2004. WDEQ changed their habitat assessment methods after 2004, thus no habitat data is presented for WDEQ assessments after that time. Habitat assessment data, substrate data, and embeddedness (silt cover) data for Tongue River mainstem stations are presented in Appendix Tables E-1 through E-5. Because habitat assessments were subjective, SCCD used caution by providing a conservative interpretation of data.

The average habitat score at reference station Tongue River TR09 from 1993 through 2004, 2010, 2013 and 2016 was 170 (Appendix Table E-1). The range in annual habitat scores at Tongue River TR09 station was from 150 in 2010 and 2016 to 184 in 2003. Although assessments were generally conducted on sampling dates within ± two (2) weeks of one another each year, differences in annual discharge affected scoring for some habitat parameters because they were flow dependent. Scores for instream cover, velocity / depth, channel flow status and width depth ratio will normally score higher when discharge is increased, but will score lower when discharge is decreased.

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The average habitat score at Tongue River TR07 station from 1996 through 1999, 2003, 2004, 2006, 2010, 2013 and 2016 was 139 (Appendix Table E-2). Scores at TR07 ranged from 108 in 2006 to 163 in 2016. Variation in habitat scores between years appeared to be primarily related to difference in annual stream discharge at the time that the habitat assessment was conducted.

The reduction in habitat score from the reference upstream station TR09 to the downstream Tongue River TR07 station was generally due to lower scores for embeddedness (silt cover on or surrounding cobble and gravel), channel flow status, channel shape, channelization, width depth ratio and bank stability. Reduced scores for some of these parameters were related not only to current land use practices, but to lingering effects from the period of extensive channelization that apparently occurred in the late 1950's to early 1960's. Effects of channelization from that period continue to affect the Tongue River stream channel to this day requiring patch work repair and bank stabilization projects. Despite the lower habitat score at Tongue River TR07 station, this station ranked high when compared to habitat scores at other Wyoming streams in the Sedimentary Mountains bioregion. This observation indicated that although Tongue River in-stream and riparian habitat have been altered due to channelization, habitat was still in better condition when compared to most Wyoming streams in the Sedimentary Mountains bioregion.

The semi-quantitative stream substrate particle size distribution varied little between the Tongue River TR09 and TR07 stations. Cobble dominated the stream substrate at each station. Average percent cobble was 66 percent at station TR09 and 55 percent at station TR07 (Appendix Tables E-1 through E-2). Average percent coarse gravel ranged from 17 percent at Tongue River TR09 to 27 percent at TR07. Silt deposition was minimal. The Tongue River TR09 station averaged less than 1 percent silt in the stream substrate and TR07 station averaged 1 percent. Sand comprised 6 percent of the average total substrate at both TR09 and TR07 stations. The amount of silt and sand in the stream substrate is important since silt and sand are detrimental to trout egg survival and maintenance of healthy benthic macroinvertebrate populations that provide food for trout (Chutter, 1969). The dominance of cobble and coarse gravel at each station allowed comparison of macroinvertebrate communities between stations because the variability caused by potential differences in the stream substrate was minimal.

Embeddedness (silt covering on or surrounding cobble and gravel) was low at the upstream reference Tongue River TR09 station. Average weighted embeddedness at TR09 from 1996 through 1999, 2003, 2004, 2006, 2010, 2013 and 2016 was 95.2. The higher the weighted embeddedness value, the lower the embeddedness or amount of silt deposited on cobble and gravel. The weighted embeddedness value of 95.2 indicated that about 95 percent of the surface of cobble and gravels were free of silt. The average weighted embeddedness at Tongue River TR07 station for the period of 1996 through 1999, 2003, 2004, 2006, 2010, 2013 and 2016 was 49.9 indicating that about 38 percent of the surface of cobble and gravels were free of silt.

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The decrease in weighted embeddedness from Tongue River TR09 station to downstream TR07 station indicated increased deposition of silt on cobble and gravel stream substrate between stations. Deposition of silt is controlled by the amount of silt contained in the water column and by the current velocity. Silt deposition will normally increase as current velocity decreases. The average current velocity measured at Tongue River TR09 station was 2.02 feet per second (fps) and 2.16 fps at the TR07 station. Because average water current velocity was slightly higher at the Tongue River TR07 station when compared to the upstream TR09 station, the apparent increased silt deposition at TR07 station was not related to difference in current velocity, but was due to increased amount of silt contained in the water column.

The general decrease in substrate particle size from the Tongue River TR09 to the Tongue River TR07 station was normal because particle size generally decreases as stream size and stream order increase (Rosgen, 1996). The observed increase in embeddedness from the TR09 station to the TR07 station was likewise considered normal for the size and stream order of the Tongue River. Embeddedness at the TR07 station should be considered moderate when compared to weighted embeddedness values at other comparable streams in the High Valleys bioregion.

The habitat assessments conducted at Tongue River TR05 station at the Kleenburn Park indicated similar habitat characteristics to the upstream Tongue River TR07 station. The average habitat score at the Tongue River TR05 station for sampling years 1995, 1998, 2004, 2006, 2010, 2013 and 2016 was 139 (Appendix Table E-3). Total habitat assessment scores at Tongue River TR05 ranged from 147 in 1998 to 127 and 127 in 2004. Although the Tongue River TR05 station was several miles downstream of TR07, the habitat quality was similar at both stations.

The semi-quantitative stream substrate particle size distribution indicated that Tongue River TR05 was dominated by cobble (47percent of substrate) and coarse gravel (28 percent of substrate) (Appendix Table E-3). Silt deposition was minimal and comprised an average of 2 percent of the stream substrate. Sand accounted for about 6 percent of the substrate. The average embeddedness was 50.8 indicating that about 40 percent of the surface of cobble and gravels were free of silt. The average measured current velocity was 2.00 fps.

Tongue River TR03 located just upstream of the Decker Highway bridge crossing was a newer monitoring station established by SCCD in 2013. WDEQ conducted sampling at this station in 1998 and 2004.

The total habitat scores at Tongue River TR03 station in 1998, 2004, 2013 and 2016 were 114, 133, 131 and 134 respectively (Appendix Table E-4). The relatively low habitat assessment score was due to high embeddedness (the amount of silt covering cobble and gravel), low pool to riffle ratio, low width to depth ratio, high disruptive pressures and low riparian width.

The semi-quantitative stream substrate particle size distribution at Tongue River station TR03

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showed a reduction in cobble to more coarse and fine gravel when compared to upstream stations TR09, TR07 and TR05. Cobble comprised an average of 31 percent, coarse gravel 32 percent and fine gravel 22 percent of substrate since 1998 (Appendix Table E-4). Silt deposition was minimal and comprised an average of 2 percent of the stream substrate. Sand accounted for about 6 percent of the substrate. The average embeddedness value was 49.6 indicating that about 37 percent of the surface of cobble and gravels were free of silt. The average measured current velocity was 1.29 fps.

The Tongue River TR01 station near the Wyoming – Montana border was established and sampled by SCCD in 2013. WDEQ previously sampled a site downstream of Tongue River TR01 in 1998. The WDEQ station was identified as Tongue River – State Line and was sampled in 1998, 2003 and 2004.

The average total habitat assessment score at TR01 was 134 with a range from 127 in 2013 to 137 in 2004 (Appendix Table E-5). The stream substrate was dominated by cobble (average 40 percent) followed by coarse gravel (average 33 percent), fine gravel (average 15 percent), sand (average 11 percent) and silt (average 1 percent). The average embeddedness score was 35.7 indicating that about 80 percent of the surface of cobble and gravels were covered or surrounded by silt. The average measured current velocity was 1.49 fps.

The riparian indicator parameters including bank vegetation, bank stability, disruptive pressures and riparian zone width scored relatively high indicating that the stream banks were stable, well vegetated, and utilization of bank vegetation was low.

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CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

Water quality monitoring for 2016 was performed at 13 stations; six sites on the mainstem of the Tongue River, and seven sites on the major tributaries that flow into the Tongue River. These seven tributaries included Smith Creek, Little Tongue River, Columbus Creek, Five Mile Creek, Wolf Creek, Goose Creek, and Prairie Dog Creek. Stations were equipped with a SCCD calibrated staff gauge or located at USGS gauging stations.

Instantaneous water temperature measurements were recorded above the maximum 20°C instream temperature standard at 12 of the 13 sites on at least one occasion; the uppermost station (TR09) did not have any temperature measurements above 20°C. Continuous temperature loggers reported temperatures above 20°C at all but the uppermost station in Tongue River Canyon. Conductivity and pH were within the expected ranges during 2016. Turbidity values were considered normal for the watershed with occasional high values occurring during late-spring, early summer precipitation and run-off events. All sites met the minimum instantaneous dissolved oxygen concentration for early and other life stages. Four tributary stations and four mainstem stations had one or more samples that were below the 8.0 mg/L water column concentration recommended to achieve the inter-gravel concentrations for early life stages.

Bacteria geometric mean concentrations in the early season were typically higher than in the late season on tributary sites. In contrast, mainstem sites had higher bacteria concentrations in the late season except on TR03 and TR09. While some mainstem sites did not meet Wyoming Water Quality Standards, the highest bacteria concentration observed at a mainstem site was 169 cfu/100 mL or 25% above the standard. Bacteria concentrations at tributary stations appeared to contribute to bacteria increases on the Tongue River at adjacent downstream stations in the upper portion of the watershed during the early season. Except for Wolf Creek during the late season, bacteria concentrations at all tributary stations exceeded Wyoming Water Quality standards in both the early season and the late season.

For the most part, bacteria concentrations decreased from 2003-2016 and from 2013-2016 at all mainstem sites in the early season but increased in the late season. In contrast, bacteria concentrations at TR09 in the early season increased since 2003, but were still well below Wyoming Water Quality standards.

With the exception of upstream reference station TR09, biological condition has trended lower since the 1990's at downstream stations TR07, TR05, TR03 and TR01. No threatened or endangered benthic macroinvertebrate taxa or fish species have been identified since sampling began in 1993. The general disappearance of stoneflies at Tongue River stations downstream of TR09 since the 1990's indicates that water quality and habitat change have negatively affected this pollution intolerant group of aquatic insects.

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Monitoring of aquatic benthic macroinvertebrate communities in the Tongue River watershed since 1993 have not identified the presence of aquatic invasive species of concern to the WGFD including zebra mussel, quagga mussel, New Zealand mudsnail and the Asian Clam. Recommended future benthic macroinvertebrate monitoring by SCCD will be attentive to the presence of aquatic invasive species.

Tubifex tubifex, a species of aquatic worm, involved in the whirling disease life cycle that may decimate trout populations, have not been collected at Tongue River stations since monitoring began indicating a low probability for the occurrence of whirling disease. However, the presence of the genus *Tubifex* and immature Tubificid worms at some stations suggest the future potential occurrence of *T. tubifex*. Whirling disease has not been detected in the Tongue River watershed or nearby Little Goose Creek and Big Goose Creek watersheds.

Continued benthic macroinvertebrate sampling should be conducted at stations in the Tongue River watershed to track the health of aquatic communities, changes in biological condition, potential occurrence of aquatic invasive species and presence of indicator species associated with whirling disease.

Attempts to determine if improvements in overall water quality have been achieved are often difficult, especially when comparing water quality data that has been collected during seasons with different hydrological and meteorological conditions. Although normal flow conditions cannot be anticipated nor expected during monitoring, these varying conditions do make water quality comparisons more difficult. Bacteria concentrations, in particular, are known to vary in response to a number of different water quality and water quantity factors, including changes in water temperature, water quantity, and suspended sediment loads. Higher *E. coli* bacteria concentrations in May could be associated to precipitation events in the spring, including run-off from snowmelt, that contribute surface contaminants and increases their concentrations. Bacteria deposits from livestock, humans, wildlife, and other sources can be transported from upland areas to streams through overland run-off. In addition, deeper, faster moving water within the stream channels can scour and suspend sediment that has been previously deposited on the channel bottom. These bed sediments have been found to contain elevated levels of bacteria. Rangeland studies in Idaho have shown that *E. coli* concentrations can be 2 to 760 times greater in bottom sediment than in the water column (Stephenson and Rychert, 1982). A similar study on the Goose Creek watershed showed up to 3-fold increases of fecal coliform bacteria when disturbing the bed sediment (SCCD, 2003). The approximate duration for which sediment dwelling bacteria populations can remain viable is unknown.

From 2000 through 2006, the local area was in a prolonged drought and below average stream discharge conditions were experienced. Years 2001 and 2002 lacked adequate peak flows during May and June which normally "flush" stream channel sediment accumulated during the previous year. During 2003 and 2010, the Tongue River experienced higher than normal peak flows, which may have had the ability to "flush" streambed sediment that had accumulated

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during the several previous drought years. Flows in 2013 and 2016 were generally below normal at most stations, especially during the early season.

The positive effects that improvement projects have on water quality may not be immediately determined due to factors such as the bacteria storage capacity of bed sediment, which is normally suspended during bankfull flows. This bacteria "storage" in bed sediments and their annual release during high flows may cause a delay in observing quantifiable changes in bacteria currently entering the system. The data provided by the 1996 – 1999 watershed assessment and subsequent interim monitoring indicate the need for additional improvement projects as well as additional future monitoring to create and measure positive water quality changes. The SCCD anticipates that voluntary, incentive based watershed planning and implementation will be successful; however, it may require several years to actually measure these achievements. Nonetheless, each improvement project that has been implemented or is currently being implemented on the watershed certainly induces positive water quality changes, whether they are immediately apparent or not.

SCCD will continue to monitor water quality in the Tongue River Watershed on a three-year rotation, pending available funding sources. Planning and implementation of remedial measures to restore full aquatic life use support in the streams in the Tongue River watershed should continue. Continued benthic macroinvertebrate sampling should be conducted at stations in the watershed to track potential changes in biological condition.

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CHAPTER 8 REFERENCES CITED

American Public Health Association (APHA), American Water Works Association, Water Environment Federation, 1998. Standard methods for the examination of water and wastewater, 20th ed., Eaton, A.D., L.S. Clesceri and A.E. Greenburg, eds., Washington, DC.

American Public Health Association (APHA), American Water Works Association, Water Environment Federation, 2005. Standard methods for the examination of water and wastewater, 21st ed., Washington, DC.

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates, and fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency: Office of Water; Washington, D.C.

Chutter, F.M. 1969. The effects of sand and silt on the invertebrate fauna of streams and rivers. Hydrobiologia 34: 57-76.

Federal Register, 2012. Volume 77, Number 97; May 18, 2012. Code of Federal Regulations, Title 40: Protection of Environment, Chapter 1, Subchapter D, Part 136: Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Analysis and Sampling Procedures; Final Rule.

Friedman, L.C. and D.E. Erdmann. 1982. Quality assurance practices for the chemical and biological analyses of water and fluvial sediments. Techniques of water-resources investigations of the United States Geological Survey. Book 5, Laboratory analysis; Chapter A6. Washington, D.C.

Gilbert, R.O. 1987. Statistical methods for environmental pollution monitoring. Van Nostrand Reinhold Press. New York, NY.

Hargett, E.G. and J.R. ZumBerge. 2006. Redevelopment of the Wyoming Stream Integrity Index (WSII) for assessing the biological condition of wadeable streams in Wyoming. Wyoming Department of Environmental Quality Water Quality Division. Cheyenne, WY. 70pp.

Hargett, E.G. 2011. The Wyoming Stream Integrity Index (WSII) – multimetric Indices for assessment of wadeable streams and large rivers in Wyoming. Wyoming Department of Environmental Quality, Water Quality Division. Cheyenne, WY.

Jessup, B.K. and J.B. Stribling. 2002. Further evaluation of the Wyoming Stream Integrity Index, considering quantitative and qualitative reference site criteria. Report to U.S. EPA Region 8, Denver, CO. by Tetra Tech, Inc. Owings Mills, MD.

Johnson, P.D., A. E. Bogan, K. M. Brown, N. M. Burkhead, J. R. Cordeiro, J. T. Garner, P. D. Hartfield, D. A. W. Lepitzki, G. L. Mackie, Eva Pip, T. A. Tarpley, J. S. Tiemann, N. V. Whelan and E. E. Strong. 2013. Conservation Status of Freshwater Gastropods of Canada and the United States, Fisheries, 38:6, 247-282.

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

King, K.W. 1990. Effects of oil field produced water discharges on pond zooplankton populations. Wyoming Department Environmental Quality Water Quality Division. Cheyenne. 26pp.

King, K.W. 1993. A bioassessment method for use in Wyoming stream and river water quality monitoring. Wyoming Department of Environmental Quality Water Quality Division. Cheyenne, WY. 85pp.

Klemm, D.J. (Editor). 1985. A guide to the freshwater Annelida (Polychaeta, Naidid and Tubificid Oligochaeta, and Hirudinea) of North America. Kendall/Hunt Publishing Company, Dubuque, IA.

Lenat, D.R., D.L. Penrose and K.W. Eagleson. 1979. Biological evaluation of non-point source pollutants in North Carolina streams and rivers. Biological Series #102. North Carolina Department of Natural Resources Division of Environmental Management. 167pp.

Lenat, D.R. and K.W. Eagleson. 1981. Biological effects of urban runoff on North Carolina streams. Biological series #102. North Carolina Department of Natural Resources and Community Development, Division of Environmental Management, Water Quality Section, Biological Monitoring Group. Raleigh, NC.

Prophet, W.W. and N.L. Edwards. 1973. Benthic macroinvertebrate community structure in a Great Plains stream receiving feedlot runoff. Water Resources Bulletin 9:583-589.

Rasmussen, Patrick. 2003. Comparison and Continuous Estimates of Fecal Coliform and Escherichia Coli bacteria in Selected Kansas Streams, May 1999 Through April 2002. USGS 03-4056.

Rosenberg, D.M. and V.H. Resh. 1993. Introduction to freshwater biomonitoring and benthic macroinvertebrates, pp. 1-9. In Rosenberg, D.M., and V.H. Resh, (editors), Freshwater biomonitoring and benthic macroinvertebrates. Chapman and Hall, New York. 488pp.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO.

Sheridan County Conservation District. 2000. Tongue River Watershed Assessment 1996-1999 Final Report. September 2000. Sheridan, WY. 325 p.

Sheridan County Conservation District. 2000a. Tongue River Watershed Management Plan. September 2000. Sheridan, WY.

Sheridan County Conservation District. 2003. 2001-2002 Goose Creek Watershed Assessment, Final Report. July 2003. Sheridan, WY.

Sheridan County Conservation District. 2004. 2003 Tongue River Monitoring Project Report. June 2004. Sheridan, WY.

Sheridan County Conservation District. 2007. 2006 Tongue River Watershed Interim Monitoring Report. October 2007. Sheridan, WY.

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Sheridan County Conservation District. 2007a. Tongue River Watershed Management Plan; Revision No. 1. May 2007. Sheridan, WY.

Sheridan County Conservation District. 2012. 2010 Tongue River Watershed Interim Monitoring Report. August 2012. Sheridan, WY.

Sheridan County Conservation District. 2012a. Tongue River Watershed Management Plan; Revision No. 2. November 2012. Sheridan, WY.

Sheridan County Conservation District 2015. 2013 Tongue River Watershed Interim Monitoring Report September 2015. Sheridan, WY.

Sheridan County Conservation District. 2015a. Water Quality Monitoring Program Quality Assurance Project Plan 2015 Update. Sheridan, WY.

Sheridan County Conservation District. 2016. Tongue River Watershed 2016 Monitoring Project, Sampling and Analysis Plan, April 2016. Sheridan, WY.

Smith, D.G. 2001. Pennak's freshwater invertebrates of the United States: porifera to crustacea. 4th edition. John Wiley & Son, Inc.

Stephenson, G.R. and R.C. Rhychert. 1982. Bottom Sediment: A Reservoir of *Escherichia coli* in Rangeland Streams. Journal of Range Management. 35:119-123.

Stribling, J.B., B.K. Jessup and J. Gerritsen. 2000. Development of biological and physical habitat criteria for Wyoming streams and their use in the TMDL process. Report to U.S. EPA Region 8, Denver, CO prepared by Tetra Tech, Inc., Owings Mills, MD.

U. S. Environmental Protection Agency. 1980. Interim guidelines and specifications for preparing quality assurance project plans. QAMS-005/80. Office of Monitoring Systems and Quality Assurance, Office of Research and Development. Washington, D.C.

U. S. Environmental Protection Agency. 1983. Methods for chemical analyses of water and wastes. 600/4-79-020. Environmental Monitoring and Support Lab. Cincinnati, OH

U.S. Environmental Protection Agency. 1995. Generic quality assurance project plan guidance for programs using community-level biological assessment in streams and wadeable rivers. EPA 841-B-95-004. Office of Water, Washington, D.C.

Wyoming Department of Environmental Quality. 2002. Tongue River Final Assessment Report; WYTR10090101. Water Quality Division, Watershed Protection. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2005. Water Quality Rules and Regulations Chapter VIII, Quality standards for Wyoming groundwaters. Cheyenne, WY.

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Wyoming Department of Environmental Quality. 2013. Water Quality Rules and Regulations Chapter 1, Quality standards for Wyoming surface waters. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2013a. Wyoming Surface Water Classification List. Water Quality Division, Surface Water Standards. Cheyenne, WY.

Wyoming Department of Environmental Quality 2013b. Wyoming Nonpoint Source Management Plan 2013 Update. Document # 13-0035. Water Quality Division. Cheyenne, WY.

Wyoming Department of Environmental Quality. 2014. Wyoming's Methods for Determining Surface Water Quality Condition and TMDL Prioritization. Document #14-0367. Water Quality Division. Watershed Program. Cheyenne, WY.

Wyoming Department of Environmental Quality/Water Quality Division. 2015. Manual of Standard Operating Procedures for Sample Collection and Analysis. Wyoming Department of Environmental Quality, Water Quality Division, Watershed Program, Cheyenne, WY.

Wyoming Department of Environmental Quality. 2016. Wyoming's 2014 Integrated 305(b) and 303(d) Report. Document #16-0126. Water Quality Division. Cheyenne, WY.

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APPENDICES

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APPENDIX A

Tongue River 2016
Watershed Maps

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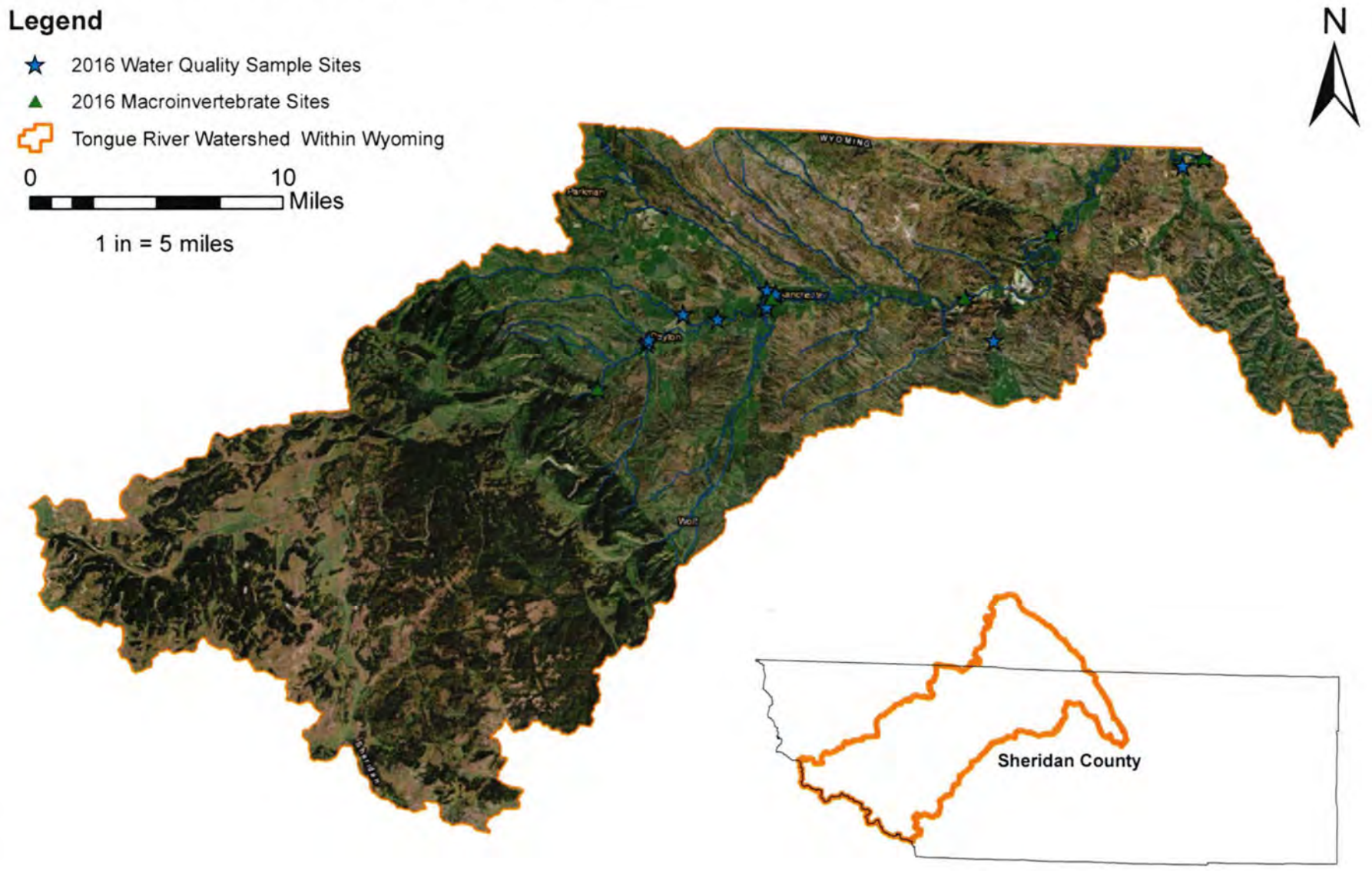
APPENDIX A. TONGUE RIVER WATERSHED 2016 MAPS
APPENDIX FIGURE A-1. PROJECT AREA WITH SAMPLE SITES

October 2018

RAMACO



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Brook Mine

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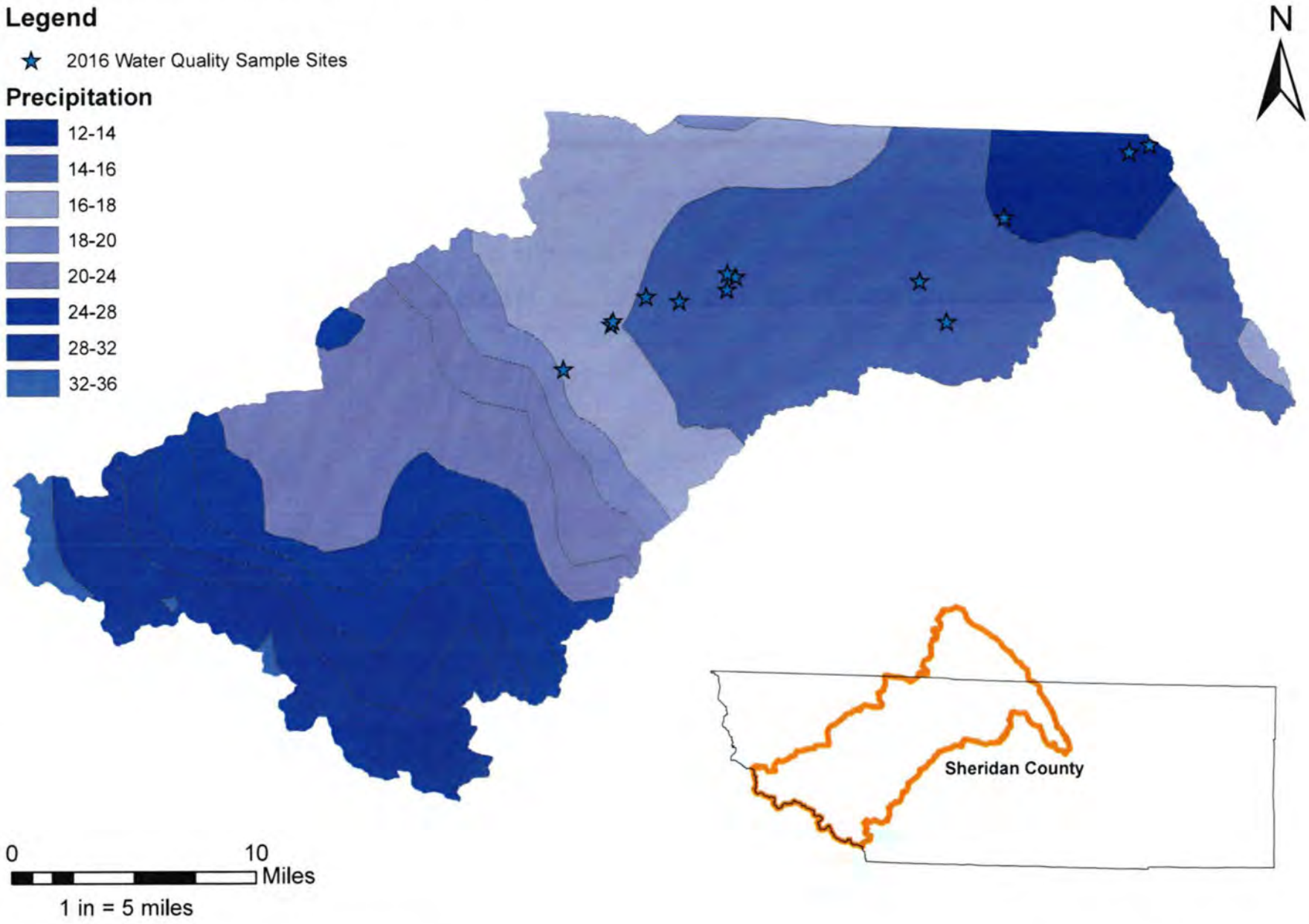
APPENDIX FIGURE A-2. PRECIPITATION ZONES



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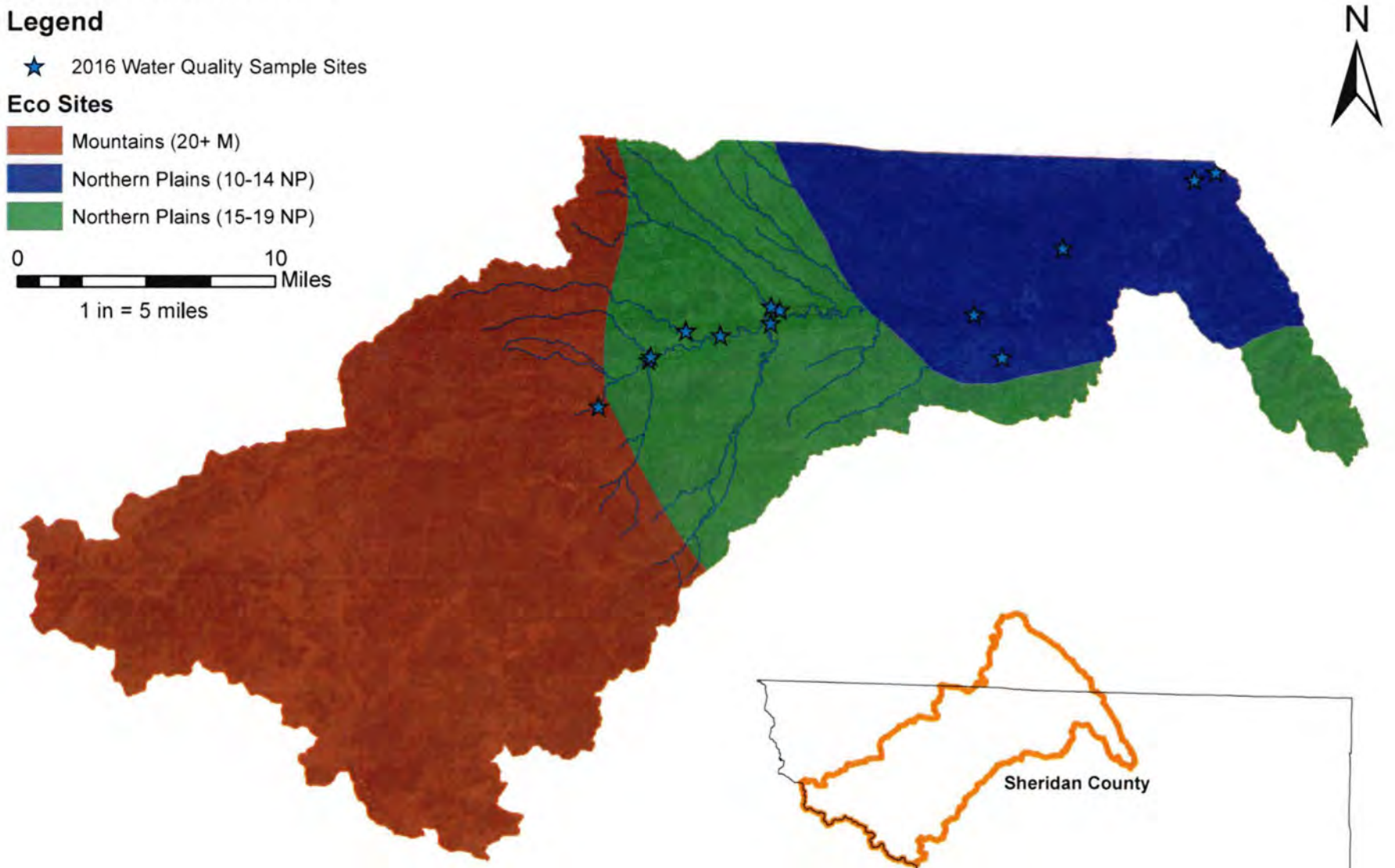
APPENDIX FIGURE A-3. ECOSITES



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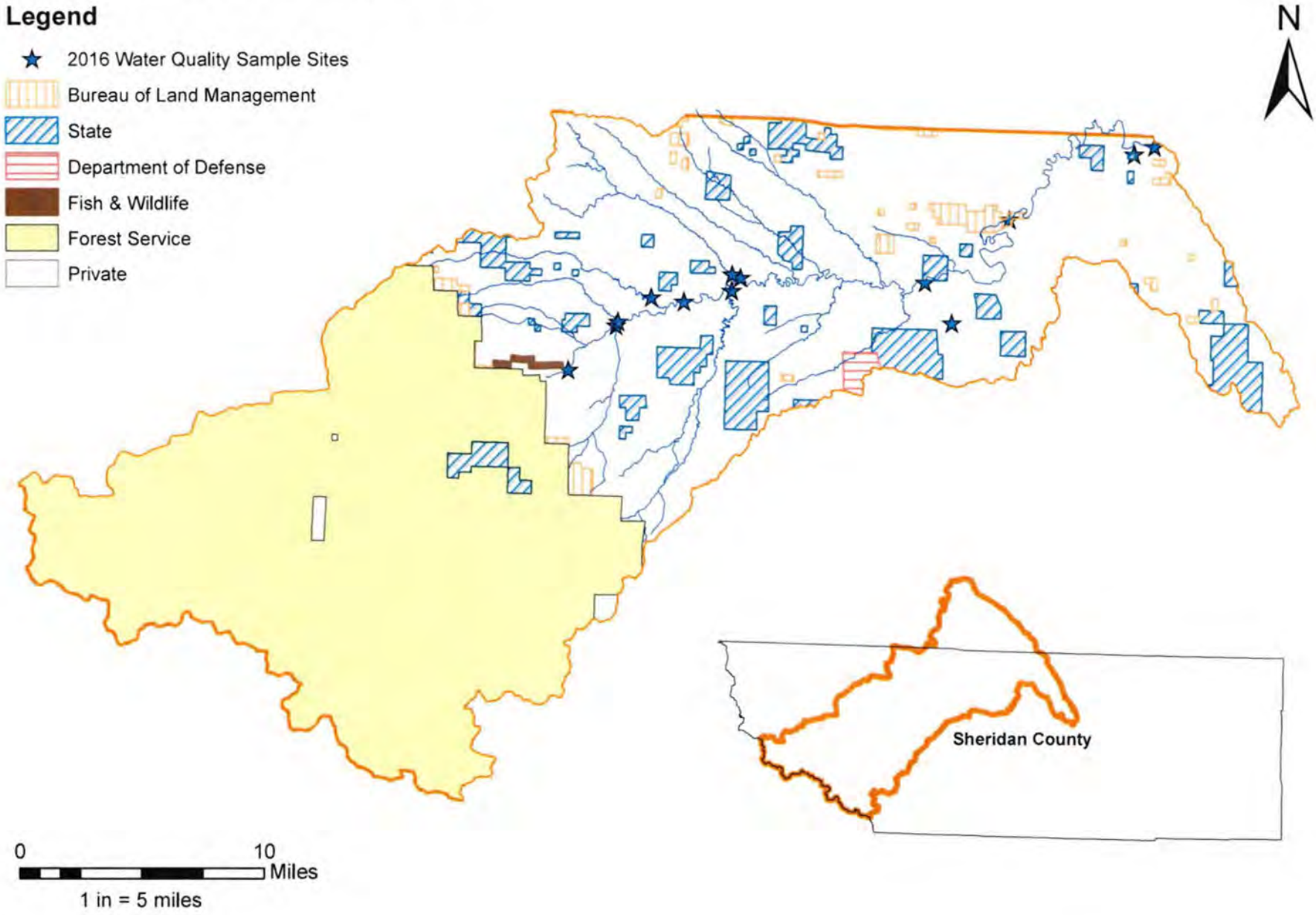
APPENDIX FIGURE A-4. LAND OWNERSHIP



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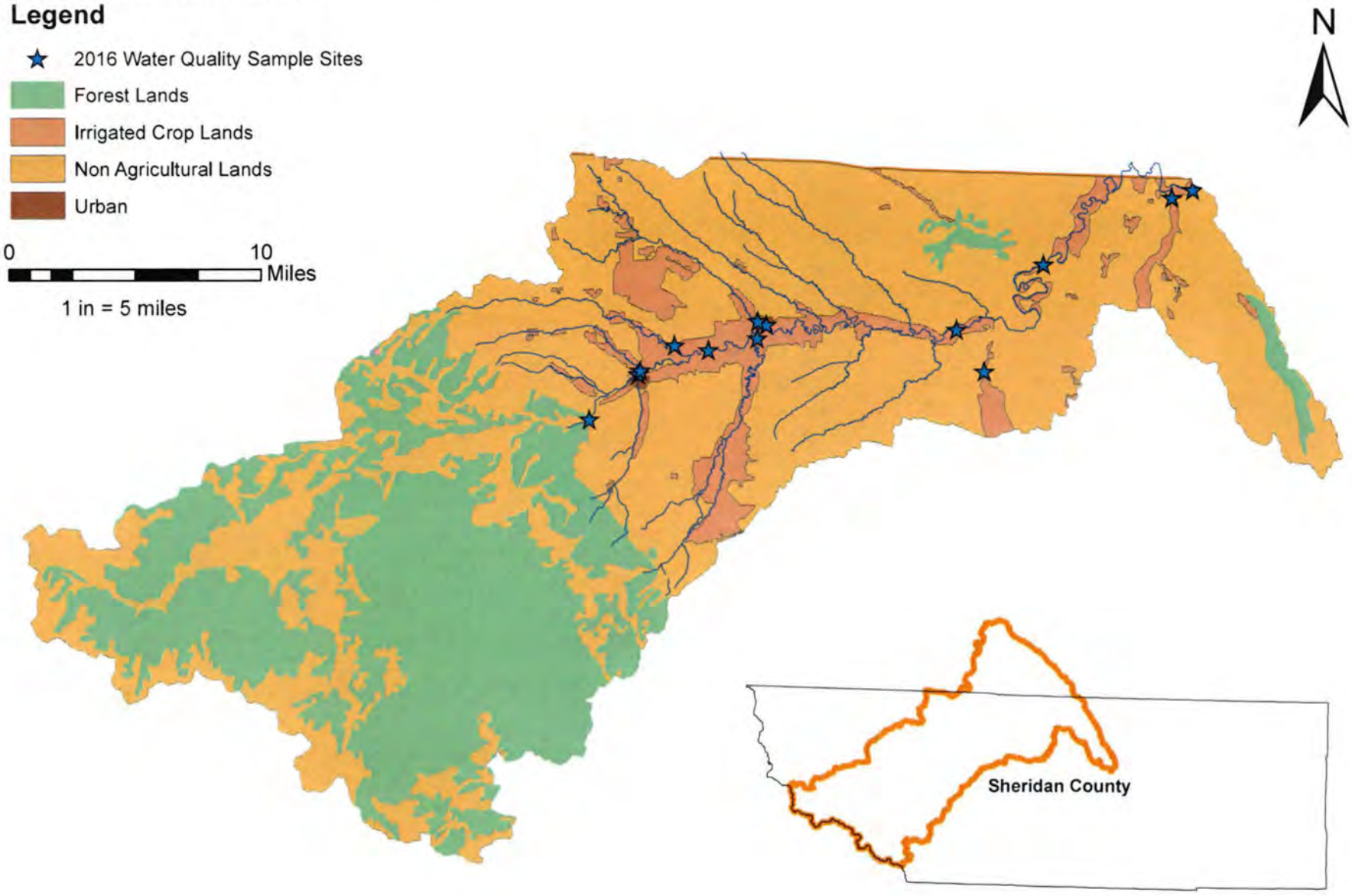
APPENDIX A. TONGUE RIVER WATERSHED 2016 MAPS
APPENDIX FIGURE A-5. LAND USE



October 2018

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Brook Mine

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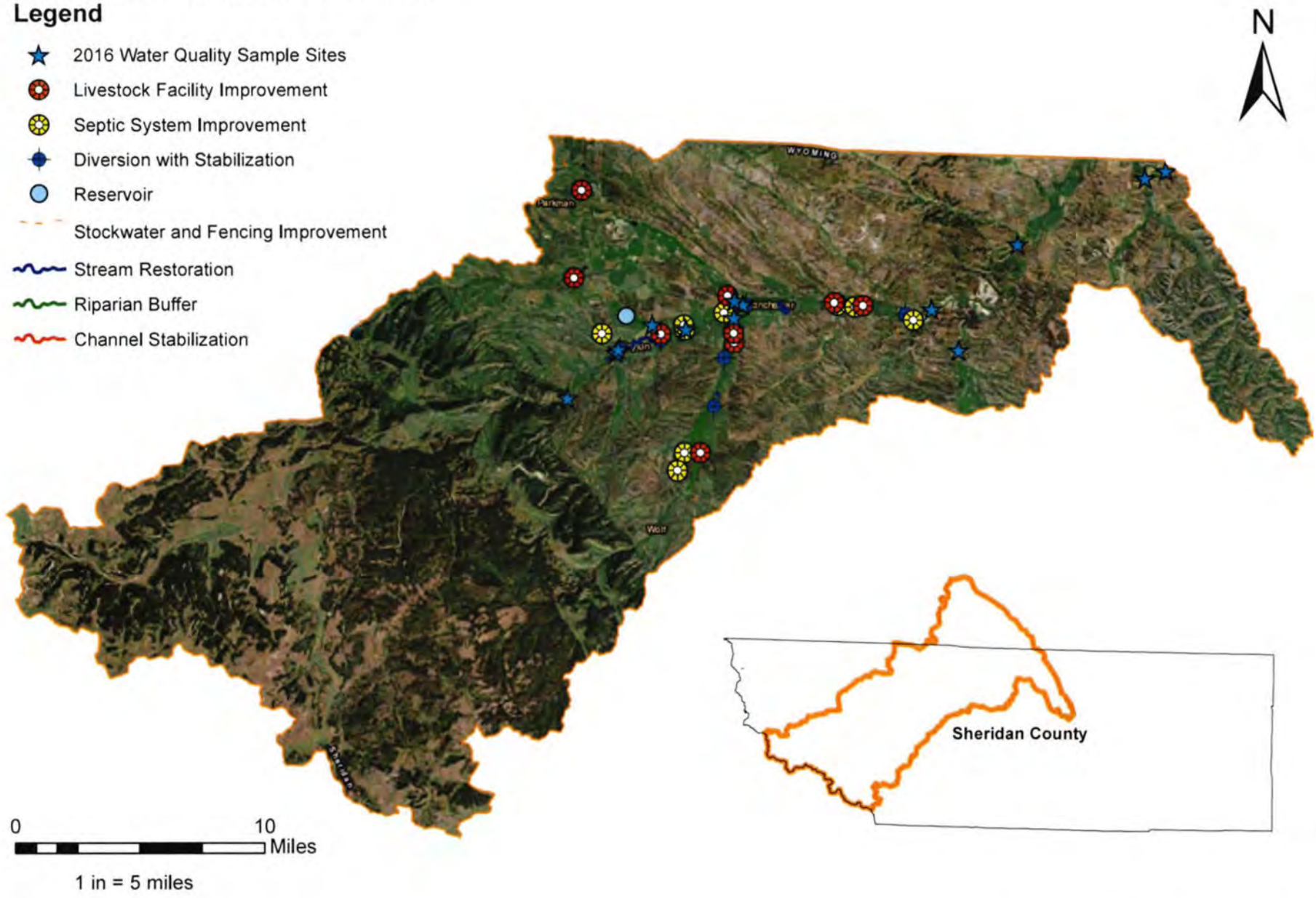
APPENDIX A. TONGUE RIVER WATERSHED 2016 MAPS
APPENDIX FIGURE A-6. PROGRESS REGISTER



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APPENDIX B

2016 Tongue River Watershed Quality Assurance/Quality Control Documentation

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APPENDIX TABLE B-1. SITE ABBREVIATIONS FOR THE SCCD 2016 TONGUE RIVER WATERSHED INTERIM MONITORING

Site Abbreviation	Descriptions
TR01	Tongue River; 200 meters downstream of river bend; off of well pad road that is off of Lower Prairie Dog Road; lowest site on the Tongue River
PD01	Prairie Dog Creek; approximately 150 yards downstream from USGS station No. 06306250; lowest site on Prairie Dog Creek
TR03	Tongue River; approximately 20 meters downstream of bridge on Decker Road (Hwy 338)
GC01	Goose Creek; located in between USGS Station No. 06305700 and HWY 339 bridge crossing; lowest site on Goose Creek
TR05	Tongue River; Off of the Kleenburn Road; in Sheridan County's Recreational Picnic Area; downstream 0.7 miles from USGS Station 06306250
TR07	Tongue River; 10 feet downstream of the Ranchester Water Treatment Plant intake
WC01	Wolf Creek; upstream of the County Road 67 bridge crossing
FMC01	Fivemile Creek; upstream of the Hwy 14 Bridge in Ranchester
TR08	Tongue River; downstream of the Halfway Lane County Road bridge
CC01	Columbus Creek; downstream of the Hwy 14 bridge crossing
LTR01	Little Tongue River; 300-400 yards upstream from the Tongue River confluence
SC01	Smith Creek; downstream of the County Road 92 bridge crossing
TR09	Tongue River; at the USGS Station No. 06298000; highest SCCD site on the Tongue River

APPENDIX TABLE B-2. CODES USED FOR THE SCCD 2016 TONGUE RIVER WATERSHED INTERIM MONITORING

CODE	PARAMETER	UNITS
SCCD	Sheridan County Conservation District	
CollectionDate	Collection Date	Month/Day/Year
CollectionTime	Collection Time	Military Time
Temp_Hanna	Water Temperature - Hanna Instrument	Degrees Centigrade (°C)
Temp_YSI	Water Temperature - YSI Instrument	Degrees Centigrade (°C)
pH	pH	Standard Units (SU)
Conductivity	Electrical Conductivity - Specific Conductance	µS/cm
DO_mg/L	Dissolved Oxygen	mg/L
DO_%	Dissolved Oxygen	Percent Saturation (%)
Staff	Staff gauge water level	feet
Discharge	Calculated Discharge	cfs
Turbidity	Turbidity	NTU
Ecoli	*Escherichia Coli*	cfu/100mL

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Appendix Table B-3. Summary of Results for Pre and Post Season Ice Tests

SN: 10612497 TR01				SN: 9927127 TR03				SN: 9775391 TR05				SN: 10484455 TR07				SN: 9927129 TR09			
Pre 4/5/16		Post 12/15/16		Pre 4/5/16		Post 12/15/16		Pre 4/5/16		Post 12/15/16		Pre 4/5/16		Post 12/15/16		Pre 4/5/16		Post 12/15/16	
Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C
11:08	23.196	9:30	14.996	11:07	23.581	9:17	14.613	11:10	23.484	9:15	14.709	11:06	23.484	9:33	13.654	11:09	23.1	9:29	14.134
11:09	23.196	9:31	9.176	11:08	23.484	9:18	8.68	11:11	22.238	9:16	8.978	11:07	23.388	9:34	8.581	11:10	23.581	9:30	8.481
11:10	23.196	9:32	5.655	11:09	23.388	9:19	5.552	11:12	12.013	9:17	5.757	11:08	23.196	9:35	5.347	11:11	21.282	9:31	5.244
11:11	23.1	9:33	3.578	11:10	23.388	9:20	3.683	11:13	7.582	9:18	3.788	11:09	23.004	9:36	3.472	11:12	11.625	9:32	3.472
11:12	13.173	9:34	2.303	11:11	23.388	9:21	2.41	11:14	4.934	9:19	2.517	11:10	22.812	9:37	2.303	11:13	7.582	9:33	2.195
11:13	8.082	9:35	1.439	11:12	13.269	9:22	1.656	11:15	3.155	9:20	1.764	11:11	22.812	9:38	1.439	11:14	5.141	9:34	1.439
11:14	5.141	9:36	0.893	11:13	8.182	9:23	1.112	11:16	2.088	9:21	1.221	11:12	15.569	9:39	0.893	11:15	3.472	9:35	1.003
11:15	3.367	9:37	0.674	11:14	5.347	9:24	0.784	11:17	1.439	9:22	0.893	11:13	9.176	9:40	0.563	11:16	2.41	9:36	0.674
11:16	2.195	9:38	0.453	11:15	3.578	9:25	0.563	11:18	0.893	9:23	0.674	11:14	5.757	9:41	0.343	11:17	1.656	9:37	0.563
11:17	1.439	9:39	0.343	11:16	2.41	9:26	0.453	11:19	0.674	9:24	0.563	11:15	3.683	9:42	0.232	11:18	1.112	9:38	0.343
11:18	1.003	9:40	0.232	11:17	1.656	9:27	0.343	11:20	0.453	9:25	0.453	11:16	2.303	9:43	0.232	11:19	0.784	9:39	0.343
11:19	0.674	9:41	0.121	11:18	1.221	9:28	0.343	11:21	0.343	9:26	0.343	11:17	1.439	9:44	0.121	11:20	0.563	9:40	0.232
11:20	0.453	9:42	0.121	11:19	0.893	9:29	0.343	11:22	0.232	9:27	0.343	11:18	1.003	9:45	0.121	11:21	0.453	9:41	0.232
11:21	0.343	9:43	0.121	11:20	0.674	9:30	0.232	11:23	0.232	9:28	0.232	11:19	0.674	9:46	0.121	11:22	0.343	9:42	0.232
11:22	0.232	9:44	0.121	11:21	0.563	9:31	0.232	11:24	0.121	9:29	0.232	11:20	0.453	9:47	0.01	11:23	0.232	9:43	0.121
11:23	0.232	9:45	0.121	11:22	0.453	9:32	0.232	11:25	0.121	9:30	0.232	11:21	0.232	9:48	0.01	11:24	0.232	9:44	0.121
11:24	0.232	9:46	0.121	11:23	0.343	9:33	0.343	11:26	0.121	9:31	0.232	11:22	0.232	9:49	0.01	11:25	0.232	9:45	0.121
11:25	0.121	9:47	0.121	11:24	0.343	9:34	0.453	11:27	0.121	9:32	0.232	11:23	0.121	9:50	0.01	11:26	0.232	9:46	0.121
11:26	0.121	9:48	0.121	11:25	0.232	9:35	0.453	11:28	0.121	9:33	0.232	11:24	0.121	9:51	0.01	11:27	0.121	9:47	0.121
11:27	0.121	9:49	0.01	11:26	0.232	9:36	0.453	11:29	0.121	9:34	0.121	11:25	0.121	9:52	0.01	11:28	0.121	9:48	0.121
11:28	0.121	9:50	0.121	11:27	0.232	9:37	0.343	11:30	0.121	9:35	0.121	11:26	0.01	9:53	0.01	11:29	0.121	9:49	0.121
11:29	0.121	9:51	0.121	11:28	0.232	9:38	0.343	11:31	0.121	9:36	0.121	11:27	0.01	9:54	0.01	11:30	0.121	9:50	0.121
11:30	0.121	9:52	0.01	11:29	0.232	9:39	0.232	11:32	0.121	9:37	0.121	11:28	0.01	9:55	0.01	11:31	0.121	9:51	0.121
11:31	0.121	9:53	0.121	11:30	0.232	9:40	0.232	11:33	0.121	9:38	0.121	11:29	0.01	9:56	0.01	11:32	0.121	9:52	0.121
11:32	0.121	9:54	0.01	11:31	0.232	9:41	0.232	11:34	0.121	9:39	0.121	11:30	0.01	9:57	0.01	11:33	0.121	9:53	0.121
11:33	0.121	9:55	0.01	11:32	0.232	9:42	0.232	11:35	0.121	9:40	0.121	11:31	0.01	9:58	0.01	11:34	0.121	9:54	0.121
11:34	0.121	9:56	0.01	11:33	0.232	9:43	0.232	11:36	0.121	9:41	0.121	11:32	0.01	9:59	0.01	11:35	0.121	9:55	0.121
11:35	0.121	9:57	0.121	11:34	0.232	9:44	0.232	11:37	0.121	9:42	0.121	11:33	0.01	10:00	0.01	11:36	0.121	9:56	0.121
11:36	0.121	9:58	0.121	11:35	0.232	9:45	0.232	11:38	0.121	9:43	0.121	11:34	0.01	10:01	0.01	11:37	0.121	9:57	0.121
11:37	0.121	9:59	0.01	11:36	0.232	9:46	0.232	11:39	0.121	9:44	0.121	11:35	0.01	10:02	0.01	11:38	0.121	9:58	0.121
11:38	0.121	10:00	0.121	11:37	0.232	9:47	0.232	11:40	0.121	9:45	0.121	11:36	0.01	10:03	0.01	11:39	0.121	9:59	0.121
11:39	0.121	10:01	0.01	11:38	0.232	9:48	0.121	11:41	0.121	9:46	0.121	11:37	0.01	10:04	0.01	11:40	0.121	10:00	0.121
11:40	0.121	10:02	0.01	11:39	0.232	9:49	0.232	11:42	0.121	9:47	0.121	11:38	0.01	10:05	0.01	11:41	0.121	10:01	0.121
11:41	0.121	10:03	0.01	11:40	0.232	9:50	0.232	11:43	0.121	9:48	0.121	11:39	0.01	10:06	0.01	11:42	0.121	10:02	0.121
11:42	0.121	10:04	0.121	11:41	0.232	9:51	0.232	11:44	0.121	9:49	0.121	11:40	0.01	10:07	0.01	11:43	0.121	10:03	0.121
11:43	0.121	10:05	0.121	11:42	0.232	9:52	0.232	11:45	0.121	9:50	0.121	11:41	0.01	10:08	0.01	11:44	0.121	10:04	0.121
11:44	0.121	10:06	0.01	11:43	0.232	9:53	0.232	11:46	0.121	9:51	0.121	11:42	0.01	10:09	0.01	11:45	0.121	10:05	0.121
11:45	0.121	10:07	0.121	11:44	0.232	9:54	0.232	11:47	0.121	9:52	0.121	11:43	0.01	10:10	0.01	11:46	0.121	10:06	0.121
11:46	0.121	10:08	0.01	11:45	0.232	9:55	0.232	11:48	0.121	9:53	0.121	11:44	0.01	10:11	0.01	11:47	0.121	10:07	0.121
11:47	0.121	10:09	0.01	11:46	0.232	9:56	0.121	11:49	0.121	9:54	0.121	11:45	0.01	10:12	0.01	11:48	0.121	10:08	0.121
11:48	0.121	10:10	0.01	11:47	0.232	9:57	0.232	11:50	0.121	9:55	0.121	11:46	0.01	10:13	0.01	11:49	0.121	10:09	0.121
11:49	0.121	10:11	0.01	11:48	0.232	9:58	0.232	11:51	0.121	9:56	0.121	11:47	0.01	10:14	0.01	11:50	0.121	10:10	0.121
11:50	0.121	10:12	0.01	11:49	0.232	9:59	0.121	11:52	0.121	9:57	0.121	11:48	0.01	10:15	0.01	11:51	0.121	10:11	0.121
11:51	0.121	10:13	0.01	11:50	0.232	10:00	0.232	11:53	0.121	9:58	0.121	11:49	0.01	10:16	0.01	11:52	0.121	10:12	0.121
11:52	0.121	10:14	0.01	11:51	0.232	10:01	0.232	11:54	0.121	9:59	0.121	11:50	0.01	10:17	0.01	11:53	0.121	10:13	0.121
11:53	0.121	10:15	0.121	11:52	0.232	10:02	0.232	11:55	0.121	10:00	0.121	11:51	0.01	10:18	0.01	11:54	0.121	10:14	0.121
11:54	0.121	10:16	0.01	11:53	0.232	10:03	0.121	11:56	0.121	10:01	0.121	11:52	0.01	10:19	0.01	11:55	0.121	10:15	0.121
11:55	0.121	10:17	0.01	11:54	0.232	10:04	0.232	11:57	0.121	10:02	0.121	11:53	0.01	10:20	0.01	11:56	0.121	10:16	0.121
11:56	0.121	10:18	0.01	11:55	0.232	10:05	0.232	11:58	0.121	10:03	0.121	11:54	0.01	10:21	0.01	11:57	0.121	10:17	0.121
11:57	0.121	10:19	0.01	11:56	0.232	10:06	0.121	11:59	0.121	10:04	0.121	11:55	0.01	10:22	0.01	11:58	0.121	10:18	0.121
11:58	0.121	10:20	0.121	11:57	0.232	10:07	0.121	12:00	0.121	10:05	0.121	11:56	0.01	10:23	0.01	11:59	0.121	10:19	0.121
11:59	0.121	10:22	0.01	11:58	0.232	10:09	0.121	12:01	0.121	10:07	0.121	11:57	0.01	10:25	0.01	12:00	0.121	10:21	0.121
12:00	0.121	10:23	0.01	11:59	0.232	10:10	0.121	12:02	0.121	10:08	0.121	11:58	0.01	10:26	0.01	12:01	0.121	10:22	0.121

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Appendix Table B-3 (continued). Summary of Results for Pre and Post Season Ice Tests

SN: 10612497 TR01				SN: 9927127 TR03				SN: 9775391 TR05				SN: 10484455 TR07				SN: 9927129 TR09			
Pre 4/5/16		Post 12/15/16		Pre 4/5/16		Post 12/15/16		Pre 4/5/16		Post 12/15/16		Pre 4/5/16		Post 12/15/16		Pre 4/5/16		Post 12/15/16	
Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C	Time	Temp, °C
12:01	0.121	10:24	0.121	12:00	0.232	10:11	0.232	12:03	0.121	10:09	0.121	11:59	0.01	10:27	0.01	12:02	0.121	10:23	0.121
12:02	0.121	10:25	0.01	12:01	0.232	10:12	0.232	12:04	0.121	10:10	0.121	12:00	0.01	10:28	0.01	12:03	0.121	10:24	0.121
12:03	0.121	10:26	0.121	12:02	0.232	10:13	0.121	12:05	0.121	10:11	0.121	12:01	0.01	10:29	0.01	12:04	0.121	10:25	0.121
12:04	0.121	10:27	0.121	12:03	0.232	10:14	0.232	12:06	0.121	10:12	0.121	12:02	0.01	10:30	0.01	12:05	0.121	10:26	0.121
12:05	0.121	10:28	0.01	12:04	0.232	10:15	0.232	12:07	0.121	10:13	0.121	12:03	0.01	10:31	0.01	12:06	0.121	10:27	0.121
12:06	0.121	10:29	0.01	12:05	0.232	10:16	0.232	12:08	0.121	10:14	0.121	12:04	0.01	10:32	0.01	12:07	0.121	10:28	0.121
12:07	0.121	10:30	0.01	12:06	0.232	10:17	0.232	12:09	0.121	10:15	0.121	12:05	0.01	10:33	0.01	12:08	0.121	10:29	0.121
12:08	0.121	10:31	0.121	12:07	0.232	10:18	0.121	12:10	0.121	10:16	0.121	12:06	0.01	10:34	0.01	12:09	0.121	10:30	0.121
12:09	0.121	10:32	0.121	12:08	0.232	10:19	0.232	12:11	0.121	10:17	0.121	12:07	0.01	10:35	0.01	12:10	0.121	10:31	0.121
12:10	0.121	10:33	0.01	12:09	0.232	10:20	0.121	12:12	0.121	10:18	0.121	12:08	0.01	10:36	0.01	12:11	0.121	10:32	0.121
12:11	0.121	10:34	0.01	12:10	0.232	10:21	0.232	12:13	0.121	10:19	0.121	12:09	0.01	10:37	0.01	12:12	0.121	10:33	0.121
12:12	0.121	10:35	0.01	12:11	0.232	10:22	0.232	12:14	0.121	10:20	0.121	12:10	0.01	10:38	0.01	12:13	0.121	10:34	0.121
12:13	0.121	10:36	0.121	12:12	0.232	10:23	0.232	12:15	0.121	10:21	0.121	12:11	0.01	10:39	0.01	12:14	0.121	10:35	0.121
12:14	0.121	10:37	0.01	12:13	0.232	10:24	0.232	12:16	0.121	10:22	0.121	12:12	0.01	10:40	0.01	12:15	0.121	10:36	0.121
12:15	0.121	10:38	0.01	12:14	0.232	10:25	0.232	12:17	0.121	10:23	0.121	12:13	0.01	10:41	0.01	12:16	0.121	10:37	0.121
12:16	0.121	10:39	0.01	12:15	0.232	10:26	0.232	12:18	0.121	10:24	0.121	12:14	0.01	10:42	0.01	12:17	0.121	10:38	0.121
12:17	0.121	10:40	0.01	12:16	0.232	10:27	0.232	12:19	0.121	10:25	0.121	12:15	0.01	10:43	0.01	12:18	0.121	10:39	0.121
12:18	0.121	10:41	0.121	12:17	0.232	10:28	0.232	12:20	0.121	10:26	0.121	12:16	0.01	10:44	0.01	12:19	0.121	10:40	0.121
12:19	0.121	10:42	0.01	12:18	0.232	10:29	0.232	12:21	0.121	10:27	0.121	12:17	0.01	10:45	0.01	12:20	0.121	10:41	0.121
12:20	0.121	10:43	0.01	12:19	0.232	10:30	0.121	12:22	0.121	10:28	0.121	12:18	0.01	10:46	0.01	12:21	0.121	10:42	0.121
12:21	0.121	10:44	0.121	12:20	0.232	10:31	0.232	12:23	0.121	10:29	0.121	12:19	0.01	10:47	0.01	12:22	0.121	10:43	0.121
12:22	0.121	10:45	0.01	12:21	0.232	10:32	0.232	12:24	0.121	10:30	0.121	12:20	0.01	10:48	0.01	12:23	0.121	10:44	0.121
12:23	0.121	10:46	0.121	12:22	0.232	10:33	0.232	12:25	0.121	10:31	0.121	12:21	0.01	10:49	0.01	12:24	0.121	10:45	0.121
12:24	0.121	10:47	0.01	12:23	0.232	10:34	0.121	12:26	0.121	10:32	0.121	12:22	0.01	10:50	0.01	12:25	0.121	10:46	0.121
12:25	0.121	10:48	0.121	12:24	0.232	10:35	0.121	12:27	0.121	10:33	0.121	12:23	0.01	10:51	0.01	12:26	0.121	10:47	0.121
12:26	0.121	10:49	0.01	12:25	0.232	10:36	0.121	12:28	0.121	10:34	0.121	12:24	0.01	10:52	0.01	12:27	0.121	10:48	0.121
12:27	0.121	10:50	0.01	12:26	0.232	10:37	0.232	12:29	0.121	10:35	0.121	12:25	0.01	10:53	0.01	12:28	0.121	10:49	0.121
12:28	0.121	10:51	0.121	12:27	0.232	10:38	0.232	12:30	0.121	10:36	0.121	12:26	0.01	10:54	0.01	12:29	0.121	10:50	0.121
12:29	0.121	10:52	0.121	12:28	0.232	10:39	0.232	12:31	0.121	10:37	0.121	12:27	0.01	10:55	0.01	12:30	0.121	10:51	0.121
12:30	0.121	10:53	0.01	12:29	0.232	10:40	0.232	12:32	0.121	10:38	0.121	12:28	0.01	10:56	0.01	12:31	0.121	10:52	0.121
12:31	0.121	10:54	0.01	12:30	0.232	10:41	0.232	12:33	0.121	10:39	0.121	12:29	0.01	10:57	0.01	12:32	0.121	10:53	0.121
12:32	0.121	10:55	0.01	12:31	0.232	10:42	0.121	12:34	0.121	10:40	0.121	12:30	0.01	10:58	0.01	12:33	0.121	10:54	0.121
12:33	0.121	10:56	0.01	12:32	0.232	10:43	0.232	12:35	0.121	10:41	0.121	12:31	0.01	10:59	0.01	12:34	0.121	10:55	0.121
12:34	0.121	10:57	0.01	12:33	0.232	10:44	0.121	12:36	0.121	10:42	0.121	12:32	0.01	11:00	0.01	12:35	0.121	10:56	0.121
12:35	0.121	10:58	0.01	12:34	0.232	10:45	0.232	12:37	0.121	10:43	0.121	12:33	0.01	11:01	0.01	12:36	0.121	10:57	0.121
12:36	0.121	10:59	0.01	12:35	0.232	10:46	0.121	12:38	0.121	10:44	0.121	12:34	0.01	11:02	0.01	12:37	0.121	10:58	0.121
12:37	0.121	11:00	0.121	12:36	0.232	10:47	0.232	12:39	0.121	10:45	0.121	12:35	0.01	11:03	0.01	12:38	0.121	10:59	0.121
12:38	0.121	11:01	0.01	12:37	0.232	10:48	0.121	12:40	0.121	10:46	0.121	12:36	0.01	11:04	0.01	12:39	0.121	11:00	0.121
12:39	0.121	11:02	0.01	12:38	0.232	10:49	0.232	12:41	0.121	10:47	0.121	12:37	0.01	11:05	0.01	12:40	0.121	11:01	0.121
12:40	0.121	11:03	0.01	12:39	0.232	10:50	0.232	12:42	0.121	10:48	0.121	12:38	0.01	11:06	0.01	12:41	0.121	11:02	0.121
12:41	0.121	11:04	0.01	12:40	0.232	10:51	0.232	12:43	0.121	10:49	0.121	12:39	0.01	11:07	0.01	12:42	0.121	11:03	0.121
12:42	0.121	11:05	0.01	12:41	0.232	10:52	0.232	12:44	0.121	10:50	0.121	12:40	0.01	11:08	0.01	12:43	0.121	11:04	0.121
12:43	0.121	11:06	0.01	12:42	0.232	10:53	0.232	12:45	0.121	10:51	0.121	12:41	0.01	11:09	0.01	12:44	0.121	11:05	0.121
12:44	0.121	11:07	0.01	12:43	0.232	10:54	0.232	12:46	0.121	10:52	0.121	12:42	0.01	11:10	0.01	12:45	0.121	11:06	0.121
12:45	0.121	11:08	0.121	12:44	0.232	10:55	0.232	12:47	0.121	10:53	0.121	12:43	0.01	11:11	0.01	12:46	0.121	11:07	0.121
12:46	0.121	11:09	0.121	12:45	0.232	10:56	0.121	12:48	0.121	10:54	0.121	12:44	0.01	11:12	0.01	12:47	0.121	11:08	0.121
12:47	0.121	11:10	0.121	12:46	0.232	10:57	0.232	12:49	0.121	10:55	0.121	12:45	0.01	11:13	0.121	12:48	0.121	11:09	0.121
12:48	0.121	11:11	0.121	12:47	0.232	10:58	0.121	12:50	0.121	10:56	0.121	12:46	0.01	11:14	0.121	12:49	0.121	11:10	0.121
12:49	0.121	11:12	0.121	12:48	0.232	10:59	0.121	12:51	0.121	10:57	0.121	12:47	0.01	11:15	0.121	12:50	0.121	11:11	0.121
12:50	0.121	11:13	0.121	12:49	0.232	11:00	0.121	12:52	0.121	10:58	0.121	12:48	0.01	11:16	0.121	12:51	0.121	11:12	0.121
12:51	0.121	11:14	0.121	12:50	0.232	11:01	0.232	12:53	0.121	10:59	0.121	12:49	0.01	11:17	0.121	12:52	0.121	11:13	0.121
12:52	0.121	11:15	0.121	12:51	0.232	11:02	0.121	12:54	0.121	11:00	0.121	12:50	0.01	11:18	0.121	12:53	0.121	11:14	0.121
12:53	0.121	11:16	0.121	12:52	0.232	11:03	0.121	12:55	0.121	11:01	0.121	12:51	0.01	11:19	0.01	12:54	0.121	11:15	0.121
12:54	0.121	11:17	0.121	12:53	0.232	11:04	0.121	12:56	0.121	11:02	0.121	12:52	0.01	11:20	0.01	12:55	0.121	11:16	0.121

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Appendix Table B-4. Summary of 2016 Water Quality Sample Blank Data for the Tongue River Watershed

Sample Date	Sample ID	Trip Blank Data		Field Blank Data			
		TURB	E. coli	Location of Field Blank	Collection Time	TURB	E. coli
		(NTU)	(cfu/100mL)			(NTU)	(cfu/100mL)
5/18/2016	~01	<0.1	<1	PD01	9:30	<0.1	<1
5/18/2016	~02	<0.1	<1	SC01	12:10	<0.1	<1
5/31/2016	~01	<0.1	<1	TR03	9:55	<0.1	<1
5/31/2016	~02	<0.1	<1	LTR01	11:20	<0.1	<1
6/13/2016	~01	<0.1	<1	GC01	10:05	<0.1	<1
6/13/2016	~02	<0.1	<1	CC01	11:20	<0.1	<1
6/27/2016	~01	<0.1	<1	TR05	11:00	<0.1	<1
6/27/2016	~02	<0.1	<1	TR08	12:45	0.6	<1
7/13/2016	~01	<0.1	<1	TR07	11:45	<0.1	<1
7/13/2016	~02	<0.1	<1	FMC01	12:55	<0.1	<1
7/28/2016	~01	<0.1	<1	WC01	13:00	<0.1	<1
7/28/2016	~02	<0.1	<1	TR09	14:15	<0.1	<1
8/10/2016	~01	<0.1	<1	TR01	9:00	<0.1	<1
8/10/2016	~02	<0.1	<1	SC01	13:05	<0.1	<1
8/22/2016	~01	<0.1	<1	PD01	9:20	<0.1	<1
8/22/2016	~02	<0.1	<1	LTR01	11:35	<0.1	<1
9/7/2016	~01	<0.1	<1	TR03	10:20	<0.1	<1
9/7/2016	~02	<0.1	<1	CC01	11:55	<0.1	<1
9/20/2016	~01	<0.1	<1	GC01	10:30	<0.1	<1
9/20/2016	~02	<0.1	<1	TR08	12:35	<0.1	<1

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Appendix Table B-5. Summary of 2016 Duplicate Samples for the Tongue River Watershed

Sample Descriptors				Field Data						Laboratory Data	
Date mmddyy	Time (military)	StationID	Duplicate of Site	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	TURB (NTU)	E_COLI (cfu/100mL)
5/18/2016	9:05	TRD01	TR01	13.1	12.7	8.51	469	ND[1]	ND[1]	23.3	52
5/18/2016	9:05	TR01		12.9	12.4	8.38	480	ND[1]	ND[1]	10.1	75
Relative Percent Difference				***1.5***	***2.4***	***1.5***	***2.3***	***ND[1]***	***ND[1]***	***79.0***	***36.2***
5/31/2016	9:30	TRD01	PD01	12.2	11.7	8.36	1466	9.63	88.6	9.5	249
5/31/2016	9:30	PD01		12.3	11.7	8.35	1493	9.65	88.8	8.8	291
Relative Percent Difference				***0.8***	***0.0***	***0.1***	***1.8***	***0.2***	***0.2***	***7.7***	***15.6***
6/13/2016	9:45	TRD01	TR03	17.5	17.0	8.16	172	8.43	87.2	16.0	160
6/13/2016	9:45	TR03		17.4	17.0	8.15	188	8.45	87.1	14.5	261
Relative Percent Difference				***0.6***	***0.0***	***0.1***	***8.9***	***0.2***	***0.1***	***9.8***	***48.0***
6/27/2016	10:40	TRD01	GC01	21.7	21.2	8.49	598	10.63	119.9	2.3	169
6/27/2016	10:40	GC01		21.6	21.1	8.47	597	10.74	120.7	2.0	259
Relative Percent Difference				***0.5***	***0.5***	***0.2***	***0.2***	***1.0***	***0.7***	***14.0***	***42.1***
7/13/2016	11:05	TRD01	TR05	19.9	19.3	8.49	378	9.35	101.7	2.5	162
7/13/2016	11:05	TR05		19.8	19.3	8.48	381	9.45	102.8	2.7	162
Relative Percent Difference				***0.5***	***0.0***	***0.1***	***0.8***	***1.1***	***1.1***	***7.7***	***0.0***
7/28/2016	12:25	TRD01	TR07	22.5	22.0	8.24	389	6.92	77.7	3.7	76
7/28/2016	12:25	TR07		22.5	22.0	8.26	391	7.10	79.2	3.6	140
Relative Percent Difference				***0.0***	***0.0***	***0.2***	***0.5***	***2.6***	***1.9***	***2.7***	***59.3***
8/10/2016	11:05	TRD01	WC01	19.6	19.1	8.15	575	8.33	89.7	2.2	119
8/10/2016	11:05	WC01		19.7	19.1	8.13	574	8.30	89.8	2.2	99
Relative Percent Difference				***0.5***	***0.0***	***0.2***	***0.2***	***0.4***	***0.1***	***0.0***	***18.3***
8/22/2016	8:55	TRD01	TR01	18.9	18.3	8.38	743	7.56	80.8	13.1	228
8/22/2016	8:55	TR01		18.8	18.3	8.38	744	7.61	80.5	13.0	276
Relative Percent Difference				***0.5***	***0.0***	***0.0***	***0.1***	***0.7***	***0.4***	***0.8***	***19.0***
9/7/2016	9:55	TRD01	PD01	16.2	15.6	8.36	1446	9.66	97.1	2.4	579
9/7/2016	9:55	PD01		16.1	15.5	8.37	1442	9.69	97.3	2.3	488
Relative Percent Difference				***0.6***	***0.6***	***0.1***	***0.3***	***0.3***	***0.2***	***4.3***	***17.1***
9/20/2016	10:10	TRD01	TR03	17.1	16.5	8.57	489	9.17	93.8	2.4	3
9/20/2016	10:10	TR03		17.0	16.4	8.61	493	9.26	94.7	2.6	6.0
Relative Percent Difference				***0.6***	***0.6***	***0.5***	***0.8***	***1.0***	***1.0***	***8.0***	***66.7***
				0.61	***0.41***	***0.32***	***1.59***	***0.82***	***0.63***	***13.39***	***32.22***

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Appendix Table B-5 (continued). Summary of 2016 Duplicate Samples for the Tongue River Watershed

Sample Descriptors				Field Data						Laboratory Data	
Date mmddyy	Time (military)	StationID	Duplicate of Site	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	TURB (NTU)	E_COLI (cfu/100mL)
5/18/2016	12:25	TRD02	TR09	9.1	8.6	8.43	151	ND[1]	ND[1]	3.2	20
5/18/2016	12:25	TR09		9.0	8.5	8.43	166	ND[1]	ND[1]	2.6	10
Relative Percent Difference				***1.1***	***1.2***	***0.0***	***9.5***	***ND[1]***	***ND[1]***	***20.7***	***66.7***
5/31/2016	11:30	TRD02	SC01	9.8	9.2	8.39	352	10.39	90.4	28.0	2420
5/31/2016	11:30	SC01		9.8	9.2	8.37	352	10.42	90.6	29.2	5480
Relative Percent Difference				***0.0***	***0.0***	***0.2***	***0.0***	***0.3***	***0.2***	***4.2***	***77.5***
6/13/2016	11:30	TRD02	LTR01	15.5	15.0	8.49	236	9.56	94.7	2.7	308
6/13/2016	11:30	LTR01		15.4	14.9	8.49	239	9.64	95.4	2.6	248.0
Relative Percent Difference				***0.6***	***0.7***	***0.0***	***1.3***	***0.8***	***0.7***	***3.8***	***21.6***
6/27/2016	13:15	TRD02	CC01	21.0	20.4	8.15	285	8.58	95.2	38.10	816
6/27/2016	13:15	CC01		20.9	20.4	8.13	286	8.62	95.5	52.6	727
Relative Percent Difference				***0.5***	***0.0***	***0.2***	***0.4***	***0.5***	***0.3***	***32.0***	***11.5***
7/13/2016	13:05	TRD02	TR08	17.8	17.3	8.52	289	9.79	102.0	1.2	32
7/13/2016	13:05	TR08		17.8	17.3	8.51	293	9.85	102.6	1.3	35
Relative Percent Difference				***0.0***	***0.0***	***0.1***	***1.4***	***0.6***	***0.6***	***8.0***	***9.0***
7/28/2016	13:15	TRD02	FMC01	21.2	20.8	7.86	518	6.60	73.9	29.5	219
7/28/2016	13:15	FMC01		21.2	20.8	7.88	527	5.70	62.1	104.0	236
Relative Percent Difference				***0.0***	***0.0***	***0.3***	***1.7***	***14.6***	***17.4***	***111.6***	***7.5***
8/10/2016	13:30	TRD02	TR09	18.4	17.9	8.65	233	8.92	94.4	0.9	16
8/10/2016	13:30	TR09		18.3	17.9	8.60	236	9.16	96.3	0.9	23
Relative Percent Difference				***0.5***	***0.0***	***0.6***	***1.3***	***2.7***	***2.0***	***0.0***	***35.9***
8/22/2016	11:45	TRD02	SC01	16.3	15.7	8.51	416	9.05	91.2	2.9	178
8/22/2016	11:45	SC01		16.0	15.5	8.50	425	9.17	92.0	3.0	160
Relative Percent Difference				***1.9***	***1.3***	***0.1***	***2.1***	***1.3***	***0.9***	***3.4***	***10.7***
9/7/2016	12:20	TRD02	LTR01	13.7	13.1	8.44	261	9.62	91.6	1.1	145
9/7/2016	12:20	LTR01		13.6	13.1	8.43	258	9.68	92.1	1.0	156
Relative Percent Difference				***0.7***	***0.0***	***0.1***	***1.2***	***0.6***	***0.5***	***9.5***	***7.3***
9/20/2016	13:00	TRD02	CC01	15.1	14.5	8.29	313	9.21	90.5	15.5	161
9/20/2016	13:00	CC01		15.0	14.5	8.30	313	9.28	91.1	16.9	144.0
Relative Percent Difference				***0.7***	***0.0***	***0.1***	***0.0***	***0.8***	***0.7***	***8.6***	***11.1***
				0.60	***0.31***	***0.18***	***1.87***	***2.46***	***2.59***	***20.18***	***25.87***
Average RPD for all samples				0.61	0.36	0.25	1.73	1.64	1.61	16.79	29.04

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APPENDIX TABLE B-6. Summary of 2016 Habitat Assessment Duplicate Samples for the the Tongue River Watershed

Stream Name	Tongue R.	Tongue R.
Location	TR09	TR09
Sampler	SCCD	SCCD
Date	10/4/2016	10/4/2016
Assessor Name	Assessor 1	Assessor 2
Habitat Parameter		
Percent Fines	15	18
Instream Cover	16	18
Embeddedness	16	16
Velocity/Depth	16	16
Channel Flow	19	18
Channel Shape	7	10
Pool/Riffle	13	13
Channel Alteration	11	13
Width/Depth	6	11
Bank Vegetation	8	8
Bank Stability	8	8
Disruptive Pressures	9	9
Riparian Width	8	4
Total Score	152	162
RPD**	6%	

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APPENDIX C

2016 Tongue River Watershed Water Quality Data

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APPENDIX TABLE C-1. SITE ABBREVIATIONS FOR THE SCCD 2016 TONGUE RIVER WATERSHED INTERIM MONITORING

Site Abbreviation	Descriptions
TR01	Tongue River; 200 meters downstream of river bend; off of well pad road that is off of Lower Prairie Dog Road; lowest site on the Tongue River
PD01	Praire Dog Creek; approximately 150 yards downstream from USGS station No. 06306250; lowest site on Prairie Dog Creek
TR03	Tongue River; approximately 20 meters downstream of bridge on Decker Road (Hwy 338)
GC01	Goose Creek; located in between USGS Station No. 06305700 and HWY 339 bridge crossing; lowest site on Goose Creek
TR05	Tongue River; Off of the Kleenburn Road; in Sheridan County's Recreational Picnic Area; downstream 0.7 miles from USGS Station 06306250
TR07	Tongue River; 10 feet downstream of the Ranchester Water Treatment Plant intake
WC01	Wolf Creek; upstream of the County Road 67 bridge crossing
FMC01	Fivemile Creek; upstream of the Hwy 14 Bridge in Ranchester
TR08	Tongue River; downstream of the Halfway Lane County Road bridge
CC01	Columbus Creek; downstream of the Hwy 14 bridge crossing
LTR01	Little Tongue River; 300-400 yards upstream from the Tongue River confluence
SC01	Smith Creek; downstream of the County Road 92 bridge crossing
TR09	Tongue River; at the USGS Station No. 06298000; highest SCCD site on the Tongue River

APPENDIX TABLE C-2. CODES USED FOR THE SCCD 2016 TONGUE RIVER WATERSHED INTERIM MONITORING

CODE	PARAMETER	UNITS
SCCD	Sheridan County Conservation District	
CollectionDate	Collection Date	Month/Day/Year
CollectionTime	Collection Time	Military Time
Hanna Temp	Water Temperature - Hanna Instrument	Degrees Centigrade (°C)
YSI Temp	Water Temperature - YSI Instrument	Degrees Centigrade (°C)
pH	pH	Standard Units (SU)
COND	Electrical Conductivity	µS/cm
DO (mg/L)	Dissolved Oxygen	mg/L
DO (%)	Dissolved Oxygen	Percent Saturation (%)
Staff	Water level/Gauge Height	feet
Discharge	Calculated Discharge or USGS Discharge	cfs
TURB	Turbidity	NTU
E_COLI	*Escherichia Coli*	cfu/100mL

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APPENDIX TABLE C-3. SCCD 2016 WATER QUALITY DATA AT SITE TR01

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Tongue River	TR01	5/18/2016	9:05	12.9	12.4	8.38	480	ND[1]	ND[1]	2.05	539.53	10.1	75
Tongue River	TR01	5/31/2016	9:25	12.7	12.2	8.14	345	8.94	83.2	2.58	917.39	25.6	261
Tongue River	TR01	6/13/2016	9:10	18.3	17.8	8.10	242	7.91	83.2	2.89	1192.10	14.1	135
Tongue River	TR01	6/27/2016	9:35	21.6	21.1	8.70	533	10.10	113.3	1.36	209.22	2.1	46
Tongue River	TR01	7/13/2016	9:55	20.4	19.9	8.31	555	8.20	89.4	0.91	82.75	1.8	58
Tongue River	TR01	7/28/2016	9:30	23.6	23.0	8.13	739	6.35	73.9	0.59	30.43	4.80	61
Tongue River	TR01	8/10/2016	9:00	22.2	21.7	8.31	769	7.21	82.2	0.90	80.67	8.80	143
Tongue River	TR01	8/22/2016	8:55	18.8	18.3	8.38	744	7.61	80.5	1.09	125.52	13.00	276
Tongue River	TR01	9/7/2016	9:40	17.7	17.2	8.48	737	8.35	86.5	1.14	139.22	12.20	132
Tongue River	TR01	9/20/2016	9:30	16.0	15.5	8.49	707	9.39	94.1	1.06	117.69	5.70	68

NOTES:
ND[1]–DO meter malfunction
ND[2]–sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	17.2	16.7	8.33	431	8.79	92.3	1.96	588.20	10.7	93
June 13-August 10	21.2	20.7	8.31	568	7.95	88.4	1.33	319.04	6.3	79
July 28-September 20	19.7	19.1	8.36	739	7.78	83.4	0.96	98.71	8.9	117
Annual	18.4	17.9	8.34	585	8.23	87.4	1.46	343.45	9.8	

APPENDIX TABLE C-4. SCCD 2016 WATER QUALITY DATA AT SITE PD01

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Prairie Dog Creek	PD01	5/18/2016	9:30	13.0	12.5	8.49	1046	ND[1]	ND[1]	1.34	48.83	16.7	189
Prairie Dog Creek	PD01	5/31/2016	9:30	12.3	11.7	8.35	1493	9.65	88.8	0.98	23.61	8.8	291
Prairie Dog Creek	PD01	6/13/2016	9:25	19.9	19.4	8.35	1317	8.55	92.8	0.88	18.39	5.2	579
Prairie Dog Creek	PD01	6/27/2016	9:45	18.7	18.1	8.32	1600	9.66	102.4	0.62	8.15	1.9	260
Prairie Dog Creek	PD01	7/13/2016	10:00	18.3	17.6	8.21	2.8mS	9.75	103.3	0.29	1.40	1.5	488
Prairie Dog Creek	PD01	7/28/2016	9:50	21.1	20.6	8.11	2.7mS	7.94	88.3	0.35	2.16	2.30	866
Prairie Dog Creek	PD01	8/10/2016	9:15	20.0	19.5	8.23	1357	6.83	73.3	0.73	11.91	3.70	214
Prairie Dog Creek	PD01	8/22/2016	9:20	17.0	16.4	8.38	1306	8.63	88.3	0.85	16.97	6.60	146
Prairie Dog Creek	PD01	9/7/2016	9:55	16.1	15.5	8.37	1442	9.69	97.3	0.79	14.31	2.30	488
Prairie Dog Creek	PD01	9/20/2016	9:50	14.6	14.1	8.49	1068	9.80	95.2	0.99	24.18	5.20	186

NOTES:
ND[1]–DO meter malfunction
ND[2]–sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	16.4	15.9	8.34	1651	9.40	96.8	0.82	20.08	6.8	332
June 13-August 10	19.6	19.0	8.24	1955	8.55	92.0	0.57	8.40	2.9	423
July 28-September 20	17.8	17.2	8.32	1575	8.58	88.5	0.74	13.91	4.0	301
Annual	17.1	16.5	8.33	1613	8.94	92.2	0.78	16.99	5.4	

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APPENDIX TABLE C-5. SCCD 2016 WATER QUALITY DATA AT SITE TR03

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Tongue River	TR03	5/18/2016	10:00	12.6	12.2	8.60	308	ND[1]	ND[1]	1.89	366.78	7.8	41
Tongue River	TR03	5/31/2016	9:55	11.8	11.3	8.18	248	9.30	84.9	2.56	508.88	16.2	214
Tongue River	TR03	6/13/2016	9:45	17.4	17.0	8.15	188	8.45	87.1	2.75	549.76	14.5	261
Tongue River	TR03	6/27/2016	10:10	21.3	20.8	8.45	378	9.31	104.1	0.94	172.60	2.3	272
Tongue River	TR03	7/13/2016	10:25	21.0	20.4	8.51	441	9.07	100.6	0.44	76.08	2.2	79
Tongue River	TR03	7/28/2016	10:15	24.1	23.6	8.37	503	7.32	86.4	0.22	36.01	4.50	11
Tongue River	TR03	8/10/2016	10:00	23.9	23.3	8.41	607	8.13	95.3	0.35	59.43	4.00	15
Tongue River	TR03	8/22/2016	9:50	20.3	19.7	8.55	538	8.51	93.2	0.60	106.32	7.10	24
Tongue River	TR03	9/7/2016	10:20	18.2	17.6	8.50	519	9.25	96.9	0.64	113.99	3.80	32
Tongue River	TR03	9/20/2016	10:10	17.0	16.4	8.61	493	9.26	94.7	0.56	98.69	2.60	6

NOTES:
ND[1]--DO meter malfunction
ND[2]--sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	16.8	16.3	8.38	313	9.03	94.2	1.72	334.82	8.6	138
June 13-August 10	21.5	21.0	8.38	423	8.46	94.7	0.94	178.77	5.5	62
July 28-September 20	20.7	20.1	8.49	532	8.49	93.3	0.47	82.89	4.4	15
Annual	18.8	18.2	8.43	422	8.73	93.7	1.10	208.85	6.5	

APPENDIX TABLE C-6. SCCD 2016 WATER QUALITY DATA AT SITE GC01

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (*C)	YSI Temp (*C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Goose Creek	GC01	5/18/2016	10:20	12.0	11.8	8.39	334	ND[1]	ND[1]	1.59	214.00	9.1	253
Goose Creek	GC01	5/31/2016	10:10	11.3	10.6	8.11	265	9.41	84.4	1.88	343.83	24.0	563
Goose Creek	GC01	6/13/2016	10:05	15.3	14.7	7.98	146	8.86	87.0	2.41	694.43	16.0	288
Goose Creek	GC01	6/27/2016	10:40	21.6	21.1	8.47	597	10.74	120.7	0.83	33.99	2.0	259
Goose Creek	GC01	7/13/2016	10:50	21.1	20.6	8.32	819	9.57	106.2	0.74	24.56	5.0	26
Goose Creek	GC01	7/28/2016	10:50	23.3	22.8	8.29	942	6.10	69.5	0.65	17.02	9.90	866
Goose Creek	GC01	8/10/2016	10:15	22.1	21.6	8.49	692	10.83	122.7	0.71	21.85	3.90	46
Goose Creek	GC01	8/22/2016	10:05	19.2	18.7	8.43	647	8.97	95.8	0.80	30.62	6.30	166
Goose Creek	GC01	9/7/2016	10:40	17.9	17.3	8.52	688	9.66	100.6	0.81	31.72	6.30	291
Goose Creek	GC01	9/20/2016	10:30	16.8	16.2	8.63	678	12.10	123.0	0.83	33.99	4.40	106

NOTES:
ND[1]--DO meter malfunction
ND[2]--sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	16.3	15.8	8.25	432	9.65	99.6	1.49	262.16	11.2	194
June 13-August 10	20.7	20.2	8.31	639	9.22	101.2	1.07	158.37	7.4	151
July 28-September 20	19.9	19.3	8.47	729	9.53	102.3	0.76	27.04	6.2	183
Annual	18.1	17.5	8.36	581	9.58	101.1	1.13	144.60	8.7	

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APPENDIX TABLE C-7. SCCD 2016 WATER QUALITY DATA AT SITE TR05

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Tongue River	TR05	5/18/2016	10:35	11.8	11.5	8.36	271	ND[1]	ND[1]	2.15	292.30	5.5	122
Tongue River	TR05	5/31/2016	10:20	10.4	9.8	8.21	206	10.19	89.8	2.78	423.61	10.6	225
Tongue River	TR05	6/13/2016	10:15	15.6	15.1	8.28	204	9.50	94.3	2.35	332.35	6.5	166
Tongue River	TR05	6/27/2016	11:00	19.8	19.4	8.41	304	9.81	106.6	1.31	142.95	3.8	68
Tongue River	TR05	7/13/2016	11:05	19.8	19.3	8.48	381	9.45	102.8	0.85	76.55	2.7	162
Tongue River	TR05	7/28/2016	11:20	24.6	24.4	8.57	438	7.03	82.4	0.58	44.08	4.80	83
Tongue River	TR05	8/10/2016	10:30	22.9	22.4	8.42	466	9.47	109.1	0.45	30.56	5.40	214
Tongue River	TR05	8/22/2016	10:20	20.7	19.1	8.46	413	9.32	100.3	0.78	67.62	5.90	276
Tongue River	TR05	9/7/2016	10:50	17.0	16.4	8.48	396	9.71	99.3	0.98	94.01	5.50	152
Tongue River	TR05	9/20/2016	10:55	16.9	16.4	8.59	385	10.03	102.3	0.84	75.25	3.70	186

NOTES:
ND[1]--DO meter malfunction
ND[2]--sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	15.5	15.0	8.35	273	9.74	98.4	1.89	253.55	5.8	138
June 13-August 10	20.5	20.1	8.43	359	9.05	99.0	1.11	125.30	4.6	127
July 28-September 20	20.4	19.7	8.50	420	9.11	98.7	0.73	62.31	5.1	169
Annual	18.0	17.4	8.43	346	9.39	98.5	1.31	157.93	5.4	

APPENDIX TABLE C-8. SCCD 2016 WATER QUALITY DATA AT SITE TR07

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Tongue River	TR07	5/18/2016	11:00	10.0	9.5	8.45	221	ND[1]	ND[1]	2.83	172.87	3.5	74
Tongue River	TR07	5/31/2016	10:35	8.6	8.1	8.26	190	10.91	92.2	3.14	208.66	6.0	276
Tongue River	TR07	6/13/2016	10:40	14.4	13.9	8.35	192	9.97	96.7	2.92	182.95	4.9	150
Tongue River	TR07	6/27/2016	11:35	16.8	16.3	8.37	263	10.68	108.8	2.08	98.99	3.4	81
Tongue River	TR07	7/13/2016	11:45	17.5	17.0	8.38	328	10.44	108.3	1.69	67.97	1.9	72
Tongue River	TR07	7/28/2016	12:25	22.5	22.0	8.26	391	7.10	79.2	1.29	41.68	3.60	140
Tongue River	TR07	8/10/2016	11:00	19.9	19.4	8.19	384	8.96	97.3	0.95	23.95	19.50	147
Tongue River	TR07	8/22/2016	10:45	17.3	16.7	8.31	363	9.72	99.9	1.91	84.83	4.70	178
Tongue River	TR07	9/7/2016	11:10	14.7	14.2	8.38	338	10.10	98.4	2.05	96.42	4.40	120
Tongue River	TR07	9/20/2016	11:35	14.7	14.2	8.41	344	10.51	102.4	2.09	99.85	3.10	118

NOTES:
ND[1]--DO meter malfunction
ND[2]--sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	13.5	13.0	8.36	239	10.50	101.5	2.53	146.29	3.9	112
June 13-August 10	18.2	17.7	8.31	312	9.43	98.1	1.79	83.11	6.7	112
July 28-September 20	17.8	17.3	8.31	364	9.28	95.4	1.66	69.35	7.1	139
Annual	15.6	15.1	8.34	301	9.82	98.1	2.10	107.82	5.5	

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APPENDIX TABLE C-9. SCCD 2016 WATER QUALITY DATA AT SITE WC01

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Wolf Creek	WC01	5/18/2016	11:15	13.4	13.0	8.45	305	ND[1]	ND[2]	0.84	22.72	9.3	171
Wolf Creek	WC01	5/31/2016	10:50	9.6	9.0	8.14	220	10.17	88.1	1.20	58.70	14.6	248
Wolf Creek	WC01	6/13/2016	10:50	17.2	16.6	8.39	237	9.26	95.1	0.99	35.18	8.7	249
Wolf Creek	WC01	6/27/2016	12:25	21.4	20.9	8.38	525	11.91	133.3	0.34	2.05	1.0	261
Wolf Creek	WC01	7/13/2016	12:30	19.8	19.3	8.36	505	11.28	122.4	0.24	0.81	1.3	145
Wolf Creek	WC01	7/28/2016	13:00	23.5	23.0	8.21	515	9.56	109.1	0.22	0.64	2.0	88
Wolf Creek	WC01	8/10/2016	11:05	19.7	19.1	8.13	574	8.30	89.8	0.20	0.50	2.2	99
Wolf Creek	WC01	8/22/2016	10:50	17.9	17.3	8.36	463	10.76	111.9	0.33	1.89	2.0	261
Wolf Creek	WC01	9/7/2016	11:20	15.6	15.1	8.37	419	10.73	106.6	0.33	1.89	2.5	162
Wolf Creek	WC01	9/20/2016	12:10	15.9	15.4	8.46	483	12.08	120.7	0.27	1.11	1.9	49

NOTES:
ND[1]--DO meter malfunction
ND[2]--sample discarded

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	16.3	15.8	8.34	358	10.66	109.7	0.72	23.89	7.0	209
June 13-August 10	20.3	19.8	8.29	471	10.06	109.9	0.40	7.83	3.0	152
July 28-September 20	18.5	18.0	8.31	491	10.29	107.6	0.27	1.21	2.1	113
Annual	17.4	16.9	8.33	425	10.45	108.6	0.50	12.55	4.6	

APPENDIX TABLE C-10. SCCD 2016 WATER QUALITY DATA AT SITE FMC01

Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Fivemile Creek	FMC01	5/18/2016	11:25	12.2	11.7	8.38	1221	ND[1]	ND[2]	6.74	1.02	5.7	886
Fivemile Creek	FMC01	5/31/2016	10:55	11.9	11.4	8.36	792	9.42	86.1	7.05	2.67	8.9	776
Fivemile Creek	FMC01	6/13/2016	11:00	16.9	16.3	7.94	453	7.84	80.1	7.09	3.02	6.3	1080
Fivemile Creek	FMC01	6/27/2016	12:35	18.1	17.5	8.03	00.4mS	9.04	94.6	7.21	4.32	14.5	733
Fivemile Creek	FMC01	7/13/2016	12:55	16.9	16.3	8.10	367	9.29	94.6	7.08	2.93	2.9	199
Fivemile Creek	FMC01	7/28/2016	13:15	21.2	20.8	7.88	527	5.70	62.1	7.04	2.59	104.00	236
Fivemile Creek	FMC01	8/10/2016	11:15	19.4	18.9	8.01	444	7.55	81.0	7.01	2.37	9.80	291
Fivemile Creek	FMC01	8/22/2016	11:00	16.8	17.2	8.08	427	8.25	84.5	7.04	2.59	40.60	291
Fivemile Creek	FMC01	9/7/2016	11:30	14.6	14.1	8.25	377	9.06	88.2	7.04	2.59	ND[2]	ND[2]
Fivemile Creek	FMC01	9/20/2016	12:20	14.6	14.1	8.31	368	9.52	92.5	7.01	2.37	7.60	411

NOTES:
ND[1]--DO meter malfunction
ND[2]--sample discarded

Arithmetic Averages (means)										Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	15.2	14.6	8.16	647	8.90	88.9	7.03	2.79	7.7	641
June 13-August 10	18.5	18.0	7.99	438	7.88	82.5	7.09	3.04	27.5	404
July 28-September 20	17.3	17.0	8.11	429	8.02	81.7	7.03	2.50	40.5	301

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APPENDIX TABLE C-11. SCCD 2016 WATER QUALITY DATA AT SITE TR08

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Tongue River	TR08	5/18/2016	11:40	10.2	9.7	8.51	216	ND[1]	ND[1]	1.99	215.20	3.4	63
Tongue River	TR08	5/31/2016	11:05	8.4	7.8	8.34	173	11.10	93.4	2.39	271.21	3.6	81
Tongue River	TR08	6/13/2016	11:15	14.6	14.0	8.45	172	9.96	96.6	2.19	242.87	2.6	101
Tongue River	TR08	6/27/2016	12:45	18.0	17.4	8.48	234	10.14	105.8	1.23	117.21	2.0	77
Tongue River	TR08	7/13/2016	13:05	17.8	17.3	8.51	293	9.85	102.6	0.69	56.48	1.3	35
Tongue River	TR08	7/28/2016	13:30	20.5	20.0	8.42	341	9.95	109.3	0.52	39.52	2.60	201
Tongue River	TR08	8/10/2016	11:40	18.3	17.8	8.41	343	9.46	99.8	0.41	29.27	8.50	114
Tongue River	TR08	8/22/2016	11:15	16.3	15.8	8.41	324	9.96	100.2	0.53	40.48	7.80	238
Tongue River	TR08	9/7/2016	11:45	14.2	13.5	8.44	312	10.48	100.5	0.61	48.34	2.50	154
Tongue River	TR08	9/20/2016	12:35	13.9	13.4	8.69	318	11.78	112.7	0.57	44.37	1.80	138

NOTES:
ND[1]–DO meter malfunction
ND[2]–sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	13.8	13.2	8.46	218	10.26	99.6	1.70	180.60	2.6	67
June 13-August 10	17.8	17.3	8.45	277	9.87	102.8	1.01	97.07	3.4	91
July 28-September 20	16.6	16.1	8.47	328	10.33	104.5	0.53	40.40	4.6	163
Annual	15.2	14.7	8.47	273	10.30	102.3	1.11	110.50	3.6	

APPENDIX TABLE C-12. SCCD 2016 WATER QUALITY DATA AT SITE CC01

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF NEW	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Columbus Creek	CC01	5/18/2016	11:50	14.1	13.6	8.35	416	ND[1]	ND[1]	0.59	5.50	16.3	120
Columbus Creek	CC01	5/31/2016	11:15	11.7	11.1	8.23	294	9.55	86.9	0.65	7.16	31.0	308
Columbus Creek	CC01	6/13/2016	11:20	19.1	18.6	8.09	321	7.88	84.2	0.40	1.90	48.6	435
Columbus Creek	CC01	6/27/2016	13:15	20.9	20.4	8.13	286	8.62	95.5	0.41	2.03	52.6	727
Columbus Creek	CC01	7/13/2016	13:35	20.4	19.8	8.10	374	8.01	87.8	0.23	0.42	24.1	461
Columbus Creek	CC01	7/28/2016	13:45	22.7	22.2	8.11	321	7.52	86.4	0.39	1.77	42.40	261
Columbus Creek	CC01	8/10/2016	12:15	19.3	18.8	8.24	256	8.13	87.2	0.65	7.16	51.40	488
Columbus Creek	CC01	8/22/2016	11:30	17.7	17.2	8.28	246	8.24	85.7	0.82	13.53	35.70	291
Columbus Creek	CC01	9/7/2016	11:55	15.5	15.0	8.21	269	9.03	89.5	0.49	3.31	19.80	210
Columbus Creek	CC01	9/20/2016	13:00	15.0	14.5	8.30	313	9.28	91.1	0.49	3.31	16.90	144

NOTES:
ND[1]–DO meter malfunction
ND[2]–sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	17.2	16.7	8.18	338	8.52	88.6	0.46	3.40	34.5	352
June 13-August 10	20.5	20.0	8.13	312	8.03	88.2	0.42	2.66	43.8	451
July 28-September 20	18.0	17.5	8.23	281	8.44	88.0	0.57	5.82	33.2	257
Annual	17.6	17.1	8.20	310	8.47	88.3	0.51	4.61	33.9	

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APPENDIX TABLE C-13. SCCD 2016 WATER QUALITY DATA AT SITE LTR01

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Little Tongue River	LTR01	5/18/2016	12:00	10.9	10.4	8.42	338	ND[1]	ND[1]	1.01	19.92	3.8	63
Little Tongue River	LTR01	5/31/2016	11:20	9.3	8.7	8.37	257	10.84	93.1	1.00	19.47	4.8	365
Little Tongue River	LTR01	6/13/2016	11:30	15.4	14.9	8.49	239	9.64	95.4	0.47	3.44	2.6	248
Little Tongue River	LTR01	6/27/2016	13:25	18.5	18.0	8.57	235	9.35	98.8	0.53	4.53	1.6	96
Little Tongue River	LTR01	7/13/2016	13:40	17.5	16.8	8.62	248	8.86	91.5	0.51	4.15	1.8	238
Little Tongue River	LTR01	7/28/2016	13:55	20.5	19.9	8.38	310	8.50	92.3	0.32	1.42	1.70	770
Little Tongue River	LTR01	8/10/2016	12:40	18.0	17.5	8.53	296	8.93	93.2	0.31	1.32	1.60	727
Little Tongue River	LTR01	8/22/2016	11:35	16.2	15.7	8.45	296	9.29	93.6	0.30	1.23	1.00	194
Little Tongue River	LTR01	9/7/2016	12:20	13.6	13.1	8.43	258	9.68	92.1	0.47	3.44	1.00	156
Little Tongue River	LTR01	9/20/2016	13:10	13.8	13.3	8.56	283	9.79	93.4	0.38	2.11	0.60	50

NOTES:
ND[1]–DO meter malfunction
ND[2]–sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	14.3	13.8	8.49	263	9.67	94.7	0.70	10.30	2.9	167
June 13-August 10	18.0	17.4	8.52	266	9.06	94.2	0.43	2.97	1.9	316
July 28-September 20	16.4	15.9	8.47	289	9.24	92.9	0.36	1.90	1.2	243
Annual	15.4	14.8	8.48	276	9.43	93.7	0.53	6.10	2.1	

APPENDIX TABLE C-14. SCCD 2016 WATER QUALITY DATA AT SITE SC01

Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Smith Creek	SC01	5/18/2016	12:10	14.3	13.7	8.54	716	ND[1]	ND[1]	0.61	3.37	6.0	520
Smith Creek	SC01	5/31/2016	11:30	9.8	9.2	8.37	352	10.42	90.6	1.04	10.14	29.2	5480
Smith Creek	SC01	6/13/2016	11:40	16.5	16.0	8.38	329	9.03	91.4	0.68	4.22	6.7	275
Smith Creek	SC01	6/27/2016	13:30	19.3	18.6	8.22	00.4 mS	8.45	90.4	1.10	11.38	73.1	3260
Smith Creek	SC01	7/13/2016	13:50	18.7	18.1	8.52	409	8.44	89.3	0.69	4.35	5.0	44
Smith Creek	SC01	7/28/2016	14:00	21.1	20.6	8.44	414	8.12	89.1	0.99	9.16	6.20	461
Smith Creek	SC01	8/10/2016	13:05	18.0	17.4	8.52	454	9.00	94.4	0.60	3.26	3.40	326
Smith Creek	SC01	8/22/2016	11:45	16.0	15.5	8.50	425	9.17	92.0	0.67	4.09	3.00	160
Smith Creek	SC01	9/7/2016	12:30	14.2	13.7	8.50	387	9.59	92.5	0.74	5.02	2.70	131
Smith Creek	SC01	9/20/2016	13:20	14.8	14.3	8.45	717	9.41	92.0	0.38	1.27	2.00	57

NOTES:
ND[1]–DO meter malfunction
ND[2]–sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	15.7	15.1	8.41	441	9.09	90.4	0.82	6.69	24.0	646
June 13-August 10	18.7	18.1	8.42	401	8.61	90.9	0.81	6.47	18.9	359
July 28-September 20	16.8	16.3	8.48	479	9.06	92.0	0.68	4.56	3.5	178
Annual	16.3	15.7	8.44	460	9.07	91.3	0.75	5.63	13.7	

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APPENDIX TABLE C-15. SCCD 2016 WATER QUALITY DATA AT SITE TR09

				Field Data								Laboratory Data	
Waterbody	Site	Date (mmddyy)	Time (military)	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
Tongue River	TR09	5/18/2016	12:25	9.0	8.5	8.43	166	ND[1]	ND[1]	2.64	255.00	2.6	10
Tongue River	TR09	5/31/2016	11:40	7.4	6.9	8.25	144	11.20	92.0	2.98	383.00	2.3	12
Tongue River	TR09	6/13/2016	11:50	13.3	12.6	8.39	154	9.94	93.2	2.96	373.00	2.5	35
Tongue River	TR09	6/27/2016	13:40	15.5	15.0	8.50	193	9.78	96.8	2.38	154.00	1.4	42
Tongue River	TR09	7/13/2016	14:00	15.2	14.8	8.51	213	9.20	90.9	2.06	98.00	1.4	29
Tongue River	TR09	7/28/2016	14:15	18.6	18.1	8.54	229	9.24	94.3	1.92	77.00	1.70	30
Tongue River	TR09	8/10/2016	13:30	18.3	17.9	8.60	236	9.16	96.3	1.80	57.00	0.90	23
Tongue River	TR09	8/22/2016	12:00	15.5	15.0	8.53	231	9.35	92.7	1.82	55.00	0.90	18
Tongue River	TR09	9/7/2016	13:00	12.8	12.3	8.53	223	9.93	92.7	1.88	64.00	1.00	25
Tongue River	TR09	9/20/2016	13:30	13.0	12.5	8.59	230	9.90	92.8	1.86	63.00	0.50	2

NOTES:
ND[1]--DO meter malfunction
ND[2]--sample discarded

	Arithmetic Averages (means)									Geometric Means
Period	TEMP	TEMP	PH	COND	DO (mg/L)	DO (%)	STAFF	Discharge	Turbidity	E.coli
May 18-July 13	12.1	11.6	8.42	174	10.03	93.2	2.60	252.60	2.0	22
June 13-August 10	16.2	15.7	8.51	205	9.46	94.3	2.22	151.80	1.6	31
July 28-September 20	15.6	15.2	8.56	230	9.52	93.8	1.86	63.20	1.0	14
Annual	13.9	13.4	8.49	202	9.74	93.5	2.23	157.90	1.5	

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APPENDIX TABLE C-16. SUMMARY STATISTICS FOR SCCD 2016 WATER QUALITY DATA

Site	Statistic	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
TR01	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	23.6	23.0	8.70	769	10.10	113.3	2.89	1192.10	25.6	276.0
	MINIMUM	12.7	12.2	8.10	242	6.35	73.9	0.59	30.43	1.8	46.0
	MEDIAN	18.6	18.1	8.35	631	8.20	83.2	1.12	132.37	9.5	103.5
	MEAN	18.4	17.9	8.34	585	8.23	87.4	1.46	343.45	9.8	125.5
	GEOMEAN	18.1	17.5	8.34	552	8.16	86.8	1.29	186.74	7.4	104.3
	COEFFICIENT OF VARIATION (%)	20.22	20.71	2.25	31.76	13.87	12.88	53.31	118.12	72.03	66.32
PD01	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	21.1	20.6	8.49	2800	9.80	103.3	1.34	48.83	16.7	866.0
	MINIMUM	12.3	11.7	8.11	1046	6.83	73.3	0.29	1.40	1.5	146.0
	MEDIAN	17.7	17.0	8.35	1400	9.65	92.8	0.82	15.64	4.5	275.5
	MEAN	17.1	16.5	8.33	1613	8.94	92.2	0.78	16.99	5.4	370.7
	GEOMEAN	16.8	16.3	8.33	1525	8.89	91.8	0.72	11.38	4.1	316.0
	COEFFICIENT OF VARIATION (%)	17.80	18.45	1.44	38.67	11.65	9.87	39.66	80.54	84.85	62.10
TR03	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	24.1	23.6	8.61	607	9.31	104.1	2.75	549.76	16.2	272.0
	MINIMUM	11.8	11.3	8.15	188	7.32	84.9	0.22	36.01	2.2	6.0
	MEDIAN	19.3	18.7	8.48	467	9.07	94.7	0.62	110.16	4.3	36.5
	MEAN	18.8	18.2	8.43	422	8.73	93.7	1.10	208.85	6.5	95.5
	GEOMEAN	18.3	17.8	8.43	398	8.71	93.5	0.79	142.48	5.1	45.4
	COEFFICIENT OF VARIATION (%)	22.51	22.96	1.90	32.45	7.89	7.00	86.26	92.23	77.61	113.96
GC01	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	23.3	22.8	8.63	942	12.10	123.0	2.41	694.43	24.0	866.0
	MINIMUM	11.3	10.6	7.98	146	6.10	69.5	0.65	17.02	2.0	26.0
	MEDIAN	18.6	18.0	8.41	663	9.57	100.6	0.82	32.85	6.3	256.0
	MEAN	18.1	17.5	8.36	581	9.58	101.1	1.13	144.60	8.7	286.4
	GEOMEAN	17.6	17.0	8.36	512	9.44	99.4	1.01	59.14	6.9	188.4
	COEFFICIENT OF VARIATION (%)	23.24	23.93	2.35	43.51	17.42	18.71	54.33	153.39	76.77	89.17
TR05	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	24.6	24.4	8.59	466	10.19	109.1	2.78	423.61	10.6	276.0
	MINIMUM	10.4	9.8	8.21	204	7.03	82.4	0.45	30.56	2.7	68.0
	MEDIAN	18.4	17.8	8.44	383	9.50	100.3	0.92	85.28	5.5	164.0
	MEAN	18.0	17.4	8.43	346	9.39	98.5	1.31	157.93	5.4	165.4
	GEOMEAN	17.4	16.8	8.43	333	9.34	98.2	1.10	111.24	5.1	152.8
	COEFFICIENT OF VARIATION (%)	25.29	26.04	1.41	27.17	9.91	8.55	62.69	88.09	39.52	38.72

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APPENDIX TABLE C-16 (CONTINUED). SUMMARY STATISTICS FOR SCCD 2016 WATER QUALITY DATA

Site	Statistic	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
TR07	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	22.5	22.0	8.45	391	10.91	108.8	3.14	208.66	19.5	276.0
	MINIMUM	8.6	8.1	8.19	190	7.10	79.2	0.95	23.95	1.9	72.0
	MEDIAN	15.8	15.3	8.36	333	10.10	98.4	2.07	97.71	4.0	130.0
	MEAN	15.6	15.1	8.34	301	9.82	98.1	2.10	107.82	5.5	135.6
	GEOMEAN	15.1	14.6	8.34	291	9.75	97.8	1.98	90.34	4.4	124.9
	COEFFICIENT OF VARIATION (%)	26.74	27.62	0.96	25.90	11.96	9.08	33.65	56.87	91.75	44.82
WC01	MAXIMUM	23.5	23.0	8.46	574	12.08	133.3	1.20	58.70	14.6	261.0
	MINIMUM	9.6	9.0	8.13	220	8.30	88.1	0.20	0.50	1.0	49.0
	MEDIAN	17.6	17.0	8.37	473	10.73	109.1	0.33	1.89	2.1	166.5
	MEAN	17.4	16.9	8.33	425	10.45	108.6	0.50	12.55	4.6	173.3
	GEOMEAN	16.9	16.4	8.32	404	10.38	107.6	0.40	3.16	3.0	153.4
	COEFFICIENT OF VARIATION (%)	23.22	23.97	1.45	29.72	11.99	14.26	74.16	160.24	101.96	45.47
FMC01	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	9.0	9.0
	MAXIMUM	21.2	20.8	8.38	1221	9.52	94.6	7.21	4.32	104.0	1080.0
	MINIMUM	11.9	11.4	7.88	367	5.70	62.1	6.74	1.02	2.9	199.0
	MEDIAN	16.9	16.3	8.09	436	9.04	86.1	7.04	2.59	8.9	411.0
	MEAN	16.3	15.8	8.13	538	8.41	84.9	7.03	2.65	22.3	544.8
	GEOMEAN	16.01	15.56	8.13	495	8.31	84.26	7.03	2.52	11.74	458.17
	COEFFICIENT OF VARIATION (%)	18.31	19.06	2.20	50.47	14.74	11.91	1.67	30.36	146.72	59.95
TR08	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	20.5	20.0	8.69	343	11.78	112.7	2.39	271.21	8.5	238.0
	MINIMUM	8.4	7.8	8.34	172	9.46	93.4	0.41	29.27	1.3	35.0
	MEDIAN	15.5	14.9	8.45	303	9.96	100.5	0.65	52.41	2.6	107.5
	MEAN	15.2	14.7	8.47	273	10.30	102.3	1.11	110.50	3.6	120.2
	GEOMEAN	14.7	14.2	8.47	264	10.28	102.2	0.90	78.96	3.0	104.9
	COEFFICIENT OF VARIATION (%)	24.76	25.83	1.11	24.77	6.99	5.94	70.15	86.41	69.09	52.77
CC01	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	22.7	22.2	8.35	416	9.55	95.5	0.82	13.53	52.6	727.0
	MINIMUM	11.7	11.1	8.09	246	7.52	84.2	0.23	0.42	16.3	120.0
	MEDIAN	18.4	17.9	8.22	304	8.24	87.2	0.49	3.31	33.4	299.5
	MEAN	17.6	17.1	8.20	310	8.47	88.3	0.51	4.61	33.9	344.5
	GEOMEAN	17.3	16.8	8.20	306	8.45	88.2	0.49	3.22	31.0	300.7
	COEFFICIENT OF VARIATION (%)	19.65	20.30	1.12	17.06	8.12	3.84	33.03	84.51	42.31	53.74

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APPENDIX TABLE C-16 (CONTINUED). SUMMARY STATISTICS FOR SCCD 2016 WATER QUALITY DATA

Site	Statistic	Hanna Temp (°C)	YSI Temp (°C)	pH (SU)	COND (umho/cm)	DO (mg/L)	DO (%)	STAFF	DISCH (cfs)	TURB (NTU)	E_COLI (cfu/100mL)
LTR01	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	20.5	19.9	8.62	338	10.84	98.8	1.01	19.92	4.8	770.0
	MINIMUM	9.3	8.7	8.37	235	8.50	91.5	0.30	1.23	0.6	50.0
	MEDIAN	15.8	15.3	8.47	271	9.35	93.2	0.47	3.44	1.7	216.0
	MEAN	15.4	14.8	8.48	276	9.43	93.7	0.53	6.10	2.1	290.7
	GEOMEAN	15.0	14.4	8.48	274	9.41	93.7	0.48	3.65	1.7	201.5
	COEFFICIENT OF VARIATION (%)	22.82	23.58	1.01	12.30	7.20	2.36	49.79	118.96	64.68	89.22
SC01	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	21.1	20.6	8.54	717	10.42	94.4	1.10	11.38	73.1	5480.0
	MINIMUM	9.8	9.2	8.22	329	8.12	89.1	0.38	1.27	2.0	44.0
	MEDIAN	16.3	15.8	8.48	412	9.03	91.4	0.69	4.28	5.5	300.5
	MEAN	16.3	15.7	8.44	460	9.07	91.3	0.75	5.63	13.7	1071.4
	GEOMEAN	16.0	15.4	8.44	444	9.05	91.3	0.72	4.73	6.6	339.2
	COEFFICIENT OF VARIATION (%)	19.83	20.51	1.16	30.32	7.71	1.82	30.08	59.79	162.63	170.10
TR09	COUNT	10.0	10.0	10.0	10.0	9.0	9.0	10.0	10.0	10.0	10.0
	MAXIMUM	18.6	18.1	8.60	236	11.20	96.8	2.98	383.00	2.6	42.0
	MINIMUM	7.4	6.9	8.25	144	9.16	90.9	1.80	55.00	0.5	2.0
	MEDIAN	14.3	13.7	8.52	218	9.78	92.8	1.99	87.50	1.4	24.0
	MEAN	13.9	13.4	8.49	202	9.74	93.5	2.23	157.90	1.5	22.6
	GEOMEAN	13.4	12.8	8.49	199	9.73	93.5	2.19	118.26	1.4	17.8
	COEFFICIENT OF VARIATION (%)	26.00	27.14	1.24	17.41	6.56	2.08	21.26	83.14	48.42	54.16

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APPENDIX TABLE C-17. USGS WATER QUALITY DATA (SELECT PARAMETERS) STATION 06306250 Prairie Dog Cr Acme

Date/Time	Temperature (°C)	Discharge (cfs)	Gage Height (ft)	Conductivity (uS/cm)	DO (mg/L)	DO (%)	pH (SU)	Dissolved Solids (mg/L)
1/23/2014 10:05	-0.1	18	1.8	1870	12.7	97	8	1400
2/27/2014 11:00	-0.4	24	2.08	1850	12.4	97	7.9	1370
3/27/2014 9:45	4.9	55	2.24	1810	11.7	105	8.2	1390
4/25/2014 10:20	9.7	48	1.96	1580	10.3	104	8.2	1170
5/20/2014 17:20	16.4	32	1.6	1930	9.7	113	8.3	1470
6/24/2014 15:25	20.7	50	2.14	1060	8.4	106	8.3	719
7/23/2014 7:40	19.4	12	1.06	1780	8.2	101	7.8	1260
8/26/2014 7:55	13.4	67	2.5	710	9.1	99	7.8	468
9/17/2014 7:45	12.1	54	2.22	932	9.6	102	7.8	598
10/22/2014 16:35	10.3	21	1.32	1730	10.5	107	8.2	1250
11/25/2014 15:50	-0.1	21	1.68	1550	12.4	97	7.9	1130
12/18/2014 12:40	-0.3	17	1.49	2020	12.5	97	8.1	1530
1/22/2015 8:35	-0.1	15	1.48	1870	13.3	103	7.8	1430
2/20/2015 9:20	2.4	31	1.71	1990	12.1	101	8.3	1490
3/24/2015 9:55	7.6	29	1.5	1700	10.6	102	8.4	1210
4/23/2015 11:00	11.9	39	1.83	1150	10.3	110	8.3	809
5/26/2015 18:45	15.4	318	5.43	855	7.2	83	7.7	573
6/18/2015 7:25	17.1	114	3.39	1060	7.9	93	7.8	745
7/17/2015 8:55	18.4	17	1.19	1400	8.3	101	8	1020
8/27/2015 9:10	17.5	19	1.22	1340	8.6	102	8.2	948
9/18/2015 12:00	14.6	9.8	0.94	1840	11.1	124	8	1370
10/29/2015 12:55	5	24	1.44	1390	12.4	112	8.4	976
11/19/2015 10:50	0.6	22	1.4	1490	13.3	105	8.2	1020
12/17/2015 8:35	-0.3	13	1.49	1740	14.1	109	7.9	1260
1/27/2016 10:40	-0.3	14	1.8	1500	12	92	7.9	1070
2/25/2016 11:20	-0.2	31	1.63	1970	13.4	103	8.3	1500
3/23/2016 8:05	3.5	18	1.27	1800	12.3	106	7.9	1360
4/27/2016 12:00	6.4	116	3.54	1460	11.3	105	8.3	1080
5/26/2016 9:30	14.1	24	1.5	1350	9.4	104	8.1	981
6/24/2016 11:40	21.8	11	1.01	1410	9.8	128	8	1050

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APPENDIX TABLE C-18. USGS WATER QUALITY DATA (SELECT PARAMETERS) STATION 06299980 Tongue River Monarch

Date/Time	Temperature (°C)	Discharge (cfs)	Gage Height (ft)	Conductivity (uS/cm)	DO (mg/L)	DO (%)	pH (SU)	Dissolved Solids (mg/L)
1/23/2014 14:35	0	79	3.54	459	13.6	105	8.3	274
2/26/2014 16:25	-0.2	56	3.16	494	12.2	95	7.9	308
3/26/2014 15:45	6.6	117	2.54	617	12.2	116	8.5	401
4/25/2014 7:20	6.8	303	3.2	394	10	94	8	237
5/21/2014 7:40	7.8	1060	4.78	217	10.4	99	7.8	125
6/25/2014 7:20	13	664	4.03	254	9	98	8	147
7/23/2014 9:15	19.6	188	2.9	322	8.3	103	8.1	186
8/26/2014 11:15	14.2	129	2.56	388	10	111	8.3	231
9/17/2014 11:10	13.3	145	2.63	377	9.8	107	8.2	222
10/22/2014 15:00	9.6	110	2.48	405	10.1	101	8.5	239
11/26/2014 8:15	0	104	2.87	432	12.5	97	8.2	257
12/18/2014 8:25	-0.2	47	2.49	480	13.3	103	8.2	284
1/22/2015 12:20	-0.1	70	3.14	471	14.2	110	8	285
2/19/2015 16:30	3.1	88	2.33	506	13	111	8.7	311
3/23/2015 17:00	10.1	102	2.41	432	13.7	141	8.5	260
4/23/2015 7:30	10.6	121	2.52	373	9.7	101	8.2	226
5/26/2015 19:40	10.9	1460	5.33	257	10.1	105	7.7	154
6/18/2015 12:30	16.2	699		261	9.3	108	7.7	156
7/17/2015 10:45	18.9	163	2.73	337	8.3	102	8	198
8/26/2015 15:50	20.2	70	2.22	460	10.4	131	8.4	284
9/18/2015 14:15	16.2	84	2.31	429	10.2	118	8.3	253
10/29/2015 10:00	4.3	82	2.29	424	12.1	107	8.3	252
11/19/2015 12:30	1.2	72	2.27	456	13.2	107	8.2	274
12/17/2015 12:15	-0.3	52	2.41	452	15.5	119	8.1	273
1/27/2016 12:15	-0.2	54	3.1	462	13.4	104	8.1	276
2/25/2016 12:55	2	66	2.23	455	14.5	119	8.5	286
3/22/2016 16:30	6.5	82	2.29	428	11.3	106	8.4	260
4/27/2016 14:00	6	217	2.89	425	11.6	107	8.4	268
5/26/2016 7:20	9.1	485	3.66	198	10	99	7.6	117
6/22/2016 15:55	22.1	195	2.79	275	10.7	140	8.3	165
7/27/2016 13:05	25.7	45	2.06	447	10.5	146	8.2	272
8/25/2016 12:55	18.2	47	2.09	445	10.5	126	8.4	265
9/22/2016 7:25	13.6	72	2.26	397	8.5	94	8.1	237

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APPENDIX TABLE C-19. USGS WATER QUALITY DATA (SELECT PARAMETERS) STATION 06306020 Tongue River Blw Youngs Creek

Date/Time	Temperature (°C)	Discharge (cfs)	Conductivity (uS/cm)	DO (mg/L)	DO (%)	pH (SU)	Dissolved Solids (mg/L)
10/30/2013 9:30	3.9	299	430	11.1	97	8.4	268
11/22/2013 8:20	0	106	501	14.3	109	8.3	312
12/20/2013 10:40	0	185	518	12.8	100	8	319
1/23/2014 12:40	0	178	586	13.4	103	8.1	357
2/27/2014 8:40	-0.4	139	646	12.9	100	7.9	403
3/27/2014 7:50	5.3	253	733	8	73	8.2	481
4/25/2014 8:55	8.1	599	424	9.9	96	8.3	256
5/20/2014 18:25	10.8	1600	240	10.3	106	8	142
6/24/2014 17:00	16.1	1520	207	9.6	111	7.9	121
7/22/2014 16:50	24.3	319	414	9.1	123	8.1	245
8/26/2014 9:30	14.5	262	491	8.6	95	8.3	301
9/17/2014 9:20	13.3	349	426	8.8	96	8.2	253
10/23/2014 8:00	8	210	507	8.9	86	8.2	305
11/25/2014 14:40	0	E 240	534	12.2	95	8.1	328
12/18/2014 11:25	-0.2	146	567	13.2	102	8.3	341
1/22/2015 10:25	-0.1	157	561	13.4	103	8.2	345
2/20/2015 7:30	3	182	622	11.7	99	8.2	381
3/24/2015 8:20	8.8	213	550	9	89	8.4	339
4/23/2015 9:00	12.6	234	446	9.1	98	8.7	277
5/26/2015 9:30	10.9	E 4600	294	8.6	89	7.8	189
6/18/2015 9:25	15.5	E 1560	266	8.7	99	7.7	159
7/17/2015 7:30	21	E 300	462	6.8	87	8	275
8/27/2015 7:50	19.2	96	595	7.2	89	8.2	373
9/18/2015 10:35	15.5	128	563	8.3	94	8.3	340
10/29/2015 11:30	5.5	178	563	11	100	8.7	345
11/19/2015 9:40	0.9	162	569	12.8	102	8.3	342
12/17/2015 10:25	-0.3	157	569	14.6	112	8.2	358
1/27/2016 8:35	-0.3	113	563	11.8	90	8.1	344
2/25/2016 10:00	-0.2	82	593	13.1	100	8.6	376
3/23/2016 9:45	5	202	564	11.2	100	8	352
4/27/2016 10:15	6	509	498	11	101	8.3	318
5/26/2016 14:00	13.4	694	247	10.2	112	7.9	148
6/24/2016 10:30	21.9	275	350	8.2	107	8	207

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APPENDIX TABLE C-20. USGS WATER QUALITY DATA (SELECT PARAMETERS) STATION 06306300 Tongue River Decker

Date/Time	Temperature (°C)	Discharge (cfs)	Gage Height (ft)	Conductivity (uS/cm)	DO (mg/L)	DO (%)	pH (SU)	Dissolved Solids (mg/L)	Suspended Sediment (mg/L)
4/8/2014 14:15	10.1	372	3.21	902	13.7	138	8.7	604	64
4/22/2014 12:30	12.8	497	3.55	692	8.5	93	8.6	446	52
5/15/2014 8:30	9.9	795	4.17	435	10	99	8.5	268	36
6/4/2014 8:40		3350	7.62	199	9.8		8	120	49
6/18/2014 10:15	12.9	1590	5.44	250	8.8	95	8	149	41
7/9/2014 9:15	19.9	722	3.96	351	8	100	8.2	208	28
7/23/2014 14:15		343	3.03	490	10.5		8.5	297	12
8/5/2014 9:15	21.5	192	2.56	625	6.8	87	8.2	391	16
8/19/2014 17:30	25.5	224	2.67	586	13.7	193	8.7	357	15
9/24/2014 9:15	15.7	329	3.03	528	8.5	97	8.2	329	17
10/29/2014 16:15		207	2.68	626	16.1		8.8	403	15
3/19/2015 10:30	6.1	271	1.79	720	11	100	8.6	470	32
4/23/2015 12:20	14.1	294	2.83	573	13.2	147	8.6	357	27
5/26/2015 14:45	12.6	4700	8.39	338	8.2	88	7.5	204	280
6/17/2015 17:00	16.4	2200	6.11	282	9.5	110	7.6	170	44
7/16/2015 15:35	24.6	315	3.11	528	11.8	162	8.8	330	17
8/20/2015 7:45	16.8	187	2.58	706	7.3	86	8	453	25
9/21/2015 11:40	16.1	157	2.44	669	11.1	129	8.4	425	14
10/21/2015 10:10	9.2	188	2.53	688	11.2	110	8.5	451	25
2/25/2016 8:00	-0.3	89	2.48	878	13.4	102	8.4	584	4
4/25/2016 17:45	9.1	900	4.26	625	9.9	98	7.8	410	113
5/26/2016 11:20	13.3	729	3.97	295	9.4	102	8	179	55
6/24/2016 7:50	21.3	286	3.06	405			8	236	3
7/27/2016 10:40	24.3	43	1.98	763	9.2	125	8.2		7
8/25/2016 10:30	17	73	2.16	677	9.7	113	8.4	438	12
9/22/2016 9:45	14.9	125	2.35	634	8	90	8.2	379	19
10/14/2016 7:50	6.7	247	2.75	598	11.4	107	8.1	385	17

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Figure C-1. 2016 Continuous Temperature Data Site TR01

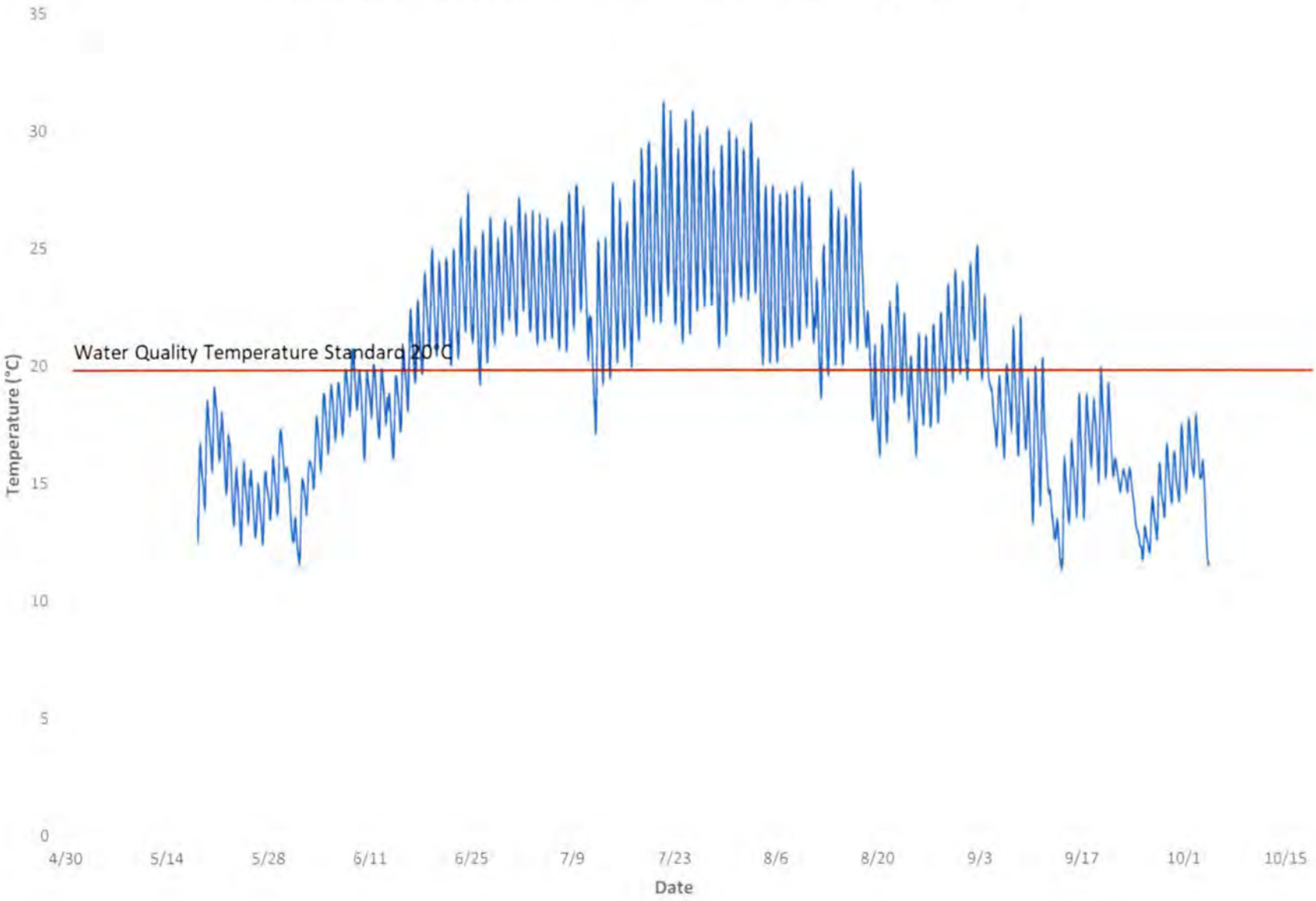

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Figure C-2. 2016 Continuous Temperature Data Site TR03

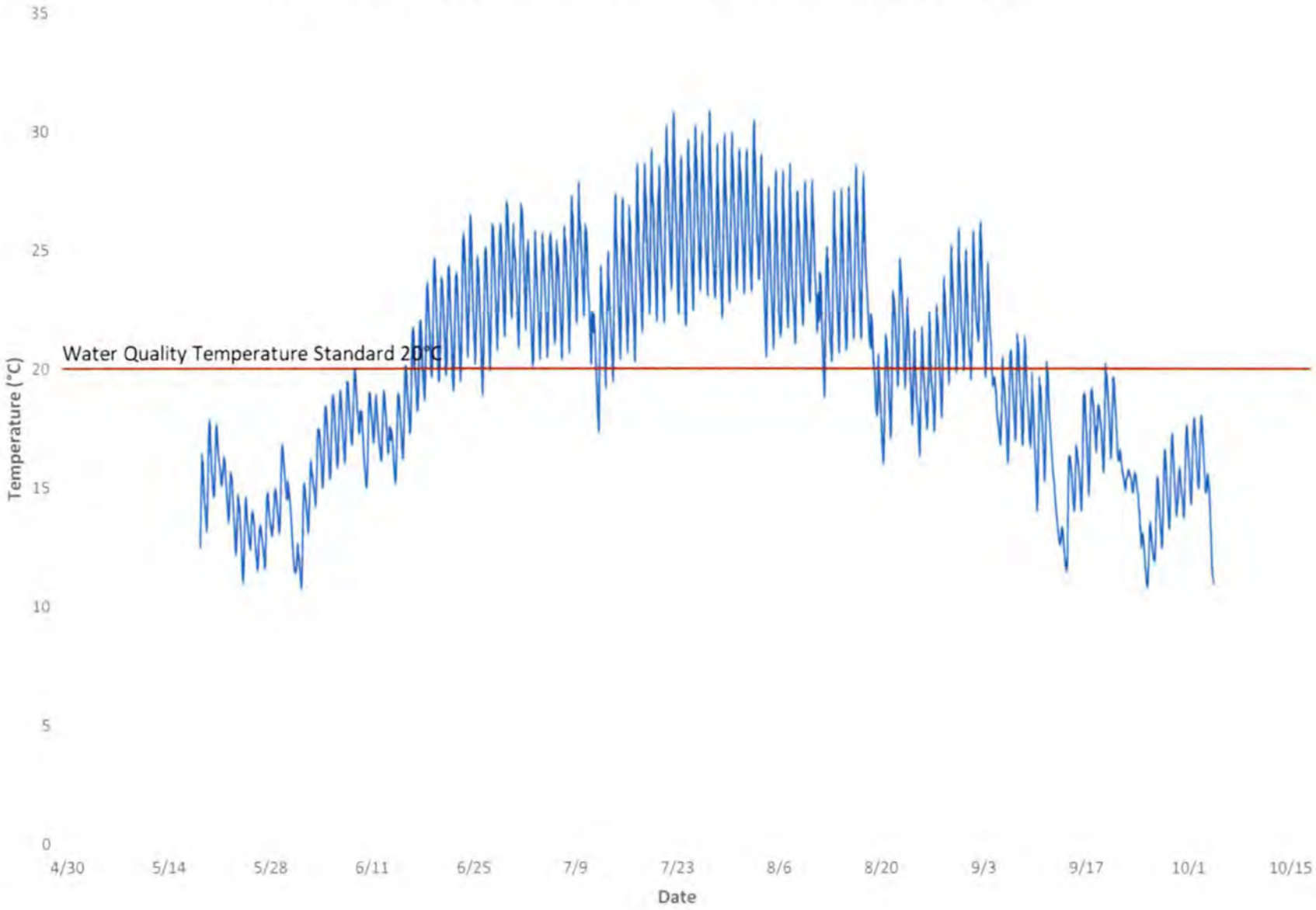

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Figure C-3. 2016 Continuous Temperature Data Site TR05

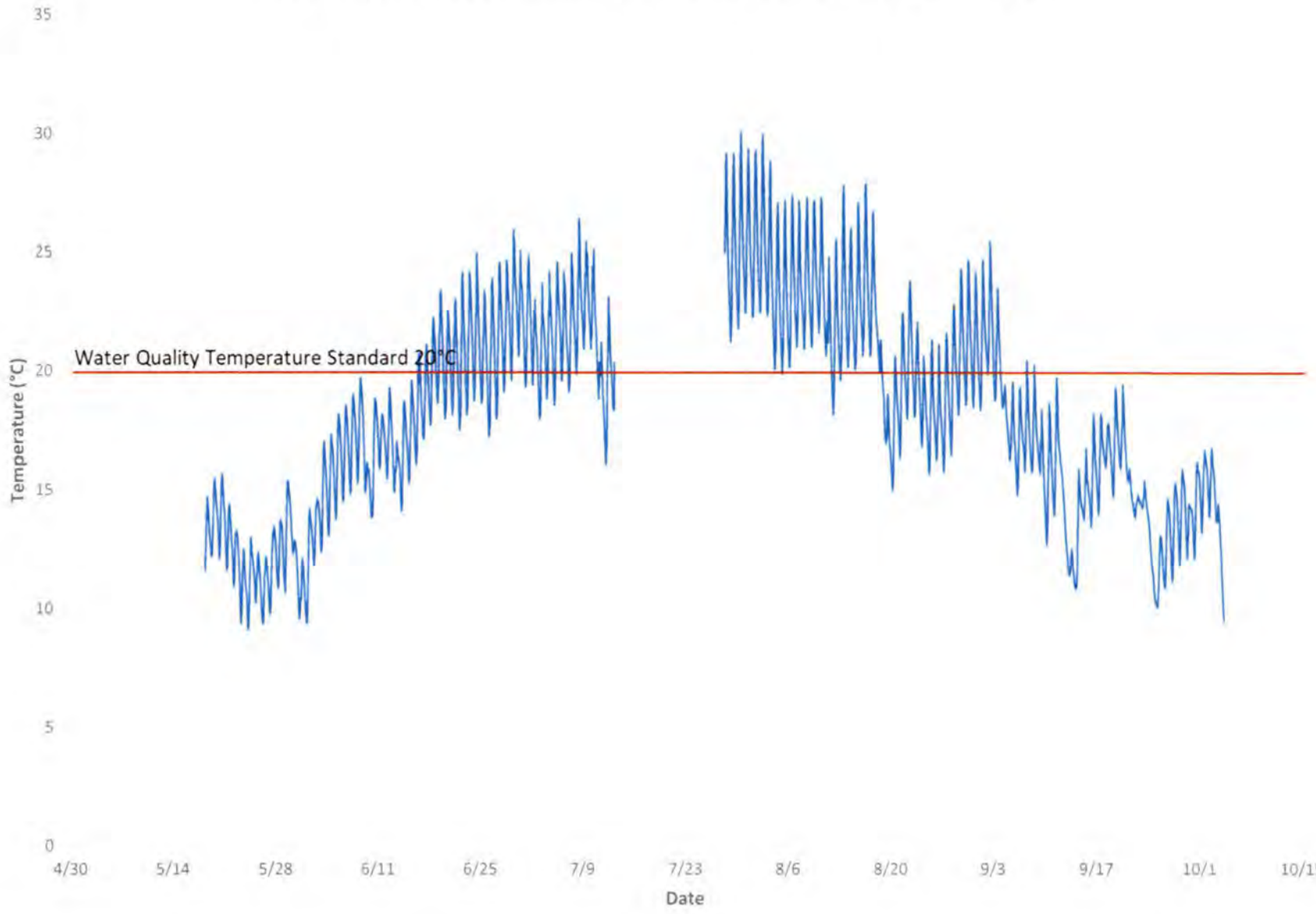

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Figure C-4. 2016 Continous Temperature Data Site TR07

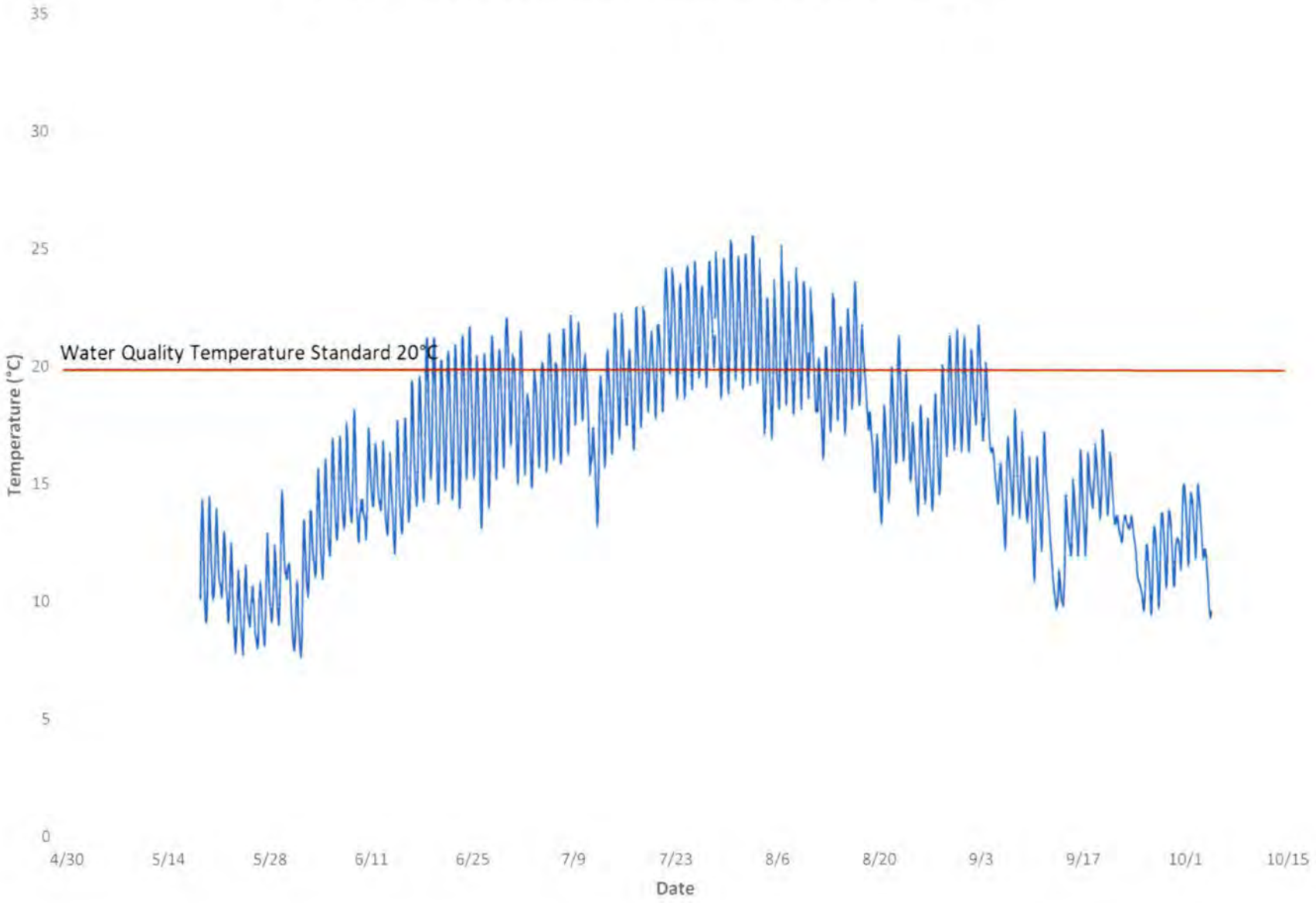

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Figure C-5. 2016 Continuous Temperature Data Site TR09

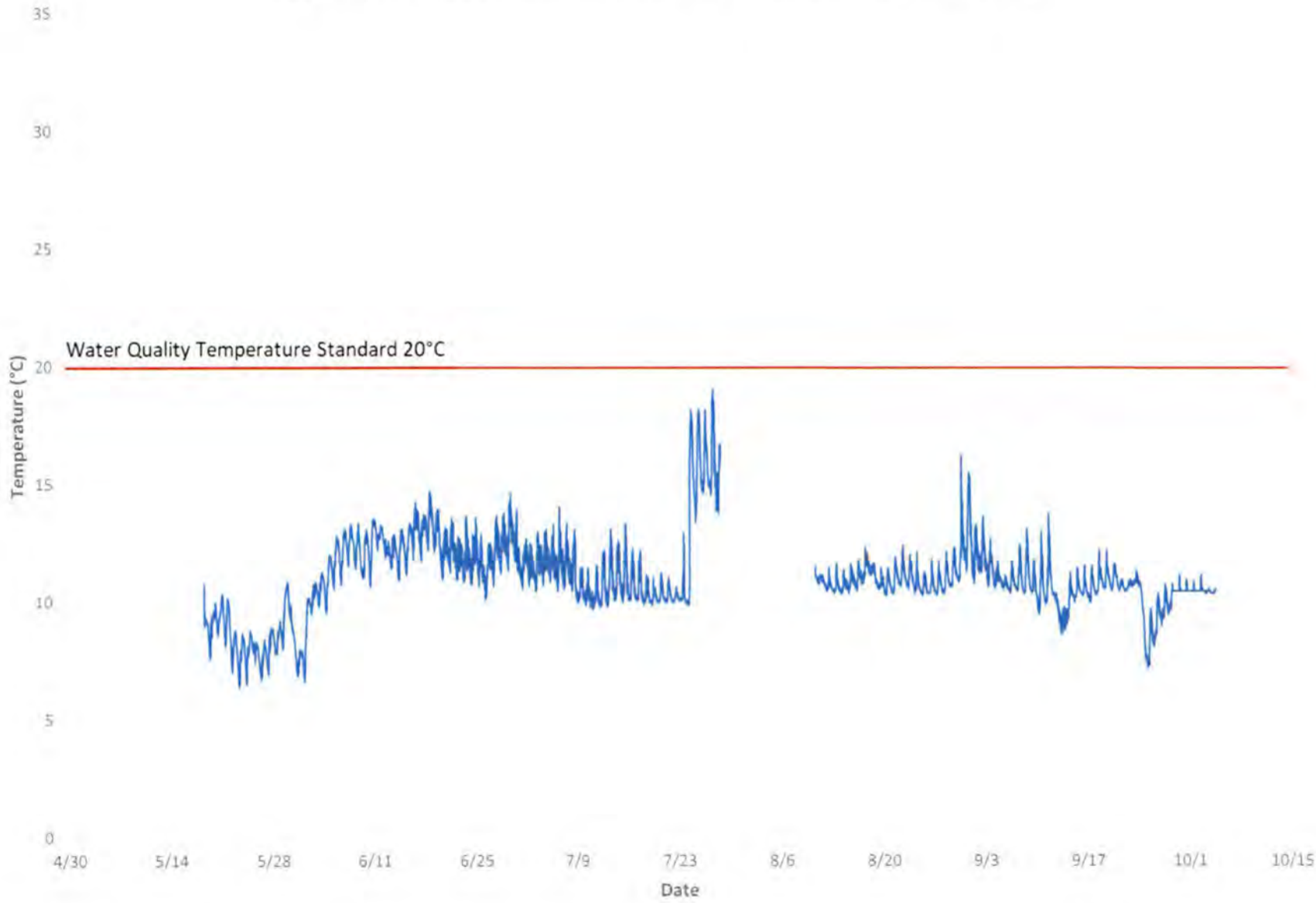

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Figure C-6. Yearly Mean Daily Water Temperature Comparisons for TR07

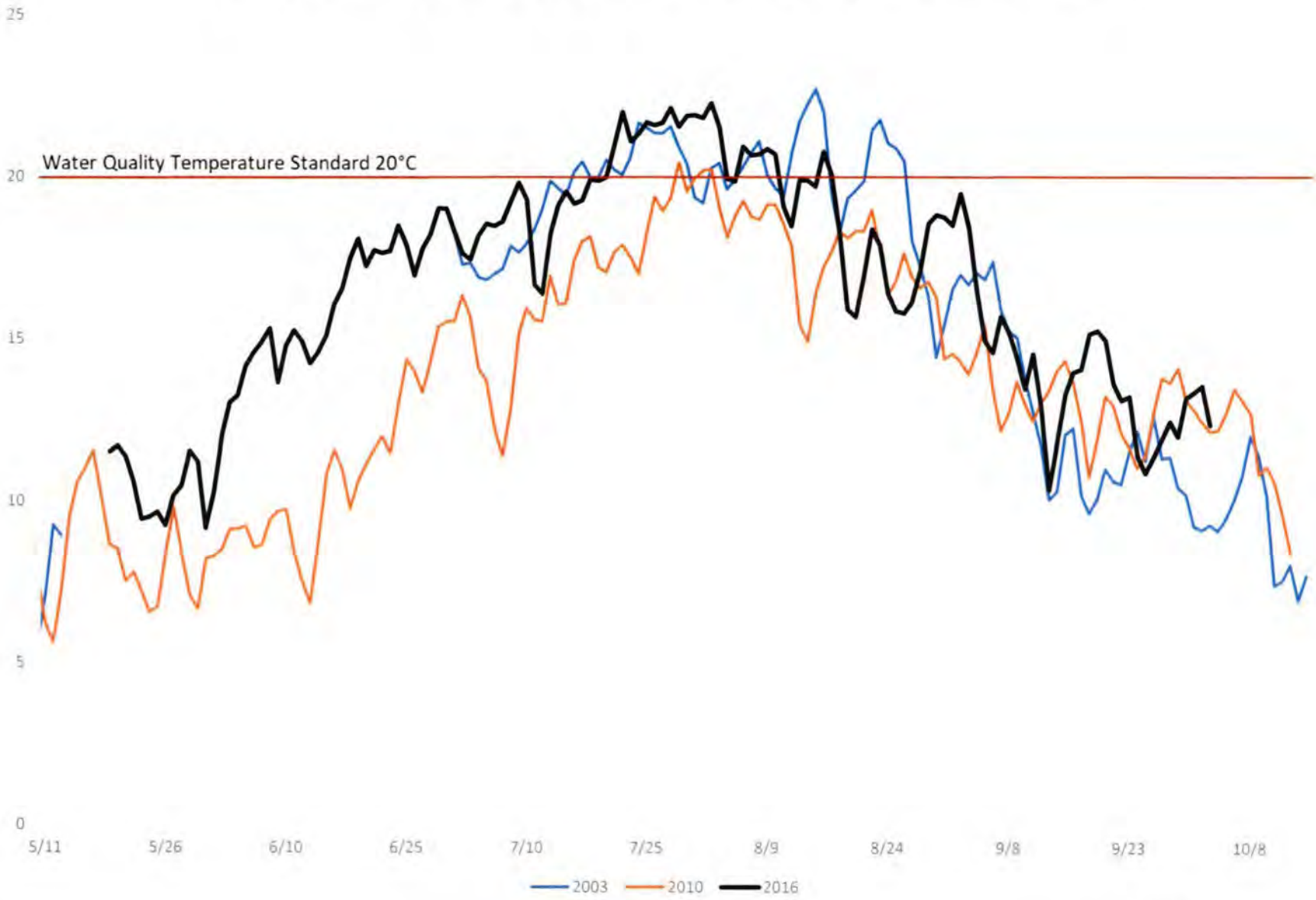

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Figure C-7. 2016 Mean Daily Flow and Normal Flow at USGS Station 06306300 Tongue River Near Decker, MT with 2016 Instantaneous Discharge (TR01)

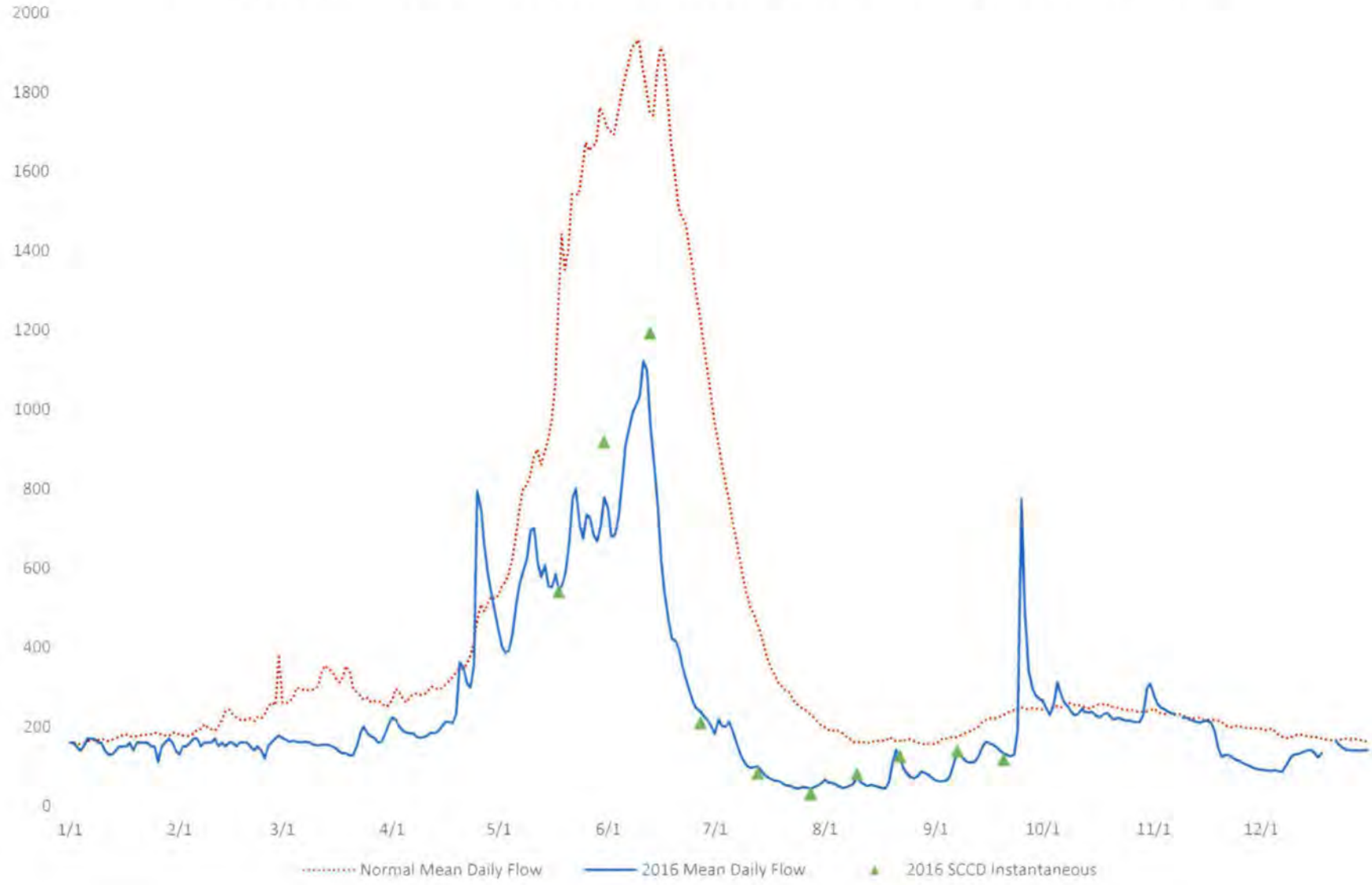

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Figure C-8. 2016 Mean Daily Flow and Normal Flow at USGS Station 06306250 Prairie Dog Creek Near Acme with 2016 Instantaneous Discharge (PD01)

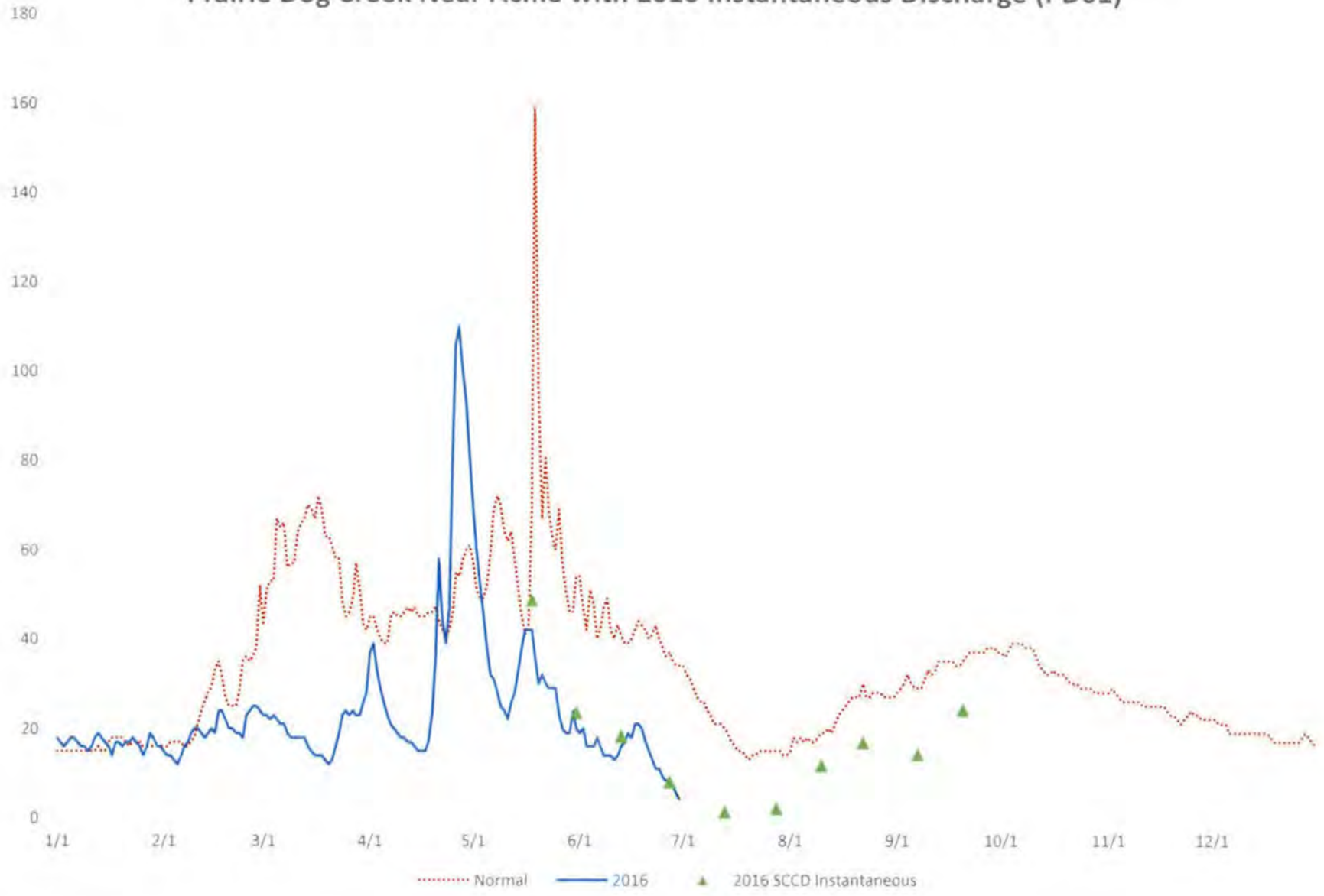

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Figure C-9. 2016 Mean Daily Flow and Normal Flow at USGS Station 06305700 Goose Creek Near Acme with 2016 Instantaneous Discharge (GC01)

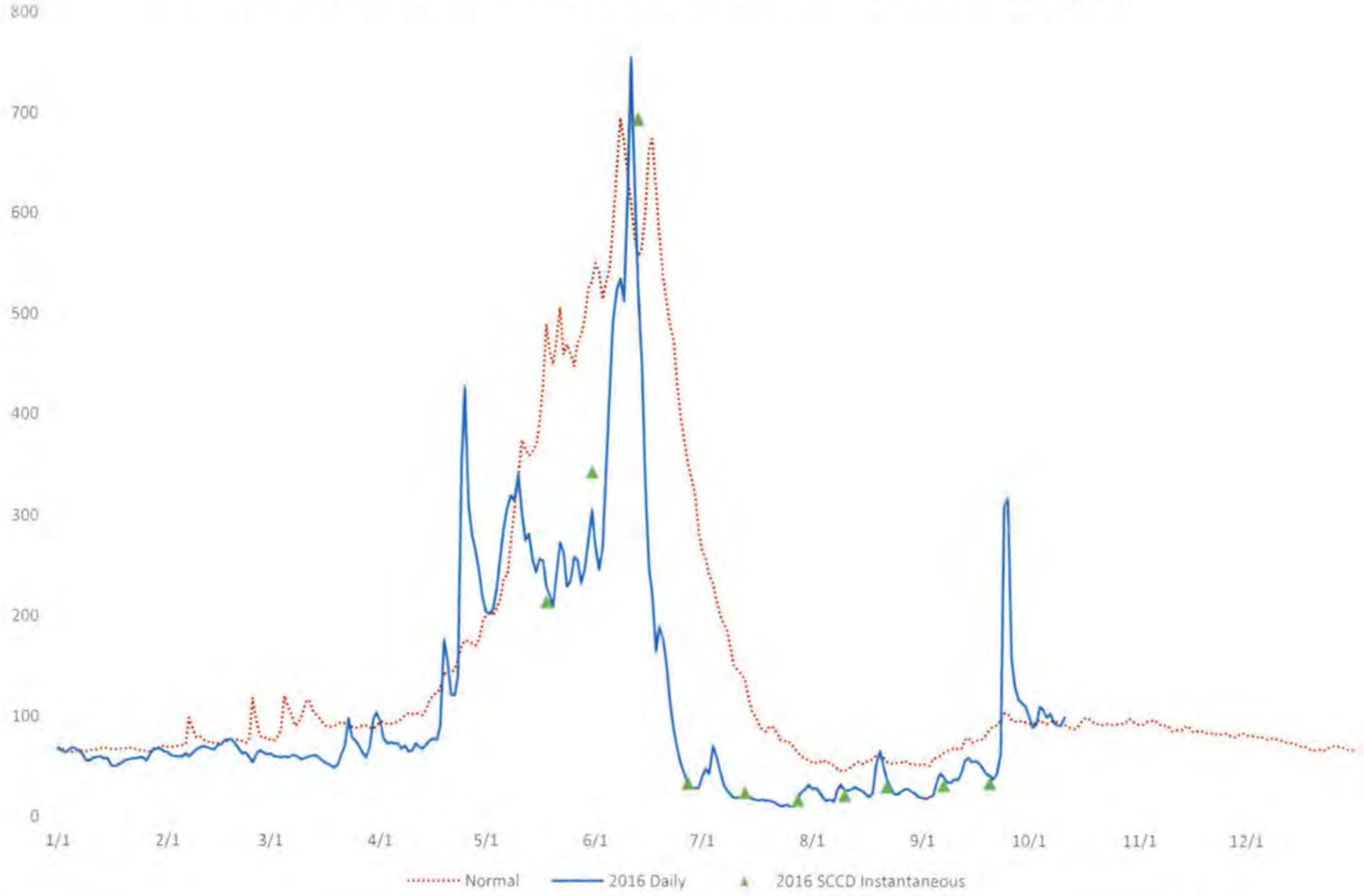

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Figure C-10. 2016 Mean Daily Flow and Normal Flow at USGS Station 06299980 Tongue River at Monarch with 2016 Instantaneous Discharge (TR05)

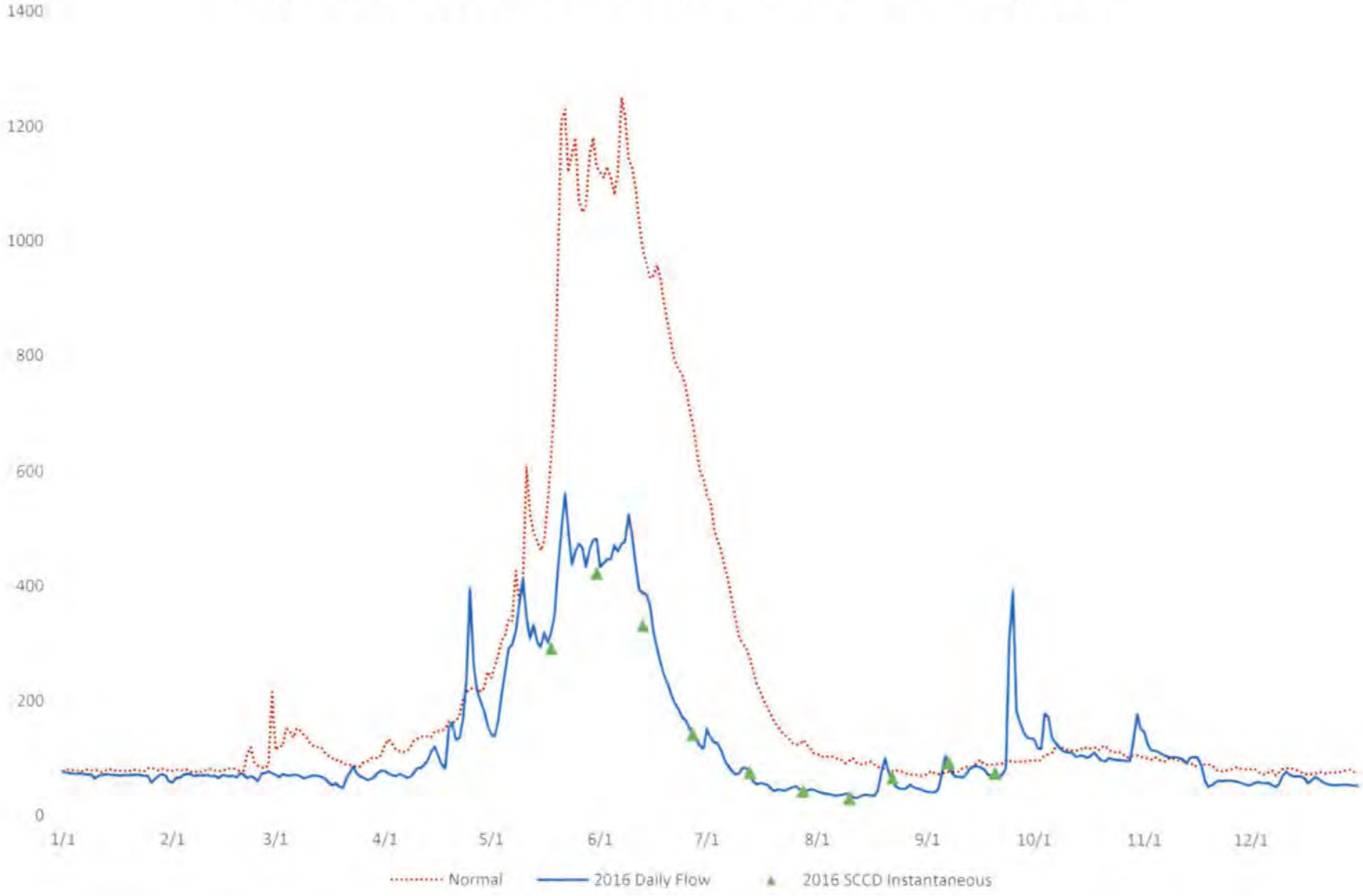

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Figure C-11. 2016 Mean Daily Flow and Normal Flow at USGS Station 06298000 Tongue River Near Dayton with 2016 Instantaneous Discharge (TR09)

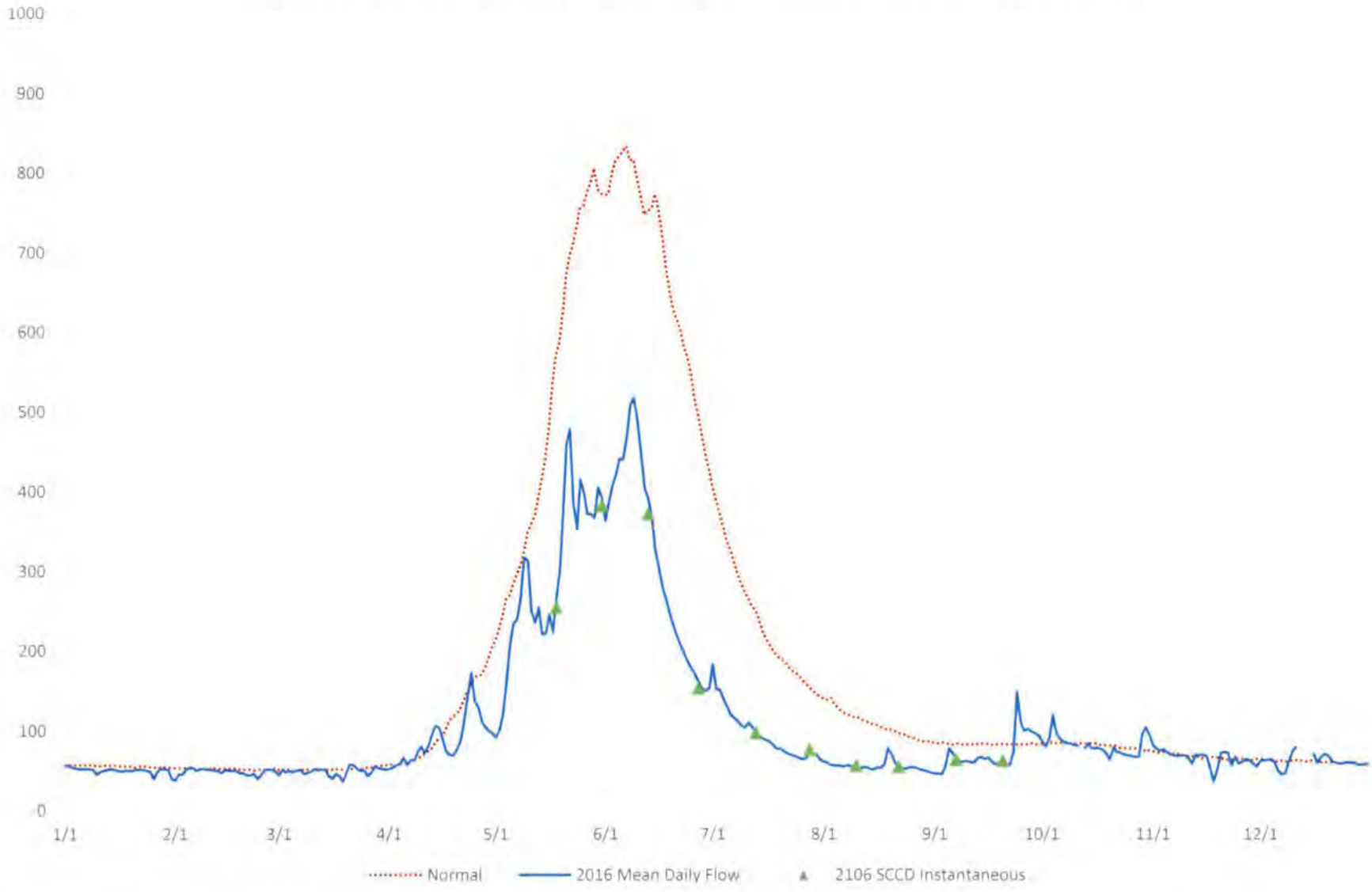

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Figure C-12. 2016 Mean Daily Air Temperature and Normal Mean Daily Air Temperature from the National Weather Service at Sheridan County Airport

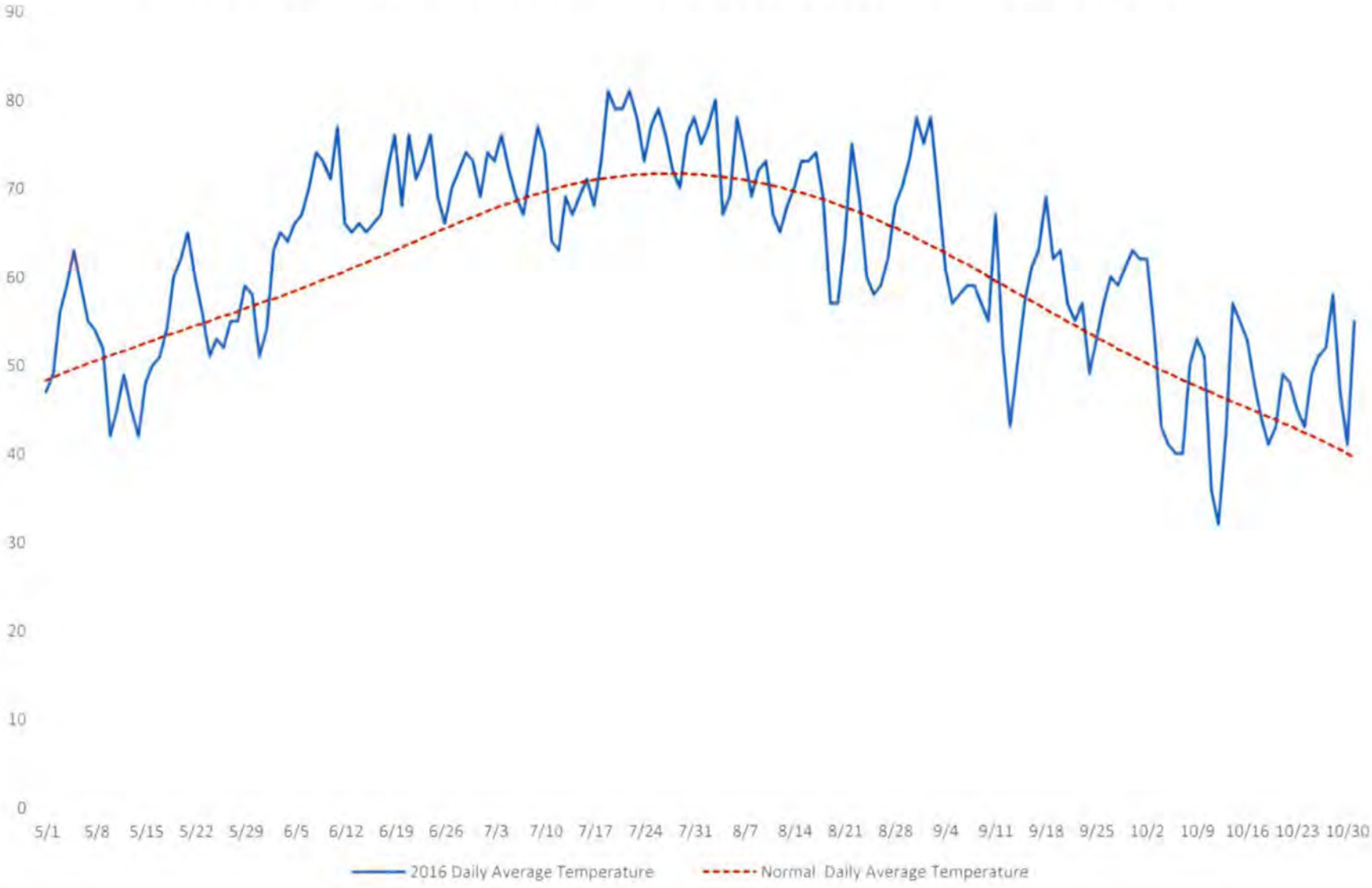

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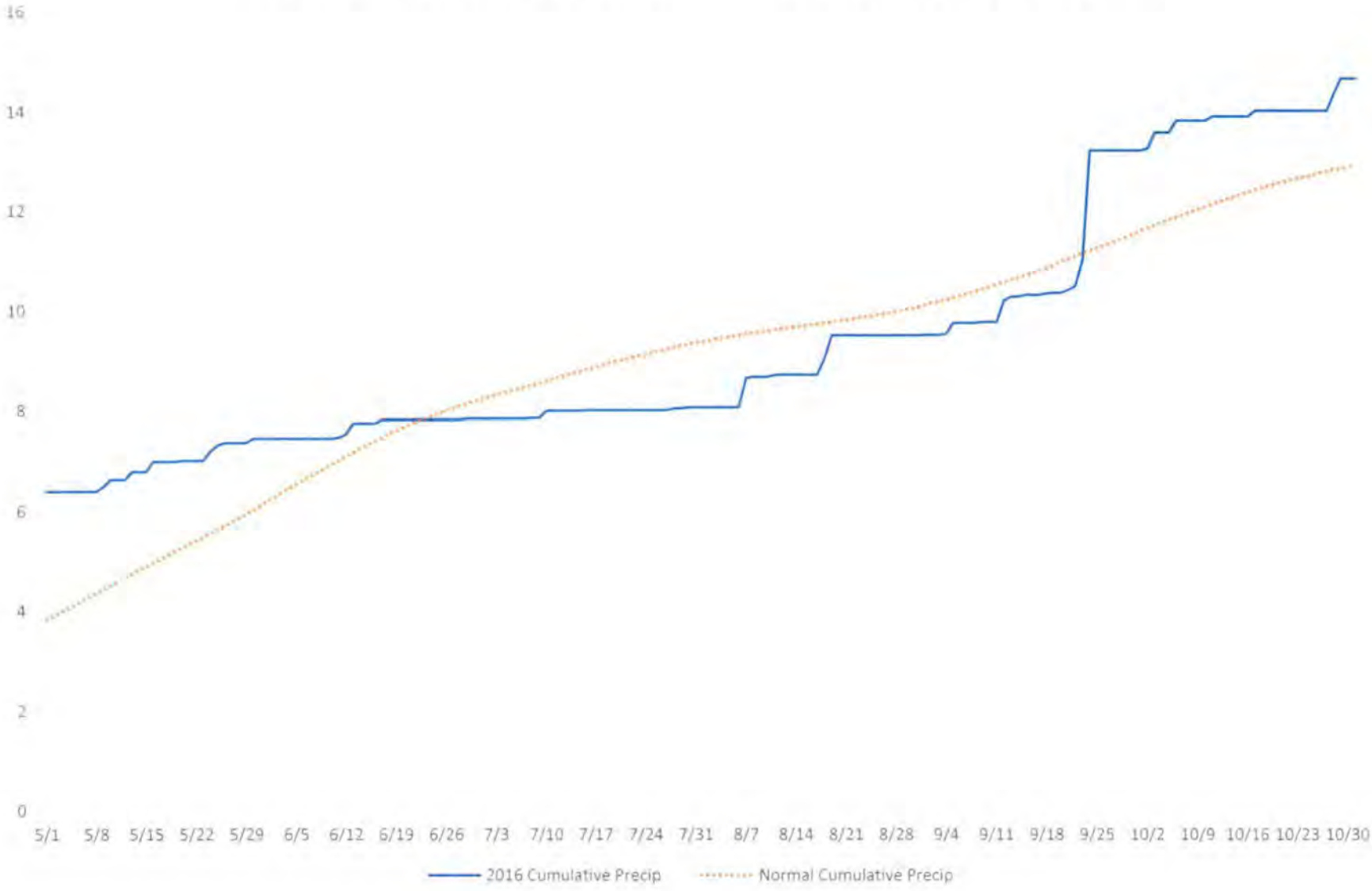
Figure C-13. 2016 Mean Daily Precipitation and Normal Mean Daily Precipitation from the National Weather Service at Sheridan County Airport



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APPENDIX D

2016 Tongue River Watershed Macroinvertebrate Data

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-1

Tongue R. Canyon, u/s USGS gauge, TR09 (formerly TRU), October 4, 2016
WY: Sheridan County Conservation District. WY DEQ protocols.
Riffle habitat, composite 8 Surber, 8 square feet total area, 500 micron
Abundances= full sample and 1 m2 basis. ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	1.429

Taxon	Abundance	%
Lebertia	2	0.19
Sperchon	8	0.77
Testudacarus	2	0.19
TOTAL: NON INSECTS	12	1.16
Ameletus	2	0.19
Baetis tricaudatus complex	2	0.19
Drunella doddsi	4	0.39
Drunella grandis	119	11.95
Ephemerella excrucians group	15	1.54
Rhithrogena	12	1.16
Tricorythodes explicatus	8	0.77
Neocloroterpes	2	0.19
Paraleptophlebia	8	0.77
TOTAL: EPHEMEROPTERA	171	17.16
Sweltsa	15	1.54
TOTAL: PLECOPTERA	15	1.54
Brachycentrus americanus	2	0.19
Brachycentrus occidentalis	115	11.57
Glossosoma	225	22.55
Hydropsyche	29	2.89
Lepidostoma (Neodinarthrum)	129	12.92
Oligophlebodes	54	5.42
TOTAL: TRICHOPTERA	554	55.57
Cleptelmis addenda	4	0.40
Optioservus	175	17.55
Zaitzevia parvula	17	1.74
TOTAL: COLEOPTERA	196	19.69
Atherix	4	0.39
Antocha	10	0.96
Hexatoma	1	0.13
TOTAL: DIPTERA	15	1.48
Chironomidae	6	0.58
Cladotanytarsus	2	0.19
Orthocladius	2	0.19
Orthocladius complex	13	1.35
Polypedilum	10	0.96
Radotanypus	2	0.19
TOTAL: CHIRONOMIDAE	35	3.47
GRAND TOTAL	997	100.00

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-2

Tongue R. Canyon, u/s USGS gauge, TR09 - Duplicate 1 (formerly TRU), October 4, 2016
WY: Sheridan County Conservation District, WY DEQ protocols.
Riffle habitat, composite 8 Surber, 8 square feet total area, 500 micron.
Abundances= full sample and 1 m2 basis. ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	1.304

Taxon	Abundance	%
Trepaxonemata	7	0.76
Nais	2	0.19
Musculium	5	0.57
Pisidium	11	1.14
Trombidiformes	2	0.19
Sperchon	9	0.95
TOTAL: NON INSECTS	35	3.80
Ameletus	2	0.19
Acentrella insignificans complex	2	0.19
Drunella doddsi	4	0.38
Drunella grandis	123	13.29
Ephemerella excrucians group	19	2.09
Epeorus	2	0.19
Rhithrogena	4	0.38
Tricorythodes explicatus	9	0.95
Paraleptophlebia	2	0.19
TOTAL: EPHEMEROPTERA	165	17.84
Sweltsa	2	0.19
Skwala	2	0.19
TOTAL: PLECOPTERA	4	0.38
Corixidae	4	0.38
TOTAL: HEMIPTERA	4	0.38
Brachycentrus occidentalis	70	7.59
Glossosoma	174	18.79
Hydropsyche	16	1.71
Lepidostoma (Neodinarthrum)	128	13.86
Oligophlebodes	74	7.97
TOTAL: TRICHOPTERA	461	49.92
Cleptelmis addenda	7	0.76
Optioservus	132	14.29
Zaitzevia parvula	14	1.52
TOTAL: COLEOPTERA	153	16.52
Atherix	5	0.57
Wiedemannia	2	0.19
Muscidae	2	0.19
Antocha	19	2.09
Limnophila	2	0.19
TOTAL: DIPTERA	30	3.23
Chironomidae	2	0.19
Cladotanytarsus	7	0.76
Odontomesa	4	0.38
Orthocladius	4	0.38
Orthocladius complex	32	3.42
Pagastia	2	0.19
Paraphaenocladius	2	0.19
Polypedilum	4	0.38
Radotanypus	16	1.71
Thienemannimyia group	4	0.38
TOTAL: CHIRONOMIDAE	74	7.97
GRAND TOTAL	924	100.00

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-3

Tongue R. u/s County Rd 67, TR07 (formerly TRL), Sept 26, 2016.
WY: Sheridan County Conservation District. WY DEQ protocols.
Riffle habitat, composite 8 Surber, 8 square feet total area, 500 micron.
Abundances= full sample and 1 m2 basis. ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	2.14

Taxon	Abundance	%
Trepaxonemata	26	1.63
Tubificinae	20	1.27
Ophidonais serpentina	9	0.54
Physella	6	0.36
Ferrissia	3	0.18
Hyalella	26	1.63
Sperchon	55	3.45
TOTAL: NON INSECTS	144	9.07
Acentrella insignificans complex	3	0.18
Baetis tricaudatus complex	26	1.63
Falliceon	29	1.81
Iswaeon	9	0.54
Caenis	3	0.18
Ephemerella excrucians group	3	0.18
Ephemera	9	0.54
Maccaffertium terminatum	6	0.36
Tricorythodes explicatus	518	32.67
Paraleptophlebia	9	0.54
TOTAL: EPHEMEROPTERA	613	38.65
Isoperla	3	0.18
TOTAL: PLECOPTERA	3	0.18
Corixidae	75	4.72
TOTAL: HEMIPTERA	75	4.72
Brachycentrus occidentalis	37	2.36
Helicopsyche	17	1.09
Cheumatopsyche	132	8.35
Hydropsyche	308	19.42
Hydroptila	3	0.18
Nectopsyche	6	0.36
Oecetis avara group	26	1.63
Neureclipsis	3	0.18
Polycentropus	3	0.18
TOTAL: TRICOPTERA	535	33.76
Petrophila	78	4.90
TOTAL: LEPIDOPTERA	78	4.90
Cleptelmis addenda	3	0.18
Dubiraphia	15	0.91
Optioservus	17	1.09
Zaitzevia parvula	6	0.36
TOTAL: COLEOPTERA	40	2.54
Ceratopogoninae	3	0.18
Ephydridae	3	0.18
Pericoma/Telmatoscopus	3	0.18
Simulium	20	1.27
Caloparyphus	3	0.18
Tipula	6	0.36
TOTAL: DIPTERA	37	2.36
Chironomidae	3	0.18
Cricotopus trifascia group	6	0.36
Eukiefferiella	14	0.91
Micropsectra	9	0.54
Microtendipes	3	0.18
Nanocladius	3	0.18
Orthocladius complex	9	0.54
Polypedilum	12	0.73
Thienemannimyia group	3	0.18
TOTAL: CHIRONOMIDAE	60	3.81
GRAND TOTAL	1586	100.00

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-4

Tongue R. u/s Acme Road (at Kleenburn Park). TR05, October 4, 2016
WY: Sheridan County Conservation District. WY DEQ protocols.
Riffle habitat, composite 8 Surber, 8 square feet total area, 500 micron.
Abundances= full sample and 1 m2 basis. ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	3.33

Taxon	Abundance	%
Trepaxonemata	72	2.73
Lumbriculidae	9	0.34
Naididae	13	0.51
Tubificinae	63	2.39
Aulodrilus	4	0.17
Galba	179	6.82
Physella	134	5.12
Pisidium	4	0.17
Sperchon	116	4.44
TOTAL: NON INSECTS	596	22.69
Acentrella insignificans complex	85	3.24
Baetis tricaudatus complex	9	0.34
Fallceon	67	2.56
Iswaeon	27	1.02
Ephemera	4	0.17
Maccaffertium terminatum	9	0.34
Tricorythodes explicatus	681	25.93
Paraleptophlebia	4	0.17
TOTAL: EPHEMEROPTERA	887	33.78
Brachycentrus occidentalis	40	1.54
Helicopsyche	63	2.39
Cheumatopsyche	40	1.54
Hydropsyche	58	2.22
Hydroptila	13	0.51
Nectopsyche	22	0.85
Oecetis avara group	18	0.68
Manilia	4	0.17
Chimarra	18	0.68
TOTAL: TRICOPTERA	278	10.58
Petrophila	31	1.19
TOTAL: LEPIDOPTERA	31	1.19
Dubiraphia	13	0.51
Microcylloepus	13	0.51
Microcylloepus	72	2.73
Stenelmis	4	0.17
Stenelmis	45	1.71
Zaitzevia parvula	9	0.34
TOTAL: COEOPTERA	157	5.97
Ceratopogoninae	4	0.17
Dasyhelea	49	1.88
Forcipomyia	9	0.34
Simulium	76	2.90
Limonia	4	0.17
TOTAL: DIPTERA	143	5.46
Chironomidae	4	0.17
Apedilum	4	0.17
Cricotopus	27	1.02
Cricotopus bicinctus group	130	4.95
Cricotopus trifascia group	40	1.54
Dicrotendipes	4	0.17
Eukiefferiella	13	0.51
Limnophyes	4	0.17
Micropsectra	36	1.36
Orthocladius	4	0.17
Orthocladius complex	63	2.39
Pentaneura	31	1.19
Pseudochironomus	85	3.24
Rheocricotopus	4	0.17
Rheotanytarsus	4	0.17
Stempellinella	9	0.34
Tanypodinae	4	0.17
Tanytarsus	4	0.17
Thienemanniella	13	0.51
Thienemannimyia group	45	1.71
TOTAL: CHIRONOMIDAE	533	20.30
GRAND TOTAL	2625	100.00

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-5

Tongue R. u/s Decker Highway, TR03, Sept 22, 2016.
WY: Sheridan County Conservation District. WY DEQ protocols.
Riffle habitat, composite 8 Surber, 8 square feet total area, 500 micron.
Abundances= full sample and 1 m2 basis. ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	8

Taxon	Abundance	%
Trepaxonemata	48	1.05
Naididae	8	0.17
Tubificinae	32	0.70
Physella	137	2.97
Pisidium	32	0.70
Sphaerium striatinum	40	0.87
Hyalella	73	1.57
Sperchon	40	0.87
TOTAL: NON INSECTS	412	8.92
Argia	16	0.35
TOTAL: ODONATA	16	0.35
Acentrella insignificans complex	65	1.40
Fallceon	266	5.77
Iswaeon	32	0.70
Ephemera	16	0.35
Asioplax edmundsi	8	0.17
Tricorythodes explicatus	1251	27.10
Neochoroterpes	178	3.85
TOTAL: EPHEMEROPTERA	1816	39.34
Helicopsyche	242	5.24
Cheumatopsyche	105	2.27
Hydropsyche	48	1.05
Nectopsyche	32	0.70
Oecetis avara group	105	2.27
TOTAL: TRICHOPTERA	533	11.54
Petrophila	24	0.52
TOTAL: LEPIDOPTERA	24	0.52
Dubiraphia	16	0.35
Dubiraphia	153	3.32
Microcylloepus	1073	23.25
Stenelmis	186	4.02
Zaitzevia parvula	16	0.35
TOTAL: COLEOPTERA	1445	31.29
Simulium	16	0.35
TOTAL: DIPTERA	16	0.35
Chironomidae	24	0.52
Cricotopus bicinctus group	16	0.35
Cricotopus trifascia group	97	2.10
Dicrotendipes	8	0.17
Nanocladius	16	0.35
Orthocladius complex	32	0.70
Pentaneura	40	0.87
Rheocricotopus	8	0.17
Rheotanytarsus	32	0.70
Thienemannimyia group	81	1.75
TOTAL: CHIRONOMIDAE	355	7.69
GRAND TOTAL	4616	100.00

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-6

Tongue R. u/s Montana Border, TR01, Sept 22, 2016.
WY: Sheridan County Conservation District. WY DEQ protocols.
Riffle habitat, composite 8 Surber, 8 square feet total area. 500 micron.
Abundances= full sample and 1 m2 basis. ABA, Inc.

IDENTIFICATION CODE	Not Listed
CORRECTION FACTOR	5

Taxon	Abundance	%
Nemata	7	0.18
Tubificinae	7	0.18
Physella	47	1.25
Sphaerium striatinum	182	4.82
Sperchon	7	0.18
TOTAL: NON INSECTS	249	6.61
Hetaerina	7	0.18
Argia	20	0.54
TOTAL: ODONATA	27	0.71
Acentrella insignificans complex	121	3.21
Fallceon	551	14.64
Iswaeon	323	8.57
Maccaffertium terminatum	13	0.36
Tricorythodes explicatus	437	11.61
Neochoroterpes	81	2.14
TOTAL: EPHEMEROPTERA	1527	40.54
Culoptila	7	0.18
Helicopsyche	81	2.14
Cheumatopsyche	114	3.04
Hydropsyche	87	2.32
Nectopsyche	7	0.18
Oecetis avara group	229	6.07
Chimarra	7	0.18
TOTAL: TRICHOPTERA	531	14.11
Petrophila	34	0.89
TOTAL: LEPIDOPTERA	34	0.89
Dubiraphia	61	1.62
Microcylloepus	524	13.91
Stenelmis	235	6.25
TOTAL: COLEOPTERA	820	21.79
Simulium	20	0.53
TOTAL: DIPTERA	20	0.53
Chironomidae	61	1.61
Cricotopus trifascia group	390	10.36
Pentaneura	54	1.43
Rheocricotopus	7	0.18
Rheotanytarsus	20	0.54
Thienemannimyia group	27	0.71
TOTAL: CHIRONOMIDAE	558	14.82
GRAND TOTAL	3766	100.00

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-7. Benthic Macroinvertebrate Metrics at Tongue River Station TR09 (Formerly known as TRU - upper canyon station): 1993-2001

METRIC	Tongue R. @ TR09 Canyon WDEQ 1993	Tongue R. @ TR09 Canyon WDEQ 1994	Tongue R. @ TR09 Canyon WDEQ 1995	Tongue R. @ TR09 Canyon WDEQ 1996	Tongue R. @ TR09 Canyon WDEQ 1997	Tongue R. @ TR09 Canyon WDEQ 1998	Tongue R. @ TR09 Canyon WDEQ 1999	Tongue R. @ TR09 Canyon USGS 1999	Tongue R. @ Canyon WDEQ 2000	Tongue R. @ Canyon WDEQ 2001 D.1	Tongue R. @ Canyon WDEQ 2001 D.2
No. Oligochaete Taxa	1	1	0	0	0	0	0	1	0	0	0
% Oligochaete Density	0.16	0.08	0	0	0	0	0	1.37	0	0	0
% Turbellaria Density	0	0	0.14	0	0	0	0	0	0	0	0
% C.Nostococladius Density	0	0	0	0	0	0	0	0	0	0.14	0.29
Density (No./ m2)	1001	3024	4679	2656	6376	4729	3637	4511	281	9725	4977
EPT Density (No./ m2)	819	2335	3652	2379	6030	4447	3120	2768	204	6421	3832
Total Taxa	33	48	41	27	26	31	27	43	24	44	33
No. EPT Taxa	23	26	22	17	20	20	17	23	15	25	21
HBI	1.89	3.20	3.65	2.09	2.38	2.54	2.23	2.92	4.40	4.40	4.45
Brillouin Diversity	2.51	2.67	2.39	2.46	2.29	2.55	2.33	2.94	2.44	2.78	2.68
No. Non-Insect Taxa	1	3	2	1	1	2	1	2	1	2	1
% Non-Insect Density	0.16	0.36	1.54	0.19	0.18	0.51	0.89	1.70	0.96	3.32	1.62
No. Odonata Taxa	0	0	0	0	0	0	0	0	0	0	0
% Odonata Density	0	0	0	0	0	0	0	0	0	0	0
No. Ephemeroptera Taxa	6	7	8	6	7	7	5	8	6	9	7
% Ephemeroptera Density	43.14	45.16	61.27	57.88	47.01	45.05	38.55	36.17	33.65	30.17	30.96
No. Plecoptera Taxa	10	10	8	5	7	7	7	5	6	9	6
% Plecoptera Density	13.25	8.17	4.8	7.03	9.93	15	8.18	3.12	6.72	10.52	7.52
No. Hemiptera Taxa	0	0	0	0	0	0	0	0	0	0	0
% Hemiptera Density	0	0	0	0	0	0	0	0	0	0	0
No. Megaloptera Taxa	0	0	0	0	0	0	0	0	0	0	0
% Megaloptera Density	0	0	0	0	0	0	0	0	0	0	0
No. Trichoptera Taxa	7	9	6	4	6	6	5	10	3	7	6
% Trichoptera Density	25.51	23.89	11.99	24.67	37.61	33.95	39.09	22.05	32.21	25.46	38.5
No. Lepidoptera Density	0	0	0	0	0	0	0	0	0	0	0
% Lepidoptera Density	0	0	0	0	0	0	0	0	0	0	0
No.Coleoptera Taxa	2	3	3	2	1	3	3	5	3	4	3
% Coleoptera Density	13.25	9.64	9.94	8.64	3.44	2.9	9.77	16.75	15.86	26.69	19.32
No. Misc. Diptera Taxa	5	5	6	3	3	3	4	4	3	7	6
% Misc. Diptera Density	3.38	2.97	3.7	1.9	1.62	1.36	2.49	7.96	9.14	1.81	1.32
No. Chironomidae Taxa	2	11	8	4	1	3	2	9	2	6	2
% Chironomidae Density	1.29	9.87	6.81	1.71	0.18	1.19	1.07	12.21	1.44	2.08	0.73
No. Predator Taxa	12	12	8	4	7	6	9	8	6	13	8
% Predator Density	6.93	6.44	3.91	6.08	5.59	5.45	7.13	4.66	9.13	8.13	5.02
No. Parasite Taxa	0	0	1	1	1	2	1	1	1	1	1
% Parasite Density	0	0	1.4	0.19	0.18	0.51	0.89	0.33	0.96	2.77	1.62
No. Collector Gatherer Taxa	10	18	18	12	9	10	10	18	7	13	7
% Collector Gatherer Density	33.92	50.74	64.78	45.36	40.32	44.02	31.81	50.14	26.92	23.67	25.21
No. Collector Filterer Taxa	1	2	2	2	1	2	1	2	2	2	3
% Collector Filterer Density	14.22	8.63	7.93	11.77	14.83	13.99	7.82	8.31	18.27	3.60	5.90
No. Macrophyte Herbivore Taxa	1	1	1	0	0	0	0	1	0	1	1
% Macrophyte Herbivore Density	0.16	0.08	0.45	0	0	0	0	1.02	0	0.14	1.18
No. Piercer Herbivore Taxa	0	0	0	0	0	1	0	0	1	1	1
% Piercer Herbivore Density	0	0	0	0	0	0.17	0	0	0.96	0.14	0.29
No. Scraper Taxa	3	5	3	3	4	4	3	7	4	6	7
% Scraper Density	36.03	30.35	16.83	32.63	31.83	23.38	47.24	28.65	41.62	51.46	52.94
No. Shredder Taxa	1	3	1	2	2	2	1	1	0	3	2
% Shredder Density	0.16	0.63	0.08	0.57	1.08	1.19	1.6	0.02	0	5.26	4.42
No. Xylophage Taxa	0	0	0	0	0	0	0	0	0	0	0
% Xylophage Density	0	0	0	0	0	0	0	0	0	0	0
No. Omnivore Taxa	4	6	6	2	3	3	2	3	2	2	2
% Omnivore Density	8.24	3.81	3.53	2.85	6.14	10.91	3.55	2.4	1.44	3.6	2.95
No. Unknown Taxa	1	1	1	1	0	1	0	2	1	2	1
% Unknown Density	0.32	1.38	1.14	0.57	0	0.34	0	4.43	0.48	0.28	0.44
Percent 1 Dominant	16.64	24.99	34.90	15.56	20.60	20.99	28.95	16.36	17.79	22.96	16.29
Percent 5 Dominant	66.89	63.96	72.45	66.98	74.51	67.06	70.67	51.24	65.86	57.82	60.03
Percent 10 Dominant	88.71	81.37	86.88	90.14	94.03	87.54	91.48	73.39	86.54	80.37	83.93
Ratio EPT/Chironomidae Density	63	7.83	11.49	52.44	52.98	78.71	80.5	5.02	50.33	31.87	104.40
Ratio Hydropsych /Tot. Trichoptera	0.55	0.27	0.65	0.46	0.39	0.41	0.2	0.38	0.57	0.14	0.14
Ratio Baetidae/Tot. Ephemeroptera	0.14	0.55	0.57	0.24	0.41	0.47	0.35	0.29	0.17	0.22	0.29
Ratio Scraper/Collector Filterers	2.54	4.58	2.12	2.77	2.15	1.67	6.05	3.45	2.29	14.31	8.97
Ratio Scraper/Scrap +Coll. Filter	0.72	0.82	0.68	0.74	0.66	0.63	0.86	0.78	0.70	0.93	0.90
Ratio Shredders/Tot. Density	0.002	0.01	0	0.01	0.01	0.01	0.02	0	0.00	0.05	0.04
BCI	117	84	82	92	129	95	109	83	93	90	100
BCI Predicted	50	50	50	50	50	50	50	50	50	50	50
BCI CTQA	42.79	59.73	61.34	54.56	38.81	52.68	45.81	60.36	53.79	55.43	49.76
BCI CTQD	83	58	58	50.73	40.42	48.14	47.61	64.55	52.09	54.72	50.25
Diversity LOGe	2.56	2.71	2.42	2.48	2.3	2.56	2.35	2.96	2.58	2.79	2.70
Diversity LOG2	3.69	3.91	3.49	3.58	3.32	3.7	3.4	4.27	3.72	4.03	3.89
Evenness	0.73	0.70	0.65	0.75	0.71	0.75	0.71	0.79	0.81	0.74	0.77
Simpson D	0.10	0.11	0.16	0.11	0.13	0.11	0.14	0.08	0.10	0.10	0.09
% Multivoltine	9.02	27.90	34.93	14.85	18.40	20.61	13.90	19.50	11.78	14.35	14.36
% Univoltine	67.81	58.67	51.71	73.96	71.20	64.29	71.72	61.73	68.27	54.04	61.21
% Semivoltine	23.18	13.43	13.36	11.20	10.40	15.10	14.39	18.77	19.95	31.61	24.41

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-8. Benthic Macroinvertebrate Metrics at Tongue River Station TR09 (Formerly known as TRU - upper canyon station); 2002-2016

METRIC	Tongue R. @ TR09 Canyon WDEQ 2002	Tongue R. @ TR09 Canyon SCCD 2003	Tongue R. @ TR09 Canyon WDEQ 2003	Tongue R. @ TR09 Canyon WDEQ 2004	Tongue R. @ TR09 Canyon WDEQ 2007 D.1	Tongue R. @ TR09 Canyon WDEQ 2007 D.2	Tongue R. @ TR09 Canyon WDEQ 2009	Tongue R. @ TR09 Canyon SCCD 2010	Tongue R. @ TR09 Canyon SCCD 2013	Tongue R. @ TR09 Canyon SCCD 2016 D.1	Tongue R. @ TR09 Canyon SCCD 2016 D.2
No. Oligochaete Taxa	0	1	0	0	0	0	1	1	0	0	1
% Oligochaete Density	0	0.38	0	0	0	0	2.51	0.75	0	0	0.19
% Turbellaria Density	0	0	0	0.35	1.00	0	0	0.19	0	0	1
% C. Nostococladius Density	0.93	6.00	1.47	0	0.18	0	0	0.19	0	0	0
Density (No./ m2)	3327	2995	7317	15252	Not Reported	Not Reported	Not Reported	1132	1049	997	924
EPT Density (No./ m2)	2620	1976	6322	13612	Not Reported	Not Reported	Not Reported	825	748	740	630
Total Taxa	40	47	33	33	38	31	30	43	34	31	41
No. EPT Taxa	24	25	19	20	23	19	17	20	19	16	16
HBI	2.16	5.06	1.86	2.44	3.32	3.46	2.62	4.39	2.69	1.98	2.19
Brillouin Diversity	Not Reported	3.00	Not Reported	Not Reported	Not Reported	Not Reported	Not Reported	2.86	Not Reported	Not Reported	Not Reported
No. Non-Insect Taxa	1	3	2	4	2	1	4	5	3	3	6
% Non-Insect Density	0.56	1.73	0.55	1.59	0.36	0.20	3.86	4.88	2.12	1.18	3.80
No. Odonata Taxa	0	0	0	0	0	0	0	0	0	0	0
% Odonata Density	0	0	0	0	0	0	0	0	0	0	0
No. Ephemeroptera Taxa	9	9	7	7	9	9	6	8	8	9	9
% Ephemeroptera Density	21.83	19.99	21.32	19.22	59.93	57.29	48.07	21.17	35.58	17.16	17.84
No. Plecoptera Taxa	7	6	2	6	6	5	5	3	4	1	2
% Plecoptera Density	2.61	2.49	1.1	2.47	4.92	3.99	2.7	1.32	3.85	1.542	0.3795
No. Hemiptera Taxa	0	0	0	0	0	0	0	0	0	0	1
% Hemiptera Density	0	0	0	0	0	0	0	0	0	0	0.3795
No. Megaloptera Taxa	0	0	0	0	0	0	0	0	0	0	0
% Megaloptera Density	0	0	0	0	0	0	0	0	0	0	0
No. Trichoptera Taxa	8	10	10	7	8	5	8	9	7	8	5
% Trichoptera Density	54.29	43.45	63.97	687.55	21.13	27.74	27.61	50.39	31.92	55.52	49.91
No. Lepidoptera Density	0	0	0	0	0	0	0	0	0	0	0
% Lepidoptera Density	0	0	0	0	0	0	0	0	0	0	0
No Coleoptera Taxa	5	3	3	3	2	2	2	3	3	3	3
% Coleoptera Density	16.04	15.19	4.41	7.76	5.28	4.59	10.04	8.05	11.73	19.66	16.51
No. Misc. Diptera Taxa	3	6	6	3	5	6	6	4	4	3	5
% Misc. Diptera Density	1.67	5.76	4.78	0.53	3.1	3.79	7.72	3.75	6.88	1.57	3.23
No. Chironomidae Taxa	8	10	3	3	6	3	3	11	5	6	10
% Chironomidae Density	2.8	11.35	3.86	0.88	4.37	2.4	2.7	10.49	7.88	3.47	7.97
No. Predator Taxa	10	10	6	8	7	Not Reported	4	6	9	5	10
% Predator Density	4.1	4.80	1.65	2.82	3.28	Not Reported	3.86	3.95	18.85	14.21	17.65
No. Parasite Taxa	0	2	0	1	Not Reported	Not Reported	Not Reported	2	2	3	2
% Parasite Density	0	1.35	0	0.53	Not Reported	Not Reported	Not Reported	3.75	1.92	1.157	1.139
No. Collector Gatherer Taxa	18	16	11	12	14	Not Reported	12	19	12	13	16
% Collector Gatherer Density	22.01	28.06	21.14	19.40	62.30	64.70	50.97	29.22	17.31	23.52	27.32
No. Collector Filterer Taxa	2	2	2	1	3	Not Reported	3	3	2	2	4
% Collector Filterer Density	4.65	13.65	7.35	4.59	6.74	Not Reported	11.2	6	16.92	3.085	4.175
No. Macrophyte Herbivore Taxa	1	1	2	0	1	0	0	0	0	1	1
% Macrophyte Herbivore Density	0.93	0.19	1.65	0	0.18	0	0	0	0	0.96	0.38
No. Piercer Herbivore Taxa	0	1	0	0	Not Reported	Not Reported	Not Reported	1	0	0	1
% Piercer Herbivore Density	0	0.19	0	0	Not Reported	Not Reported	Not Reported	0.19	0	0	0.38
No. Scraper Taxa	5	6	6	5	4	4	5	5	6	6	7
% Scraper Density	63.06	47.50	63.79	69.31	23.86	22.71	29.15	40.44	34.62	45.31	41.37
No. Shredder Taxa	1	1	2	1	2	Not Reported	3	2	3	0	0
% Shredder Density	3.54	1.15	2.76	2.47	0.81	Not Reported	1.93	3.94	8.27	0	0
No. Xylophage Taxa	Not Reported	0	Not Reported	0	Not Reported	Not Reported	Not Reported	0	Not Reported	Not Reported	Not Reported
% Xylophage Density	Not Reported	0.00	Not Reported	0	Not Reported	Not Reported	Not Reported	0	Not Reported	Not Reported	Not Reported
No. Omnivore Taxa	2	4	3	3	Not Reported	Not Reported	Not Reported	4	1	2	1
% Omnivore Density	0.75	1.92	1.29	0.53	Not Reported	Not Reported	Not Reported	11.81	2.12	11.76	7.59
No. Unknown Taxa	2	2	1	1	Not Reported	Not Reported	Not Reported	1	0	0	0
% Unknown Density	0.75	1.15	0.37	0.18	Not Reported	Not Reported	Not Reported	0.75	0	0	0
Percent 1 Dominant	31.72	20.77	52.94	56.79	31.15	28.54	16.41	21.72	16.54	22.56	18.79
Percent 5 Dominant	70.52	52.89	75.18	82.36	46.99	78.84	61.00	54.87	61.15	76.54	68.12
Percent 10 Dominant	86.38	70.38	89.52	93.65	56.65	89.22	82.43	73.61	75.19	89.65	85.01
Ratio EPT/Chironomidae Density	28.13	5.81	22.42	101.58	19.67	14.39	29.00	6.95	9.01	6.61	3.69
Ratio Hydropsych /Tot. Trichoptera	0.08	0.24	0.06	0.07	0.25	0.10	0.40	0.11	0.476	0.05	0.03
Ratio Baetidae/Tot. Ephemeroptera	0.36	0.23	0.25	0.41	0.53	0.51	0.29	0.15	0.075	0.012	0.012
Ratio Scraper/Collector Filterers	13.00	3.48	8.68	15.12	Not Reported	Not Reported	Not Reported	6.75	2.04	14.56	9.79
Ratio Scraper/Scrap +Coll. Filter	0.93	0.78	0.90	0.94	Not Reported	Not Reported	Not Reported	0.87	0.67	0.94	0.91
Ratio Shredders/Tot. Density	Not Reported	0.01	Not Reported	Not Reported	Not Reported	Not Reported	Not Reported	0.04	0.005	0.00	0.00
BCI	73	79	90	98	82	Not Reported	80	75	82	76	66
BCI Predicted	50	50	50	50	50	50	50	50	50	50	50
BCI CTQA	68.59	63.64	55.83	51.00	80.66	No Report	62.61	67.02	60.71	64.46	75.15
BCI CTQD	Not Reported	Not Reported	Not Reported	Not Reported	Not Reported	Not Reported	Not Reported	62.31	57.72	57.16	68.27
Diversity LOGe	3.61	3.04	2.91	1.81	2.29	Not Reported	2.74	2.94	2.85	2.39	2.83
Diversity LOG2	2.51	4.39	2.02	2.60	3.31	Not Reported	3.95	4.24	4.11	3.45	3.8
Evenness	0.06	0.79	0.06	0.07	Not Reported	Not Reported	Not Reported	0.78	0.81	0.7	0.71
Simpson D	0.15	0.08	0.29	0.34	Not Reported	Not Reported	Not Reported	0.09	Not Reported	Not Reported	Not Reported
% Multivoltine	11.19	19.42	9.38	Not Reported	Not Reported	Not Reported	Not Reported	15.78	21.54	29.11	31.5
% Univoltine	71.08	60.39	84.74	Not Reported	Not Reported	Not Reported	Not Reported	66.43	59.04	48.78	49.15
% Semivoltine	17.72	20.19	5.88	Not Reported	Not Reported	Not Reported	Not Reported	17.79	19.42	22.11	19.35

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-9. Benthic Macroinvertebrate Metrics at Tongue River Station TR07 (Formerly known as TRL - lower Ranchester station); 1996-2016

METRIC	Tongue R. @ TR07 WDEQ 1996	Tongue R. @ TR07 WDEQ 1997	Tongus R. @ TR07 WDEQ 1998	Tongue R. @ TR07 SCCD 1999	Tongue R. @ TR07 SCCD 2003 D. 1	Tongue R. @ TR07 SCCD 2003 D. 2	Tongue R. @ TR07 SCCD 2004	Tongue R. @ TR07 SCCD 2006	Tongue R. @ TR07 SCCD 2010	Tongue R. @ TR07 SCCD 2013	Tongue R. @ TR07 SCCD 2016
No. Oligochaete Taxa	3	4	0	0	4	4	1	7	3	3	2
% Oligochaete Density	3.65	1.42	0	0	3.08	1.41	1.44	2.28	0.54	4.12	1.81
% Turbellaria Density	0.58	1.06	0	0.37	3.42	4.77	4.87	2.15	0.71	3.44	1.63
% C.Nostococladius Density	0	0	0	0	0	0	0	0	2.49	0	0
Density (No./ m2)	41985	18304	17529	22072	16852	22839	25178	4806	1742	2938	1566
EPT Density (No./ m2)	33895	16303	14140	18037	12687	15011	15387	2359	1076	2123	1151
Total Taxa	37	37	36	40	39	35	39	52	37	43	48
No. EPT Taxa	19	20	19	21	15	12	12	18	11	13	20
HBI	3.88	3.33	4.24	3.79	6.39	6.48	6.13	6.62	6.70	6.38	5.97
Brillouin Diversity	2.31	2.34	1.94	2.36	2.82	2.75	Not Reported	2.97	2.29	Not Reported	Not Reported
No. Non-Insect Taxa	4	5	1	2	8	8	4	13	6	10	7
% Non-Insect Density	4.23	2.48	0.37	0.74	9.58	6.72	16.88	11.07	3.92	11.25	9.074
No. Odonata Taxa	0	0	0	0	0	0	0	0	0	0	0
% Odonata Density	0	0	0	0	0	0	0	0	0	0	0
No. Ephemeroptera Taxa	7	7	7	9	5	5	4	8	5	6	10
% Ephemeroptera Density	26.53	39.33	13.99	45.71	27.4	23.31	14.85	32.81	40.05	31.93	38.66
No. Plecoptera Taxa	4	3	4	5	0	0	0	0	1	0	1
% Plecoptera Density	1.72	1.06	1.46	1.28	0	0	0	0	0.18	0	2.88
No. Hemiptera Taxa	0	0	0	0	1	0	0	0	0	0	1
% Hemiptera Density	0	0	0	0	0.17	0	0	0	0	0	4.719
No. Megaloptera Taxa	0	0	0	0	0	0	0	0	0	0	0
% Megaloptera Density	0	0	0	0	0	0	0	0	0	0	0
No. Trichoptera Taxa	8	10	8	7	10	7	8	10	5	7	9
% Trichoptera Density	52.49	48.69	65.18	34.73	39.9	42.4	46.26	18.44	21.53	40.34	33.76
No. Lepidoptera Density	1	1	1	1	1	1	1	1	1	1	1
% Lepidoptera Density	0.19	0.71	0.55	0.55	0.68	0.71	0.32	0.18	0.53	0.52	4.9
No.Coleoptera Taxa	3	3	4	3	6	6	7	5	5	5	4
% Coleoptera Density	7.11	4.58	5.52	4.21	17.81	20.31	9.08	18.78	6.24	2.06	2.54
No. Misc. Diptera Taxa	2	1	4	1	3	2	4	4	3	3	6
% Misc. Diptera Density	0.77	0.18	4.22	2.93	1.54	0.71	0.96	4.04	14.77	0.49	2.36
No. Chironomidae Taxa	8	7	7	12	5	6	9	11	11	11	9
% Chironomidae Density	6.91	3.01	8.65	9.89	2.9	5.83	11.65	14.75	12.81	9.61	3.81
No. Predator Taxa	5	3	6	6	6	7	5	5	2	8	6
% Predator Density	1.14	1.06	1.64	2.19	1.02	0.36	1.92	1.24	0.89	8.16	3.99
No. Parasite Taxa	0	0	1	1	2	0	0	2	2	2	1
% Parasite Density	0	0	0.37	0.37	2.91	0	0	3.86	2.67	3.26	3.45
No. Collector Gatherer Taxa	16	15	13	17	13	16	15	25	17	21	25
% Collector Gatherer Density	35.56	42.52	21.72	53.42	35.44	33.2	33.01	53.54	48.07	45.49	46.82
No. Collector Filterer Taxa	4	4	3	3	4	5	5	5	3	6	5
% Collector Filterer Density	47.12	36.34	64.64	34.74	25.35	20.85	19.66	17.89	31.68	41.2	29.4
No. Macrophyte Herbivore Taxa	0	0	0	0	0	0	0	0	0	1	1
% Macrophyte Herbivore Density	0	0	0	0	0	0	0	0	0	0.34	0.73
No. Piercer Herbivore Taxa	0	0	0	0	1	1	0	1	2	1	2
% Piercer Herbivore Density	0	0	0	0	0.17	0.35	0	0.35	2.67	0.34	4.9
No. Scraper Taxa	6	8	7	7	7	6	5	7	3	2	5
% Scraper Density	10.38	9.35	7.35	6.21	25.12	35.35	35.58	18.26	5.18	0.69	7.62
No. Shredder Taxa	1	2	1	1	0	0	3	1	1	2	2
% Shredder Density	0.38	8.12	0.55	0.18	0	0	0.32	0.18	3.02	0.52	0.73
No. Xylophage Taxa	0	0	0	0	0	0	0	0	0	Not Reported	Not Reported
% Xylophage Density	0	0	0	0	0	0	0	0	0	Not Reported	Not Reported
No. Omnivore Taxa	4	4	4	4	5	4	4	5	5	0	1
% Omnivore Density	4.99	2.12	2.57	2.75	9.41	9.36	4.49	4.57	4.80	0	2.36
No. Unknown Taxa	1	1	1	1	1	1	1	1	2	0	0
% Unknown Density	0.38	0.53	1.1	0.18	0.51	0.53	4.91	0.18	1.07	0	0
Percent 1 Dominant	43.65	35.1	58.93	30.71	14.04	15.55	23.08	24.04	37.9	29.35	32.67
Percent 5 Dominant	68.65	75.31	75.13	74.41	56	58.65	56.73	55.09	72.96	66.26	70.05
Percent 10 Dominant	80.77	87.3	85.25	84.66	81	83.73	78.63	70.52	85.24	81.54	80.94
Ratio EPT/Chironomidae Density	11.67	29.71	9.32	8.28	23.12	11.27	5.25	3.48	4.82	7.53	19.18
Ratio Hydropsych /Tot. Trichoptera	0.87	0.74	0.94	0.92	0.5	0.41	0.36	0.58	0.83	0.92	0.82
Ratio Baetidae/Tot. Ephemeroptera	0.14	0.24	0.49	0.29	0.71	0.67	0.67	0.21	0.96	0.84	0.11
Ratio Scraper/Collector Filterers	0.22	0.26	0.11	0.18	0.99	1.69	1.81	1.02	0.16	0.016	0.26
Ratio Scraper/Scrap.+Coll. Filter.	0.18	0.2	0.1	0.15	0.5	0.63	0.64	0.5	0.14	0.47	0.21
Ratio Shredders/Tot. Density	0	0.08	0.01	0	0	0	Not Reported	0	0.03	0.08	0.01
BCI	71	72	73	71	62	59	59	57	57	57	61
BCI Predicted	53	53	53	53	53	53	53	53	53	53	53
BCI CTQA	74.7	73.76	72.33	74.53	85.54	92.06	89.171	92.6	93.49	93.44	87.29
BCI CTQD	75.32	71.33	75.08	76.41	86.12	89.93	Not Reported	92.73	94.99	93.17	88.23
Diversity LOGe	2.31	2.35	1.94	2.37	2.82	2.75	2.61	3.00	2.34	2.63	2.55
Diversity LOG2	3.33	3.39	2.81	3.42	4.07	3.97	3.77	4.33	3.37	3.80	3.67
Evenness	0.64	0.65	0.54	0.64	0.77	0.77	0.58	0.76	0.65	0.70	0.66
Simpson D	0.22	0.17	0.36	0.18	0.08	0.09	0.11	0.09	0.19	Not Reported	Not Reported
% Multivoltine	20.05	19.44	27.21	25.96	28.25	25.44	Not Reported	26.54	46.4	74.5	62.98
% Univoltine	69.76	74.38	65.05	68.01	53.25	53.71	Not Reported	53.99	47.2	22.32	34.46
% Semivoltine	10.19	6.17	7.73	6.03	18.49	20.85	Not Reported	19.47	6.41	3.18	2.54

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-10. Benthic Macroinvertebrate Metrics at Tongue River Station TR05 (Formerly known as TR1 - Kleenburn station); 1995 -2016

METRIC	Tongue R. @ TR05 WDEQ 1995	Tongue R. @ TR05 WDEQ 1998	Tongue R. @ TR05 WDEQ 2004	Tongue R. @ TR05 SCCD 2006 D. 1	Tongue R. @ TR05 SCCD 2006 D. 2	Tongue R. @ TR05 SCCD 2010	Tongue R. @ TR05 SCCD 2013	Tongue R. @ TR05 SCCD 2016
No. Oligochaete Taxa	1	4	2	1	2	1	3	4
% Oligochaete Density	0.59	4.47	5.66	1.43	1.88	0.17	1.18	3.41
% Turbellaria Density	1.91	1.30	0.90	2.15	2.92	3.67	0.36	2.73
% C.Nostocoeladius Density	0	0	0	0	0	0	0	0
Density (No./ m2)	6852	8668	20928	3762	3364	1611	3372	2625
EPT Density (No./ m2)	5510	5698	9980	2046	1944	1009	2242	1165
Total Taxa	44	50	32	36	38	36	40	56
No. EPT Taxa	24	21	14	15	15	16	15	17
HBI	4.77	4.64	6.56	6.59	6.46	7.00	6.31	6.37
Brillouin Diversity	2.64	3.09	Not Reported	2.87	2.72	2.68	Not Reported	Not Reported
No. Non-Insect Taxa	5	8	8	5	7	6	9	9
% Non-Insect Density	3.82	7.81	14.40	6.98	7.03	4.68	3.76	22.70
No. Odonata Taxa	1	1	1	0	0	1	1	0
% Odonata Density	0.29	0.19	0.13	0	0	0.83	0.17	0
No. Ephemeroptera Taxa	12	12	6	7	7	8	7	8
% Ephemeroptera Density	64.36	36.88	7.71	22.36	16.64	23.7	14.87	33.79
No. Plecoptera Taxa	2	2	0	0	0	0	0	0
% Plecoptera Density	0.3	3.17	0	0	0	0	0	0
No. Hemiptera Taxa	0	0	0	0	0	0	0	0
% Hemiptera Density	0	0	0	0	0	0	0	0
No. Megaloptera Taxa	0	0	0	0	0	0	0	0
% Megaloptera Density	0	0	0	0	0	0	0	0
No. Trichoptera Taxa	10	7	8	8	8	8	8	9
% Trichoptera Density	15.76	25.69	39.97	32.03	41.15	38.88	51.62	10.58
No. Lepidoptera Density	1	1	0	1	0	1	1	1
% Lepidoptera Density	0.29	2.61	0	0.18	0	0.33	1.54	1.20
No.Coleoptera Taxa	5	3	4	5	5	5	5	4
% Coleoptera Density	11.19	11.74	32.26	24.86	22.48	27.04	14.02	5.97
No. Misc. Diptera Taxa	1	5	1	2	1	1	1	5
% Misc. Diptera Density	0.59	6.9	0.26	3.04	0.34	2.67	8.89	5.46
No. Chironomidae Taxa	7	11	4	8	10	6	8	20
% Chironomidae Density	3.39	5.04	5.27	10.55	12.35	1.83	5.13	20.31
No. Predator Taxa	4	7	3	1	1	2	5	6
% Predator Density	0.88	5.97	2.57	1.43	0.69	1.00	5.30	6.66
No. Parasite Taxa	2	1	1	1	1	1	2	1
% Parasite Density	1.03	0.37	0.39	1.79	0.86	0.17	0.68	4.44
No. Collector Gatherer Taxa	19	25	12	15	18	14	19	33
% Collector Gatherer Density	58.47	47.49	24.81	34.88	29.16	28.89	31.28	67.98
No. Collector Filterer Taxa	3	4	4	5	5	6	6	7
% Collector Filterer Density	10.16	16.94	6.17	22.54	26.40	16.18	36.07	7.85
No. Macrophyte Herbivore Taxa	0	0	0	0	0	0	1	0
% Macrophyte Herbivore Density	0	0	0	0	0	0	0.34	0
No. Piercer Herbivore Taxa	2	0	0	1	1	0	1	1
% Piercer Herbivore Density	0.3	0	0	0.36	0.17	0	1.37	0.5119
No. Scraper Taxa	7	7	5	8	7	6	4	4
% Scraper Density	22.08	18.26	58.87	33.45	33.62	47.39	21.54	10.75
No. Shredder Taxa	0	1	0	0	0	1	1	3
% Shredder Density	0	0.19	0	0	0	0.17	1.88	1.20
No. Xylophage Taxa	0	0	0	0	0	0	Not Reported	Not Reported
% Xylophage Density	0	0	0	0	0	0	Not Reported	Not Reported
No. Omnivore Taxa	4	5	4	5	5	5	1	1
% Omnivore Density	5.6	10.81	4.37	5.55	9.09	5.83	1.54	1.536
No. Unknown Taxa	3	0	1	0	0	1	0	0
% Unknown Density	1.47	0	1.41	0	0	0.33	0	0
Percent 1 Dominant	26.07	20.86	29.56	13.95	18.52	20.53	18.29	25.94
Percent 5 Dominant	66.13	49.92	68.38	57.24	64.15	57.91	59.15	47.27
Percent 10 Dominant	83.5	67.61	82.78	75.48	79.76	79.61	78.80	62.63
Ratio EPT/Chironomidae Density	23.74	13.07	9.05	5.15	4.68	34.09	12.96	2.19
Ratio Hydropsych./Tot. Trichoptera	0.61	0.45	0.06	0.17	0.15	0.21	0.396	0.351
Ratio Baetidae/Tot. Ephemeroptera	0.54	0.14	0.13	0.15	0.15	0.46	0.345	0.212
Ratio Scraper/Collector Filterers	2.17	1.08	9.54	1.48	1.27	2.93	0.597	1.37
Ratio Scraper/Scrap.+Coll. Filter	0.68	0.52	0.90	0.60	0.56	0.75	0.374	0.58
Ratio Shredders/Tot. Density	0	0	0	0	0	0	0.019	0.012
BCI	63	68	61	60	59	65	58	57
BCI Predicted	50	53	53	53	53	53	53	53
BCI CTQA	79.98	77.52	87.38	87.61	89.63	81.36	90.55	93.2
BCI CTQD	79.22	76.54	Not Reported	87.95	88.13	77.87	87.23	93.83
Diversity LOGe	2.66	3.11	2.38	2.90	2.75	2.73	2.83	3.16
Diversity LOG2	3.84	4.49	3.43	4.18	3.96	3.94	4.09	4.55
Evenness	0.70	0.80	0.07	0.81	0.76	0.76	0.77	0.78
Simpson D	0.12	0.08	0.17	0.08	0.10	0.10	Not Reported	Not Reported
% Multivoltine	34.42	12.10	Not Reported	16.01	16.64	14.44	71.97	78.16
% Univoltine	52.62	68.34	Not Reported	58.59	60.55	56.59	13.83	16.04
% Semivoltine	12.96	19.55	Not Reported	25.40	22.81	27.96	14.19	5.80

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-11. Benthic Macroinvertebrate Metrics at Tongue River Station TR03 - Decker HWY; 1998-2016

METRIC	Tongue R. TR03 WDEQ 1998	Tongue R. TR03 WDEQ 2004	Tongue R. TR03 SCCD 2013	Tongue R. TR03 SCCD 2016
No. Oligochaete Taxa	3	4	2	2
% Oligochaete Density	4.02	3.16	2.3	0.87
% Turbellaria Density	0	3.33	1.41	1.05
% C Nostococladius Density	0	0	0	0
Density (No./ m2)	12047	11500	2835	4616
EPT Density (No./ m2)	9404	2804	1170	2348
Total Taxa	39	38	43	37
No. EPT Taxa	17	12	15	12
HBI	4.62	7.28	6.24	6.52
Brillouin Diversity	1.89	Not Reported	Not Reported	Not Reported
No. Non-Insect Taxa	6	13	7	8
% Non-Insect Density	4.53	35.09	9.08	8.92
No. Odonata Taxa	0	1	1	1
% Odonata Density	0	0.18	0.18	0.35
No. Ephemeroptera Taxa	10	4	8	7
% Ephemeroptera Density	88.53	19.12	29.54	39.34
No. Plecoptera Taxa	1	0	0	0
% Plecoptera Density	0.67	0	0	0
No. Hemiptera Taxa	1	0	1	0
% Hemiptera Density	0.17	0	0.18	0
No. Megaloptera Taxa	0	0	0	0
% Megaloptera Density	0	0	0	0
No. Trichoptera Taxa	6	8	7	5
% Trichoptera Density	8.9	5.26	11.74	11.54
No. Lepidoptera Density	1	0	1	1
% Lepidoptera Density	1.01	0	0.53	0.52
No Coleoptera Taxa	3	4	4	4
% Coleoptera Density	7.71	32.63	33.63	31.29
No. Misc. Diptera Taxa	3	3	2	1
% Misc. Diptera Density	1.35	3.16	2.48	0.35
No. Chironomidae Taxa	8	5	12	10
% Chironomidae Density	7.23	4.56	10.85	7.69
No. Predator Taxa	6	4	6	5
% Predator Density	2.53	3.86	8.9	6.29
No. Parasite Taxa	1	1	0	1
% Parasite Density	0.17	0.35	0	0.87
No. Collector Gatherer Taxa	18	11	23	22
% Collector Gatherer Density	77.42	34.91	72.06	80.42
No. Collector Filterer Taxa	2	6	7	6
% Collector Filterer Density	6.54	3.16	11.57	5.94
No. Macrophyte Herbivore Taxa	0	0	1	0
% Macrophyte Herbivore Density	0	0	0.71	0
No. Piercer Herbivore Taxa	1	0	1	0
% Piercer Herbivore Density	0.17	0	2.85	0
No. Scraper Taxa	5	7	4	2
% Scraper Density	7.55	55.09	3.74	5.77
No. Shredder Taxa	0	1	1	1
% Shredder Density	0	0.18	0.18	0.70
No. Xylophage Taxa	0	0	Not Reported	Not Reported
% Xylophage Density	0	0	Not Reported	Not Reported
No. Omnivore Taxa	5	2	0	0
% Omnivore Density	2.87	0.53	0	0
No. Unknown Taxa	1	2	0	0
% Unknown Density	2.85	0.35	0	0
Percent 1 Dominant	59.97	24.74	21.89	27.10
Percent 5 Dominant	76.73	75.44	58.54	65.38
Percent 10 Dominant	86.62	87.54	73.67	80.42
Ratio EPT/Chironomidae Density	10.84	5.35	3.80	6.61
Ratio Hydropsych /Tot. Trichoptera	0.72	0.133	0.213	0.267
Ratio Baetidae/Tot. Ephemeroptera	0.08	0.073	0.391	0.2
Ratio Scraper/Collector Filterers	1.15	17.44	0.323	0.97
Ratio Scraper/Scrap.+Coll. Filter.	0.54	0.946	0.244	0.403
Ratio Shredders/Tot. Density	0	0.002	0.002	0.012
BCI	79	72	71	69
BCI Predicted	65	65	65	65
BCI CTQA	91.95	90.879	91.49	94.43
BCI CTQD	82.56	Not Reported	91.85	92.82
Diversity LOGe	1.90	2.39	2.89	2.59
Diversity LOG2	2.75	3.45	4.17	3.73
Evenness	0.52	0.67	0.77	0.72
Simpson D	0.37	0.141	Not Reported	Not Reported
% Multivoltine	11.43	Not Reported	52.49	56.12
% Univoltine	80.11	Not Reported	12.10	14.34
% Semivoltine	8.46	Not Reported	35.41	29.55

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APPENDIX D. TONGUE RIVER WATERSHED 2016 BENTHIC MACROINVERTEBRATE DATA

APPENDIX TABLE D-12. Benthic Macroinvertebrate Metrics at Tongue River Station TR01 - near state line; 1998-2016

METRIC	Tongue R. TR01 WDEQ 1998 Dup. 1	Tongue R. TR01 WDEQ 1998 Dup. 2	Tongue R. TR01 WDEQ 2003	Tongue R. TR01 WDEQ 2004	Tongue R. TR01 - Dup. 1 SCCD 2013	Tongue R. TR01 - Dup. 2 SCCD 2013	Tongue R. TR01 SCCD 2016
No. Oligochaete Taxa	4	4	2	2	2	2	1
% Oligochaete Density	21.08	4.75	3.93	6.81	0.88	1.83	0.18
% Turbellaria Density	0.35	1.71	0.94	0.24	1.07	1	0
% C.Nostocoocladius Density	0	0	0	0.24	0	0	0
Density (No./ m2)	15306	14851	7182	22515	5701	4810	3766
EPT Density (No./ m2)	7693	9062	Not Reported	11756	3268	2018	2058
Total Taxa	45	43	33	43	32	33	31
No. EPT Taxa	19	20	14	14	13	12	13
HBI	5.8	5.24	6.29	6.47	5.92	5.96	5.9
Brillouin Diversity	2.69	2.73	Not Reported	Not Reported	Not Reported	Not Reported	Not Reported
No. Non-Insect Taxa	9	9	7	12	5	7	5
% Non-Insect Density	22.85	17.72	7.66	11.35	2.83	5.37	6.61
No. Odonata Taxa	2	1	0	1	1	0	2
% Odonata Density	0.53	0.16	0	0.12	0.02	0	0.71
No. Ephemeroptera Taxa	8	10	5	7	5	6	6
% Ephemeroptera Density	39.89	48.93	18.54	31.42	35.92	27.01	40.54
No. Plecoptera Taxa	2	2	0	0	0	0	0
% Plecoptera Density	0.36	0.63	0	0	0	0	0
No. Hemiptera Taxa	1	0	0	0	0	0	0
% Hemiptera Density	0.18	0	0	0	0	0	0
No. Megaloptera Taxa	0	0	0	0	0	0	0
% Megaloptera Density	0	0	0	0	0	0	0
No. Trichoptera Taxa	9	8	9	7	8	6	7
% Trichoptera Density	10.02	11.52	41.2	20.79	21.41	14.93	14.11
No. Lepidoptera Density	0	0	1	1	1	1	1
% Lepidoptera Density	0	0	2.25	0.84	0.35	0.17	0.89
No.Coleoptera Taxa	4	3	5	3	3	3	3
% Coleoptera Density	11.8	9.16	16.46	10.63	20.00	23.15	21.79
No. Misc. Diptera Taxa	1	3	1	2	2	1	1
% Misc. Diptera Density	0.18	0.63	8.43	5.73	11.50	20.47	0.53
No. Chironomidae Taxa	9	7	6	10	7	9	6
% Chironomidae Density	14.43	11.34	5.43	19.12	7.96	8.89	14.82
No. Predator Taxa	10	7	3	5	7	5	5
% Predator Density	3.02	1.89	1.5	1.19	10.29	10.40	8.93
No. Parasite Taxa	0	1	1	1	1	2	2
% Parasite Density	0	0.16	0.75	1.55	0.18	0.34	0.36
No. Collector Gatherer Taxa	23	21	14	17	11	13	13
% Collector Gatherer Density	69.25	68.66	29.03	46.95	56.80	52.68	75.54
No. Collector Filterer Taxa	2	3	5	5	6	7	6
% Collector Filterer Density	2.61	4.35	20.41	27.12	27.60	31.54	11.43
No. Macrophyte Herbivore Taxa	0	0	1	0	0	1	0
% Macrophyte Herbivore Density	0	0	15.73	0	0	0.17	0
No. Piercer Herbivore Taxa	1	1	0	0	2	1	0
% Piercer Herbivore Density	3.69	3.11	0	0	3.18	2.35	0
No. Scraper Taxa	5	5	6	6	3	3	4
% Scraper Density	10.37	15.07	18.35	8.96	1.24	2.18	3.57
No. Shredder Taxa	0	0	0	0	1	1	1
% Shredder Density	0	0	0	0	0.35	0.34	0.18
No. Xylophage Taxa	0	0	Not Reported	0	Not Reported	Not Reported	Not Reported
% Xylophage Density	0	0	Not Reported	0	Not Reported	Not Reported	Not Reported
No. Omnivore Taxa	3	4	4	3	1	0	0
% Omnivore Density	1.76	1.57	14.23	2.75	0.35	0	0
No. Unknown Taxa	1	1	0	0	0	0	0
% Unknown Density	9.14	5.28	0	0	0	0	0
Percent 1 Dominant	27.59	34.16	15.73	22.82	27.60	20.47	14.64
Percent 5 Dominant	64.14	58.38	58.05	59.26	73.96	64.09	59.11
Percent 10 Dominant	79.95	74.69	76.03	79.81	89.54	82.55	82.50
Ratio EPT/Chironomidae Density	3.49	5.38	11	1.46	7.2	4.71	3.69
Ratio Hydropsych./Tot. Trichoptera	0.28	0.35	0.18	0.351	0.695	0.259	0.38
Ratio Baetidae/Tot. Ephemeroptera	0.05	0.06	0.14	0.259	0.768	0.658	0.652
Ratio Scraper/Collector Filterers	3.69	3.46	0.9	0.33	0.045	0.069	0.31
Ratio Scraper/Scrap.+Coll. Filter.	0.79	0.78	0.47	0.248	0.043	0.065	0.251
Ratio Shredders/Tot. Density	0	0	0	0	0.004	0.003	0.002
BCI	66	69	64	60	63	60	64
BCI Predicted	55	55	55	55	55	55	55
BCI CTQA	83.82	79.36	86.56	91.85	87.56	92.18	86.47
BCI CTQD	85.33	82.35	Not Reported	Not Reported	89.13	92.32	87.79
Diversity LOGe	2.70	2.74	4.67	2.74	2.39	2.66	2.73
Diversity LOG2	3.90	3.95	3.24	3.96	3.46	3.83	3.94
Evenness	0.71	0.73	0.10	0.05	0.69	0.76	0.79
Simpson D	0.13	0.14	0.08	0.102	Not Reported	Not Reported	Not Reported
% Multivoltine	16.7	16.11	25.84	Not Reported	66.89	59.56	60.71
% Univoltine	70.56	74.26	57.68	Not Reported	13.29	18.12	14.11
% Semivoltine	12.74	9.63	16.48	Not Reported	19.82	22.32	25.18

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APPENDIX E

2016 Tongue River Watershed Habitat Assessment Data

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TABLE E-1. STREAM HABITAT, SUBSTRATE, AND VELOCITY DATA COLLECTED DURING HABITAT ASSESSMENTS AT TONGUE RIVER STATION TR09

Stream Name	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.
Location	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon	TR09 Canyon
Sampler	WDEQ	WDEQ	WDEQ	WDEQ	WDEQ	WDEQ	WDEQ	WDEQ	WDEQ	WDEQ	SCCD	WDEQ	WDEQ	SCCD	SCCD	SCCD	Average
Date	10/19/1993	10/20/1994	10/16/1995	9/26/1996	10/13/1997	10/13/1998	10/12/1999	9/20/2000	10/10/2001	9/19/2002	9/24/2003	9/30/2003	10/11/2004	9/9/2010	9/9/2013	10/4/2016	All Years
HABITAT PARAMETER																	
Percent Fines	19	16	18	18	17	19	19	19	18	20	17	18	19	12	17	14	18
Instream Cover	16	18	18	19	18	19	19	18	19	18	17	19	20	17	19	16	18
Embeddedness	18	19	17	19	20	20	20	18	18	20	20	20	20	20	19	15	19
Velocity/Depth	18	18	18	18	18	19	16	17	18	15	16	20	20	15	19	16	18
Channel Flow	18	18	18	19	19	18	19	18	17	18	14	20	17	18	16	19	18
Channel Shape	9	11	11	11	11	9	9	10	11	6	8	7	7	10	7	7	9
Pool/Riffle	11	14	14	13	12	13	14	14	14	12	12	15	15	9	14	13	13
Channel Alteration	15	15	15	14	14	15	15	15	15	15	11	15	15	14	12	11	14
Width/Depth	7	9	13	13	11	11	6	1	2	3	4	10	3	3	4	6	7
Bank Vegetation	8	9	9	9	9	9	10	10	10	15	8.5	10	10	9	10	8	10
Bank Stability	10	9	9	9	9	9	10	10	10	10	10	10	10	9	10	8	10
Disruptive Pressures	10	10	10	10	10	10	10	10	10	10	9	10	10	10	10	9	10
Riparian Width	6	7	8	9	9	2	6	7	10	10	8.5	10	10	4	9	8	8
Total Score	165	173	178	181	177	173	173	167	172	172	155	184	176	150	166	150	170
SUBSTRATE																	
Mean % Cobble	72	64	68	83	81	82	62	58	37	49	74	68	45	63	83	65	66
Mean % Coarse Gravel	15	18	11	7	9	10	16	27	25	34	11	22	44	12	4	14	17
Mean % Fine Gravel	7	10	7	4	3	4	19	12	15	17	8	6	10	9	7	9	9
Mean % Silt	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Mean % Sand	6	8	4	5	7	3	3	3	9	0	7	4	1	18	6	12	6
Mean % Clay	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean % Organic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean % Precipitate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weighted Embeddedness	92.0	95.0	92.2	95.4	99.0	99.0	98.6	88.8	96.8	100.0	97.0	100.0	100.0	97.5	94.6	77.5	95.2
STREAM VELOCITY																	
Mean (Ft. per Second)	2.40	1.70	2.00	2.30	1.72	2.45	1.88	1.82	1.54	5.58	1.50	2.00	1.59	1.23	1.12	1.49	2.02

Note: WDEQ assessments from 10/10/2007 and 10/15/2009 not reported

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TABLE E-2. STREAM HABITAT, SUBSTRATE, AND VELOCITY DATA COLLECTED DURING HABITAT ASSESSMENTS AT TONGUE RIVER STATION TR07

Stream Name	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.
Location	TR07	TR07	TR07	TR07	TR07	TR07	TR07	TR07	TR07	TR07	TR07
Sampler	WDEQ	WDEQ	WDEQ	SCCD	SCCD	WDEQ	SCCD	SCCD	SCCD	SCCD	Average
Date	10/11/1996	10/14/1997	10/12/1998	10/26/1999	9/22/2003	10/13/2004	9/19/2006	9/7/2010	9/7/2013	9/26/2016	All Years
HABITAT PARAMETER											
Percent Fines	20	19	20	20	18	18	13	19	16	20	18
Instream Cover	12	13	19	16	16	19	6	10	16	16	14
Embeddedness	1	7	4	2	10	18	5	12	10	14	8
Velocity/Depth	14	16	17	19	12	20	16	15	16	18	16
Channel Flow	15	16	15	15	19	15	16	18	15	19	16
Channel Shape	8	8	10	9	11	11	3	10	10	12	9
Pool/Riffle	12	13	14	14	13	15	8	11	14	13	13
Channel Alteration	11	9	9	11	11	7	7	6	8	11	9
Width/Depth	5	2	2	3	2	3	2	2	5	9	4
Bank Vegetation	8	7	8	7	9	9	8.5	10	8	8	8
Bank Stability	6	8	6	8	9	9	8.5	10	8	9	8
Disruptive Pressures	6	10	9	8	8	9	7.5	8	8	8	8
Riparian Width	9	9	2	2	9	6	7.5	8	8	6	7
Total Score	127	137	135	134	146	161	108	139	142	163	139
SUBSTRATE											
Mean % Cobble	72	66	42	69	54	36	38	40	66	64	55
Mean % Coarse Gravel	18	24	51	18	29	45	11	35	12	24	27
Mean % Fine Gravel	9	7	7	14	12	11	17	24	11	12	12
Mean % Silt	0	1	0	0	1	0	0	0	4	0	1
Mean % Sand	1	2	0	0	4	8	34	1	6	0	6
Mean % Clay	0	0	0	0	0	0	0	0	0	0	0
Mean % Organic	0	0	0	0	0	0	0	0	0	0	0
Mean % Precipitate	0	0	0	0	0	0	0	0	0	0	0
Weighted Embeddedness	21.8	47.6	33.0	25.4	59.1	84.0	31.8	65.0	58.0	73.4	49.9
STREAM VELOCITY											
Mean (Ft. per Second)	3.20	2.31	2.26	2.60	1.90	1.60	1.70	2.25	1.76	2.05	2.16

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TABLE E-3. STREAM HABITAT, SUBSTRATE, AND VELOCITY DATA COLLECTED DURING HABITAT ASSESSMENTS AT TONGUE RIVER STATION TR05

Stream Name	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.
Location	TR05	TR05	TR05	TR05	TR05	TR05	TR05	TR05
Sampler	WDEQ	WDEQ	WDEQ	SCCD	SCCD	SCCD	SCCD	Average
Date	9/12/1995	10/15/1998	10/13/2004	9/19/2006	9/23/2010	9/5/2013	10/4/2016	All Years
HABITAT PARAMETER								
Percent Fines	19	17	13	14	18	17	16	16
Instream Cover	10	16	10	7	14	15	17	13
Embeddedness	11	8	7	15	9	7	6	9
Velocity/Depth	14	15	15	14	16	17	16	15
Channel Flow	19	18	17	19	19	14	16	17
Channel Shape	11	10	10	12	11	11	13	11
Pool/Riffle	8	11	10	2	11	13	12	10
Channel Alteration	11	15	10	10	5	7	14	10
Width/Depth	5	4	1	2	2	4	2	3
Bank Vegetation	9	9	10	10	8	8	9	9
Bank Stability	8	8	10	8	8	8	9	8
Disruptive Pressures	9	10	6	10	10	10	9	9
Riparian Width	10	6	8	5	8	8	7	7
Total Score	144	147	127	128	139	139	146	139
SUBSTRATE								
Mean % Cobble	73	24	32	78	30	64	30	47
Mean % Coarse Gravel	18	41	38	9	40	16	32	28
Mean % Fine Gravel	7	29	11	7	25	14	29	17
Mean % Silt	1	0	10	0	0	0	0	2
Mean % Sand	2	6	7	5	5	6	8	6
Mean % Clay	0	0	0	0	0	0	0	0
Mean % Organic	0	0	0	0	0	0	0	0
Mean % Precipitate	0	0	0	0	0	0	0	0
Weighted Embeddedness	62.6	49.0	42.0	55.0	54.5	48.4	43.8	50.8
STREAM VELOCITY								
Mean (Ft. per Second)	2.58	1.56	1.72	1.82	1.64	1.85	2.86	2.00

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TABLE E-4. STREAM HABITAT, SUBSTRATE, AND VELOCITY DATA COLLECTED DURING HABITAT ASSESSMENTS AT TONGUE RIVER STATION TR03

Stream Name	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.
Location	TR03	TR03	TR03	TR03	TR03	TR01	TR01	TR01	TR01	TR01	TR01
Sampler	WDEQ	WDEQ	SCCD	SCCD	Average	WDEQ	WDEQ	WDEQ	SCCD	SCCD	Average
Date	10/15/1998	10/12/2004	9/3/2013	9/22/2016	All Years	10/15/1998	10/22/2003	10/20/2004	9/3/2013	9/22/2016	All Years
HABITAT PARAMETER											
Percent Fines	12	17	14	11	14	14	20	17	16	9	15
Instream Cover	17	12	9	15	13	16	9	10	13	14	12
Embeddedness	4	7	14	8	8	2	2	4	7	8	5
Velocity/Depth	15	17	12	16	15	14	14	16	13	17	15
Channel Flow	18	19	16	15	17	18	16	15	16	18	17
Channel Shape	10	8	11	12	10	11	11	10	11	11	11
Pool/Riffle	8	12	5	13	10	11	8	8	7	12	9
Channel Alteration	13	13	11	11	12	14	15	15	14	13	14
Width/Depth	1	2	1	3	2	2	0	2	3	7	3
Bank Vegetation	6	8	10	9	8	8	10	10	8	8	9
Bank Stability	6	8	8	8	8	8	10	10	7	8	9
Disruptive Pressures	3	4	10	9	7	8	10	10	8	9	9
Riparian Width	1	6	10	4	5	5	9	10	4	7	7
Total Score	114	133	131	134	128	131	134	137	127	141	134
SUBSTRATE											
Mean % Cobble	11	26	45	41	31	59	30	17	60	36	40
Mean % Coarse Gravel	39	44	29	17	32	17	58	49	24	17	33
Mean % Fine Gravel	33	19	14	22	22	12	12	26	8	19	15
Mean % Silt	0	9	0	0	2	1	0	1	1	0	1
Mean % Sand	16	2	12	19	12	11	0	6	8	28	11
Mean % Clay	0	0	0	0	0	0	0	0	0	0	0
Mean % Organic	0	0	0	0	0	0	0	0	0	0	0
Mean % Precipitate	0	0	0	0	0	0	0	0	0	0	0
Weighted Embeddedness	35.0	35.6	75.8	51.9	49.6	25.0	23.6	35.8	42.4	51.8	35.7
STREAM VELOCITY											
Mean (Ft. per Second)	1.28	1.12	1.21	1.54	1.29	1.81	1.72	1.70	0.82	1.41	1.49

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TABLE E-5. STREAM HABITAT, SUBSTRATE, AND VELOCITY DATA COLLECTED DURING HABITAT ASSESSMENTS AT TONGUE RIVER STATION TR01

Stream Name	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.	Tongue R.
Location	TR01	TR01	TR01	TR01	TR01	TR01
Sampler	WDEQ	WDEQ	WDEQ	SCCD	SCCD	Average
Date	10/15/1998	10/22/2003	10/20/2004	9/3/2013	9/22/2016	All Years
Habitat Parameter						
Percent Fines	14	20	17	16	9	15
Instream Cover	16	9	10	13	14	12
Embeddedness	2	2	4	7	8	5
Velocity/Depth	14	14	16	13	17	15
Channel Flow	18	16	15	16	18	17
Channel Shape	11	11	10	11	11	11
Pool/Riffle	11	8	8	7	12	9
Channel Alteration	14	15	15	14	13	14
Width/Depth	2	0	2	3	7	3
Bank Vegetation	8	10	10	8	8	9
Bank Stability	8	10	10	7	8	9
Disruptive Pressures	8	10	10	8	9	9
Riparian Width	5	9	10	4	7	7
Total Score	131	134	137	127	141	134
Substrate						
Mean % Cobble	59	30	17	60	36	40
Mean % Coarse Gravel	17	58	49	24	17	33
Mean % Fine Gravel	12	12	26	8	19	15
Mean % Silt	1	0	1	1	0	1
Mean % Sand	11	0	6	8	28	11
Mean % Clay	0	0	0	0	0	0
Mean % Organic	0	0	0	0	0	0
Mean % Precipitate	0	0	0	0	0	0
Weighted Embeddedness	25.0	23.6	35.8	42.4	51.8	35.7
Stream Velocity						
Mean (Ft. per Second)	1.81	1.72	1.70	0.82	1.41	1.49

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APPENDIX F

2016 Tongue River Watershed Photos

TFR 6 2/025
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Tongue River Site TR01 Photopoints

Early Season Upstream

Site TR01 Facing Upstream
6/13/2016

Late Season Upstream

Site TR01 Facing Upstream
8/10/2016

Early Season Downstream

Site TR01 Facing Downstream
6/13/2016

Late Season Downstream

Site TR01 Facing Downstream
8/10/2016

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RECD 10-25-18

Scanned, 02/26/2020

Prairie Dog Creek Site PD1 Photopoints

Early Season
Upstream

Site PD1 Facing Upstream
6/13/2016

Late Season
Upstream

Site PD1 Facing Upstream
8/10/2016

Early Season
Downstream

Site PD1 Facing Downstream
6/13/2016

Late Season
Downstream

Site PD1 Facing Downstream
8/10/2016

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Tongue River Site TR03 Photopoints

Early Season Upstream

Site TR03 Facing Upstream
6/13/2016

Late Season Upstream

Site TR03 Facing Upstream
8/10/2016

Early Season Downstream

Site TR03 Facing Downstream
6/13/2016

Late Season Downstream

Site TR03 Facing Downstream
8/10/2016

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Goose Creek Site GC1 Photopoints

Early Season
Upstream

Site GC1 Facing Upstream
6/13/2016

Late Season
Upstream

Site GC1 Facing Upstream
8/10/2016

Early Season
Downstream

Site GC1 Facing Downstream
6/13/2016

Late Season
Downstream

Site GC1 Facing Downstream
8/10/2016

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Tongue River Site TR05 Photopoints

Early Season Upstream

Site TR05 Facing Upstream
6/13/2016

Late Season Upstream

Site TR05 Facing Upstream
8/10/2016

Early Season Downstream

Site TR05 Facing Downstream
6/13/2016

Late Season Downstream

Site TR05 Facing Downstream
8/10/2016

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Tongue River Site TR07 Photopoints

Early Season

Site TR07 Facing Upstream
6/13/2016

Late Season
Upstream

Site TR07 Facing Upstream
8/10/2016

Early Season
Downstream

Site TR07 Facing Downstream
6/13/2016

Late Season
Downstream

Site TR07 Facing Downstream
8/10/2016

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Wolf Creek Site WC01 Photopoints

Early Season Upstream

Site WC01 Facing Upstream
6/13/2016

Late Season Upstream

Site WC01 Facing Upstream
8/10/2016

Early Season Downstream

Site WC01 Facing Downstream
6/13/2016

Late Season Downstream

Site WC01 Facing Downstream
8/10/2016

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Five Mile Creek Site FMC01 Photopoints

Early Season Upstream

Site FMC01 Facing Upstream
6/13/2016

Late Season Upstream

Site FMC01 Facing Upstream
8/10/2016

Early Season Downstream

Site FMC01 Facing Downstream
6/13/2016

Late Season Downstream

Site FMC01 Facing Downstream
8/10/2016

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Tongue River Site TR08 Photopoints

Early Season Upstream

Site TR08 Facing Upstream
6/13/2016

Late Season Upstream

Site TR08 Facing Upstream
8/10/2016

Early Season Downstream

Site TR08 Facing Downstream
6/13/2016

Late Season Downstream

Site TR08 Facing Downstream
8/10/2016

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Columbus Creek Site CC01 Photopoints

Early Season
Upstream

Site CC01 Facing Upstream
6/13/2106

Late Season
Upstream

Site CC01 Facing Upstream
8/10/2016

Early Season
Downstream

Site CC01 Facing Downstream
6/13/2016

Late Season
Downstream

Site CC01 Facing Downstream
8/10/2016

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Little Tongue River LTR01 Photopoints

Early Season Upstream

Site LTR01 Facing Upstream
6/13/2016

Late Season Upstream

Site LTR01 Facing Upstream
8/10/2016

Early Season Downstream

Site LTR01 Facing Downstream
6/13/2016

Late Season Downstream

Site LTR01 Facing Downstream
8/10/2016

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Smith Creek Site SC01 Photopoints

Early Season Upstream

Site SC01 Facing Upstream
6/13/2016

Late Season Upstream

Site SC01 Facing Upstream
8/10/2016

Early Season Downstream

Site SC01 Facing Downstream
6/13/2016

Late Season Downstream

Site SC01 Facing Downstream
8/10/2016

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Tongue River Site TR09 Photopoints

Early Season Upstream

Site TR09 Facing Upstream
6/13/2016

Late Season Upstream

Site TR09 Facing Upstream
8/10/2016

Early Season Downstream

Site TR09 Facing Downstream
6/13/2016

Late Season Downstream

Site TR09 Facing Downstream
8/10/2016

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Tongue River Site TR01 Reach Assessment Photos

Upstream

Site TR01 Bottom of Riffle Facing Upstream
9/22/2016 1045

Downstream

Site TR01 Top of Riffle Facing Downstream
9/22/2016 1045

Panorama of Riffle

Site TR01 Panorama from River Right Bank of Entire Riffle
9/22/2016 1045

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Tongue River Site TR03 Reach Assessment Photos

Upstream

Site TR03 Bottom of Riffle Looking Upstream
9/22/2016 1355

Downstream

Site TR03 Bottom of Riffle Facing Downstream
9/22/2016 1355

Panorama of Riffle

Site TR03 Panorama from River Right Bank of Entire Riffle
9/22/2016 1415

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Addendum D6-11-168

Brook Mine

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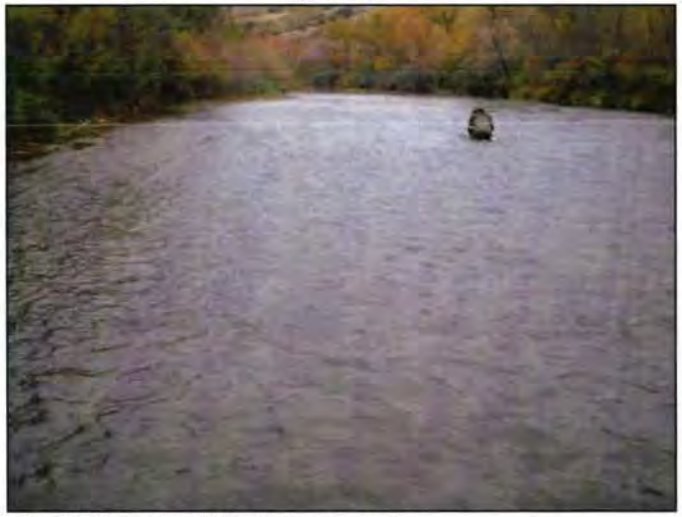
Tongue River Site TR05 Reach Assessment Photos

Upstream



Site TR05 Base of Riffle Facing Upstream
10/04/2016 925

Downstream

Site TR05 Base of Riffle Facing Downstream
10/04/2016 925

Panorama of Riffle

Site TR05 Panorama from Right River Bank of Entire Riffle
10/04/2016 925

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Tongue River Site TR07 Reach Assessment Photos

Upstream

Site TR07 Bottom of Riffle Facing Upstream
9/26/2016 1140

Downstream

Site TR07 Top of Riffle Facing Downstream
9/26/2016 1140

Panorama of Riffle

Site TR07 Panorama from Right River Bank of Entire Riffle
9/26/2016 1205

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Tongue River Site TR09 Reach Assessment Photos

Upstream

Site TR09 Bottom of Riffle Facing Upstream
10/04/2016 1200

Downstream

Site TR09 Bottom of Riffle Facing Downstream
10/04/2016 1200

Panorama of Riffle

Site TR09 Panorama from River Right Bank of Entire Riffle
10/04/2016 1200

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ADDENDUM D6-12

Big Horn Coal Mine
Groundwater Materials

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APPENDIX D6

HYDROLOGY

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GROUNDWATER HYDROLOGY

GENERAL AREA

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INTRODUCTION

This section of Appendix D6 will deal with the present occurrence of groundwater within the general Big Horn Mine area. The general Big Horn Mine area is defined as the potential five-foot groundwater drawdown contour for the life of the mine. This contour and the 15-foot drawdown contour, indicative of a significant drawdown impact, are depicted on Exhibit D6-1. The extent of those drawdown contours were determined by considering the total dewatering effects of the present mining operations (Pit 1 Truck-Shovel, Pit 3 Scraper, Pit 4 and Pit 5) and the proposed Pit 3 Truck-Shovel/Amendment One operation (herein referred to as the Pit 3 operation or area). The drawdown calculations are presented in the Mine plan.

Emphasis will be directed to the review and definition of existing subsurface movement, distribution, quantity and quality of water, including a description of the geologic setting and identification of principal recharge and discharge areas.

Much of the following is based upon a review of previous studies conducted within the vicinity of the active Big Horn coal mine, experience gained during mining operations at the mine and the empirical data collected from the general area. Specifically, studies conducted by the Big Horn Coal Company within the general area include the "Proposed Dragline Pit Area, Amendment Three Hydrology Report" on the now-active Pit 3 Scraper operation. Among other studies on the immediate area are those conducted by Argonne National Laboratories (Dettmann and Olson, 1977), the Water Resources Research Institute, University of Wyoming (1977), and the Montana Bureau of Mines and Geology (Van Voast and Thompson, 1982). Regionally, the most recent results of studies by Van Voast, et. al.. (1978) on spoil aquifer hydraulics were also cited. Alluvial valley floor evaluations of the general area have been conducted and will be referenced (Appendix D11).

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GEOHYDROLOGIC SETTING

Aquifer Identification

The Tongue River Member of the Fort Union Formation underlies the area and consists of interbedded coals, shales, sandstones, siltstones and sandy shales. The following stratigraphic units were investigated as potential groundwater aquifers:

1. Consolidated sediments overlying and underlying the coal seams.
2. The Dietz 2 (Armstrong) coal seam.
3. The Dietz 3 (Upper Monarch) coal seam.
4. The Monarch (Lower Monarch) coal seam.
5. The Carney coal seam.
6. The reclaimed - mine spoils.

Quaternary alluvial deposits lying within the Tongue River and Goose Creek valley were also investigated as potential aquifers. This evaluation is presented in Appendix D11 and to some extent in the Groundwater Hydrology - Pit 3 operation section.

The stratigraphic sequences, lithologic thicknesses and local structure of these units are illustrated by geologic cross sections, isopach maps and structure contour maps in Appendices D5 and D11.

The stratigraphic units within the general Big Horn Mine area that are capable of yielding enough water to be classified as aquifers are the Fort Union coal seams, the Tongue River and Goose Creek alluvium and the reclaimed mine spoils. Due to the fine-grained nature of the consolidated sediments of the Fort Union Formation, they characteristically serve as aquicludes or confining beds between the more permeable coal aquifers. The drilling of aquifer test wells and geologic exploration holes within the area has shown that these fine-grained sediments yield no or very small quantities of water.

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The permeability of the coal seams is of a secondary nature. It is a result of fracture systems existing within the coal and the nature of the local fracture system determines the degree of permeability (Komar, et. al., 1973; Rehm, et. al., 1980; Schubert, 1980).

As mining in the area has progressed and overburden rock materials (spoils) are backfilled into the pits, groundwaters have readily re-entered the spoils. Sources of the re-entering water are undisturbed coal seams and alluvium. The hydraulic characteristics of the resaturated mine spoils are actively being investigated by the Kiewit Mining & Engineering Hydrology staff at Big Horn Coal.

Geologic Features Influencing Aquifers

A thorough explanation of the geology, including a geologic explanation of the origin of the sediments is given in Appendix D5. The lithology of the sediments lying between the coal seams consists generally of high amounts of clay and silt-sized particles. Such fine-grained sediments transmit only very small amounts of water, serving locally as confining beds between the permeable coal bed aquifers. In general, the geologic structure of the area is relatively simple. The interbedded fine-grained sediments and coal beds dip east-southeast at approximately 1.5^{o}-3.0^{o}. They lie unbroken by faulting and exhibit essentially no local warping.

Two large perennial streams having broad actively degrading channels and well defined terraces flow through the Big Horn Mine area: the Tongue River and its major tributary, Goose Creek. Much of the Big Horn Mine area is capped with unsaturated remnant Tongue River terraces which are higher in elevation than, and not in hydraulic communication with, the present Tongue River terrace system.

The most significant source of groundwater recharge within the vicinity of the Big Horn Coal Mine is the Tongue River. The gradient of the Tongue River is

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less than the dip of the Fort Union Formation, consequently the permeable strata (coal seams) that subcrop beneath the saturated Tongue River alluvium are subject to recharge at the point of intersection. Alluvial aquifer tests conducted in the immediate vicinity have revealed that the alluvial materials are sufficiently permeable to permit unimpeded recharge.

An understanding of the alluvial recharge mechanism can be gained by a review of the potentiometric surface maps. Exhibit D6-2 and D6-3 show influent stream conditions for the Tongue River in the alluvial aquifer for both May and August. Exhibits D6-4, D6-5 and D6-6 are potentiometric surface maps for the Dietz 2, Dietz 3 and Monarch coals. These maps, coupled with the Dietz 2, Dietz 3 and Monarch coal structure contour maps (Appendix D5), show that hydrostatic pressure within the coal seams rapidly increases downdip from their subcrops. This is indicative of direct recharge at the point of intersection between the coals and alluvium.

The four major coal beds of economic interest in the Big Horn Mine area are, in descending stratigraphic order: Dietz 2, Dietz 3, Monarch and Carney. Only the first three beds are presently in production. Extensive exploratory drilling has verified that these coal seams cannot be classified as aquifers where they lie stratigraphically higher in elevation than the Tongue River (refer to the Groundwater Hydrology sections of Pits 3, 4 and 5 for site-specific discussions) and are not subject to recharge from the river. These coals lying stratigraphically updip of their alluvial subcrops have burned extensively (Appendix D5) and baked overlying rocks into a hard rock type, known locally as "clinker" or "scoria". Significant clinker deposits are found in and to the north and west of the Big Horn Mine area. These deposits are generally permeable but do not receive significant recharge and generally do not yield a significant quantity of water, except in

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special cases, to be classified as aquifers. No such cases exist within or near the general Big Horn Mine area.

Although not a natural feature, several underground mines are present in the Big Horn Mine area (Mine Plan). The exact influence of the mined areas on aquifers is not well understood. They are generally viewed as groundwater sinks but the influence on aquifer properties, particularly confining influence, is site-specific.

Groundwater Flow

Wells

Within the general area of the Big Horn Coal Mine, 139 observation water wells have been completed to ascertain hydraulic properties of the aqufiers and groundwater movement. Twenty of these wells have thus far been removed from the groundwater monitoring network by mining activities. The currently active network includes: 61 alluvial wells, 5 Dietz 1 coal wells, 12 Dietz 2 coal wells, 10 Dietz 3 coal wells, 13 Monarch coal wells, five Dietz 3 and Monarch coal seams combined wells, three Carney coal wells, nine wells completed in localized Fort Union water-bearing formations (Pit 4 area), and 11 wells completed in reclaimed spoils. Exhibit D6-7 shows the locations of all active observation water wells. Addendum D6-1 presents a comprehensive listing of all these observation wells, including completion information.

Shale packers are fitted in all coal wells in order to separate aquifer units, minimize potential mixing of aquifer waters and prohibit the entrance of surface water runoff. Coal wells are drilled with air/water injection. The alluvial and burn wells are drilled with air and revert drilling fluid. After drilling and casing emplacement, the alluvial and burn wells are gravel packed to limit entry of fine-grained material into the well and to ensure good well efficiency. Finally, all

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wells are flushed with water and blown out with the rig's air compressor to remove any foreign mud and debris introduced during drilling. During this completion period, the productivity of the wells, in gallons per minute, was measured as closely as possible. A thorough description of an observation well's construction can be found on the last page of its lithologic log, Appendix D5. Figure D6-1 pictorially illustrates the typical designs of groundwater observation wells.

Monitoring Water Levels

A listing of the currently active groundwater monitoring sites for the Big Horn Mine area is presented in Addendum D6-1. Water levels from all observation wells are recorded at the beginning of every month after the well is installed. Certain selected wells have been equipped with Steven's F-68 continuous water level recorders where more detailed groundwater hydrographs are desired. The frequency of monitoring the alluvial water wells (17 Tongue River and 10 Goose Creek) upstream of the mining operation has been reduced to quarterly. Almost three years of monthly data was obtained from these alluvial wells, and because mining should not affect this area, quarterly monitoring is sufficient to determine future fluctuations in water levels.

The extent and severity of mine-associated aquifer dewatering is not only dependent upon the size, location and orientation of the excavations, but also upon the source and rate of aquifer recharge. The Tongue River is the most significant source of aquifer recharge within the immediate area. Aquifers being dewatered at the Big Horn Coal Mine include the Dietz 2, Dietz 3 and Monarch coal seams and the Tongue River alluvium. The Dietz 2 and Dietz 3 coal seams are presently being dewatered by the Pit 1 excavation and the Monarch seam is being dewatered by both Pits 1 and 3. The Tongue River alluvium is currently being dewatered along the southern highwall of Pit 3.

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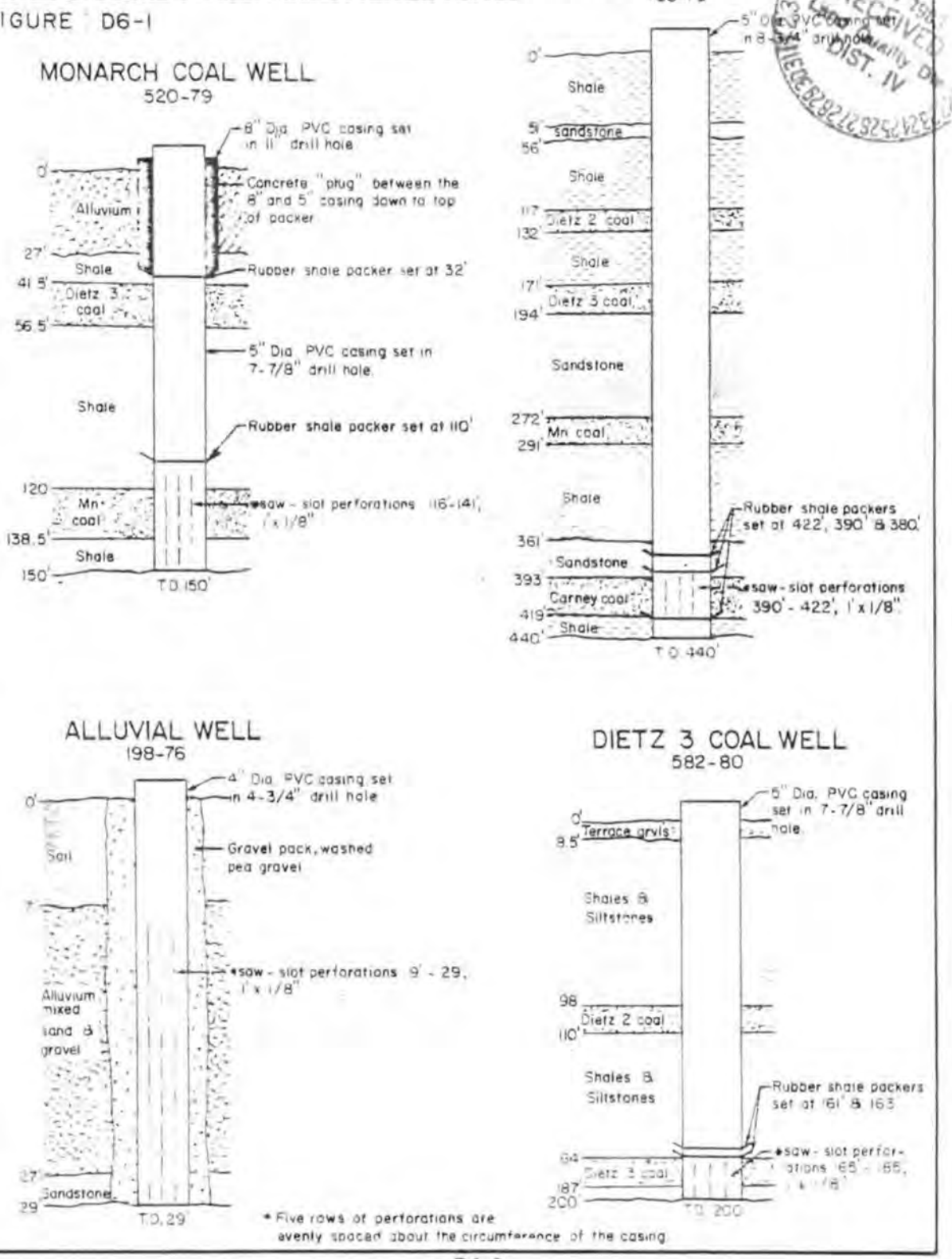
TYPICAL DESIGN OF BIG HORN COAL GROUNDWATER OBSERVATION WELLS

FIGURE D6-1



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Fluctuations of the groundwater elevations for representative wells are shown in Figures D6-2 through D6-4 and Exhibit D6-8. As can be seen from these groundwater hydrographs, the greatest water level declines have been observed in those wells located closest to the mine excavations.

As illustrated by Exhibit D6-8, no significant water level declines have occurred in the Dietz 2 coal aquifer during the observation period. This suggests that the Dietz 2 coal is being locally recharged at a rate which is sufficient to negate dewatering by the Pit 1 excavation.

Exhibit D6-8 and Figure D6-3 show that the greatest overall drawdown in the Dietz 3 coal aquifer during the observation period has occurred in those wells which are nearest the Pit 1 excavation. The vast majority of groundwater inflow to Pit 1 has historically been from the exposed coal seams in the north highwall. Mining has progressed in Pit 1 to the point that backfilling has covered over most of the exposed coal in the north highwall, thus, decreasing the volume of groundwater discharge and coal aquifer dewatering. Exhibit D6-8 illustrates how the Dietz 3 coal water levels have recently begun to recover. Those observation wells situated closest to the coal's Tongue River alluvial subcrop have exhibited the greatest amount of recovery. Also, water levels observed at well BH208 change directly with river stage fluctuations due to its location immediately adjacent to the Dietz 3 coal erosional subcrop under the Tongue River alluvium. This is indicative of the tremendous potential that the Tongue River and its alluvium have to rapidly recharge the groundwater system after reclamation in the area is completed.

The Monarch coal water well hydrographs, Exhibit D6-8 and Figure D6-4, show drawdowns ranging from approximately eight feet to 65 feet. The degree of drawdown is a function of an observation well's location with respect to the

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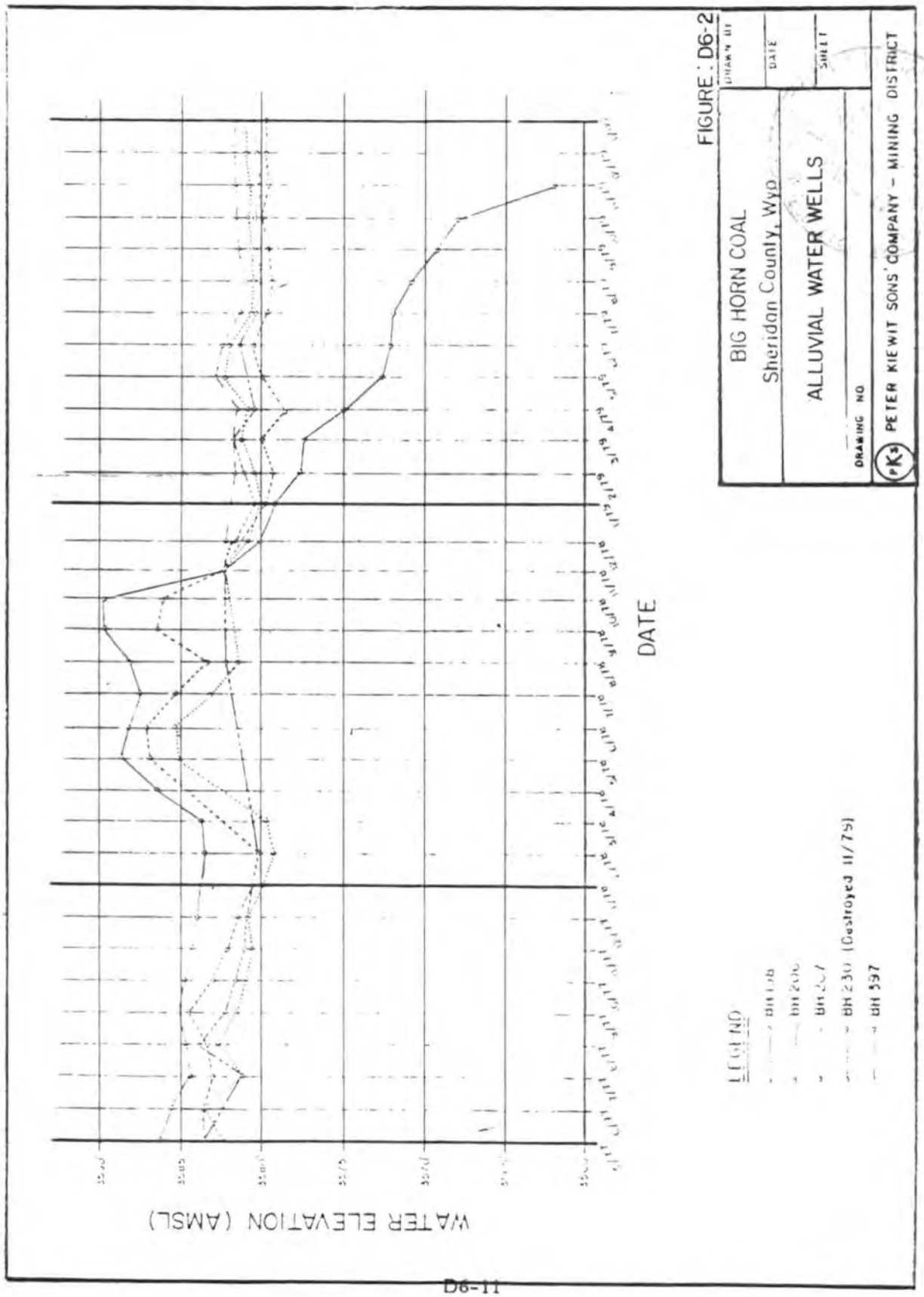

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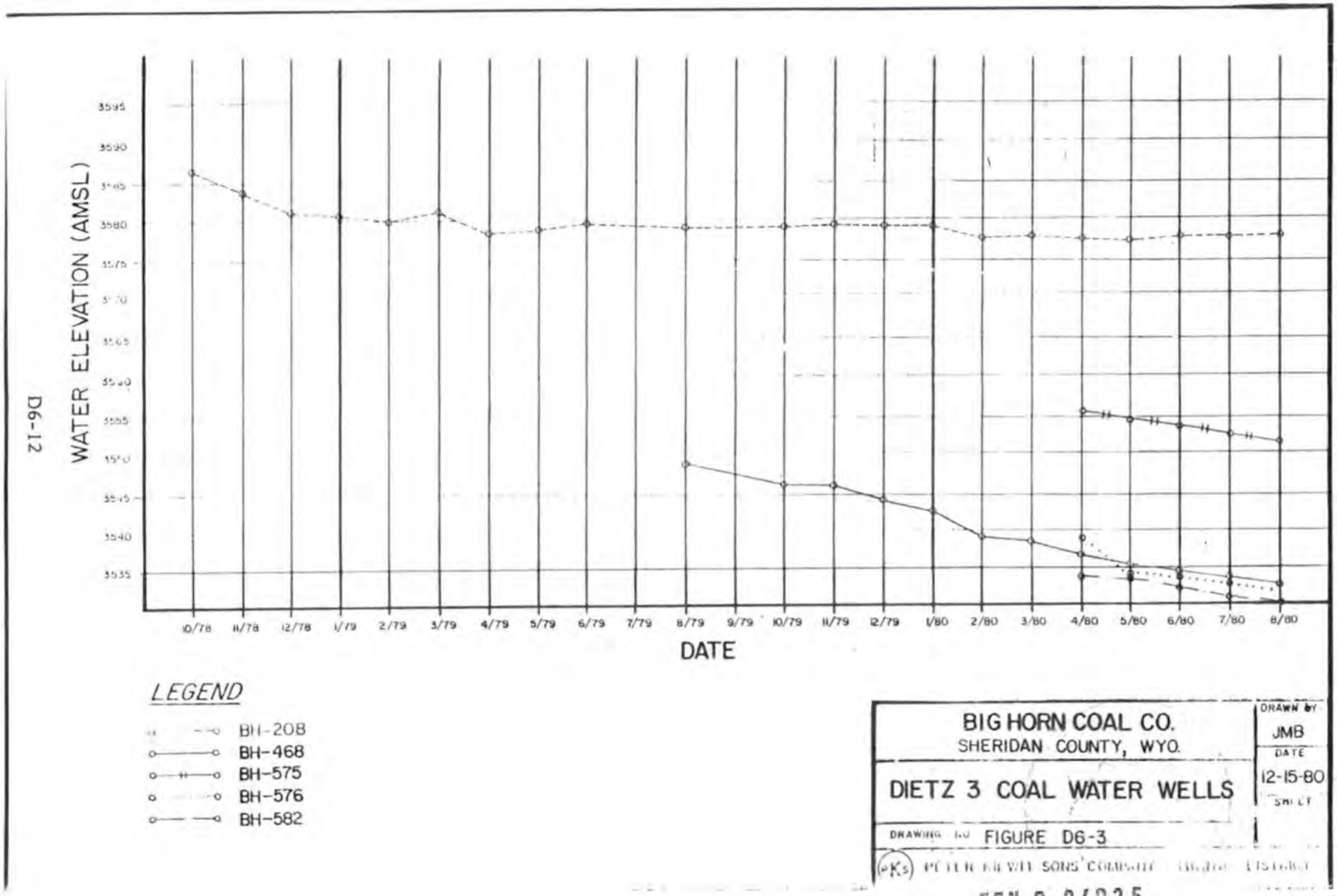

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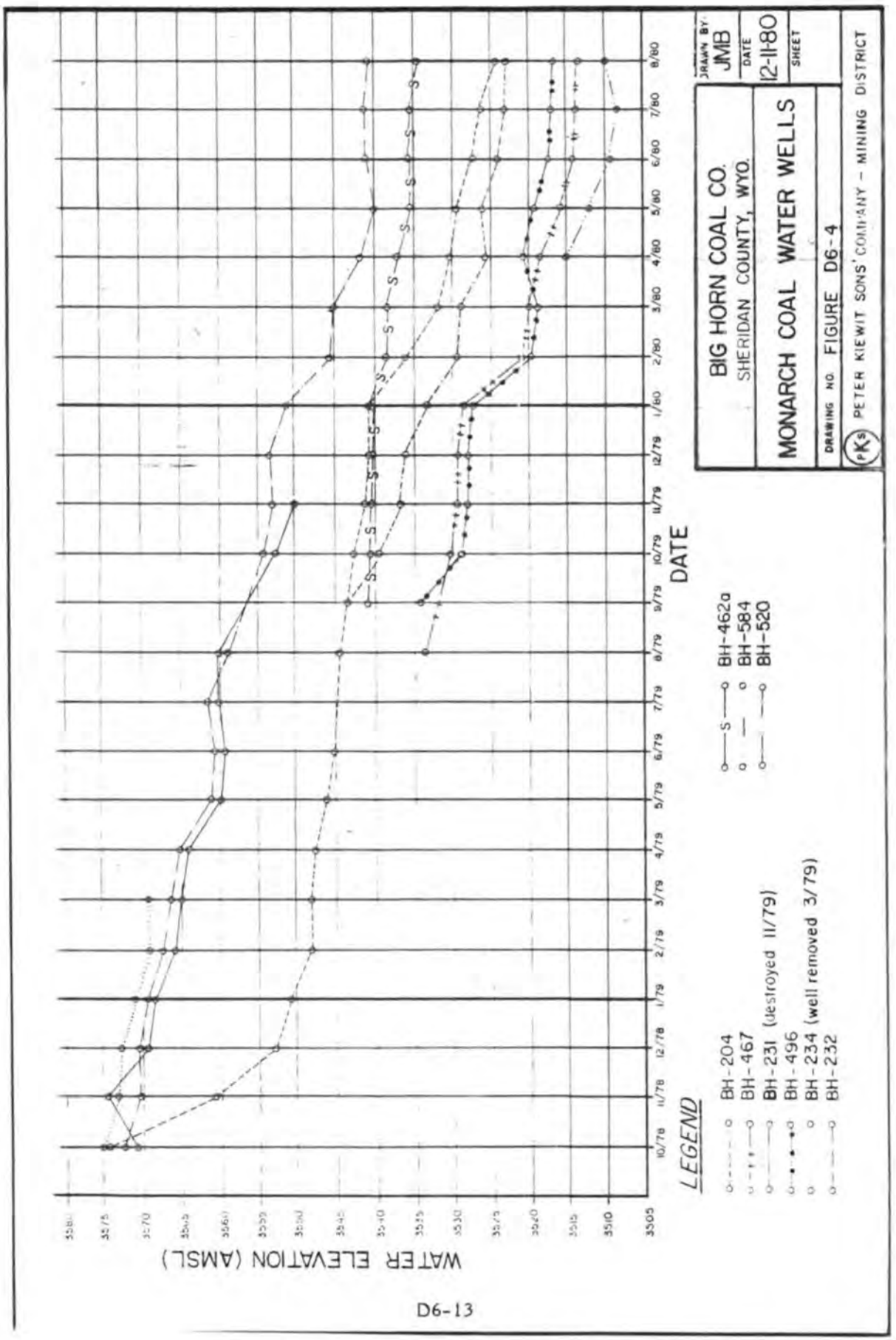

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operating pits. For example, water levels observed at wells BH204 and BH520 show the greatest decline because of the influence that both Pits 1 and 3 have upon the aquifer in this area. As previously stated, backfilling has greatly decreased the lengths of exposed coal seams in the northern highwall of Pit 1. As a result, dewatering of the Monarch coal aquifer has been greatly reduced and, consequently, its water levels have been steadily recovering.

The Carney coal aquifer observation wells, Exhibit D6-8, have shown no drawdown signifying there has been no effect on the aquifer.

The alluvial groundwater hydrographs, Exhibit D6-8 and Figure D6-2, illustrate how water level changes in the alluvial aquifer are dependent upon stage fluctuations of the Tongue River. The alluvial water table rises in direct response to an increase in the river's stage during the spring runoff period, then declines as the river's stage returns to base flows. In the area of discussion, this dependency is directly correlatable to the distance from the river and the proximity to Pit 3. Specifically, well BH207A, located 750 feet south of the alluvial gravel exposure along the southern highwall of Pit 3, continues to respond to Tongue River flow variations, yet has exhibited a steady water level decline following the spring runoff period every year. Well BH198 has experienced negligible drawdown due to its close proximity to the Tongue River.

Water levels observed at well BH230, Figure D6-2, showed a decline of about 20 feet before the well was removed by mining activities. The alluvium was completely dewatered prior to the well's removal. Figure D6-5 is an alluvial cross section through observation well BH207 and BH230. It illustrates the drawdown of the alluvial water table in the direction of Pit 3 in November 1979. Figure D6-6 is this same alluvial cross section as it currently appears, October 1982. As the alluvium is dewatered by the Pit 3 excavation, its ability to recharge the coal

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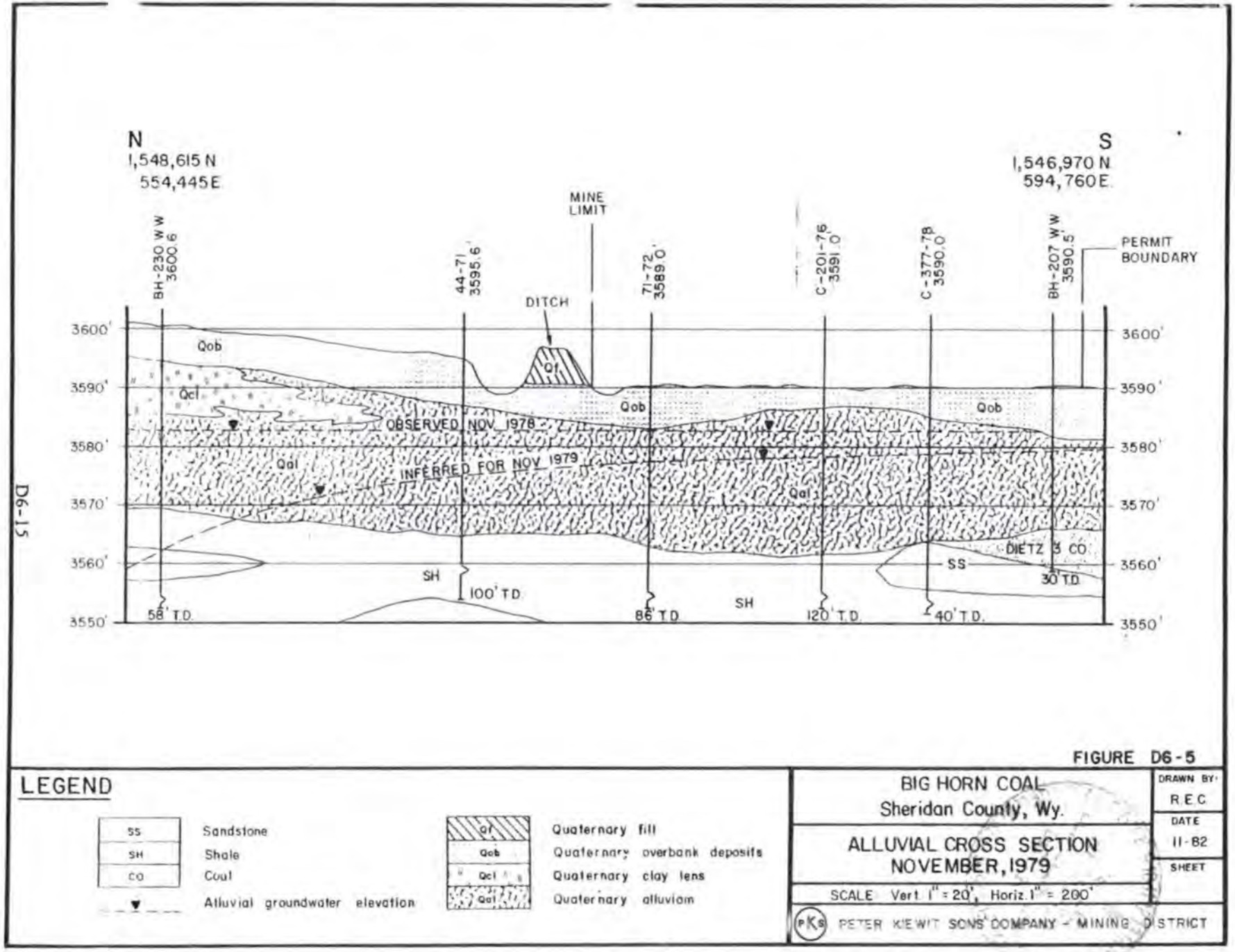

FIGURE D6-5

D6-15

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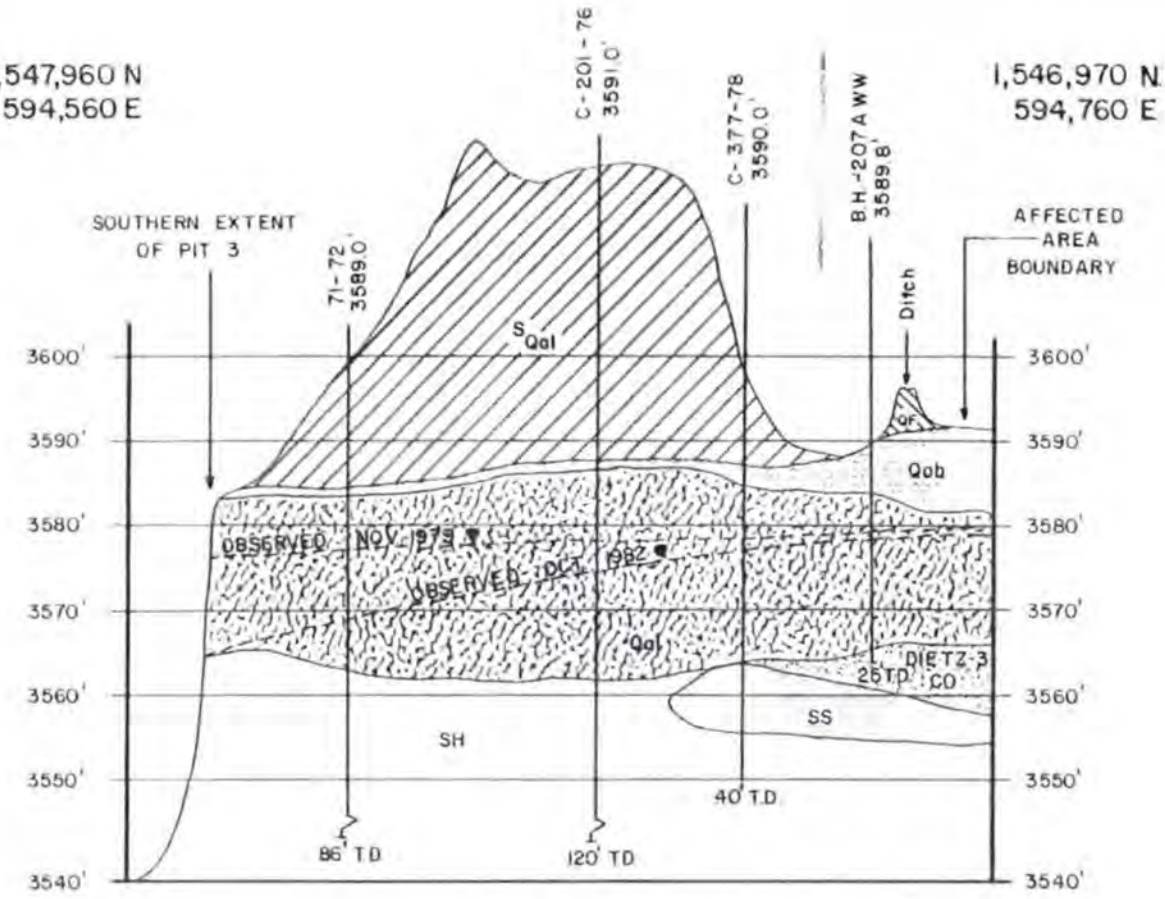

FIGURE D6-6

LEGEND

SS	Sandstone
SH	Shale
CO	Coal
▼	Alluvial groundwater elevation
Qf	Quaternary fill
Qab	Quaternary overbank deposits
Qal	Quaternary alluvium
S Qal	Stockpiled alluvial gravels

BIG HORN COAL
Sheridan County, Wy.

ALLUVIAL CROSS SECTION
OCTOBER, 1979

SCALE: Vert 1" = 20', Horiz 1" = 200'

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DATE: 11-82
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aquifers will be slightly decreased. Upon reclamation of Pit 3, the alluvium will be replaced, thus restoring the alluvial aquifer to premining functions. The reconstruction of the alluvial aquifer in Pit 3 is addressed in detail in the Reclamation Plan.

The reclaimed spoil water level hydrographs are illustrated in Exhibit D6-8. To date, the saturation level of the reclaimed spoils has remained relatively constant. As Pits 1 and 3 advance, continued observation of the spoil water levels will be necessary to draw any conclusions concerning final saturation levels.

Potentiometric Surfaces

Exhibits D6-2 and D6-3 show the potentiometric surface for the alluvium based on measurements taken May 19 and August 10, 1981. Both maps show the alluvium receiving water from the Tongue River and discharging water into the Pit 3 excavation. Groundwater flow paths in the alluvial aquifer directly adjacent to Pit 3 have adjusted and warped to the north toward the pit where dewatering is occurring. Here, the gradient is increased to the pit opening. The normal flow pattern for the alluvial groundwater, however, is downstream, as would be expected, at an average gradient of approximately 0.0018 ft/ft. This compares to 0.001 ft/ft for the Tongue River. Flow direction and gradient appears to be fairly consistent throughout the year.

Exhibits D6-4, D6-5 and D6-6 show the potentiometric surfaces for the Dietz 2, Dietz 3 and Monarch coal seam aquifers based on measurements taken September 3, 1982. Comparison of these maps with the respective top of coal structure contour maps (Appendix D5) shows that the coal seam aquifers are confined. Water levels in observation wells have declined according to their relative distances from the mined areas. Drawdowns have been greatest adjacent to the Pit 1 excavation, resulting in strong hydraulic gradients toward the pit. It

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should be noted that none of the coal wells have yet drawn down to the top of the contributing aquifer.

Undisturbed regional potentiometric surfaces of these three coal seam aquifers generally slope downdip with hydraulic gradients in the range of 0.01 to 0.05 ft/ft. Groundwater flow patterns in the Dietz 3 and Monarch seams are basically controlled by the geologic structure, in that recharge enters along alluvial subcrops beneath the Tongue River and flows downdip to the east-southeast. Recharge also enters the Dietz 2 coal seam along its alluvial subcrop, but the groundwater flow paths become warped and turn to the north-northeast along the strike. This may indicate the presence of a significant source of recharge to the Dietz 2 coal seam south of the general area.

Aquifer Hydraulics

Pumping Tests

Aquifer pumping tests have been conducted on the Dietz 1 coal, Dietz 2 coal, Dietz 3 coal, Monarch coal, saturated sandstone, reclaimed spoils and the alluvial aquifers within and adjacent to the Big Horn Coal Mine permit boundary.

Extensive pump testing of the Tongue River and Goose Creek alluvial aquifers includes single well tests on wells BH207A, BH230, BH627 and BH640, and multiple well tests on wells BH198, BH397, BH398, BH399, BH400, BH401, BH403, BH404, BH405, BH406, BH407, BH507, BH508, BH509, BH510, BH623, BH624, BH625, BH626, BH634, BH635, BH636, BH637, BH638, BH639, BH644 and BH645.

Aquifer pumping tests have been conducted on the Dietz 1 coal aquifer even though it has not been disturbed, nor is it proposed to be disturbed, by mining in the general area. Two single well tests and one multiple well test have been performed on the Dietz 1 coal aquifer.

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Tests performed on the Dietz 2 coal aquifer include single well tests on wells BH469 and BH596, and a multiple well test on wells BH647 and BH466.

Tests performed on the Dietz 3 coal aquifer include single well tests on wells BH468, BH575, BH576 and BH582, and a multiple well test on wells BH462 and BH462A.

Tests performed on the Monarch coal aquifer include single well tests on wells BH231, BH232, BH467, BH496, BH584, BH408, BH555 and BH562, and a multiple well test on wells BH462 and BH462A.

A saturated Fort Union Formation sandstone unit that could be affected by mining in Pit 4 was pump tested to determine possible impacts to it and estimate groundwater inflow to the excavation. Tests include multiple well tests on wells BH392 and BH393, and single well tests on wells BH390, BH391 and BH395.

As backfilling has followed coal removal, groundwater has re-entered the spoils at the Big Horn Coal Mine. This resaturation has undoubtedly occurred due to the nearby source of recharge: the Tongue River and Goose Creek. As mining and backfilling continue, pump testing of the resaturated spoils will be ongoing to aid in predicting the hydraulic properties of the postreclamation aquifer. To date, single well tests have been run on wells BH656, BH657 and BH658, and multiple well tests have been run on wells BH655, BH745 and BH746.

The aquifer test data log sheets and aquifer coefficient calculations for each test are not presented in this section (General Area) of the report. Table D6-1 summarizes where these pumping test data are presented.

Aquifer coefficients were derived for the single well drawdown and recovery tests by the Jacob modified non-equilibrium formula as described by Johnson Division, UOP Incorporated (1975, pp. 113-118). The bailer tests were analyzed according to the Skibitzke method as discussed by Lohman (1979, pp. 29-30). The

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Table D6-1. Location of aquifer pump test data log sheets, calculations and summary tables.

Well No.	Aquifer	Data and Calculations in Report
198	Alluvium	Appendix D11
207A	Alluvium	Appendix D11
230	Alluvium	Appendix D11
397	Alluvium	Appendix D11
398	Alluvium	Appendix D11
399	Alluvium	Appendix D11
400	Alluvium	Appendix D11
401	Alluvium	Appendix D11
403	Alluvium	Appendix D11
404	Alluvium	Appendix D11
405	Alluvium	Appendix D11
406	Alluvium	Appendix D11
407	Alluvium	Appendix D11
507	Alluvium	Appendix D11
508	Alluvium	Appendix D11
509	Alluvium	Appendix D11
510	Alluvium	Appendix D11
623	Alluvium	Appendix D11
624	Alluvium	Appendix D11
625	Alluvium	Appendix D11
626	Alluvium	Appendix D11
627	Alluvium	Appendix D11
634	Alluvium	Appendix D11
635	Alluvium	Appendix D11
636	Alluvium	Appendix D11
637	Alluvium	Appendix D11
638	Alluvium	Appendix D11
639	Alluvium	Appendix D11
640	Alluvium	Appendix D11
644	Alluvium	Appendix D11
645	Alluvium	Appendix D11
463	Dietz-1	Pit 3 Operation
463A	Dietz-1	Pit 3 Operation
464	Dietz-1	Pit 3 Operation
688	Dietz-1	Pit 3 Operation
466	Dietz-2	Pit 3 Operation
469	Dietz-2	Pit 3 Operation
596	Dietz-2	Pit 3 Operation
674	Dietz-2	Pit 3 Operation
468	Dietz-3	Pit 3 Operation
575	Dietz-3	Pit 3 Operation
576	Dietz-3	Pit 3 Operation
582	Dietz-3	Pit 3 Operation

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Table D6-1. Cont'd.

Well No.	Aquifer	Data and Calculations in Report
462	Dietz-3/Monarch	Pit 3 Operation
462A	Dietz-3/Monarch	Pit 3 Operation
231	Monarch	Pit 3 Operation
232	Monarch	Pit 3 Operation
467	Monarch	Pit 3 Operation
496	Monarch	Pit 3 Operation
584	Monarch	Pit 3 Operation
408	Monarch	Pit 5 Operation
555	Monarch	Pit 5 Operation
562	Monarch	Pit 5 Operation
390	Sandstone	Pit 4 Operation
391	Sandstone	Pit 4 Operation
392	Sandstone	Pit 4 Operation
393	Sandstone	Pit 4 Operation
395	Sandstone	Pit 4 Operation
655	Spoils	Pit 3 Operation
656	Spoils	Pit 3 Operation
657	Spoils	Pit 3 Operation
658	Spoils	Pit 3 Operation
745	Spoils	Pit 3 Operation
746	Spoils	Pit 3 Operation

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data collected during the multiple well aquifer tests were analyzed by the Theis non-equilibrium well formula as described by Walton (1962, pp. 4-8) and Johnson Division, UOP Incorporated (1975, pp. 108-113).

Results

Tables presenting a summary of aquifer test results can be found in the respective sections of this report or Appendix D11 as referred to in Table D6-1.

Transmissivity values for the coal aquifers in the general area show a great deal of spatial variability. The Monarch coal seam, in the Pit 3 area for example, has a low transmissivity value of 8 gpd/ft and a high transmissivity value of 780 gpd/ft. Monarch seam transmissivity values in the Pit 5 area range from approximately 1 gpd/ft to 12 gpd/ft. Transmissivity values for the Dietz 3 coal seam range from 2 gpd/ft to 702 gpd/ft. The Dietz 2 coal seam has a low transmissivity value of 20 gpd/ft and high value of 252 gpd/ft. Dietz 1 coal seam transmissivity values range from 11 gpd/ft to 170 gpd/ft.

The permeability of a coal seam is a direct function of the degree and nature of fracturing that has occurred within that seam. "Fractures are the only cause of permeability in coal" (Rehm, et al., 1980). The distribution and orientation of cleating in a coal seam is normally quite variable, thus, the hydraulic conductivity of the coal seam will exhibit a wide spatial variability.

Another cause of the wide range in transmissivity values for the coal aquifers is the varying degrees of local recharge and proximity to the recharge and discharge areas. Generally, the coal wells situated immediately downdip of the respective coal subcrops beneath the Tongue River and its alluvium exhibit the larger transmissivity values and the coal wells situated immediately downdip (or gradient) of the mine excavations exhibit the smaller transmissivity values. The Monarch coal wells completed in the Pit 5 area exhibit low transmissivity values

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because the Monarch coal remnant is not subject to recharge from the Tongue River (Groundwater Hydrology - Pit 5 section).

The confined nature of the coal seam aquifers is indicated by the low storage coefficients (Dietz 1 = 1.4×10^{-4}, Dietz 2 = 5.0×10^{-5}, Dietz 3 and Monarch = 1.4×10^{-4}). The drawdown curve plotted for observation well BH462 matched up with a leaky artesian type curve indicating there must be some degree of slow vertical seepage to the interburden above the Monarch and Dietz 3 coal aquifers south of the active mining area. The Theis drawdown curves plotted for observation wells BH466 and BH463A matched up with the nonleaky artesian type curve indicating the Dietz 2 and Dietz 1 coals are confined aquifers.

A wide range of transmissivity values for the reclaimed spoils were found (11 gpd/ft to 22,466 gpd/ft), indicating diverse conditions exist along the pit floors where resaturation has occurred. A reasonable explanation for this wide range of transmissivity values would be that the rubble, consisting primarily of boulders and wasted coal which comprises the floor of the pits, provides an extremely wide variation in hydraulic properties (Van Voast, et. al., 1978). Low values of storage coefficients indicate that the spoil aquifer is confined between less permeable strata, again indicative of an aquifer created along the pit floor that is comprised of coarse spoil material overlain by finer-grained materials. Because the spoils appear to be confined, or at least semi-confined, the aquifer thickness is not exactly known, therefore, the permeability is not known. Also, as the voids in the rubble comprising the base of the backfilled spoils are filled in or lost due to compaction, the hydraulic properties may change over time.

Pumping test results indicate that the Tongue River and Goose Creek alluvium is a very significant aquifer with transmissivity values ranging from about

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9,000 to 60,000 gpd/ft. Storage coefficients are in the order of 10^{-1} to 10^{-2} indicative of an unconfined to "semi" confined aquifer.

These aquifer pump test results indicate that coal seams are less significant aquifers when comparing transmissivity values but are regional in areal extent.

Due to the fact that the geohydrologic settings are different and different aquifers exist within the operating and proposed pit boundaries at Big Horn Coal, separate groundwater hydrology sections will follow to address site-specific aquifer hydraulics.

Groundwater Quality

Sampling Program

All of Big Horn Coal's currently active groundwater quality sampling sites are shown in Exhibit D6-7 and summarized in Table D6-2. These sites are sampled on a regular time schedule with additional miscellaneous samples collected during aquifer pump tests.

Samples have been collected in accordance with the Revised Guideline No. 8, Wyoming DEQ. Samples were collected after three times the volume of the casing had been pumped out or when the specific conductance reached static equilibrium. Temperatures, pH and specific conductance are measured in the field. Samples were field acidified and filtered according to accepted practices and each sample collected was packed in ice and sent to either the KME Environmental Lab in Sheridan, WY or Inter-Mountain Laboratory in Sheridan, WY for analysis. Analytical lab results for select wells are given in Addendum D6-2. The water-bearing strata in Pits 4 and 5 are local in areal extent and are discontinuous with those affected aquifers present in the Pit 1 and Pit 3 operations, therefore, water quality analysis for wells sampled in Pits 4 and 5 are presented and discussed in the respective Groundwater Hydrology sections.

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Table D6-2. Groundwater quality sampling sites.

Well No.	Aquifer	Frequency(1)
BH397	Alluvium (T.R.)	S, Sm, F
BH371	Alluvium (T.R.)	S, Sm, F
BH508	Alluvium (T.R.)	S, Sm, F
BH207A	Alluvium (T.R.)	S, Sm, F
BH645	Alluvium (T.R.)	S, Sm, F
BH644	Alluvium (T.R.)	S, Sm, F
BH403	Alluvium (G.C.)	S, Sm, F
BH525**	Alluvium (G.C.)	S, Sm, F
BH463**	Dietz-1 Coal	S, F
BH469	Dietz-2 Coal	S, F
BH596	Dietz-2 Coal	S, F
BH208	Dietz-3 Coal	S, F
BH468	Dietz-3 Coal	S, F
BH582**	Dietz-3 Coal	S, F
BH386	Dietz-3 and Monarch Coal	S, F
BH408***	Monarch Coal	S, F
BH467	Monarch Coal	S, F
BH496	Monarch Coal	S, F
BH520	Monarch Coal	S, F
BH465	Carney Coal	S, F
BH392	Overburden Sandstone and Qal.	S, Sm, F
BH529**	Sand And Qal. C.N.C.D.	S, Sm, F

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Table D6-2. Cont'd.

Well No.	Aquifer	Frequency(1)
BH654	Reclaimed Spoils	S, F
BH655	Reclaimed Spoils	S, F
BH656	Reclaimed Spoils	S, F
BH657	Reclaimed Spoils	S, F
BH745	Reclaimed Spoils	S, F
BH746	Reclaimed Spoils	S, F

(1) Minimum frequency presented. Additional sampling may be performed for specific permit applications.
S = Spring (May)
Sm = Summer (August)
F = Fall (October-November)
W = Winter (January)

** Dropped from the groundwater quality sampling network
*** Destroyed; replaced with BH562

These changes were initiated May 17, 1982 after approval by the Wyoming DEQ.

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The coal wells are sampled in the spring and fall and the alluvial and spoil wells are sampled during high flow in the Tongue River in early spring and during low flow in the fall.

Data Analysis

Table D6-3 presents a summary of the major chemical constituents for the Dietz 2 coal well BH469. The total dissolved solids concentration of water from this well has remained a relatively constant 1200 milligrams per liter, which exceeds the recommended drinking water standard (McKee and Wolf, 1963). The principal cation is sodium and the principal anion is bicarbonate. The bicarbonate concentration exceeds the recommended drinking water standard of 150 mg/l and the total iron concentration exceeds the recommended drinking water standard of 0.30 mg/l (McKee and Wolf, 1963).

Tables D6-4 and D6-5 present groundwater quality data for the Dietz 3 coal water wells BH208 and BH468, respectively. As indicated by the difference in mean values between these two tables, the Dietz 3 coal water quality exhibits spatial variation. Well BH208, completed quite close to the Dietz 3 alluvial subcrop, exhibits higher concentrations of calcium, magnesium, sulfate, total iron and total dissolved solids along with a much higher total hardness than did well BH468. Yet, well BH468 shows higher concentrations of sodium and bicarbonate than well BH208. Water samples from coal bed aquifers of the Fort Union Formation in the Decker, MT area have chemical characteristics similar to these two Dietz 3 coal wells. That is, "the principal cation is sodium and the principal anion is bicarbonate. . . and waters from coal beds which are in close hydrologic connection with alluvium or sandstone contain anomalously high concentrations of calcium, magnesium and sulfate" (Van Voast and Hedges, 1975). The quality of water from well BH208 is very similar to the quality of alluvial groundwater in the

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Table D6-3. Major chemical constituents for sample site BH469. Source: Dietz 2 coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	31.40	31.40	31.40
TDS, mg/l	1120	1230	1188
Lab Cond. umohs/cm	1820	1970	1919
Lab pH	7.8	8.1	7.9
Total Hardness, mg/l	36	54	44
Total Alkalinity as $CaCO_3$, mg/l	1020	1040	1034
CATION ANALYSIS			
Calcium, mg/l	6	11	8
Magnesium, mg/l	5	8	6
Potassium, mg/l	2	10	7
Sodium, mg/l	471	492	480
Fe Total, mg/l	.08	2.99	1.26
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	1250	1270	1263
Sulfate, mg/l	2	49	10
NO_2+NO_3 as "N", mg/l	< .01	2.56	-
Chloride, mg/l	37	42	39
Fluoride, mg/l	.40	3.13	2.61

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Table D6-4. Major chemical constituents for sample site BH208. Source: Dietz 3 coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	2.34	2.34	2.34
TDS, mg/l	1150	1560	1334
Lab Cond. umohs/cm	1230	1890	1694
Lab pH	7.3	8.2	7.7
Total Hardness, mg/l	605	830	711
Total Alkalinity as $CaCO_3$, mg/l	253	325	302
CATION ANALYSIS			
Calcium, mg/l	86	125	112
Magnesium, mg/l	84	126	105
Potassium, mg/l	17	22	19
Sodium, mg/l	133	154	143
Fe Total, mg/l	.18	218.00	25.71
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	308	396	368
Sulfate, mg/l	581	789	705
NO_2+NO_3 as "N", mg/l	.12	1.92	.59
Chloride, mg/l	9	14	11
Fluoride, mg/l	< .01	.54	.33

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Table D6-5. Major chemical constituents for sample site BH468. Source: Dietz 3 coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	31.30	31.30	31.30
TDS, mg/l	934	1120	1058
Lab Cond. umohs/cm	1470	1850	1737
Lab pH	7.5	7.9	7.7
Total Hardness, mg/l	32	44	37
Total Alkalinity as $CaCO_3$, mg/l	796	991	936
CATION ANALYSIS			
Calcium, mg/l	7	9	8
Magnesium, mg/l	4	5	4
Potassium, mg/l	< 1	10	8
Sodium, mg/l	378	458	435
Fe Total, mg/l	.22	1.13	.40
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	971	1210	1144
Sulfate, mg/l	< 1	18	-
NO_2+NO_3 as "N", mg/l	< .01	.03	-
Chloride, mg/l	32	39	36
Fluoride, mg/l	.62	1.90	1.55

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area. This is another positive indication that the Tongue River alluvium is a source of recharge to the coal bed aquifers at their subcrops.

Groundwater samples taken from well BH208 were found to have sulfate as the principal anion and sodium, calcium and magnesium as the principal cations. The sulfate concentration was found to be considerably high and greatly exceeded the recommended drinking water standard of 250 mg/l (McKee and Wolf, 1973). Total iron also exceeded the standard.

Sodium and bicarbonate are the principal cation and anion, respectively, for the samples taken from well BH468. The total dissolved solids, bicarbonate and total iron concentrations all exceed the recommended drinking water standards. The sulfate concentration was found to be low.

Tables D6-6, D6-7 and D6-8 present the major chemical constituents of the groundwater from Monarch coal wells BH467, BH496 and BH520. The mean total dissolved solids concentration is essentially the same for all three wells and has remained approximately 1,000 milligrams per liter. Sodium and bicarbonate are the predominant ions. The concentration of bicarbonate, total iron and total dissolved solids concentrations exceed the recommended drinking water standards for each well. Of these three wells, BH520 exhibits slightly less calcium carbonate and bicarbonate and much more sulfate. This is an indication that the Monarch coal seam is in hydrologic communication with a source of recharge high in sulfate (refer to the discussion on reclaimed spoil aquifer water quality).

Table D6-9 presents groundwater quality data for Carney well BH465. Again, characteristic of coal water quality in the area, the Carney water was of a sodium bicarbonate type. Bicarbonate was overwhelmingly the predominant anion, while sodium was the predominant cation. The bicarbonate, total iron, and total

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Table D6-6. Major chemical constituents for sample site BH467. Source: Monarch coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	27.4	27.4	27.4
TDS, mg/l	958	1120	1051
Lab Cond. umohs/cm	1590	1970	1751
Lab pH	7.4	8.1	7.7
Total Hardness, mg/l	46	59	52
Total Alkalinity as $CaCO_3$, mg/l	870	1020	935
CATION ANALYSIS			
Calcium, mg/l	10	14	12
Magnesium, mg/l	4.4	6	5
Potassium, mg/l	4	11	9
Sodium, mg/l	394	464	422
Fe Total, mg/l	< .05	1.36	.65
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	1060	1250	1140
Sulfate, mg/l	< 1	3	2
NO_2+NO_3 as "N", mg/l	< .01	.06	-
Chloride, mg/l	31	34	32
Fluoride, mg/l	1.11	1.50	1.15

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Table D6-7. Major chemical constituents for sample site BH496. Source: Monarch coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	27.1	27.1	27.1
TDS, mg/l	870	980	925
Lab Cond. umohs/cm	1410	1570	1499
Lab pH	6.6	7.69	7.16
Total Hardness, mg/l	33	94	50
Total Alkalinity as $CaCO_3$, mg/l	794	882	837
CATION ANALYSIS			
Calcium, mg/l	6	13	9
Magnesium, mg/l	4	18	7
Potassium, mg/l	8.6	14	10
Sodium, mg/l	348	394	370
Fe Total, mg/l	< .05	.12	-
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	969	1080	1023
Sulfate, mg/l	< 1	7	-
NO_2+NO_3 as "N", mg/l	< .01	5.72	-
Chloride, mg/l	12	16	14
Fluoride, mg/l	14	1.73	1.39

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Table D6-8. Major chemical constituents for sample site BH520. Source: Monarch coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	21.7	21.7	21.7
TDS, mg/l	870	1060	993
Lab Cond. umohs/cm	1440	1720	1610
Lab pH	7.7	8.0	7.9
Total Hardness, mg/l	50	53	51
Total Alkalinity as $CaCO_3$, mg/l	479	631	548
CATION ANALYSIS			
Calcium, mg/l	10	14	12
Magnesium, mg/l	3.7	6	5
Potassium, mg/l	8.5	19	12
Sodium, mg/l	337	379	360
Fe Total, mg/l	.05	2.09	.62
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	584	770	669
Sulfate, mg/l	156	388	285
NO_2+NO_3 as "N", mg/l	.01	4.73	1.16
Chloride, mg/l	6	10	8
Fluoride, mg/l	1.00	2.13	1.55

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Table D6-9. Major chemical constituents for sample site BH465. Source: Carney coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	24.90	24.90	24.90
TDS, mg/l	782	1060	949
Lab Cond. umohs/cm	1470	1620	1564
Lab pH	7.7	7.9	7.8
Total Hardness, mg/l	46	82	55
Total Alkalinity as $CaCO_3$, mg/l	832	910	854
CATION ANALYSIS			
Calcium, mg/l	9	18	11
Magnesium, mg/l	5	10	7
Potassium, mg/l	3	12	7
Sodium, mg/l	370	400	387
Fe Total, mg/l	.08	8.59	1.66
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	1020	1100	1041
Sulfate, mg/l	12	25	16
NO_2+NO_3 as "N", mg/l	< .01	.46	-
Chloride, mg/l	23	30	26
Fluoride, mg/l	1.51	1.83	1.71

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dissolved solids concentrations did not meet the acceptable drinking water standards.

Tables D6-10 and D6-11 present the Tongue River alluvial groundwater quality upstream of the mining operation, Table D6-12 presents the Goose Creek alluvial groundwater quality upstream of the mining operation and Tables D6-13 through D6-16 present the Tongue River alluvial groundwater quality downstream of mining activity.

Tables D6-10 and D6-11 show a significant difference between the water quality of the two upstream sites. Temporal variation in water quality at each well is also apparent upon inspection of the complete lab results, Addendum D6-2. Groundwater sampled from well BH371 may not be entirely from the Tongue River alluvial aquifer. This well is situated very near to the zero alluvial isopach and the exact completion of the well is questionable. Well BH508 is much more representative of the Tongue River alluvial water quality upstream of mining activity. Water from this well is of a calcium bicarbonate type and its total dissolved solids concentration averages 277 milligrams per liter. This water type is a reflection of the predominant chemical composition of the Tongue River at site TR1. The seasonal variations in alluvial water quality are closely tied to seasonal fluctuations in the quality of the Tongue River. This phenomena is closely related to snowmelt runoff in the Big Horn Mountains and man-related activities (particularly irrigation) upstream. These two Tongue River alluvial monitoring wells upstream of mining will continue to be sampled on an annual basis.

The chemical composition of the Goose Creek alluvial groundwater upstream of mining is represented by well BH403, Table D6-12. The total dissolved solids concentration averages 476 milligrams per liter. Magnesium, calcium and

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Table D6-10. Major chemical constituents for sample site BH371. Source: Qal coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	-	-	-
TDS, mg/l	652	3142	1377
Lab Cond. umohs/cm	1060	3740	1863
Lab pH	7.3	8.1	7.6
Total Hardness, mg/l	481	1293	767
Total Alkalinity as $CaCO_3$, mg/l	402	561	475
CATION ANALYSIS			
Calcium, mg/l	61	171	111
Magnesium, mg/l	61	210	120
Potassium, mg/l	< 1	15	-
Sodium, mg/l	70	488	171
Fe Total, mg/l	.22	607	71.3
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	491	684	579
Sulfate, mg/l	226	1453	554
NO_2+NO_3 as "N", mg/l	< .01	11.9	-
Chloride, mg/l	15	205	66
Fluoride, mg/l	.29	.83	.50

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Table D6-11. Major chemical constituents for sample site BH508. Source: Qal coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	.39	.39	.39
TDS, mg/l	238	316	277
Lab Cond. umohs/cm	437	520	470
Lab pH	7.5	7.9	7.7
Total Hardness, mg/l	206	243	224
Total Alkalinity as $CaCO_3$, mg/l	175	218	197
CATION ANALYSIS			
Calcium, mg/l	43	72	56
Magnesium, mg/l	7	29	20
Potassium, mg/l	< 1	4	-
Sodium, mg/l	12	20	15
Fe Total, mg/l	1.03	22.90	4.10
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	213	265	240
Sulfate, mg/l	37	76	56
NO_2+NO_3 as "N", mg/l	.01	.21	.06
Chloride, mg/l	< 1	2	-
Fluoride, mg/l	.13	.40	.21

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Table D6-12. Major chemical constituents for sample site BH403. Source: Qal coal.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	.66	.75	.71
TDS, mg/l	360	666	476
Lab Cond. umohs/cm	622	960	739
Lab pH	7.3	8.0	7.7
Total Hardness, mg/l	286	437	349
Total Alkalinity as $CaCO_3$, mg/l	235	291	259
CATION ANALYSIS			
Calcium, mg/l	29	85	67
Magnesium, mg/l	26	54	42
Potassium, mg/l	< 1	7	-
Sodium, mg/l	3	52	12
Fe Total, mg/l	.18	15.60	2.86
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	287	354	315
Sulfate, mg/l	90	245	150
NO_2+NO_3 as "N", mg/l	< .01	.51	-
Chloride, mg/l	2	7	4.9
Fluoride, mg/l	.19	.52	.29

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Table D6-13. Major chemical constituents for sample site BH207A. Source: Alluvium.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	.76	.86	.80
TDS, mg/l	450	568	513
Lab Cond. umohs/cm	734	963	834
Lab pH	7.5	7.9	7.7
Total Hardness, mg/l	326	431	379
Total Alkalinity as $CaCO_3$, mg/l	280	316	295
CATION ANALYSIS			
Calcium, mg/l	51	69	61
Magnesium, mg/l	51	63	55
Potassium, mg/l	8	11	9
Sodium, mg/l	32	43	37
Fe Total, mg/l	1.20	41.95	9.07
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	342	385	360
Sulfate, mg/l	136	187	162
NO_2+NO_3 as "N", mg/l	< .01	.20	-
Chloride, mg/l	2.9	4	3
Fluoride, mg/l	.27	.51	.36

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Table D6-14. Major chemical constituents for sample site BH397. Source: Alluvium.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	.89	1.03	.96
TDS, mg/l	468	1060	662
Lab Cond. umohs/cm	750	1430	1009
Lab pH	7.4	7.8	7.6
Total Hardness, mg/l	369	735	485
Total Alkalinity as $CaCO_3$, mg/l	298	453	345
CATION ANALYSIS			
Calcium, mg/l	73	131	94
Magnesium, mg/l	45	109	61
Potassium, mg/l	< 1	6	3
Sodium, mg/l	27	73	43
Fe Total, mg/l	.11	1.65	.44
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	364	553	421
Sulfate, mg/l	129	408	218
NO_2+NO_3 as "N", mg/l	< .01	.4	.09
Chloride, mg/l	2	10	5
Fluoride, mg/l	.09	.37	.17

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Table D6-15. Major chemical constituents for sample site BH644. Source: Alluvium.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	.40	.65	.55
TDS, mg/l	454	594	523
Lab Cond. umohs/cm	720	971	813
Lab pH	7.1	7.8	7.5
Total Hardness, mg/l	342	506	436
Total Alkalinity as $CaCO_3$, mg/l	271	436	362
CATION ANALYSIS			
Calcium, mg/l	73	108	93
Magnesium, mg/l	38	58	50
Potassium, mg/l	< 1	3.6	-
Sodium, mg/l	20	31	27
Fe Total, mg/l	.38	9.94	2.99
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	331	532	442
Sulfate, mg/l	100	127	118
NO_2+NO_3 as "N", mg/l	.02	1.22	.29
Chloride, mg/l	1.9	3.9	4
Fluoride, mg/l	.19	.40	.25

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Table D6-16. Major chemical constituents for sample site BH645. Source: Alluvium.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	.87	1.24	1.07
TDS, mg/l	574	724	657
Lab Cond. umohs/cm	807	1130	932
Lab pH	7.3	8.0	7.6
Total Hardness, mg/l	400	481	448
Total Alkalinity as $CaCO_3$, mg/l	275	300	290
CATION ANALYSIS			
Calcium, mg/l	73	108	98
Magnesium, mg/l	43	54	49
Potassium, mg/l	2	5	3
Sodium, mg/l	42	62	51
Fe Total, mg/l	.14	2.73	.92
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	335	366	353
Sulfate, mg/l	199	299	249
NO_2+NO_3 as "N", mg/l	.04	.70	.33
Chloride, mg/l	4	13	6
Fluoride, mg/l	.13	.30	.17

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bicarbonate are the dominant ions. This water type is a reflection of the predominant chemical composition of Goose Creek at site GCO.

As indicated by Tables D6-13 through D6-16 the Tongue River alluvial water quality immediately downstream of mining activity does not vary spatially. The concentration of the major chemical constituents is essentially the same for all four wells. The total dissolved solids concentration can be highly variable but averages between 500 and 650 milligrams per liter. There has been no noticeable change in the chemical composition of the alluvial groundwater, with calcium and magnesium the predominant cations and bicarbonate and sulfate the predominant anions. The bicarbonate and total iron cencentrations are in excess of the acceptable drinking water standards. The concentration of sulfate is also very close to being in excess and the water was found to be very hard. No appreciable seasonal trends have been observed in the downstream alluvial water quality.

Tables D6-17 through D6-20 present groundwater quality data for Pit 3 and Pit 1 spoil wells BH657, BH745, BH654 and BH656. As these tables illustrate, the quality of spoils water is difficult to appraise because of extreme diversity. Unlike the relatively uniform quality of groundwater from coal bed and alluvial aquifers, the spoils water quality is extremely variable. Studies conducted by the Montana Bureau of Mines and Geology on resaturated spoils at mines in southeastern Montana (Van Voast and Hedges, 1978) describe several reasons for this variability: "Saturated thicknesses of spoils have not yet attained equilibrium and changing water levels change the amount of salts available for solution. Complete circulation of groundwater through the reclaimed spoils has not yet occurred, therefore, a uniform areal distribution of dissolved salts has not been established. A complex distribution of salts exist in the overburden and when these materials are moved and mixed by mining the diversity is amplified. Also, the presence of

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Table D6-17. Major chemical constituents for sample site BH654. Source: Spoils.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	2.29	3.82	3.06
TDS, mg/l	1260	3730	3185
Lab Cond. umohs/cm	1840	4110	3555
Lab pH	6.3	7.4	6.9
Total Hardness, mg/l	546	2210	1884
Total Alkalinity as $CaCO_3$, mg/l	402	710	611
CATION ANALYSIS			
Calcium, mg/l	115	444	367
Magnesium, mg/l	63	288	236
Potassium, mg/l	16	40	29
Sodium, mg/l	205	284	251
Fe Total, mg/l	2.94	82.20	33.32
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	490	866	746
Sulfate, mg/l	579	2110	1783
NO_2+NO_3 as "N", mg/l	< .01	3.06	-
Chloride, mg/l	9.3	21	16.4
Fluoride, mg/l	.18	.82	.38

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Table D6-18. Major chemical constituents for sample site BH656. Source: Spoils.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	3.82	4.06	3.94
TDS, mg/l	972	1270	1184
Lab Cond. umohs/cm	1480	1850	1725
Lab pH	7.3	7.8	7.6
Total Hardness, mg/l	305	552	493
Total Alkalinity as $CaCO_3$, mg/l	335	457	405
CATION ANALYSIS			
Calcium, mg/l	62	112	98
Magnesium, mg/l	36	69	60
Potassium, mg/l	15	19	17
Sodium, mg/l	203	229	210
Fe Total, mg/l	22.31	139.00	54.25
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	409	558	493
Sulfate, mg/l	416	598	540
NO_2+NO_3 as "N", mg/l	<.01	1.16	-
Chloride, mg/l	8.5	10.0	9.1
Fluoride, mg/l	.66	1.07	.86

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Table D6-19. Major chemical constituents for sample site BH657. Source: Spoils.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	2.77	4.29	3.53
TDS, mg/l	2484	5950	4238
Lab Cond. umohs/cm	2920	6140	4610
Lab pH	6.8	7.5	7.1
Total Hardness, mg/l	1430	3890	2527
Total Alkalinity as $CaCO_3$, mg/l	735	1350	1062
CATION ANALYSIS			
Calcium, mg/l	353	443	411
Magnesium, mg/l	84	676	365
Potassium, mg/l	29	34	32
Sodium, mg/l	289	470	385
Fe Total, mg/l	2.71	74.7	38.7
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	897	1650	1296
Sulfate, mg/l	1235	3220	2172
NO_2+NO_3 as "N", mg/l	.17	4.72	2.54
Chloride, mg/l	20	89	56
Fluoride, mg/l	.40	.60	.48

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Table D6-20. Major chemical constituents for sample site BH745. Source: Spoils.

GROUNDWATER

Constituent	Minimum	Maximum	Mean
GENERAL PARAMETERS			
SAR	1.27	1.27	1.27
TDS, mg/l	2990	2990	2990
Lab Cond. umohs/cm	3390	3390	3390
Lab pH	7.3	7.3	7.3
Total Hardness, mg/l	1970	1970	1970
Total Alkalinity as $CaCO_3$, mg/l	481	481	481
CATION ANALYSIS			
Calcium, mg/l	339	339	339
Magnesium, mg/l	272	272	272
Potassium, mg/l	31	31	31
Sodium, mg/l	129	129	129
Fe Total, mg/l	12.3	12.3	12.3
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	587	587	587
Sulfate, mg/l	1740	1740	1740
NO_2+NO_3 as "N", mg/l	< .01	< .01	< .01
Chloride, mg/l	16	16	16
Fluoride, mg/l	.37	.37	.37

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'mine-floor' aquifers that are more transmissive cause analyses of samples from spoil wells to reflect water quality from these zones rather than the entire saturated thickness."

The total dissolved solids concentration of water from the reclaimed spoils has been high and exceedingly greater than the recommended drinking water standard. Of the principal cations (calcium, magnesium and sodium) calcium is predominant, and of the principal anions (bicarbonate and sulfate) sulfate is predominant. Total hardness, magnesium, total iron, bicarbonate and sulfate all exceed the recommended drinking water standard (McKee and Wolf, 1963).

In summary, the following conclusions can be made:

1. The mean total dissolved solids concentrations were slightly greater for the coal seam waters.
2. The mean calcium, magnesium, sulfate and total iron concentrations were higher in the alluvial water.
3. The mean bicarbonate, potassium, sodium, chloride and fluoride concentrations were higher in the coal seam waters.
4. The total alkalinity of the alluvial water is greater than the coal seam waters.
5. The alluvial water is very hard and the coal seams yield significantly softer water than the alluvium.
6. The spoils water is highly mineralized and extremely variable.
7. No aquifer in the area can actually be recommended as a suitable domestic drinking water supply. In general, the quality of water from all aquifers in the area is poor and may only be adequate for livestock and industrial usage.

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Water Rights and Uses

A listing of all valid water appropriations within the Big Horn Coal Company permit area and a three-mile radius around it was obtained from the State Engineer's Office, Cheyenne, WY in December 1980. This listing is summarized in Addendum D6-3 and depicted on Exhibit D6-9. This depicts groundwater appropriations potentially impacted by mining.

Present groundwater uses in the area include: stock watering, domestic, and industrial water supply used primarily as a fire retardant and for vehicle washing. Mine and private water wells are completed in alluvial aquifers along perennial streams and coal aquifers which are regionally significant.

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GROUNDWATER HYDROLOGY

PIT 3 OPERATION

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INTRODUCTION

This portion of the Groundwater Hydrology report will emphasize the existing subsurface movement, distribution, quantity and quality of water in the immediate area of the Pit Three Truck-Shovel/Amendment One operation (referred to as the Pit 3 operation). Included will be a description of the geologic setting and identification of principal recharge and discharge areas.

GEOHYDROLOGIC SETTING

Aquifer Identification

The only stratigraphic units within the Pit 3 operation that are capable of yielding enough water to be classified as aquifers are the Fort Union Formation coal seams. The drilling of aquifer test wells and geologic exploration holes within the area has shown that the fine-grained sediments which separate the coal seams yield no or very small quantities of water and characteristically serve as aquicludes or confining beds. All of the lithologic and geophysical logs are presented in Appendix D5. The stratigraphic sequences, lithologic thicknesses and local structure maps are also given in Appendix D5.

Geologic Features Influencing Aquifers

A major portion of the Pit 3 operation is surrounded by the Tongue River, a large perennial stream having a broad actively degrading channel and well defined terraces. The Pit 3 area can be geomorphically characterized as a gently sloping plateau or bluff rising above the Tongue River floodplain and decreasing in elevation from west to east. Much of the bluff is capped by unsaturated remnant Tongue River terrace gravels which are neither in lithologic nor hydraulic communication with the present Tongue River terrace system (Appendices D5 and D11). Geologic cross sections and the surficial geology map (Appendix D5) illustrate the vertical separation which exists between the paleoterrace gravels and

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the present Tongue River terrace gravels. For instance, the paleoterraces which cap the western end of the bluff lie approximately 120 feet higher in elevation than the present terrace system. Throughout the entire perimeter of the affected area there is only one location where the paleoterraces come into contact with the present Tongue River terrace system: at the northeastern edge of the affected area, near the center of the border between Section 13 and 14. A geologic cross section normal to this contact, Figure D6-7, shows that even though lithologic communication exists, the maximum observed (two years of monthly data) alluvial water table elevation has never been great enough to saturate the adjacent paleoterrace gravels.

Big Horn Coal Company is currently mining the Monarch coal seam in Pit 3 west of, and immediately adjacent to, the affected area. This pit is located to the north of the Tongue River and much of it is situated in an abandoned meander loop. Since the meander was abandoned, five to 20 feet of colluvium derived from the adjacent hills (one of them being the affected area) has been deposited over the paleo-river gravels. The area lies predominantly above the Tongue River floodplain, however, these gravels are in hydraulic communication with the present Tongue River terrace system and are actively being dewatered.

Extensive exploratory drilling within the affected area has verified the presence of four distinct water-bearing strata: the Dietz 2 (Armstrong) coal seam, the Dietz 3 (Upper Monarch) coal seam, the Monarch (Lower Monarch) coal seam, and the Carney coal seam, listed in descending stratigraphic order. The Carney seam will not be mined.

No water was encountered in the Dietz 2 coal seam updip of an imaginary line connecting the Dietz 2 alluvial subcrops to the north and south of the bluff. As illustrated by the surficial geology map and cross sections in Appendix D5, the

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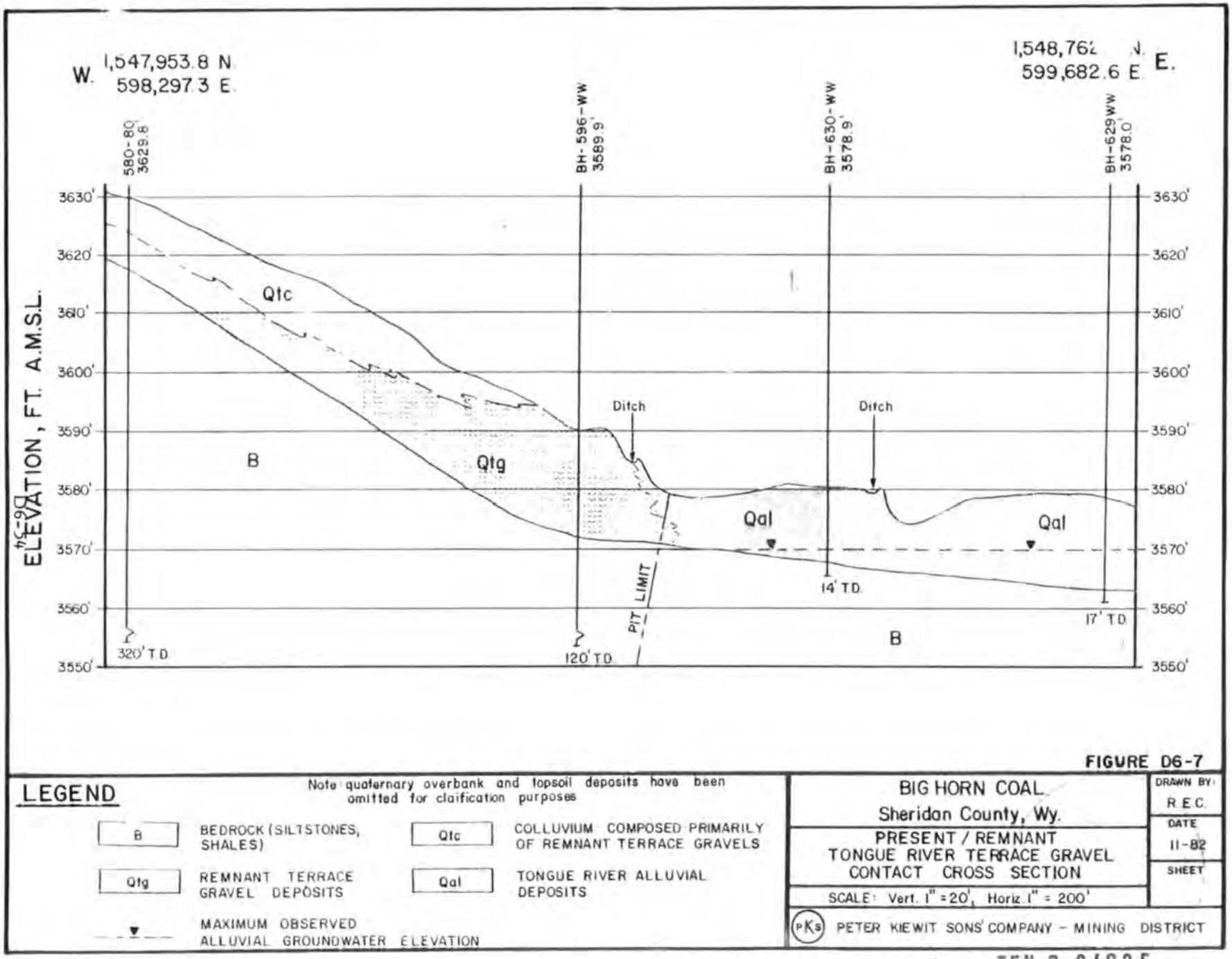

FIGURE D6-7

LEGEND

Note: quaternary overbank and topsoil deposits have been omitted for clarification purposes

B — BEDROCK (SILTSTONES, SHALES)	Qtc — COLLUVIUM COMPOSED PRIMARILY OF REMNANT TERRACE GRAVELS
Qtg — REMNANT TERRACE GRAVEL DEPOSITS	Qal — TONGUE RIVER ALLUVIAL DEPOSITS
▼ — MAXIMUM OBSERVED ALLUVIAL GROUNDWATER ELEVATION	

BIG HORN COAL
Sheridan County, Wy.
PRESENT / REMNANT TONGUE RIVER TERRACE GRAVEL CONTACT CROSS SECTION
SCALE: Vert. 1" = 20', Horiz. 1" = 200'
PETER KIEWIT SONS' COMPANY – MINING DISTRICT

DRAWN BY: R.E.C.
DATE: 11-82
SHEET

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Dietz 2 seam outcrops around the west side of the bluff. It is, therefore, not subject to recharge from the Tongue River updip of this imaginary line. The degree of recharge from direct precipitation-infiltration into the outcrop and burn area stratigraphically above the Tongue River is relatively nil.

All geologic strata to be disrupted within the affected area either crop out on the west side of the bluff or are actively being excavated in the active Pit 3. They extend continuously to the southeast and are unbroken by any faulting.

The Dietz 2, Dietz 3 and Monarch coal seams are extensively burned to the north and west of the affected area. Recharge to these areas which are stratigraphically above the Tongue River is primarily by precipitation-infiltration at the scoria (burn) outcrops.

Groundwater Flow

Monitoring Water Levels

The well completion summary (Table D6-21) lists those observation wells that have been selected to illustrate the water level fluctuations for all aquifers within and around the Pit 3 operation. Fluctuations for each of the selected wells have been shown in Exhibit D6-8 and in Figures D6-2 through D6-4. Water levels from all of the selected wells have been recorded every month following the completions. Where more detailed groundwater level hydrographs are desired, Steven's F-68 continuous recorders have been installed (Exhibit D6-7).

Potentiometric Surfaces

Descriptions of the existing potentiometric surfaces of the Dietz 2 coal, Dietz 3 coal, Monarch coal and alluvial aquifers within and around the Pit 3 operation are found in the General Area-Groundwater Hydrology section.

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Table D6-21. Well completion summary.

Locations							Elevations		Depths (ft.)			Completions				Diameters (in.)	
	WY Coordinates		T.57N.		R.84W.		Grd.	Csg.			Packer	Perf.	Gravel	Geol.	Date	Drill	PVC
Well #	North	East	Sec.	1/4	1/4	1/4	Elev.	Ht.	Total	Csg.	Base	Interval	Pkd.	FM.	Drilled	Bit	Csg.
WW198-76	1546187.8	594899.3	14	SE	SW	SW	3589.4	0.4	29	29	None	9-29	x	Alluvium	6/04/76	4 3/4	4
WW206-78	1546552.5	595212.8	14	NW	SE	SW	3586.5	2.4	27	27	None	7-27	x	Alluvium	6/04/76	4 3/4	4
WW207-76[a]	1546061.5	594741.2	14	SW	NW	SW	3589.1	2.9	30	30	None	8-28	x	Alluvium	6/07/76	4 3/4	4
WW207A-80	1547118.3	594737.5	14	SE	NW	SW	3589.8	2.3	25	25	None	5-25	x	Alluvium	4/23/80	7 7/8	5
WW230-77[b]	1548361.0	594458.9	14	SW	SW	NW	3600.6	0.0	58	58	None	20-58	x	Alluvium	3/08/77	7 7/8	5
WW397-78	1546054.3	594917.4	14	SE	SW	SW	3591.5	1.9	30	30	None	8-24	x	Alluvium	12/18/78	7 7/8	5
WW630-80	1548606.2	599231.0	13	SW	SW	NW	3578.9	1.9	14	14	None	2-12	x	Alluvium	8/13/80	7 7/8	5
WW638-80	1551166.0	596152.4	11	SE	SE	SW	3569.5	1.6	21	21	None	0-20	x	Alluvium	8/19/80	7 7/8	5
WW645-80	1546659.7	600037.7	13	NE	SW	SW	3579.7	1.8	23	23	None	10-20	x	Alluvium	8/21/80	7 7/8	5
WW469-79	1545247.5	600804.1	24	NW	NE	NW	3614.9	2.3	253	253	221	227-244		Dietz-2	8/02/79	7 7/8	5
WW596-80	1548220.0	599038.0	14	NE	NE	SE	3589.9	1.4	120	96	96	96-109		Dietz-2	4/22/80	7 7/8	5
WW647-80	1542548.6	600603.1	24	SW	NW	SW	3673.0	0.9	341	312	312	314-334		Dietz-2	9/30/80	7 7/8	5
WW674-81	1546149.2	597189.3	14	SE	SW	SE	3611.0	1.5	90	90	57	60-80		Dietz-2	7/27/81	7 7/8	5
WW208-76	1547164.9	595321.6	14	SW	NE	SW	3592.5	1.8	50	50	20	30-50		Dietz-3	6/07/76	6 3/4	4
WW468-79	1545523.0	599689.0	24	NW	NW	NW	3605.6	2.0	290	290	228	230-270		Dietz-3	6/28/79	7 7/8	5
WW575-80	1549144.4	596919.5	14	NW	SW	NE	3682.6	0.9	190	190	158	162-182		Dietz-3	7/17/80	7 7/8	5
WW576-80	1548571.4	598465.4	14	SW	SE	NE	3607.0	1.2	170	170	135	140-160		Dietz-3	3/18/80	7 7/8	5
WW582-80	1546358.2	597972.3	14	SW	SE	SE	3614.4	2.2	200	200	163	165-185		Dietz-3	3/24/80	7 7/8	5
WW462A-79	1539386.4	595013.6	27	SE	NE	NE	3703.3	1.6	314	314	255	265-304		Dietz-3/M[a]	7/19/79	7 7/8	5
WW231-77[b]	1548581.1	594308.0	14	SW	SW	NW	3601.9	1.8	85	85	64	65-85	x	Monarch	3/08/77	7 7/8	5
WW204-76	1547086.6	595261.5	14	SW	NE	SW	3591.9	2.3	150	150	110	120-140		Monarch	6/07/76	6 3/4	4
WW232-77[a,b]	1549738.1	594863.4	14	NE	SW	NW	3606.9	1.9	98	98	76	78-98	x	Monarch	3/09/77	7 7/8	5

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Table D6-21. Cont'd.

WW467-79	1545078.0	599659.0	24	SW	NW	NW	3619.1	1.7	380	380	342	343-364	Monarch	6/27/79	7 7/8	5
WW496-79	1548860.6	596573.6	14	SW	SW	NE	3687.6	1.9	278	278	243	245-270	Monarch	7/25/79	7 7/8	5
WW520-79	1545941.1	594941.3	14	SE	SW	SW	3589.9	2.5	150	150	110	116-141	Monarch	8/03/79	7 7/8	5
WW584-80	1546627.9	598799.3	14	NE	SE	SE	3618.7	2.0	340	340	300	303-327	Monarch	3/25/80	7 7/8	5
WW465-79	1544255.0	597922.0	23	NW	SE	NE	3635.1	0.9	440	440	390	390-422	Carney	6/13/79	8 3/4	5
WW597-80	1548911.0	597284.0	14	SE	SW	NE	3666.5	1.7	440	440	404	405-425	Carney	4/22/80	7 7/8	5
WW654-81	1544349.2	592108.7	22	NE	SW	NE	3739.7	0.7	220	220	180	180-220	Spoils	1/28/81	7 7/8	5
WW656-81	1544628.5	591351.0	22	SW	NW	NE	3653.2	2.8	110	110	70	70-110	Spoils	1/29/81	7 7/8	5
WW657-81	1549126.2	593083.3	15	NW	SE	NE	3627.8	2.2	80	80	40	40-80	Spoils	1/29/81	7 7/8	5
WW745-82	1548366.2	592746.1	15	SW	SE	NE	3633.3	1.8	84	80	60	64-84	Spoils	1/29/81	7 7/8	5

* Removed by mining operations in Pit Three, November, 1979.

** Removed by mining operations in Pit Three, April, 1980

*** Removed by mining operations in Pit Three, August, 1980

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Aquifer Hydraulics

Aquifer pumping tests have been conducted on the Dietz 2 coal, Dietz 3 coal, Monarch coal, Tongue River alluvium and reclaimed spoil aquifers within and adjacent to the Pit 3 operation. The aquifer test data log sheets, which contain all of the pertinent field information pertaining to each test, are presented in Addendum D6-4. Graphs plotting the data and showing the appropriate straight line or curve fits along with all aquifer coefficient calculations are also presented in Addendum D6-4. All test data and calculations for the Tongue River alluvial aquifer are presented in Appendix D11.

Table D6-22 presents a summary of the aquifer test results. Transmissivity values for the coal aquifers in the area vary considerably. The average aquifer coefficients for the affected coal aquifers are as follows:

Coal Seam	Transmissivity	Storage Coefficient
Monarch	628 gpd/ft	4.6×10^{-4}
Dietz 3	253 gpd/ft	4.6×10^{-4}
Dietz 2	250 gpd/ft	5.0×10^{-5}

The confined nature of the coal seam aquifers is indicated by the low storage coefficients. The Tongue River alluvium is a very significant aquifer. The average transmissivity for the tested wells is approximately 39,250 gpd/ft and the storage coefficient is approximately 2.6×10^{-1}, indicative of an unconfined aquifer.

Hydraulic characteristics of the spoils were needed to predict the contribution of groundwater that will be discharged into the mine pit from the resaturated backfill as mining progresses eastward into the Pit 3 truck-shovel Amendment One operation. Also, as mining and backfilling continue, pump testing of the resaturated spoils will be ongoing to further aid in predicting the hydraulic properties of the postreclamational aquifer. To date, three single well tests and

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Table D6-22. Summary of aquifer tests.

Well #	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Perm. (gpd/ft^2)	Storage Coeff.	Comments
230	Alluvium	4/22/77	Jacob Time Recovery	0.68	15.0	0.60	25.00	33,700	2,106	---	Limited recovery points.
207A	Alluvium	4/24/80	Jacob Time Drawdown and Recovery	4.50	14.1	1.61	8.76	68,244	4,265	---	Good straight-line fit for drawdown and recovery.
198 & 397	Alluvium	2/19/79	Jacob Time Drawdown	12.47	69.0	6.62	10.42	53,576	2,060	0.14	Good straight-line fit for the observation well 198. Reasonably good lines for the pumping well 397.
627	Alluvium	8/3/81	Jacob Time Drawdown and Recovery	24.50	39.1	2.40	16.29	99,229	18,308	---	Good straight-line fit for recovery curve and poor fit for drawdown curve.
640	Alluvium	7/24/81	Jacob Time Drawdown and Recovery	6.00	39.6	4.54	8.72	26,116	1,933	---	Difficult interpretations for both curves - point scatter greatest on recovery curve.
623	Alluvium	7/30/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	47.63	---	0.74	---	23,424	1,889	0.60	Observation well for the pumping well 645. Excellent drawdown curve-agrees favorably with the Theis curve results.
624	Alluvium	7/30/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	45.63	---	1.02	---	23,594	1,582	0.62	Observation well for the pumping well 645. Good draw down curve-agrees favorably

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Table D6-22. Cont'd.

Well #	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Perm. (gpd/ft^2)	Storage Coeff.	Comments
625	Alluvium	7/30/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	47.63	---	0.38	---	30,735	2,383	0.14	Observation well for the pumping well 645. Excellent drawdown curve-agrees with Theis curve results. Poor recovery curve.
626	Alluvium	7/30/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	45.63	---	0.17	---	46,865	3,317	0.12	Observation well for the pumping well 645. Jacob drawdown and Theis curves agree favorably. Poor recovery curve.
645	Alluvium	7/30/81	Jacob Time Drawdown and Recovery	29.63	39.85	3.78	10.54	26,573	2,311	---	Pumping well for multiple well test. Excellent straight-line fit for recovery curve.
634	Alluvium	8/6/81	Jacob Time Drawdown Theis Non-Equilibrium	22.50	---	0.15	---	22,333	1,329	0.08	Observation well for the pumping well 638. Good Jacob drawdown curve. Very good Theis type curve fit.
639	Alluvium	8/6/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	21.28	---	0.23	---	31,425	5,363	0.19	Observation well for the pumping well 635. Good Jacob drawdown. Poor Jacob recovery. Very good Theis

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Table D6-22. Cont'd.

Well #	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Perm. (gpd/ft^2)	Storage Coeff.	Comments
635	Alluvium	8/6/81	Jacob Time Drawdown and Recovery	27.67	38.39	2.12	18.11	31,185	1,801	---	Pumping well for multiple well test. Excellent straight-line fit for recovery curve.
636	Alluvium	8/4/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	41.75	---	0.26	---	50,683	8,228	0.47	Observation well for the pumping well 644. Good straight-line fit for Jacob drawdown curve.
637	Alluvium	8/4/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	41.75	---	0.68	---	30,743	2,968	0.10	Observation well for the pumping well 644. Excellent straight-line fits for Jacob drawdown and recovery curves Excellent Theis type curve fit. All results agree with one another.
638	Alluvium	8/4/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	39.75		0.41	---	33,913	5,709	0.10	Observation well for the pumping well 644. Excellent straight-line fits for Jacob drawdown and recovery curves Excellent Theis type curve fit. All results agree with

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Table D6-22. Cont'd.

Well #	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Perm. (gpd/ft^2)	Storage Coeff.	Comments
644	Alluvium	8/4/81	Jacob Time Drawdown and Recovery	22.50	37.82	5.12	7.34	35,033	4,819	---	Pumping well for multiple well test. Excellent straight-line fit for recovery curve.
647 & 466	Dietz 28C Coal	1/2/81	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	8.92	3.72	39.93	0.10	252	19.40	5.0×10^{-5}	Pumping well 647-large data point scatter on drawdown curve but good straight-line fit for recovery. Observation well 466-good stragiht-line fit for drawdown and recovery using the Jacob method. Excellent fit with the nonleaky artesian type curve using the Theis method
469	Dietz 28C Coal	7/3/80	Jacob Time Drawdown and Recovery	5.35	3.38	57.45	0.06	20	1.40	---	Value for Δs obtained from first part of drawdown curve Reasonably good straight-line fit for recovery. Well produces enough methane gas to cause pump cavitation.
596	Dietz 28C	6/19/81	Jacob Time Drawdown	5.42	16.21	59.48	0.27	250	20.8	---	Good straight-line fit for

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Table D6-22. Cont'd.

Well #	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Perm. (gpd/ft^2)	Storage Coeff.	Comments
582	Dietz 3 coal	3/27/80	Jacob Time Drawdown and Recovery	4.75	7.0	69.21	.10	702	30.5	---	Good straight-line fit for drawdown
468	Dietz 3 coal	2/22/80	Jacob Time Drawdown and Recovery	5.67	7.8	48.04	.16	391	16.3	---	Good straight-line fit for drawdown and recovery.
576	Dietz 3 coal	5/8/80	Jacob Time Drawdown	6.25	1.7	47.02	.04	24	1.0	---	Well produces methane gas which may invalidate results
575	Dietz 3 coal	3/26/80	Jacob Time Recovery Bailer Test	5.00	0.7	40.41	.02	2	0.1	---	Good straight-line fit on late data points.
467	Monarch coal	2/26/80	Jacob Time Drawdown and Recovery	5.50	7.7	28.30	.27	849	40.4	---	Good straight-line fit for drawdown and recovery.
584	Monarch coal	4/9/80	Jacob Time Drawdown and Recovery	5.67	8.1	46.18	.18	779	37.1	---	Good straight-line fit for drawdown and recovery.
496	Monarch coal	4/3/80	Jacob Time Drawdown and Recovery	4.75	3.7	40.14	.09	256	12.2	---	Good straight-line fit for late recovery points.
232	Monarch coal	4/21/77	Jacob Time Drawdown and Recovery	1.10	4.5	26.17	.17	54	2.6	---	Good straight-line fit for drawdown and recovery.
231	Monarch coal	4/21/77	Jacob Time Recovery	1.93	6.8	27.50	.25	8	0.4	---	Good straight-line fit for recovery.
462 462A	Dietz 3/ Monarch coal combined	5/9/80	Theis Non-Equilibrium	6.88	19.5	12.53	---	144	3.6	4.6 x 10^{-4}	Pumping well 462A - no drawdown or recovery data points Aquifer coefficients derived from observation well 462.

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Table D6-22. Cont'd.

Well #	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Perm. (gpd/ft^2)	Storage Coeff.	Comments
464	Dietz 1B Coal	6/11/80	Jacob Time Drawdown and Recovery	5.50	0.17	83.75	0.01	11	0.85	---	Good straight-line fit for drawdown and recovery.
463 & 463A	Dietz 1AB Coal	6/9/80	Jacob Time Drawdown and Recovery Theis Non-Equilibrium	6.58	2.45	89.14	0.03	54	3.14	1.4×10^{-4}	Pumping well 463-reasonably good straight-line fit for drawdown curve and poor fit for recovery curve. Aquifer coefficients derived from observation well 463A-excellent fit with the nonleaky artesian type curve.
688	Dietz 1B Coal	11/13/81	Jacob Time Drawdown and Recovery	5.55	6.43	45.74	0.14	170	13.60	---	Good straight-line fit for drawdown and recovery.
655	Spoils	7/21/81	Jacob Time Drawdown and Recovery Time-Calculated Recovery Theis Non-Equilibrium	26.00	36.99	0.82	---	22,466	---	6.0×10^{-3}	Pumping well 654-unable to measure water level. Aquifer coefficients derived from observation well 655. Excellent straight-line fit for the drawdown and both the residual and calculated recovery curves. Good curve match with the non-equilibrium type curve.

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Table D6-22. Cont'd.

Well #	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Perm. (gpd/ft^2)	Storage Coeff.	Comments
656	Spoils	7/14/81	Jacob Time Recovery	5.03	1.29	25.78	0.05	11	---	---	Large data point scatter on drawdown curve. Reasonably good straight-line fit for recovery.
657	Spoils	10/ 6/81	Slug Method	1.58	---	10.35	---	26	---	---	Instantaneous withdrawal of casing storage volume (10.6 gal.). Recovery curve matched with a slug test type curve.
657	Spoils	8/10/82	Jacob Time Drawdown and Recovery	3.25	0.65	5.28	0.12	58	---	---	Excellent straight-line fit for recovery.
658	Spoils	10/ 6/81	Slug Method	1.92	---	12.82	---	57	---	---	Instantaneous withdrawal of casing storage volume (13.1 gal.). Recovery curve matched with a slug test type curve.

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Table D6-22. Cont'd.

Well #	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Perm. (gpd/ft^2)	Storage Coeff.	Comments
745	Spoils	7-9-82	Jacob Time Drawdown and Recovery	4.73	1.67	2.72	0.60	14,696	---	---	Pumping well 745, observation well 746. Poor fit for drawdown curve - no interpretation. Fair recovery curve.
746	Spoils	7-9-82	Jacob Time Drawdown and Recovery Theis Non-equilibrium Time-Calculated Recovery	6.32	---	.064	---	20,627	---	2.1 x 10^{-4}	Fair residual drawdown and recovery curves. Good curve match with a leaky artesian type curve. Excellent calculated recovery curve.

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two multiple well tests have been conducted on the reclaimed spoils and a very wide range of aquifer coefficient values have been found. Therefore, a mean transmissivity value and storage coefficient value of all spoil aquifer pump tests conducted at the Big Horn Coal and the Decker Coal Mines (Van Voast, et. al., 1978) were used to predict the contribution of groundwater to the Pit 3 operation from the backfilled spoils.

Groundwater Quality

The groundwater quality sampling program and data analysis of all water-bearing strata within and adjacent to the Pit 3 operation are presented in the General Area-Groundwater Hydrology section.

A Dietz 3 coal well (BH582) has been dropped from the groundwater quality monitoring network since well BH468 is only 1950 feet away from well BH582. Long-term water quality analysis is similar and well BH468 is better situated to monitor changes due to mining activities.

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GROUNDWATER HYDROLOGY

PIT 4 OPERATION

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INTRODUCTION

This portion of the Groundwater Hydrology report will define the existing subsurface movement, distribution, quantity and quality of water in the immediate area of Pit 4. Included will be a description of the geologic setting and identification of the principal recharge and discharge areas.

GEOHYDROLOGIC SETTING

Aquifer Identification

Within the Big Horn Coal Mine area, the most significant aquifers are the stream alluvial deposits and the thicker coal seams. The economically recoverable coal seam within Pit 4 is an isolated, unburned remnant of the Monarch seam. Its limits are defined by a burn line to the west, the Acme No. 1 underground mine to the east, a subcrop in unconsolidated colluvial and Hidden Water Creek terrace deposits to the north, and a subcrop in unconsolidated colluvial and old Tongue River terrace deposits to the south. These features are best understood by referring to the geology map, Exhibit D6-10. The surficial geology map, Appendix D5, may also be helpful.

The Monarch coal seam has been extensively burned over a large area to the west of Pit 4. The minable reserve is bordered entirely along its western edge by clinker rock. As illustrated by Exhibit D6-10, approximately 1,000 feet west of the affected area boundary of Pit 4, this clinker rock appears to have been scoured away by the ancient Tongue River and unconsolidated terrace gravel deposits. These now act to separate the Monarch coal reserve and adjacent clinker from the main clinker body farther to the west. These old terrace gravels are isolated from the active, contemporary Tongue River terraces.

Extensive exploratory drilling within and around the Pit 4 area has revealed that the minable Monarch coal, the clinker rock, and the old terrace gravels do not

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yield groundwater. The entire suite of lithologic and geophysical logs of every plug hole, core hole and observation water well, along with a drill hole location map is presented in Appendix D6. Hydrologic investigations were not conducted on these three stratigraphic units. Table D6-23 is a listing of the exploration drill holes which indicated that these units are dry.

As discussed in the section on geomorphology, Hidden Water Creek is underlaid with up to 30 feet of very fine to coarse-grained, poorly sorted alluvium of local origin. Just north of the proposed Pit 4 box cuts, the base elevation of the alluvium is about four to 19 feet below the top of the Monarch coal. Exploration drilling has indicated that the intermittent subflows and surface flows of Hidden Water Creek do not recharge the Monarch coal in the proposed pit area. As Table D6-23 has shown, most of the drilling in the area was conducted during the spring months of 1978. The Monarch coal was found to be only damp in those holes nearest the Monarch's subcrop in the Hidden Water Creek alluvium which was saturated at that time.

The northern extent of the Pit 4 excavations will approximately parallel the ten-foot alluvial isopach contour (Exhibit D6-11) of Hidden Water Creek. This alluvium is the only potential aquifer that will be directly affected during the mining process. However, hydrologic investigations were also conducted on a saturated sandstone closely underlying the Monarch coal.

In December 1978, five 5-inch observation wells were completed as two cross sections in the Hidden Water Creek alluvium and the underlying sandstone (WW392 through WW396). While drilling, the alluvium was dry, but the sandstone produced from five to approximately 100 gallons per minute. It was felt that in completing each well in two horizons, water levels in the alluvium could be observed during periods of intermittent subflow, while potentiometric elevations for the sandstone

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Table D6-23. Exploration drill holes which indicate the minable Monarch coal, the clinker, and the old Tongue River terrace deposits within and around Pit 4 do not yield groundwater.

Well No.	Date Drilled	Total Depth (ft)
287-78	4/25/78	40
288-78	4/25/78	60
289-78	4/25/78	80
294-78	5/01/78	40
295-78	5/01/78	140
296-78	5/02/78	60
297-78	5/02/78	44
298-78	5/02/78	60
299-78	5/02/78	80
301-78	5/02/78	40
302-78	5/02/78	40
315-78	6/02/78	89
316-78	6/02/78	93
323-78	6/12/78	80
324-78	6/13/78	180
326-78	6/14/78	80
327-78	6/14/78	76
328-78*	6/15/78	60
332-78	6/20/78	300
337-78	6/22/78	40
338-78	6/22/78	80
339-78	6/26/78	80
340-78	6/26/78	80
341-78	6/27/78	60
342-78	6/27/78	45.5
343-78	6/27/78	60
344-78	6/27/78	45.5
345-78	6/27/78	40
346-78*	6/27/78	60
347-78	6/28/78	60
WW390-79*	4/09/79	110
WW391-79	4/10/79	97

* Monarch coal was damp

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aquifer could be obtained when the alluvium was dry. In April 1979, two observation wells were completed in the sandstone underlying the Monarch coal within the Pit 4 area. Geologic data suggest that this sandstone is continuous with that underlying the Hidden Water Creek alluvium. In summary, seven observation water wells have been installed, two to monitor only the said sandstone, and five to monitor the Hidden Water Creek alluvium when it is saturated, although potentiometric elevations for the sandstone can be measured in these five wells when the alluvium is dry. Exhibit D6-12 shows the locations of these water wells and Table D6-24 summarizes the well completion data.

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Hydrographs of water elevations for the observation wells are presented in Exhibit D6-13. Shown on the hydrographs is the elevation of the base of the alluvium at the respective cross sections of wells. Wells 392 through 396, completed in the alluvium and underlying sandstone, show water elevations corresponding to stream runoff and subflows in the spring and early summer of 1979. Wells 390 and 391, completed only in the sandstone, report an approximate three month lag between the peak in alluvial groundwater elevations. This suggests that recharge from Hidden Water Creek is somewhat restricted by the shale interburden which exists between the alluvium and sandstone, and possibly the low transmissivities of the sandstone aquifer.

The groundwater hydrographs of observation wells completed in the Hidden Water Creek alluvium and underlying sandstone prove that the alluvium contained water only during the spring and early summer runoff of 1979. The amount of precipitation received as snowfall the winter of 1979-80 was extremely less than that received the previous year. Hidden Water Creek flowed for only a three day period the spring of 1980, and as can be seen on the groundwater hydrographs, the alluvium did not become saturated that year at all. The relationship between the

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Table D6-24. Pit 4 well completion summary.

Well No.	Geol. Stratum	Date Drilled	WY Coordinates North	WY Coordinates East	Sec. T57 R84	Elevations (ft) Ground Elev.	Elevations (ft) Csg. Ht.	Depths (ft) Total*	Depths (ft) Packer Base	Depths (ft) Perforation Interval	Diameters (in) Bit	Diameters (in) Csg.
WW390	Sandstone	4-09-79	1,549,564.6	589,539.2	15 NE¼SW¼NW¼	3709.68	2.05	110	75	75-110	7 7/8	5
WW391	Sandstone	4-10-79	1,549,187.1	589,542.4	15 NE¼SW¼NW¼	3681.30	1.20	97	41	41-97	7 7/8	5
WW392	Alluvium/Sandstone	12-12-78	1,551,802.2	587,358.2	9 NW¼SE¼SE¼	3698.56	1.85	50	Gravel packed	27-50	7 7/8	5
WW393	Alluvium/Sandstone	12-13-78	1,551,736.9	587,286.4	9 SW¼SE¼SE¼	3701.30	3.23	65	Gravel packed	46-65	7 7/8	5
WW394	Alluvium/Sandstone	12-13-78	1,551,686.1	587,227.7	9 SW¼SE¼SE¼	3701.80	2.69	39	Gravel packed	19-39	7 7/8	5
WW395	Alluvium/Sandstone	12-14-78	1,550,086.3	589,209.3	15 SE¼NW¼NW¼	3666.40	1.60	60	Gravel packed	42-60	7 7/8	5
WW396	Alluvium/Sandstone	12-14-78	1,549,950.8	589,212.5	15 SE¼NW¼NW¼	3671.10	1.56	60	Gravel packed	42-60	7 7/8	5

* Casing depth = total depth

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surface flows and groundwater elevations is evident in the 1979 hydrograph of Hidden Water Creek, Figure D6-12, in the Surface Water section of this report. Since the alluvium only intermittently contains water, and since excavations in this lithology are expected to be in the winter months, no further hydrologic studies were conducted on the alluvium.

With the exception of well 391, groundwater elevations for all wells suggest that the sandstone aquifer is confined. The consistently lower water elevation of well 391 may depict a local pressure release in the aquifer. Although no perched water tables were encountered during the drilling of wells 390 and 391, and no springs have been observed on the hillsides of the general Pit 4 area, the consistently high water levels of well 390 may be a result of leakage from higher strata or surface runoff into the well through the adjacent borehole 280-78. Wells 392 through 396 show water elevations above the top of the sandstone aquifer but below the base of the alluvium for most of the period of record. Water levels for wells 392 through 394 indicate that the alluvium is dry for all but the period of spring runoff. It is assumed that the alluvium is dry during the same period for wells 395 and 396, and that the water levels there, even though generally slightly above the base of the alluvium, are actually potentiometric elevations from the sandstone aquifer.

Exhibit D6-14 shows the potentiometric surface for the sandstone aquifer constructed from observations taken November 1979. The elevation contours depict the potentiometric surface gradually sloping from the northwest to the southeast, which is also the general dip of the regional stratigraphy (refer to Appendix D5). The Pit 4 geology map shows the sandstone unit outcropping to the south of the Pit 4 area along the steep slopes overlooking the Tongue River. Recharge to the aquifer occurs from the northwest, most notably via slow leakage

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from the intermittent subflows of Hidden Water Creek. Discharge from the aquifer is presumed to occur at the outcrop to the south, although no active springs or seeps have been observed indicating they may flow intermittently.

Aquifer Hydraulics

In order to evaluate possible mining impacts on the sub-Monarch coal sandstone aquifer and estimate groundwater inflow into the Pit 4 excavations, single and multiple well drawdown and recovery tests were conducted on wells 390 and 393 and well 395. Specifics on test results and descriptions are presented in Table D6-25. All aquifer test data is supplied in Addendum D6-6.

Upon reviewing the test results, it is apparent that the aquifer exhibits a broad range in transmissivities. Values of transmissivity range from about 16,960 gpd/ft at WW393 to approximately 2 gpd/ft at wells WW390 and WW391. The storage coefficient of 4.4×10^{-4}, obtained from the multiple well test, is indicative of a confined aquifer.

The range of transmissivities observed from the sandstone aquifer tests must be primarily attributed to facies changes within the sandstone unit. The sandstone isopach map, Exhibit D6-15, drawn from available drill hole data, shows that aquifer thicknesses correspond with aquifer transmissivities. However, sandstone transmissivities divided by respective unit thicknesses results in a range of permeabilities which indicate that the thicker portions of the aquifer consist of cleaner, better sorted sand, whereas the thinner portions of the unit are also siltier. These observations suggest that mining in the Pit 4 area will not disturb any significant aquifer.

Groundwater Quality

Groundwater quality sampling in the Pit 4 area was initiated in early 1979. Samples have been collected from wells 392 and 395 which are both completed in

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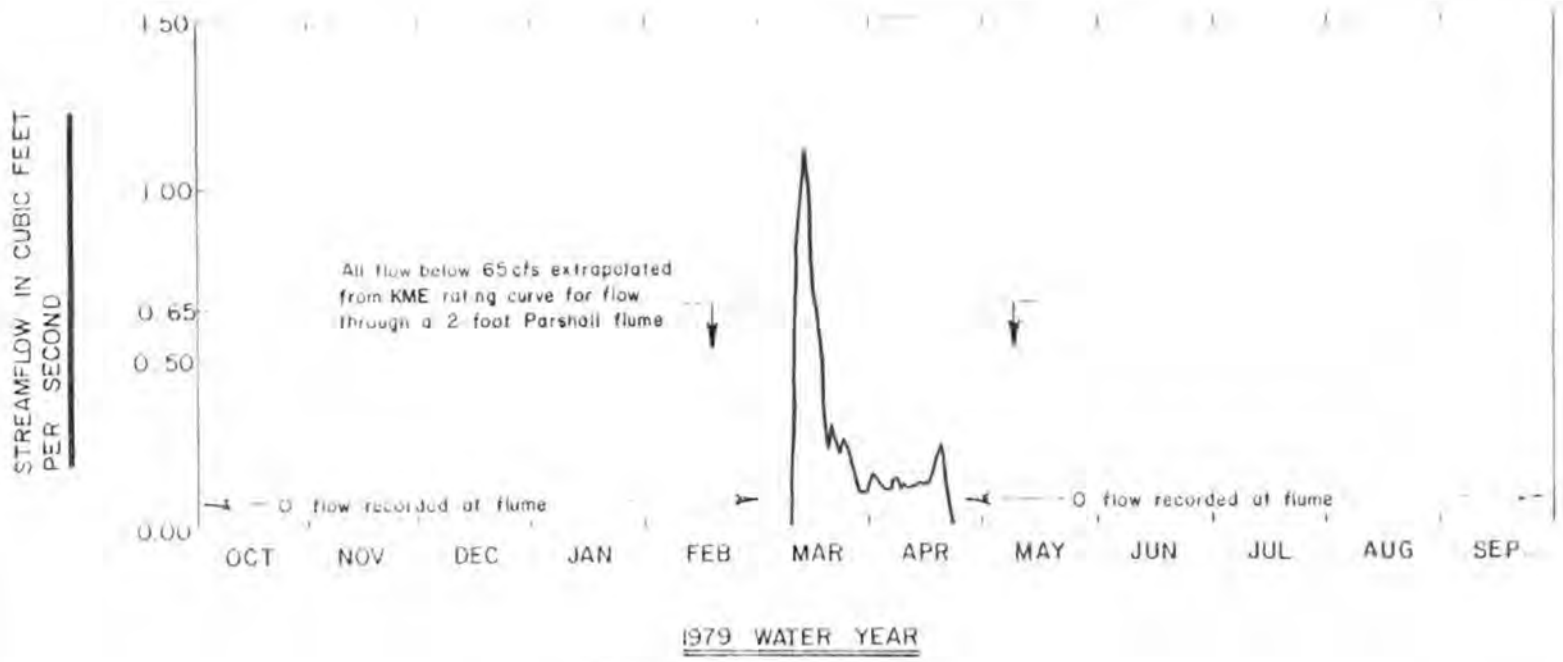
FIGURE D6-12 *Hydrograph of Hidden Water Creek at the K.M.E. 2 foot Parshall flume, 1979 water year*



Peak: 1.11 CFS March 15
Volume: 21 acre-feet

FIGURE D6-12

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Table D6-25. Summary of Pit 4 area aquifer tests.

Well No.	Aquifer	Date of Test	Test Type	Length of Test (hrs)	Prod. Rate (gpm)	Final Draw-down (ft)	Specific Capacity (gpm/ft)	Trans-missivity (gpd/ft)	Perme-ability (gpd/ft^2)	Storage Coefficient	Comments
WW390-79	Sandstone	11/14/79	Bailer method, recovery	1.90	1.44	37.33	0.04	2.22	0.44	-	Bailed well
WW391-79	Sandstone	11/15/79	Bailer method, recovery	2.70	1.86	31.79	0.06	1.93	0.39	-	Bailed well
WW392-78	Sandstone	2/26/79	Specific capacity	12.80	38.50	19.03	2.02	-	-		Pumping well
WW393-78	Sandstone	2/26/79	Theis, time/drawdown	12.80	-	0.73	-	16,960	848	$4.4x10^{-4}$	Observation well
WW395-78	Sandstone	4/20/79	Jacob, time/drawdown	3.48	15.76	48.53	0.32	438	88	-	Pumping well

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the Hidden Water Creek alluvium and the underlying sandstone aquifer. As previously discussed, Hidden Water Creek alluvium will become saturated during the spring and early summer months from snowmelt runoff. It has been recognized that snowmelt runoff may not be sufficient enough to saturate the alluvium every year. The Hidden Water Creek alluvium cannot be termed an aquifer as it is not a reliable source of groundwater. Since the sampling network was initiated, a representative groundwater quality sample could only be collected from the alluvium one time, which was during the spring of 1979. The sandstone aquifer which was sampled lies under the Hidden Water Creek alluvium and the Monarch coal remnant to be mined, separated by a thin, relatively impermeable shale. Water quality sampling from wells completed in this aquifer was initiated in late winter and continued in the spring after snowmelt and the following fall of 1979. A sample was also collected from this aquifer in the spring of 1980 and will be continued semi-annually.

Samples were collected in accordance with the State of Wyoming DEQ, Revised Guideline No. 4 and Revised Guideline No. 8. Field and analytical lab results are presented in Table D6-26. These data indicate that sulfate and bicarbonate are the principal anions while calcium and magnesium are the principal cations. Overall, the quality of this aquifer is similar to that of most Fort Union aquifers sampled in this area. A statistical or seasonal analysis of water quality changes is not advised until a longer record has been established. A comparison of groundwater quality (Table D6-26) revealed a similarity in concentrations of all the common constituents in samples taken from the sandstone/saturated alluvial aquifer (2/26/79, 10/24/79 and 5/13/80), and the sandstone/saturated alluvial aquifer (4/24/79). An apparent concentration increase in total and dissolved iron and dissolved manganese following saturation of the alluvium was also observed.

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Table D6-26. Groundwater quality sampling of the sandstone aquifer (Fort Union Formation) underlying Pit 4, Big Horn Coal Company.

Parameters*	Sampling Period			
	Spring		Fall	Spring
Well Number	392	395	392	392
Date of Sampling	2/26/79	4/24/79	10/24/79	5/13/80
Aquifer Sampled	SS	SS/Qal	SS	SS
Field pH	7.02	ND**	7.44	7.14
Field specific conductance umhos/cm	3600	ND	4100	3000
Water temperature (C°)	12.0	ND	12.0	11.0
Lab pH	7.8	8.1	7.5	7.6
Total dissolved solids	2700	3120	3300	3200
Lab specific conductance (umhos/cm)	3440	3200	3280	3370
Ammonia Nitrogen (as N)	1.11	0.10	0.02	0.05
Total Phosphorus (as P)	0.39	0.22	0.03	0.11
Total Alkalinity	364	308	376	371
Bicarbonate	444	376	459	453
Carbonate	0	0	0	0
Chloride	28	30	34	26
Fluoride	0.74	0.63	0.66	0.66
Nitrate-Nitrite (as N)	1.11	0.30	0.15	0.27
Sulfate	1900	1844	1952	1820
Total Hardness	1940	1838	1985	1850
Calcium	263	248	256	241
Magnesium	312	297	327	304
Potassium	30	29	28	25
Sodium	192	178	185	205
Cations-Anions	0.13	-0.18	-0.73	+0.59
Aluminum (D)	0.6	0.4	0.3	<0.1
Arsenic (D)	<0.005	<0.005	<0.005	<0.005
Cadmium (D)	<0.005	<0.005	<0.005	<0.005
Chromium (D)	0.02	0.02	<0.02	<0.02
Copper (D)	0.05	0.02	<0.02	<0.01
Iron (D)	0.06	0.09	<0.05	<0.05
(T)	2.52	7.88	0.10	0.14
Lead (D)	<0.02	<0.02	<0.02	<0.02
Manganese (D)	0.01	0.04	<0.02	<0.02
Mercury (D)	<0.0002	<0.0002	<0.001	<0.001
Nickel (D)	0.06	0.04	<0.01	<0.01
Selenium	<0.005	<0.005	<0.005	<0.005
Barium	<0.5	<0.5	<0.5	<0.5
Zinc (D)	0.07	0.05	0.03	0.03
Boron	-	0.7	0.4	0.3

* Concentration in mg/l unless otherwise noted
** ND = No data

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This fits well with the hypothesis presented earlier in the groundwater section, that the surface and interflow components of Hidden Water Creek's hydrologic regime interact with the sandstone aquifer. This is supported by examining seasonal static groundwater levels (Exhibit D6-13).

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GROUNDWATER HYDROLOGY

PIT 5 OPERATION

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INTRODUCTION

This portion of the Groundwater Hydrology report will define the existing subsurface movement, distribution, quantity and quality of water in the immediate area of Pit 5. Included will be a description of the geologic setting and identification of the principal recharge and discharge areas.

GEOHYDROLOGIC SETTING

Aquifer Identification

The Tongue River Member of the Fort Union Formation underlying the Pit 5 area consists of an interbedded sequence of sandstones, siltstones, claystones, coals and various gradations among the four. Coals in the area have burned extensively and baked the overlying rocks into a hard rock type known locally as "clinker" or "scoria". The following stratigraphic units were investigated as potential groundwater aquifers:

1. Consolidated sediments overlying and underlying the coals seams.
2. The Dietz 2BC coal seam.
3. The Dietz 3 (Upper Monarch) coal seam.
4. The Monarch (Lower Monarch) coal seam.
5. The Carney coal seam.
6. The clinker (scoria or burn) formed from the burning of the Dietz 2BC, Dietz 3 and Monarch coal seams.

The stratigraphic sequences, lithologic thicknesses and local structure of these units are shown in cross sections A-A', B-B' and C-C' presented in Appendix D5. The entire suite of lithologic and geophysical logs of every plug hole, core hole, and water well, along with coal seam isopachs and structure contour maps are also presented in Appendix D5.

Extensive exploratory drilling within and around the Pit 5 area has revealed that only the Monarch and Carney coal seams will yield enough water to be classified as aquifers. Due to the fine-grained nature of the consolidated sediments of the Fort Union Formation, they characteristically serve as aquicludes

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or confining beds between the more permeable coal aquifers. The Dietz 2BC and Dietz 3 coal seams in the Big Horn Coal area are characteristically capable of storing and transmitting groundwater, but as can be seen from Exhibit D6-16, partial surficial geology and minable limits map (also refer to Appendix D5), they are essentially isolated erosional remnants within the Pit 5 area. Hydrologic investigations were, therefore, not conducted on the Dietz 2BC and the Dietz 3 coal seams, or their "burns", within the Pit 5 area. The Carney coal seam is separated from the base of the Monarch coal seam by approximately 120 feet of interburden and no vertical leakage into the pit excavations is expected to occur. One observation water well completed in the Carney coal seam was intended for use as an occasional static water level measuring point and stock watering well and has since been destroyed by mining. The Monarch coal seam, being the only water-bearing formation in the area to be disrupted by mining, will be the main subject of the following discussion.

Geologic Features Influencing Aquifers

A thorough explanation of the geology is given in Appendix D5. In general, the geology of the area is relatively simple. The strata, being composed of interbedded fine-grained sediments and coal beds, dip east-southeast at approximately 3°. They lie unbroken by faulting and exhibit essentially no local warping.

The three coal seams (Dietz 2BC, Dietz 3 and Monarch) mined in Pit 5 are small remnants or "windows" of unburned, once-continuous coal beds. The Dietz 2BC and Dietz 3 minable reserves are completely surrounded by clinker rock and, therefore, do not directly outcrop on the surface. They are capable of indirectly receiving precipitation-infiltration recharge from the clinker updip and, on the same token, quickly discharge this groundwater back through the clinker

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downdip. The Monarch minable reserve is also completely surrounded by clinker rock but is bordered on its eastern edge by the abandoned Acme No. 1 underground mine (Exhibit D6-16). As stated in the previous section, the Dietz 2BC and Dietz 3 are isolated erosional remnants, therefore, their recharge areas are very small (Exhibit D6-16). As a consequence, these two seams are essentially dry. Exploratory drilling has confirmed this fact. The Monarch burn is not an isolated erosional remnant and its outcrop is areally quite extensive. Large-scale geologic reconnaissance of the coal reserves to the northwest of Pit 5 has shown that most of the Monarch coal has been burned, but an estimate of the area (i.e. in acres) which is exposed Monarch burn or Monarch burn covered by residual soils has not been estimated by the geologists. Drilling into the Monarch coal seam within its minable limits has shown that it yields varying small amounts of groundwater depending on the site location. This variance in yield is typical of fractured rock hydrology and may also be attributable to the adjacent underground mine. A follow-up on this discussion can be found in the potentiometric surface section.

Groundwater Flow

Wells

Within the vicinity of the Pit 5 area, six observation water wells have been completed to ascertain the hydraulic characteristics of the aquifers. Of these wells, there are completed in the Monarch coal seam, two in the Monarch burn updip of the minable Monarch coal, and one in the Carney coal seam. Exhibit D6-16 shows the location of these water wells and Table D6-27 summarizes the well completion data. Figure D6-8 pictorially illustrates the designs of the wells.

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Table D6-27. Well completion summary.

Well No.	Completions: Coal Zn	Date Drilled	Locations: Wt Coordinates North	East	Sec	1/4-1/4			Elevations (ft): Grd Elev	Csg Mt	Depths (ft): Total	Csg	Outer base	Test interval	Diameter (in): Drill Bit	Csg
[illegible]-79	Monarch	5/22/79	1,553,297.6	588,571.8	10	[illegible]	[illegible]	SW	3956.51	0.44	240	230	190	195 - 2[illegible]	7-7/8	5
[illegible]-79[3]	Carney	4/16/79	1,554,326.5	586,459.8	9	NE	SE	NE	3884.81	1.50	280	280	244	245 - 265	7-7/8	5
[illegible]-80	Monarch	2/7/80	1,555,326.9	587,572.6	5	SW	SE	NE	3881.38	0.74	60	60	26	30 - 50	7-7/8	5
[illegible]-80	Monarch	2/14/80	1,554,340.4	589,325.5	10	NE	SW	NW	3832.78	0.80	111	111	84	86 - 106	7-7/8	5
[illegible]-80	Monarch Burn	10/20/80	1,555,681.8	586,036.4	9	NW	NW	NE	3926.96	2.95	48	48	3	23 - 43	7-7/8	5
[illegible]-80	Monarch Burn	10/20/80	1,556,278.5	586,671.1	9	NE	SW	NE	3916.53	0.45	36	36	3	10 - 30	7-7/8	5

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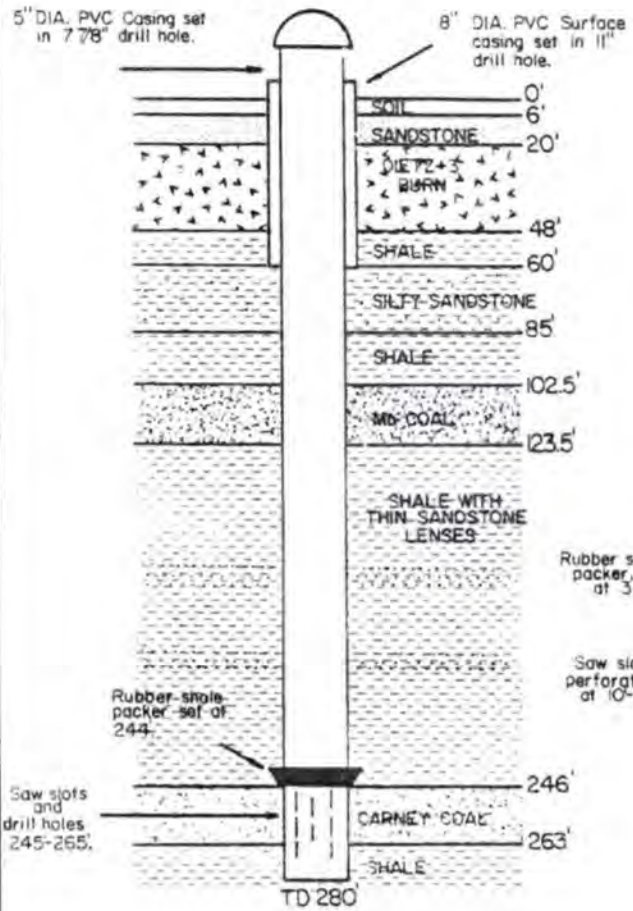
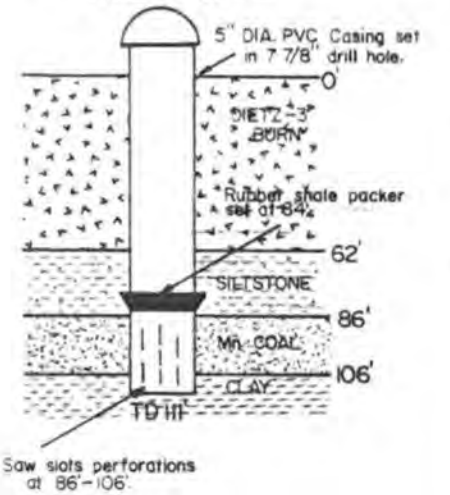
TYPICAL DESIGN OF BIG HORN COAL GROUNDWATER OBSERVATION WELLS

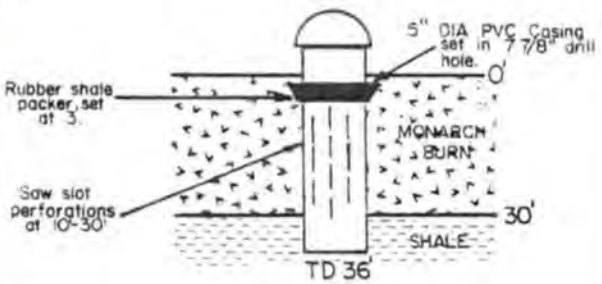
FIGURE D6-8

CARNEY COAL WELL WW429-79



MONARCH COAL WELL WW562-80





BIG HORN COAL CO. SHERIDAN, WYOMING	JMB
DESIGN OF OBSERVATION WELLS PIT FIVE	11-13-80
DRAWING NO.	1
PETER KIEWIT SONS' COMPANY — MINING DISTRICT	

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Monitoring Water Levels

The well completion summary, Table D6-27, lists the dates when each observation water well was completed. Beginning with that month, the water level in each well has been measured and recorded monthly. A graph of the monthly water levels (Figure D6-9) in the Monarch coal observation wells illustrates that the potentiometric surface is being held constant and the aquifer is in a state of dynamic equilibrium.

Mining activity in Pit 5 has recently destroyed four of the six original groundwater monitoring wells, two of which were completed in the Monarch coal seam (WW408 and WW555), the other two in the Monarch burn (WW648 and WW649). Replacement wells will not be installed. The two remaining observation wells (WW429 and WW562) will continue to be monitored until precluded by mining advancement.

Potentiometric Surface

Exhibit D6-6 shows the potentiometric surface for the Monarch coal seam "remnant" in Pit 5 based on water level measurements taken October 22, 1980. The surface was constructed by first determining its general strike and dip using the three-point method on the three water level elevation points. Then, with the aid of the Monarch coal structure contour maps (Appendix D5) the potentiometric surface contour lines were "fit" so as to depict decreasing hydrostatic pressure in both the direction of the surrounding burn and in the direction of the underground mine workings. The potentiometric surface slopes downdip with an average hydraulic gradient of 5×10^{-2} ft/ft and intersects the base of the Monarch coal seam approximately at the edge of the minable limit. Nowhere within the minable limit area does the potentiometric surface intersect the top of the Monarch coal

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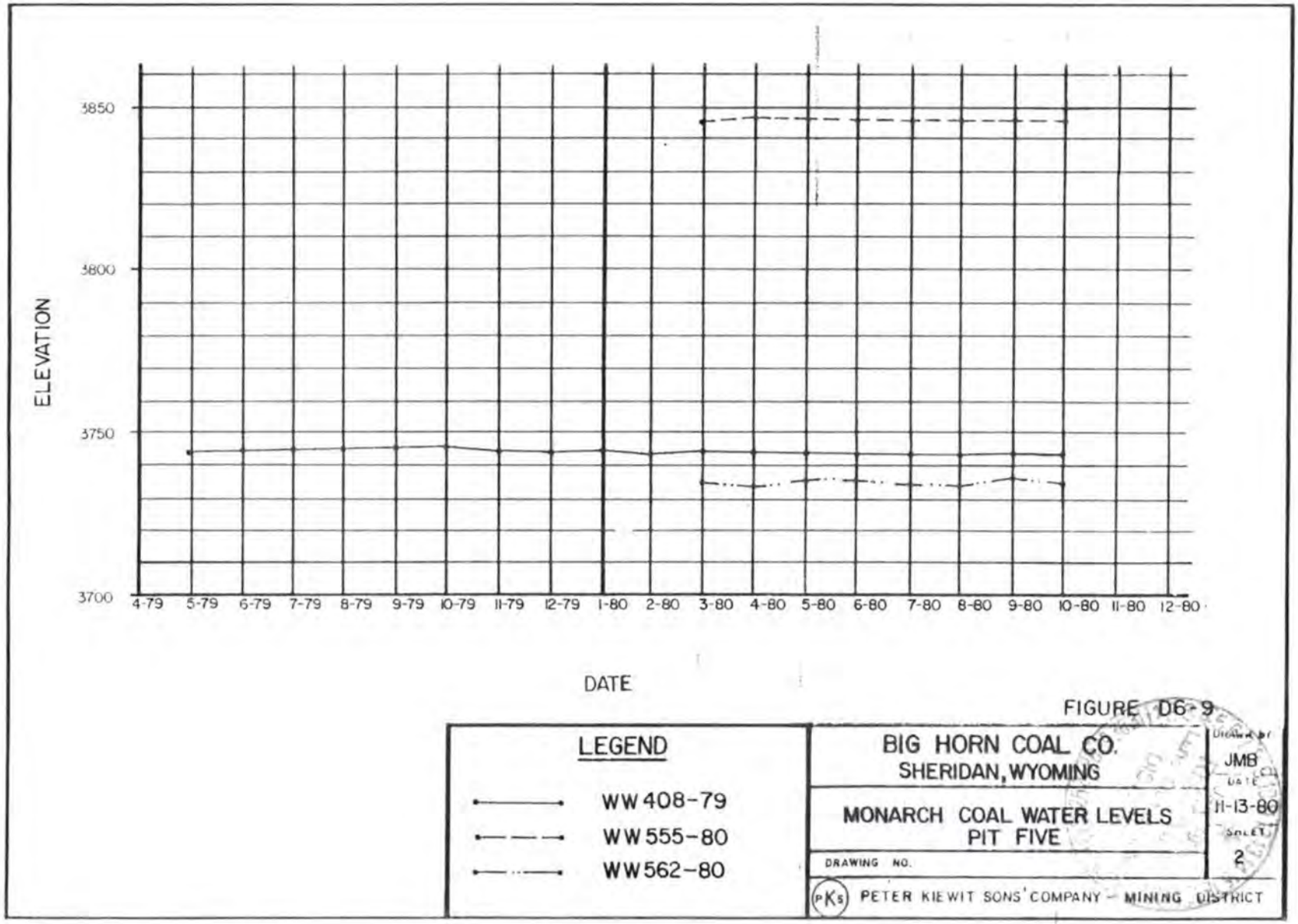

FIGURE D6-9

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seam. A profile of the potentiometric surface was plotted onto a portion of the Pit 5 geologic cross section A-A' of Appendix D5 and is shown in Exhibit D6-17.

The recharge and discharge areas are, therefore, defined: recharge must occur updip of the minable reserves via precipitation-infiltration into the scoria outcrops. The water then enters the coal seam and moves downdip/gradient toward the Acme No. 1 underground mine and is discharged into the abandoned rooms. In other words, groundwater in the Monarch coal seam is essentially free to "fall" into the underground workings. The lithology of the material stratigraphically above the Monarch coal seam is sufficiently fine-grained and essentially impermeable enough to consider the Monarch a confined aquifer. Although, because the abandoned underground mine acts as a large discharge "sink", the hydrostatic pressure cannot become great enough to cause artesian conditions. Recharge to the Monarch coal must be sporadic and intermittent and most likely occurs during or shortly after significant precipitation events. The scoria updip of the Monarch's minable limit was essentially dry on October 22, 1980. Observation wells WW648 and WW649 exhibited approximately 0.10'-0.50' of water along the base of the burn at that time and no significant precipitation had been observed in the area since mid-August 1980.

Aquifer Hydraulics

Pumping Tests

Long term pumping tests are always advisable when trying to interpret the hydrology of fractured rock. Attempts to perform long-term, constant-discharge pumping tests with a small horsepower submersible pump on each of the three Monarch coal water wells in the area proved unsuccessful. A withdrawal rate that was low enough to prevent the wells from being pumped dry in a relatively short period of time could not be established. A multiple well pumping test was

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considered impossible to perform due to the fact that the Monarch coal will not yield enough water to prevent excessive drawdown from occurring in the pumped well. Therefore, in order to obtain at least an estimate of the transmissivity of the Monarch coal seam, the bailer method was employed. These bailer tests were analyzed according to the Skibitzke method as discussed by Lohman (1979, pp. 29-30). The recovery rate of well WW555-80 was fast enough to obtain a straight-line recovery curve in order to derive aquifer coefficients by the Jacob modified non-equilibrium formula as described by Johnson Division, UOP Incorporated (1975, pp. 113-118). The storage coefficient was estimated using the method discussed by Lohman, 1979, p. 53. All aquifer test data are supplied in Addendum D6-6.

Results

Table D6-28 presents a summary of the aquifer test results. Transmissivity values were found to be very low, ranging from 11.92 gpd/ft down to 0.85 gpd/ft. Of the three wells, WW555 exhibits the highest transmissivity value, has approximately 15 feet of head above the base of the coal seam, and is located the farthest distance away from the underground mine. Well WW562-80 exhibits the lowest transmissivity value, has approximately 8.50 feet of head above the base of the coal seam and is situated closest to the underground mine. Again, this is an indication of the "sink" effect the abandoned underground mine has on the Monarch coal aquifer.

Groundwater Quality

Sampling and Data Analysis

Groundwater quality samples have been collected from the three wells completed in the Monarch coal seam within Pit 5. Well WW429 was not sampled since the Carney coal seam will remain undisturbed and no vertical leakage into

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Table D6-28. Summary of aquifer tests.

Well No.	Aquifer	Date of Test	Test Type	Length of Test (hrs.)	Prod. Rate (gpm)	Final Drawdown (ft.)	Specific Capacity (gpm/ft.)	Transmissivity (gpd/ft.)	Permeability (gpd/ft²)	Comments
WW406-79	Monarch Coal	12/19/79	Bailer Method	4.07	0.21	5.97	0.04	1.08	0.06	Bailed mud and rocks, so calculated T value may be too high. Valve was sticking open. Not a fast enough recovery rate to plot an accurate Jacob Time Recovery curve.
65555-80	Monarch Coal	3/4/80	Bailer Method, Jocob Time Recovery	1.83	1.0c	8.35	0.13	11.92	0.81	Bailer operated efficiently throughout test. Plotted good straight-line recovery curve
65562-80	Monarch Coal	3/5/80	Bailer Method	3.80	0.41	8.63	0.05	0.85	0.05	Bailed out all but 0.67 gallons of the water stored in casing. Not a fast enough recovery rate to plot an accurate Jacob Time Recovery curve.

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the pit is expected. Not enough groundwater has been observed in either well WW648 or WW649 to permit collection of a representative water quality sample from the Monarch burn. Samples were collected in accordance with Revised Guideline No. 4 and Revised Guideline No. 8, Wyoming DEQ. The Monarch wells, not capable of yielding enough water to be continuously pumped, were thieve-sampled wth a bailer. Samples were collected after at least three times the volume of the casing below the static head had been bailed out. Samples were field acidified and filtered according to accepted practices and each sample collected was packed in ice and sent to Northern Testing Laboratory in Billings, MT for analysis. Analytical lab results and field parameters are given in Addendum D6-7. All concentrations are in milligrams per liter except for conductivity, which is umhos per centimeter, and those which are otherwise noted.

One sample has been collected from well WW308 in the spring and one in the fall. In addition, one sample each has been collected from wells WW555 and WW562 in early spring. A statistical seasonal analysis of water quality changes is not advised until a longer record has been established. The major chemical constituents of those four water quality samples have been listed in Table D6-29. These data indicate that sulfate and bicarbonate are the principal cations. The ion concentrations which greatly exceeded the recommended drinking water standard (McKee and Wolf, 1963) are sulfate, bicarbonate, magnesium and iron. Except for the high iron concentration, the overall quality of the Monarch coal groundwater in Pit 5 is similar to that of most Fort Union aquifers sampled in the area. It is interesting to note that the mineral analysis of ash from overburden core hole BH611-80 (Appendix D5) has shown an anomalously high iron content for the Monarch coal.

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Table D6-29. Major chemical constituents of the Monarch coal aquifer underlying Pit 5, Big Horn Coal Company.

Constituent	WW408-79 10/09/79	WW408-79 5/20/80	WW555-80 3/05/80	WW562-80 3/06/80
Lab Ph	7.4	7.2	7.0	7.2
TDS, mg/	2400	2560	984	720
Sp. Cond., umohs/cm	2610	2780	1200	990
Tot. hardness, mg/	1530	1620	711	294
Tot. alkalinity as $CaCO_3$, mg/	460	513	405	472
Calcium, mg/	210	231	113	55
Magnesium, mg/	244	253	105	38
Potassium, mg/	38	29	19	21
Sodium, mg/	114	108	31	129
Boron, mg/	0.80	0.80	0.50	0.20
Iron-Dissolved, mg/	0.14	1.03	.05	.05
Iron-Total, mg/	44.20	77.00	- - Not analyzed for - -	
Bicarbonate as HCO_3, mg/	561	626	495	576
Carbonate as CO_3, mg/	0	0	0	0
Sulfate, mg/	1250	1310	404	119
NO_2+NO_3 as "N", mg/	8.21	6.40	0.14	0.15
Chloride, mg/	12	12	8	6

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Groundwater quality samples will continue to be collected from the Monarch coal monitoring wells until they are destroyed by mining advancement.

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SURFACE WATER

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INTRODUCTION

The following discussion of the various surface water regimes of concern in the Big Horn Mine area will be organized according to drainage systems. Within each drainage system heading, DEQ (Department of Environmental Quality) Guideline 6A (March 30, 1982 edition) format for surface water studies will be applied. Discussion and information presented under the "Tongue River - Goose Creek System" will be similar to that information found in Appendix D11, Alluvial Valley Floors (AVF), but will not address those areas of concern peculiar to the AVF. For this specialized AVF information, the reader is directed to Appendix D11.

Tongue River - Goose Creek System

Drainage Basin Description

A previous study conducted by WRRI (1977) described the area of interest as follows:

> "The Tongue River which is the major drainage in the study area from Monarch, WY to Decker, MT is an interstate tributary of the Yellowstone River and has its headwaters in the Big Horn Mountains. The flow of the Tongue River is allocated between Wyoming and Montana by the 1950 Yellowstone River Compact which allots 40 percent of the unadjudicated divertible flow to Wyoming and 60 percent to Montana.
>
> Two ephemeral streams and one perennial stream contribute to the flow of the Tongue River within the study area from the west (Exhibit D6-7 and D6-18). Hidden Water Creek is a small ephemeral stream with a drainage area of 8.48 square miles which feeds into the Tongue River directly upstream of Acme (Section 15, T57N, R84W).

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Ash Creek, an ephemeral stream with a drainage area of 27.3 square miles, feeds into the Tongue River directly above the Whitney Benefits Mine Permit Area (Section 1, T57N, R84W). Young's Creek, a perennial stream with a drainage area of 62.5 square miles, contributes to the flow of the Tongue River directly downstream from the Whitney Benefits Mine Permit Area (Section 30, T58N, R82W). Both Ash Creek and Young's Creek have portions of their headwaters in Montana.

Two major north-flowing tributaries enter the Tongue River within the study area. Goose Creek, a perennial stream with a drainage area of 414 square miles, flows by the Big Horn Coal Mine and feeds into the Tongue River at Acme (Section 15, T57N, R84W). Prairie Dog Creek, a perennial stream with a drainage area of 358 square miles, contributes to the flow of the Tongue River near the Wyoming-Montana border (Section 23, T58N, R83W). Both of these tributaries have their headwaters in the Big Horn Mountains.

Beatty Gulch is a small ephemeral drainage with an area of 8.23 square miles. It is a north-flowing tributary of the Tongue River (Section 31, T58N, R83W) and crosses the Whitney Benefits Mine Permit area.

The floodplains of Goose Creek and the Tongue River are underlain by alluvial sands, silts, clays and gravels of Holocene Age (Mapel, 1976). Terraces at elevation of up to 25 feet above the floodplain are common. The terraces are generally formed on colluvial clays and silts which are probably also of Holocene Age (Leopold and Miller, 1954). The alluvial and colluvial sediments are deposited in valleys cut in a series of interbedded, fluvial and lacustrine, sands, silts,

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clays, and coals of Paleocene Age named the Fort Union Formation (Lowry and Cummings, 1966). The hills and bluffs bounding the alluviated valleys are also formed on the Fort Union Formation. The aquifers of primary interest in this study are those in the Quaternary sediments flooring the valley of the Tongue River. Sediments underlying tributary valleys have not been investigated here."

Additional studies conducted by WRRI (1977) for the Tongue River calculated roughness coefficients for the left overbank, channel, and right overbank. Averages for the coefficients in the Big Horn Mine area were calculated to be .049, .031 and .044, respectively. In general, the Tongue River forms a well defined incised channel. It is an erosive system exhibiting downcutting and sediment transport throughout its reaches in the area of interest. Average gradient in this stretch is .001 feet per foot. Additional information regarding characteristics of the Tongue River system is presented in the following sections.

Surface Runoff

Infiltration

Infiltration rates of typical Tongue River and Goose Creek alluvial, colluvial, alluvial-colluvial undifferentiated, and residual soils were measured with double ring infiltrometers. Mean infiltration rates for these soils were 2.8, 1.42, 1.25 and 7.85 (one site only) inches per hour, respectively. These data are presented in Addendum D11-2. In general, alluvial soils are thick (4 to 8 feet) and overlie stream transported sands and gravels. Residual soils are generally thin (less than two feet) and are formed in place from weathered bedrock. Permeability of soil types in both classes varies and is generally a function of soil texture. Infiltration rates in alluvial soils varied depending upon soil type and degree of compaction by cattle grazing and other man-related disturbances.

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Double ring infiltration tests (Exhibit D11-13) were conducted to study infiltration and potential for aquifer recharge from precipitation. Procedurally, the double rings were prewetted in order to determine long-term infiltration potential due solely to gravity flow. This technique eliminates variability due to solute potential and ambient soil moisture conditions at the time of the test.

These data indicate that infiltration rates exhibited a large range of variability, particularly in the residual soils. In all but one case, these rates range from moderate to very high. This indicates that infiltration potential would exceed precipitation intensity of most storms which would, in turn, yield limited overland flow.

Potential recharge to aquifers from infiltrated precipitation could take place where alluvial aquifers underlie coarse-textured soils but would probably not occur through residual soils since the parent bedrock is essentially impermeable. The degree of alluvial recharge would be a function of precipitation intensity, duration, soil moisture storage, and evapotranspiration.

Considering the high pan evaporation rates in the area (64 inches per year) (WRRI, 1977), and potential consumptive use (evapotranspiration) for a grass, hay, arid pasture system (19.33 inches per growing season) (WRRI, 1977), potential vertical recharge to alluvial deposits would be extremely low if existent at all. Recharge to the alluvium would occur primarily from high flows in the Tongue River or Goose Creek during spring runoff.

Streamflow

The Tongue River annual hydrograph reaches its peak late in May or in June and is lowest in mid-August. This hydrograph is indicative of a snow-melt runoff regime where accumulated snow in the Big Horn Mountains melts in the spring resulting in increased flows in the Tongue River and its tributaries.

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Evapotranspiration, irrigation and domestic use, and lack of recharge account for August low-flow values.

These effects are reflected in Tables D6-30 through D6-32 as compiled by the Water Resources Research Institute, 1977, which show instantaneous discharge ranges, annual flow ranges, and mean monthly discharges, respectively, at the U.S.G.S. gaging stations. Figures D6-10 and D6-11 show annual flow duration curves for the Tongue River near Acme, and the Tongue River at the state line near Decker. Exhibits D6-19 and D6-20 illustrate the mean daily discharge hydrographs of Goose Creek for the 1980 and 1981 water years, and Exhibits D6-21 and D6-22 illustrate the mean daily discharge hydrographs of the Tongue River for the 1980 and 1981 water years. Exhibits D6-23 and D6-24, the mean daily discharge hydrographs of the Tongue River below the Goose Creek confluence for the 1980 and 1981 water years, were not obtained from the newly established streamflow monitoring station TR2B but were developed by adding Goose Creek and Tongue River flows together.

Tongue River 100-Year 24-Hour Flood Analysis

On May 19, 1978, the Tongue River was gaged at 17,500 cubic feet/second (cfs) at the U.S.G.S. gaging station on the Wyoming-Montana state line near Decker, MT. This is the highest peak flow ever recorded at the State Line Station. A flood frequency analysis prior to this flood event was completed by the University of Wyoming, Water Resource Research Institute (1977). Using data from this station for their 100-year flood predictions along the Tongue River, they determined the 100 year flood at the state line to be 9261 cfs. The Institute also predicted the 100-year flood for the Acme Station to be 10,230 cfs. The Acme Station is located upstream from the State Line Station. In their flood analysis, they estimated that the contribution from the storm would be approximately 10%

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Table D6-30. Instantaneous discharge ranges at the U.S.G.S. gaging stations.

Station	Period of Record	Avg. Discharge (cfs)	Max. Discharge (cfs)	Max. Discharge Date	Min. Discharge (cfs)	Min. Discharge Date
Tongue River near Dayton	1918-1929 1940-1975	189	3,400	6-03-44	18	11-29-19
Goose Creek below Sheridan	1941-1975	184	5,450	6-16-63	4.0	8-11-57
Tongue River near Acme	1939-1957	403	9,110	6-04-44	3.7	8-24-40
Tongue River at State Line near Decker, MT	1961-1975	514	7,480	6-15-67	3.0	8-23-61

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Table D6-31. Annual flow ranges at the U.S.G.S. gaging stations.

Station	Period of Record	Average Annual Volume (Ac-ft)	Maximum Annual Volume (Ac-ft)	Maximum Annual Volume Water Year	Minimum Annual Volume (Ac-ft)	Minimum Annual Volume Water Year
Tongue River near Dayton	1918-1929 1940-1975	136,900	229,055	1924	78,533	1960
Goose Creek below Sheridan	1941-1975	133,300	225,622	1944	42,633	1960
Tongue River near Acme	1938-1957	292,000	511,239	1944	138,686	1940
Tongue River at State Line near Decker, MT	1961-1975	372,400	552,700	1975	135,560	1961

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Table D6-32. Mean monthly discharges (cfs) at the U.S.G.S. gaging stations.

Month	Station: Tongue River near Dayton (1918-1929 1940-1975)	Goose Creek below Sheridan (1941-1975)	Tongue River near Acme (1939-1957)	Tongue River at State Line near Decker, MT (1961-1975)
Oct	85	103	200	266
Nov	70	96	189	245
Dec	63	79	157	197
Jan	58	70	141	197
Feb	64	82	154	268
Mar	53	98	204	368
Apr	109	118	341	406
May	544	448	1,175	1,197
Jun	754	771	1,598	2,059
Jul	267	169	409	558
Aug	119	52 min.	112 min.	177 min.
Sep	90	87	152	242

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Figure D6-10 Annual Flow Duration Curve for the U.S.G.S. Tongue River Near Acme, Wyoming Gaging Station (From W.R.R.I., 1977).

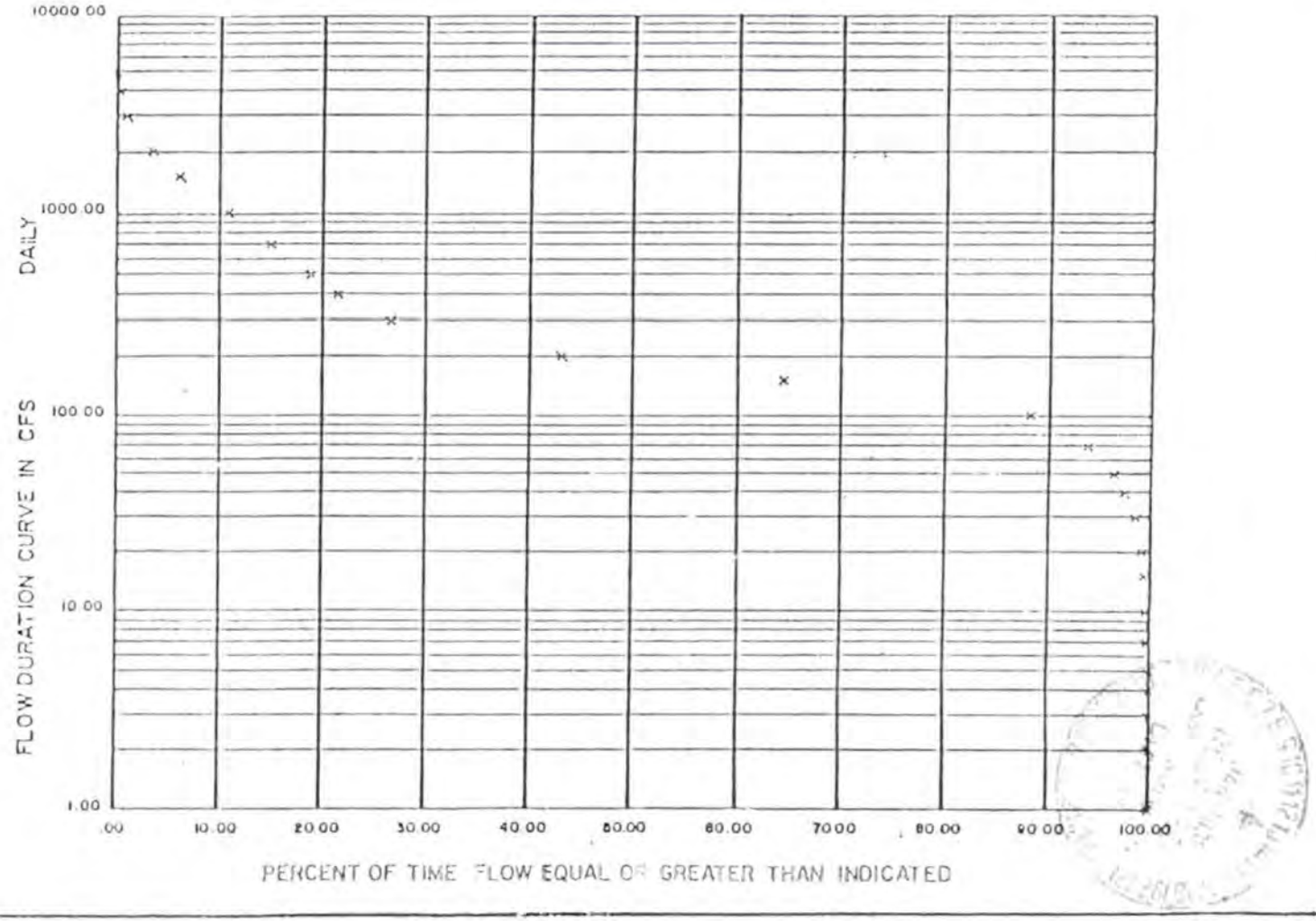

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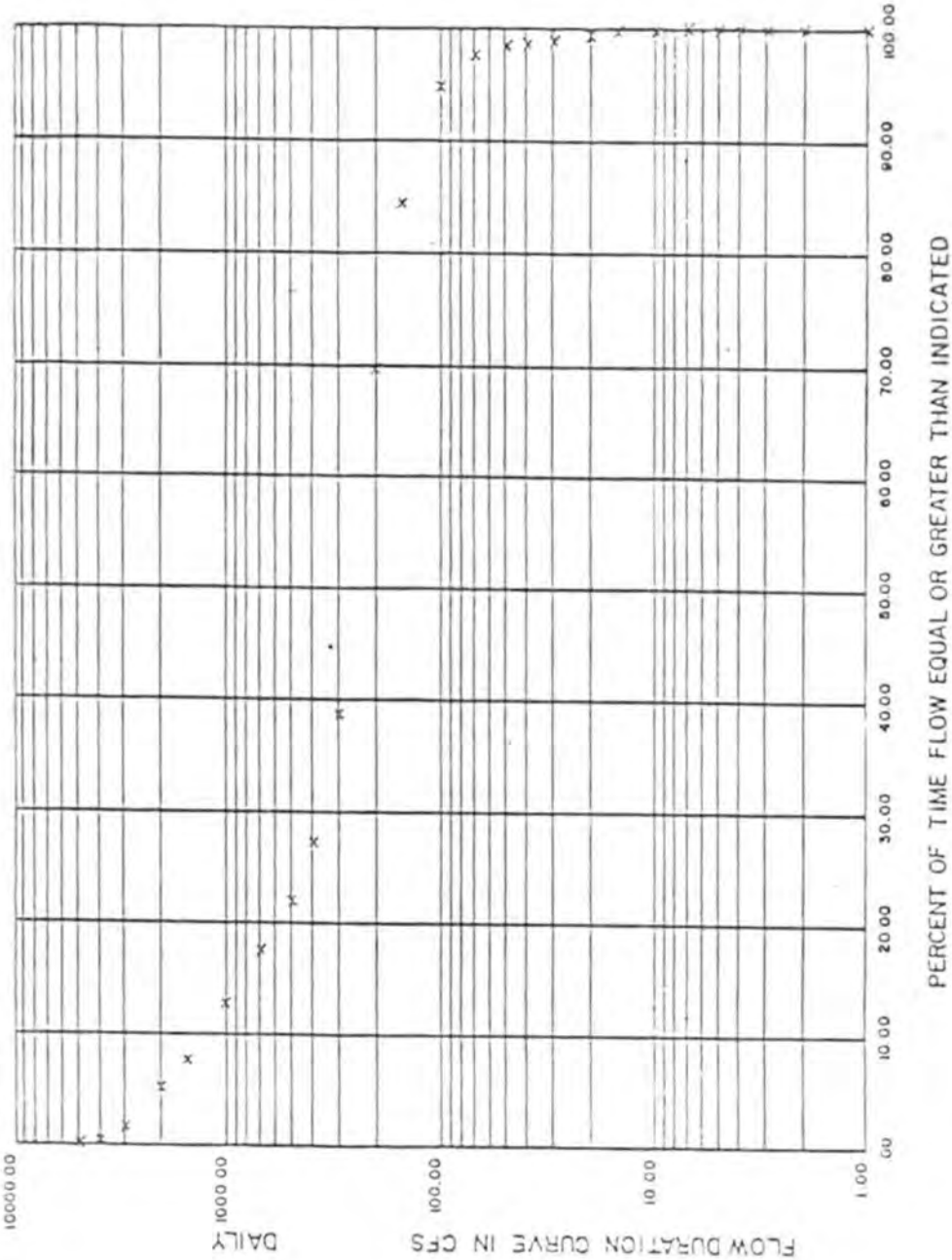
Figure D6-11 Annual Flow Duration Curve for the U.S.G.S. Tongue River at State Line near Decker, Montana Gaging Station (From W.R.R.I., 1977)



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higher for the State Line Station than the Acme Station. Based on this, the Institute used a figure of 11,300 cfs as an estimate of the 100-year flood at the state line to determine the 100-year floodplain.

Using the period of record from 1961 to 1979, KME hydrologists estimated the 100-year flood of the Tongue River at the State Line Station. This estimate was based on both analytical solutions and graphical techniques that show the distribution of flood occurrence. These techniques resulted in the following:

1. Using the Log-Pearson Type III with a skew coefficient that is calculated from the 19 years of data, the 100-year flood is estimated at 19,960 cfs. (Linsley, Jr., et al., 1975).
2. Using Log-Pearson Type III with a regional skew coefficient determined by the U.S.G.S. the 100-year flood is 15,100 cfs.
3. From the Gumbel graphical techniques the 100-year flood is 11,800 cfs. This is assuming that a linear relation exists between the discharge and the recurrence interval.
4. Using the flood flow frequency analysis from the Hydrologic Engineering Center (HEC, June 1976) and adjusting for a high outlier, the computed 100-year flood is 13,000 cfs. This approximation is based on the assumption that the 1978 peak was not equaled or exceeded since 1923.
5. Using the HEC Flood Flow Program, adjusting for the high outlier and using regional coefficients, the expected probability flood is 15,700 cfs.

In examining the different techniques, the best approximation of the 100-year flood event would be the HEC model adjusting for high outliers. It is clearly shown by this method that the 1978 point is a high outlier. The Log-Pearson Type III method does not adjust for the high outlier and tends to overestimate the flood with the limited data available. The HEC analysis adjusts the high outlier for the

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observed historic period in which the flood peak was not equaled or exceeded. The use of the 1923 data is verified by Mr. Schreibeis, a life-long rancher in the Tongue River valley. He marked the 1923 high water mark and was able to point it out.

This method was then applied at the U.S.G.S. Acme Station previously located on the Tongue River downstream of the Big Horn Mine and at the U.S.G.S gaging station on Goose Creek below Sheridan. The computed value of the 100 year flood from this method was 13,050 cfs at the Acme Station and 6,810 cfs for the Goose Creek Station below Sheridan. Since no major perennial streams flow into Goose Creek or the Tongue River between these sites, these values were used to generate the 100 year floodplain map presented in Appendix D11.

Quality

Surface water quality was examined for the Tongue River - Goose Creek fluvial system as collected from those surface water sites discussed under Monitoring of this section. Sample collection was initiated in 1977. Additional sites were added or deleted as new needs arose. Samples have been collected in accordance with Revised Guideline No. 4 and No. 8, Wyoming DEQ. The surface water sampling program is based on the annual hydrograph and seasonal variations. A full analysis (conservative constituents and total and dissolved trace metals) is performed at least monthly during the spring runoff and the summer low flow, and at least quarterly during the fall and winter months. Additionally, samples are collected from the mine discharges on a monthly basis by the KME Reclamation Department for the NPDES water quality monitoring program.

Depth integrated samples were field acidified and filtered according to accepted practices and each sample collected was packed in ice and sent to Northern Testing Laboratory in Billings, MT or Inter-Mountain Lab (IML) in Sheridan, WY for analysis. Analytical lab results (mg/l unless otherwise indicated)

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are given in Addendum D6-8. Total dissolved solids (TDS) and sodium adsorption ratios (SAR) along with other major parameters are summarized in Table D6-33. Dissolved oxygen is sampled for perennial streams in the field and is reported with other field results and analytical lab results in Addendum D6-8. Turbidity and alkalinity are not sampled in the field, but applicable EPA recommended holding times are met. Frank Putman (former DEQ hydrologist) sent a letter on May 2, 1980 to our primary water quality laboratory (Northern Testing Laboratory) indicating that field analysis of these parameters is not necessary. Field chlorine sampling is not necessary for our area. Metal concentrations, in general, were very low and often below detectable levels. Data presented in Addendum D6-8 does not indicate the date of sampling at each site for each page. The date of sampling for each parameter analyzed correlates sequentially with the dates presented on the first page(s) of each site. Page numbers are indicated in the top right portion of each page. Note that overflow from inadequate space often resulted which, in turn, resulted in two or more pages numbered 1, 2, etc.

Surface water in the study area is of higher quality than groundwater in the alluvium. TDS means range from 267 to 395 mg/l with the overall mean at 348 mg/l. Sodium adsorption ratios (SARs) are consistently low in the excellent range of approximately one. Surface water is consistently classified as a calcium bicarbonate type. Average pH value for all surface sites was 8.10.

Average water quality from surface site GC0 was in excess of recommended drinking water standards (McKee & Wolf, 1963) for iron, total hardness, and bicarbonate. Mean TDS was 395 mg/l, principal cation was calcium, and principal anion was bicarbonate.

Average water quality from surface site GC2 was in excess of recommended drinking water standards (McKee & Wolf, 1963) for iron, total hardness, and

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Table D6-33. Major chemical constituents for sample site TR1.

Constituent	Min.	Max.	Mean
GENERAL PARAMETERS			
SAR	.20	3.95	.84
TDS, mg/l	52	1520	267.12
Lab Cond. umohs/cm	177	2040	432.60
Lab pH	7.5	8.5	8.1
Total Hardness, mg/l	85	688	191.41
Total Alkalinity as $CaCO_3$, mg/l	80	367	151.13
CATION ANALYSIS			
Calcium mg/l	23	103	41.90
Magnesium, mg/l	7	105	21.12
Potassium, mg/l	1	20	2.37
Sodium, mg/l	4	238	18.79
Boron, mg/l	< .1	.5	*
Fe Dissolved, mg/l	< .05	.27	*
Fe Total, mg/l	< .05	23.8	2.29
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	97	448	190.75
Carbonate as CO_3, mg/l	0.0	16	.74
Sulfate, mg/l	12	830	74.51
NO_2+NO_3 as "N", mg/l	< .01	2.40	*
Chloride, mg/l	< 1	4	*

* Mean not calculated due to limiting amount (more than one) of "less than" values.

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Table D6-33. Cont'd.
Major chemical constituents for sample site TR2B.

Constituent	Min.	Max.	Mean
GENERAL PARAMETERS			
SAR	.38	5.79	1.40
TDS, mg/l	94	414	350.93
Lab Cond. umohs/cm	209	1780	572
Lab pH	7.50	8.50	8.08
Total Hardness, mg/l	91	418	234.93
Total Alkalinity as $CaCO_3$, mg/l	78	536	196.93
CATION ANALYSIS			
Calcium mg/l	21	128	51.87
Magnesium, mg/l	9	41	25.60
Potassium, mg/l	1	18	3.23
Sodium, mg/l	6	272	35.66
Boron, mg/l	< .1	.28	*
Fe Dissolved, mg/l	< .05	.18	*
Fe Total, mg/l	< .05	7.53	1.37
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	95	654	238.40
Carbonate as CO_3, mg/l	0.0	11	.91
Sulfate, mg/l	25	478	110.80
NO_2+NO_3 as "N", mg/l	< .01	3.06	.40
Chloride, mg/l	1	12	3.65

* Mean not calculated due to limiting amount (more than one) of "less than" values.

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Table D6-33. Cont'd.
Major chemical constituents for sample site GC0.

Constituent	Min.	Max.	Mean
GENERAL PARAMETERS			
SAR	.48	.82	.64
TDS, mg/l	52	700	395
Lab Cond. umohs/cm	177	1000	622.78
Lab pH	7.4	8.7	8.1
Total Hardness, mg/l	77	468	291.66
Total Alkalinity as $CaCO_3$, mg/l	62	314	200.46
CATION ANALYSIS			
Calcium mg/l	16	102	56.09
Magnesium, mg/l	8	65	36.88
Potassium, mg/l	1	5	2.87
Sodium, mg/l	6	49	24.97
Boron, mg/l	< .1	.20	*
Fe Dissolved, mg/l	< .05	.30	*
Fe Total, mg/l	< .05	7.29	1.28
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	76	378	243.93
Carbonate as CO_3, mg/l	0.0	15	2.20
Sulfate, mg/l	26	249	135.13
NO_2+NO_3 as "N", mg/l	.06	1.32	.40
Chloride, mg/l	1	11	4.97

* Mean not calculated due to limiting amount (more than one) of "less than" values.

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Table D6-33. Cont'd.
Major chemical constituents for sample site GC2.

Constituent	Min.	Max.	Mean
GENERAL PARAMETERS			
SAR	.30	.82	.64
TDS, mg/l	.48	702	380.17
Lab Cond. umohs/cm	142	1000	587.67
Lab pH	7.4	8.6	8.1
Total Hardness, mg/l	62	470	279.39
Total Alkalinity as $CaCO_3$, mg/l	49	316	192.78
CATION ANALYSIS			
Calcium mg/l	14	82	52.72
Magnesium, mg/l	7	65	35.97
Potassium, mg/l	< 1	5	2.93
Sodium, mg/l	5	48	23.99
Boron, mg/l	< .01	.3	*
Fe Dissolved, mg/l	< .05	.30	*
Fe Total, mg/l	< .05	17.3	*
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	60	386	232.42
Carbonate as CO_3, mg/l	0.0	17	1.08
Sulfate, mg/l	21	253	128.25
NO_2+NO_3 as "N", mg/l	.07	1.35	.35
Chloride, mg/l	< 1	11	4.71

* Mean not calculated due to limiting amount (more than one) of "less than" values.

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Table D6-33. Cont'd.
Major chemical constituents for sample site BH003.

Constituent	Min.	Max.	Mean
GENERAL PARAMETERS			
SAR	.30	6.52	3.38
TDS, mg/l	156	1500	1136
Lab Cond. umohs/cm	264	2140	1699
Lab pH	7.6	8.3	7.95
Total Hardness, mg/l	119	639	437.21
Total Alkalinity as $CaCO_3$, mg/l	102	627	469.33
CATION ANALYSIS			
Calcium mg/l	31	119	80.38
Magnesium, mg/l	10	88	57.67
Potassium, mg/l	1.3	20	14.43
Sodium, mg/l	7.5	320	238.67
Boron, mg/l	< .01	.50	*
Fe Dissolved, mg/l	< .05	.18	*
Fe Total, mg/l	< .05	8.94	.78
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	125	765	571.13
Carbonate as CO_3, mg/l	0.0	19	.79
Sulfate, mg/l	32	663	462.92
NO_2+NO_3 as "N", mg/l	.06	22.20	4.35
Chloride, mg/l	1.70	14	9.43

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Table D6-33. Cont'd.
Major chemical constituents for sample site TR5B.

Constituent	Min.	Max.	Mean
GENERAL PARAMETERS			
SAR	.17	4.19	2.90
TDS, mg/l	122	2270	1325.80
Lab Cond. umohs/cm	225	2690	1325.75
Lab pH	7.7	8.5	8.13
Total Hardness, mg/l	95	1100	616.6
Total Alkalinity as $CaCO_3$, mg/l	88	467	331.78
CATION ANALYSIS			
Calcium mg/l	4.4	182	103.61
Magnesium, mg/l	21	156	87.03
Potassium, mg/l	1	32	17.09
Sodium, mg/l	4	320	186.53
Boron, mg/l	< .1	.30	*
Fe Dissolved, mg/l	< .05	.08	*
Fe Total, mg/l	< .05	1.86	*
ANION ANALYSIS			
Bicarbonate as HCO_3, mg/l	108	569	403.06
Carbonate as CO_3, mg/l	0.0	16	.92
Sulfate, mg/l	16	1160	664.06
NO_2+NO_3 as "N", mg/l	.02	11.91	2.87
Chloride, mg/l	.70	17	9.8

* Mean not calculated due to limiting amount (more than one) of "less than" values.

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bicarbonate. Mean TDS was 380 mg/l, principal cation was calcium, and principal anion was bicarbonate.

Average water quality from surface site TR1 was in excess of recommended drinking water standards (McKee & Wolf, 1963) for iron, total hardness, and bicarbonate. Mean TDS was 267 mg/l, principal cation was calcium and principal anion was bicarbonate.

Average water quality from surface site TR2B was in excess of recommended drinking water standards (McKee & Wolf, 1963) for iron, total hardness, and bicarbonate. Mean TDS was 351 mg/l, principal cation was calcium, and principal anion was bicarbonate.

As can be seen by these summaries, surface water in the study area is generally in excess of recommended drinking water standards (McKee & Wolf, 1963) for iron, total hardness, and bicarbonate, principal cation is calcium, and principal anion is bicarbonate. In addition, total alkalinity is in excess of recommended limits (McKee & Wolf, 1963) for stock use in Goose Creek, but not in the Tongue River.

Average water quality from discharge point TR5B was in excess of recommended drinking water standards (McKee & Wolf, 1963) for TDS, total hardness, bicarbonate and sulfate. Mean TDS was 1326 mg/l, principal cation was sodium, and principal anion was sulfate.

Average water quality from discharge point BH003 was in excess of recommended drinking water standards (McKee & Wolf, 1963) for TDS, total hardness, total iron, bicarbonate, and sulfate. Mean TDS was 1136 mg/l, principal cation was sodium, and principal anion was bicarbonate.

Further examination of the surface water quality data reveals that certain general conclusions can be made about natural seasonal variations in the Tongue

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River and Goose Creek. Inorganic cation and anion concentrations, with the exception of nitrates, varied inversely to the seasonal hydrographs for each of the sites sampled. Inorganic ion concentrations, total dissolved solids, and specific conductance were generally lowest in May during high flow conditions, and highest in July and August during periods of low flow. Thus, these constituents are dependent upon the dilution capabilities of the stream.

Nitrate concentations were at a minimum in July and reached maximum levels in the middle of winter. This would indicate that nitrates are assimilated by algae in the summer and converted to non-inorganic forms. Thus, nitrate concentrations would reach a minimum in mid-summer when algae biomass was greatest and would be conversely maximized in the middle of winter when no algae or nitrate assimilatory organisms were present.

One final seasonal variation which was evident was the total suspended solids concentrations (TSS) and turbidity which were highest in May during spring snowmelt runoff and generally lowest in October. Snowmelt runoff usually produces large quantities of suspended solids and the increased streamflow, as a result of snowmelt, also will increase the possibility of streambank-derived sediment. Thus, TSS concentrations are expected to be highest in the spring. Low TSS concentrations and turbidity in October are due, in part, to decreased suspended organic solids, minimal amount of runoff with decreased stream velocities and subsequent streamflow.

Quality of Goose Creek, above the confluence at site GC0, is similar but with considerably higher concentrations of bicarbonate and dissolved solids. The Goose Creek site is located downstream of the City of Sheridan and receives sewage effluent. The Wyoming DEQ found extremely high coliform bacteria counts in Goose Creek below the sewage outfall. Counts decrease downstream due to

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die-off and dilution. Quality at site TR2B, reflects the Goose Creek input and the mine effluent point discharges. But because flow from mine effluents (average of about 1.4 cfs) contribute only a very small increase to the total flow of the Tongue River, the high effluent dissolved solids concentrations cause only a slight change in the chemical quality of the river.

Olson and Dettmann (1976), in a paper by the Argonne National Laboratory, studied the water quality effects of the Big Horn Mine on the Tongue River. They found that the effect of the mine on concentrations of dissolved constituents in the Tongue River is small and actually immeasurable within the range of analytical precision and short-term variations in ambient constituent concentrations. Mass loading calculations for the Tongue River were performed by the KME Hydrology Department for the period of August 1977 to December 1979 and it was found that the mean effluents account for approximately 1% increase in the river's TDS concentration. Olson and Dettmann also found that trace element concentrations are relatively low at all stream and mine discharge sampling points, concluding that toxic trace elements will not present environmental problems at this site.

A sedimentation monitoring program was established in 1978, upstream (GC0, GC2, TR1) and downstream (TRBR, TR2, TR2B) of the relocated channel and from the two discharge sites (TR5B, BH003). No appreciable long-term increase in total suspended solids has been observed (Table D6-34). Monitoring of sediment concentrations in Goose Creek and the Tongue River will continue according to the present schedule which samples for sediment with each water quality sampling.

Channel Geometry

Seven geologic alluvial cross sections for the Tongue River and Goose Creek were constructed and appear in Appendix D11. In addition, stream channel and floodplain cross sections were surveyed to aid in determining the 100-year flood

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Table D6-34. Sediment data - site TR1.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
10/15/77	0900	2.33	108	10.5	3.1	
11/17/77	1145	2.20	89.4	50	12.1	
1/10/78	1400	3.02	67.4	8.5	1.5	
3/29/78	1600	2.40	210.1	212	120.2	
4/24/78	1600	2.33	114.1	12	3.7	
5/16/78	1100	4.31	1277	678	2339	
5/19/78	1645	7.50	3971	1210	12958.84	
6/07/78	1130	5.90	2376	383	2457	
7/18/78	1545	3.12	381	21	21.6	
7/31/78	-	-	-	16	-	
8/08/78	1110	2.79	231.4	24	14.98	
8/08/78	1505	2.79	231.4	17.6	10.98	
8/09/78	1445	2.80	234.2	2.4	1.52	
8/10/78	-	2.67	200.0	15.2	8.2	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site TR1.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
8/14/78	1400	2.73	215.3	35.6	20.67	
8/15/78	0930	3.07	317.9	48	41.15	
8/17/78	0900	-	-	38.4	-	
8/28/78	0900	-	-	6	-	
9/14/78	0900	2.52	165	9	4.01	
10/03/78	1115	2.52	165	2.52	1.12	
10/07/78	1000	2.44	148.3	4	1.6	
3/24/79	1130	2.75	220.6	168	99.95	
4/07/79	0845	2.55	171.6	54	24.99	
4/09/79	1330	2.64	192.6	53.6	27.84	
4/17/79	-	2.55	171.6	45.6	21.1	
4/27/79	1145	2.62	187.8	16	8.1	
4/28/79	1000	2.55	171.6	26	12.03	
5/02/79	1340	2.70	207.5	20	11.19	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697

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Table D6-34. Cont'd.
Sediment data - site TR1.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
5/10/79	1600	2.76	223.2	13	7.83	
5/17/79	-	-	-	190.4	-	
5/24/79	1430	4.00	765.6	231.2	477.39	
5/26/79	0900	4.17	879.1	248	587.99	
5/31/79	1300	-	-	187	-	
6/11/79	1045	3.63	554.6	48.8	72.99	
6/14/79	1440	3.72	601.6	98.7	160.14	
6/22/79	1045	3.30	404.13	30.4	33.13	
6/29/79	1025	3.05	311.1	28.8	24.16	
7/20/79	0835	2.40	140.3	15.2	5.75	
7/30/79	1345	2.41	142.3	23.2	8.9	
12/11/79	1320	2.01	77.87	8.3	1.74	
3/19/80	1130	2.13	94.41	269.6	68.65	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site TR1.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
4/29/80	1145	2.70	207.52	94.8	53.06	
5/27/80	1405	3.65	564.84	54.8	83.48	
6/16/80	1145	3.80	645.69	243.89	424.72	
7/15/80	1345	2.71	210.09	8.6	4.87	
8/11/80	1030	1.99	75.33	13.6	2.76	
9/02/80	1200	2.16	98.9	12.8	3.41	
12/09/80	1415	2.40	140.34	9.2	3.48	
3/02/81	1100	2.14	95.89	5.4	1.4	
4/21/81	1500	2.80	234.17	66.8	42.19	
5/12/81	1200	2.75	220.56	85.3	50.74	
6/02/81	1245	4.41	1058.68	26.6	75.95	
6/22/81	1245	3.55	515.06	18.7	25.98	
8/05/81	1200	2.53	167.21	15.7	7.08	
9/01/81	1230	2.16	98.9	5.2	1.39	
12/14/81	1205	-	-	4.8	-	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site TR2.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
10/16/77	0940	-	195	7.5	4	
11/18/77	1130	-	154	2.5	1	
3/30/78	1100	-	364	114.5	112.6	
4/26/78	1215	-	195	12.5	6.6	
5/16/78	1645	-	2371	246.5	1578.0	
6/07/78	1415	-	4155	294.0	3298.0	
7/18/78	1815	-	711	27.0	51.8	
8/15/78	1330	-	485	45.0	58.9	
9/14/78	1315	-	327	11.0	9.7	
10/07/78	1330	-	278	5.0	3.8	
5/12/79	1400	-	-	23.0	-	
5/26/79	1100	-	-	218.0	-	
7/30/79	1225	-	-	26.4	-	
12/11/79	1020	-	-	7.8	-	
3/19/80	1345	-	-	170.5	-	
4/29/80	0930	-	-	92.8	-	
5/27/80	1100	-	-	68.0	-	
6/16/80	0900	-	-	199.8	-	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site TR2.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
7/15/80	1015	-	-	9.6	-	
8/11/80	0900	-	-	18.1	-	
9/02/80	0935	-	-	17.7	-	
12/09/80	1015	-	-	10.1	-	
3/02/81	1330	-	-	7.1	-	
4/22/81	1043	-	-	31.1	-	
5/12/81	0930	-	-	198.4	-	
6/02/81	1015	-	-	31.2	-	
6/22/81	0845	-	-	17.0	-	
8/05/81	0930	-	-	28.9	-	
9/01/81	0930	-	-	18.4	-	
12/14/81	1030	-	-	4.1	-	
3/29/82	1045	-	-	192.0	-	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site TR2B.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
12/09/80	1015	-	-	11.30	-	No staff
3/02/81	1415	-	-	6.20	-	No staff
4/22/81	1220	.86	-	46.90	-	Gaging station
5/12/81	0845	1.05	-	25.80	-	installed, but
6/02/81	0915	4.00	-	50.40	-	flow rating
6/22/81	0845	2.51	-	31.60	-	curve not yet
8/05/81	0805	.84	-	28.70	-	established
9/01/81	0830	.38	-	17.50	-	
12/14/81	1000	1.22	-	16.10	-	
3/29/82	0950	.84	-	106.40	-	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site GC0.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
4/09/79	1600	.79	179.77	26.4	12.8	
4/17/79	1200	.81	185.51	18	9.01	
4/27/79	1155	.80	182.63	19.2	9.46	
5/02/79	1500	.97	232.7	53.2	33.39	
5/17/79	1300	-	-	86.4	-	
5/24/79	1350	1.18	297.73	92	73.87	
5/30/79	1345	2.29	685.33	151.5	280.02	
6/11/79	1105	1.55	419.53	91	102.96	
6/14/79	1450	2.20	651.63	133.4	234.44	
6/22/79	1100	1.34	349.35	57.2	53.89	
6/29/79	1100	1.20	304.09	43.2	35.43	
7/30/79	1445	.60	127.2	18	6.18	
12/11/79	1425	.20	31.95	11	.95	
3/19/80	1035	.67	146.13	32.5	12.81	
5/27/80	1445	1.30	336.28	122.2	110.83	
6/16/80	1300	1.36	355.92	133.3	127.96	
7/15/80	1420	.49	98.6	7	1.86	
8/11/80	1045	.16	24.14	26.8	1.74	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site GC0.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
9/02/80	1240	.25	42.3	27.6	3.15	
12/09/80	1515	.57	119.25	9.4	3.02	
3/02/81	1000	.26	44.44	13.5	1.62	
4/21/81	1040	.22	36.02	38	3.69	
5/12/81	1245	.27	46.6	22	2.76	
6/02/81	1315	3.5	1168.3	66.1	208.27	
6/22/81	1345	1.24	316.89	40.4	34.53	
8/05/81	1245	.4	76.39	25.1	5.17	
9/01/81	1250	.18	27.99	11.6	.88	
12/14/81	1313	.52	106.25	3.4	.97	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site GC2.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
3/19/80	1215	-	-	17.80	-	
4/29/80	1115	.66	143.4	28.10	10.87	
5/27/80	1330	1.32	342.8	85.40	78.95	
6/16/80	1105	1.57	426.3	48.80	56.11	
7/15/80	1250	.41	78.8	15.60	3.32	
8/11/80	1000	.13	18.6	18.70	.94	
9/02/80	1135	.25	42.3	16.20	1.85	
12/09/80	1330	.35	64.6	7.20	1.25	
3/02/81	1130	.29	51.0	8.10	1.11	
4/21/81	1300	.27	46.6	25.80	3.24	
5/12/81	1142	.28	48.8	25.00	1220.00	
6/02/81	1215	2.46	749.9	51.40	103.96	
6/22/81	1140	1.23	313.7	23.50	19.88	
8/05/81	1045	.40	76.4	32.60	6.72	
9/01/81	1200	.18	27.99	18.80	1.42	
12/14/81	1140	-	-	9.40	-	
3/29/82	1314	-	-	16.70	-	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site TRBR.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
12/11/79	1120	-	-	10.4	-	
3/19/80	1300	-	-	184.8	-	
4/29/80	1030	-	-	108.0	-	
5/27/80	1235	-	-	66.4	-	
6/16/80	1030	-	-	61.2	-	
7/15/80	1100	-	-	6.0.	-	
8/11/80	0930	-	-	19.6	-	
9/02/80	0940	-	-	17.6	-	
12/10/80	1040	-	-	23.2	-	
3/02/81	1400	-	-	7.6	-	
5/12/81	1000	-	-	148.0	-	
6/02/81	1050	-	-	21.2	-	
6/22/81	1020	-	-	22.8	-	
8/05/81	0940	-	-	17.2	-	
9/01/81	1000	-	-	8.4	-	
12/14/81	1110	-	-	10.0	-	
3/29/82	1105	-	-	256.0	-	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site BH003.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
7/31/79	0945	.65	4.10	18.80	.21	
12/11/79	1150	.29	1.17	12.80	.04	
3/19/80	1300	.26	.99	67.20	.18	
4/29/80	1050	.31	1.30	17.60	.06	
5/27/80	1300	.23	.82	26.60	.06	
6/16/80	1045	.21	.71	30.80	.06	
7/15/80	1130	.21	.71	30.10	.06	
9/02/80	1100	.39	1.86	15.90	.08	
12/09/80	1300	.29	1.17	8.80	.03	
3/02/81	1230	.05	.13	12.80	.03	
5/12/81	1045	.39	1.86	35.60	.18	
6/02/81	1100	.89	-	14.20	-	Flume malfunction
6/22/81	1030	.33	1.44	8.80	.03	
8/05/81	1015	.04	.10	39.20	.01	
9/01/81	1020	.50	.18	18.70	.01	
12/14/81	1115	.81	.60	12.00	.02	
3/29/82	1145	.45	.11	43.25	.01	

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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Table D6-34. Cont'd.
Sediment data - site TR5B.

Date	Time	Gage Height (feet)	Discharge (cfs)	Total Suspended Solids (mg/l)	Sediment Load (tons/day)*	Comments
7/30/79	1305	.13	.38	22.60	.02	2 ft. flume
12/11/79	1110	.13	.38	29.80	.03	2 ft. flume
3/19/80	1320	.18	.58	36.40	.06	2 ft. flume
4/29/80	1030	.01	.02	23.10	.001	2 ft. flume
5/27/80	1230	.10	.29	12.00	.01	2 ft. flume
6/16/80	1000	.14	.43	10.80	.01	2 ft. flume
7/15/80	1100	.10	.29	11.60	.01	2 ft. flume
8/11/80	0930	.15	.46	10.40	.01	2 ft. flume
9/02/80	1015	.10	.29	7.10	.01	2 ft. flume
3/02/81	1300	.18	.58	66.10	.10	2 ft. flume
4/22/81	0930	.32	.54	31.80	.05	9 in. flume
5/12/81	1015	.39	.73	45.40	.09	9 in. flume
6/02/81	1030	.54	1.20	63.50	.21	9 in. flume
6/22/81	1000	.60	1.41	41.10	.16	9 in. flume
8/05/81	0950	.21	.28	16.90	.01	9 in. flume
9/01/81	1000	.15	.17	7.00	.003	9 in. flume
12/14/81	1055	.56	1.26	9.20	.03	9 in. flume
3/29/82	1100	.44	.87	27.50	.06	9 in. flume

* Sediment Load = Total Suspended Solids (mg/l) x Discharge (cfs) x 0.002697.

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extent. These cross sections are presented in the Reclamation Plan. Results from the 100 year flood study were discussed previously in the flood section of this Appendix.

Monitoring

Surface water quality and quantity monitoring sites have been established upstream and downstream of the Big Horn Mine (Exhibit D6-7 and Addendum D6-1). Six surface water quality sites have been established on perennial streams or at "continuously" flowing discharge sites near the vicinity of the Big Horn Mine. Two sites are located on the Tongue River, one above (TR1) and one below (TR2B) any active or proposed mining. Two sites are located upstream of the mine on Goose Creek (GC0, GC2) a perennial tributary to the Tongue River. BH003 and TR5B are located at "continuously" flowing discharge points for Pits 1 and 3 Scraper operations. Continuously recording discharge gages are located adjacent to all sites except GC2 and are summarized in Addendum D6-1. TRBR is immediately downstream of the relocated channel and is utilized as part of the sediment monitoring system. In addition, several other KME and U.S.G.S. gaging and water quality stations are located in the vicinity of the Big Horn Mine.

Prior to the installation of site TR2B on the Tongue River, site TR2 was the active monitoring site. Due to the proposal to continue mining downstream of site TR2, site TR2B was added and site TR2 was discontinued. This change was authorized by Bill Kearney of the Wyoming DEQ in a letter dated May 17, 1982. Water quality data for the discontinued TR2 site has been compiled and analyzed in Appendix D11 as part of the AVF study.

Depth integrated water quality samples are collected from perennial streams by either holding the mouth of a sample bottle upstream and moving the bottle

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vertically at a constant rate until the bottle fills or a sampler is suspended off a bridge, cable car, or boat and moved vertically until the sampler is filled. Sediment samples are also collected, utilizing a U.S.G.S. DH-48 sediment sampler employing the above-mentioned technique.

One depth integrated water quality sample is collected at each site. Although specific measurements are not taken each time a sample is collected, the distance from the edge of the channel is as follows:

TR1	1/3 to 1/2 total distance from left bank
GC2	1/2 total distance from left bank
TR2B	1/3 to 1/2 total distance from right bank
GC0	1/3 to 1/2 total distance from left bank
TR5B	Middle of channel above flume
BH003	Middle of channel above flume

Sampling frequency is discussed in the surface water quality subsection.

Perspective of Stream Channel Related to the Fluvial System

The Tongue River and Goose Creek channels are well developed as indicated in the Channel Geometry and Stream Flow sections and are the primary component of the fluvial system for the area of concern. Their relationship to the general fluvial system is described under Drainage Basin Description of this Appendix, and is evidenced in Exhibit D6-18.

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Tongue River - Goose Creek Subsystems of Concern

Hidden Water Creek

Drainage Basin Description

Description of the Hidden Water Creek drainage basin, including geomorphology and a pictorial survey are presented and discussed in the Alluvial Valley Floor Evaluation of this section under Geomorphology and Pictorial Survey. Depiction of the various drainage basins and their stream ordering are shown on Exhibit D6-18.

Surface Runoff

Infiltration

Infiltration tests and results are discussed and presented in the Alluvial Valley Floor Evaluation of this section under Infiltration.

Streamflow, Flood Study, and Channel Geometry

No perennial, intermittent or ephemeral streams pass through the proposed mining area of Pit 4. However, surface water studies have been initiated for Hidden Water Creek, whose channel is immediately north of the pit disturbance area. Surface hydrology studies have involved the recording of all flows for water years 1979 and 1980, the collection and analysis of water samples, and the calculation of storm runoffs and crest elevations using synthesized unit hydrographs and flood routing procedures.

In October 1978, a two-foot Parshall flume, fitted with a Stevens continuous recorder, was installed in the Hidden Water Creek channel, just north of the proposed pit area (Exhibits D6-7 and D6-25). The resultant hydrograph for water year 1979 is shown in Figure D6-12. The hydrograph illustrates approximately 45 days of continuous flow, with a peak of 1.11 cfs, occurring on March 15, 1979. Total runoff volume is approximately 21 acre-feet. Data collected from the 1980

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water year indicate only three days of runoff, a peak of 1.50 cfs on March 10, 1980, and a total runoff volume of 5.63 acre-feet. The shape and timing of the hydrograph is indicative of snowmelt runoff, and it is interesting to note that no thunderstorm runoff was recorded. By law, the creek would be defined as intermittent.

For the development of mineral resources, a variety of indirect methods have been proposed to estimate runoff per unit area or the streamflow characteristics of ungaged channels. Early efforts included the transfer of streamflow records from adjacent or nearby ungaged basins, and the estimation of runoff from drainage basin size and areal variation of normal precipitation. More recent methods use numerous basin characteristics and multiple-regression analysis to estimate parameters of discharge. Further development of these techniques led to various models relating to rainfall (precipitation) and runoff. Many of these techniques have worked well for limited areas, generally in humid regions, but have lacked transfer power to arid regions. The relatively sophisticated methods have been hampered by the need for numerous input data, some of which are highly variable with time and often not available. To obtain a more reliable and easily applied utility, the channel geometry method of indirectly determining streamflow characteristics was developed in 1966 from the hydraulic-geometry concept. This method is based on the assumption that channel size and shape of a site are determined mainly by the direct results of the water and sediment discharge past that site. Measurements of the channel geometry, therefore, provide information on discharge characteristics.

The accuracy of the channel-geometry technique varies with the type of stream being measured, the discharge parameter being estimated, regional conditions of climate, geology and topography, the sophistication of the equation

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used, and the experience of the person collecting and applying the data. The method is most accurate when applied to perennial streams with stable banks, i.e. streams with coarse material protecting the bed and banks from erosion and low gradient streams with well vegetated banks formed largely of cohesive silt and clay. Conversely, the method is probably least accurate when applied to streams of flashy or erratic discharge that have sandy noncohesive banks, and lack a well developed growth of riparian vegetation (Hedman, E.R., 1980).

Reaches of the channels at which measurements are to be made are selected to conform as closely as possible to the following criteria:

1. Channel shape should be uniform throughout.
2. The bed and banks should be of a material that has permitted the channel to develop into a normal size and shape for the flow regimen.
3. The channel banks should appear to have been permanent for some time.

The channel feature used to determine the widths is the "active channel". The active channel is a short-term geomorphic feature subject to change by prevailing discharges. The upper limit is defined by a break in the relatively steep bank slope of the active channel to a more gently sloping surface beyond the channel edge. The break in slope normally coincides with the lower limit of permanent vegetation. These features individually, or in combination, define the active channel reference level. The section beneath the reference level is that portion of the stream entrenchment in which the channel is actively, if not totally, sculptured by the normal process of water and sediment discharge.

At sites where the active channel is identified, a tape measure is stretched tightly across the active channel at the active channel reference level. The width is recorded and samples of the channel material are collected for analysis, if necessary.

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The discharge characteristics determined for Hidden Water Creek (Table D6-35) were rated poor. Several (12) active channel reference levels were identified and measured at this site and the measurements were quite consistent. However, the discharge characteristics were rated poor because of the unusual channel material. The channel material was quite coarse, which would indicate an armored channel and should give good results, but the material is very light in weight. A large percentage of it is scoria or clinker and it appears that it can be moved quite easily by the flow. Because equations have not been developed for this type of channel material, the equation for sand channels was used for the annual runoff. The equations for streams in the northern plains were used to compute the flood-frequency values and the overall results were rated poor. It is assumed that if the discharge values are in error, they would be too large.

Flows in Hidden Water Creek were diverted away from the original channel by a berm and diversion channel constructed in conjunction with the Acme No. 1 underground coal mining operation. The exact date of the diversion is unknown, but it was definitely sometime prior to 1927. The diversion channel and berm are shown in all maps and accompanying this report, but for some unknown reason the berm is shown to be breached at the original point of diversion (1,550,060N - 589,790E). In actuality, the diversion berm has not been breached and Exhibit D6-26 is of three surveyed topographic profiles which clearly illustrate this fact. The location of these surveyed land surface profiles are shown in Exhibit D6-25. Subsequent to the development of the topographic maps, a mine shaft sinkhole has formed in the diversion channel just downstream of the diversion channel-natural channel confluence. Profile YY-Y' (Hidden Water Creek Sinkhole Thalweg) defines this feature. To date, all surface flows have been observed to

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Table D6-35. Hidden Water Creek flow predictions, using Hedman channel geometry technique.

WAC (feet)	Qa (ac-ft)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)	Remarks
	$4.0W^{1.5}$	$4.8W^{1.6}$	$24.0W^{1.4}$	$46W^{1.35}$	$61W^{1.3}$	$130W^{1.3}$	$160W^{1.25}$	
4.2	30	48	180	320	390	840	960	Poor

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disappear in the sinkhole. Water intercepted by the sinkhole very probably enters the shafts of the Acme No. 1 mine, and flows downdip to the southeast.

In order to size the culverts for the haulroads that will extend across the Hidden Water Creek diversion channel (Mine Plan) the flood hydrograph resulting from a precipitation event of a ten-year return period and a six-hour duration was calculated using the computer program "TR-20" developed by the U.S. Soil Conservation Service (1969). A rain depth of 1.60 inches for the event was taken from the Precipitation Frequency Atlas for Wyoming (N.O.A.A., Atlas II, 1973). A six-hour duration storm event was chosen for mine design purposes, since the six-hour duration more than exceeds the 1.47 hour time of concentration of the watershed. A ten-year return period was chosen since, given an expected one-year mine life, the risk that this event might occur is only 10%. A curve number of 75 was used based on the hydrologic grouping of soils within the watershed and an antecedent moisture condition II was used. This condition is appropriate for this area and for sound engineering practices. The resultant hydrograph has a peak discharge of 183 cfs, with a peak time of 4.32 hours.

In order to ascertain whether or not the ten-year, six-hour storm hydrograph floodplain might encroach upon the mining operation, the U.S. Corps of Engineers HEC-2 computer program was utilized to plot a water surface profile. The flood hydrograph data, and the dimensions and roughness coefficient characteristics of the channel and overbank deposits were used in the HEC-2 program. Seven cross sections were surveyed across the Hidden Water Creek valley to provide accurate topographic control. Five of these cross sections, A through E, presented in Addendum D6-9, show the flood surface elevations. Cross section locations are shown on Exhibit D6-25, which displays the ten-year, six hour storm floodplain.

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The emplacement of the haulroad culverts in the creek diversion channel will act to slightly backwater the ten-year six hour design flood. The effect of the backwater will be seen as a somewhat expanded floodplain map and higher flood peak elevations on respective cross sections for the channel in the vicinity of the culverts. Given the culvert design and emplacement specifications (refer to Mine Plan), the backwater elevation at the culverts is approximately 1.5 feet above the culverts. This corresponds to a water elevation of 3656.5 feet at the entrance of the culverts. Cross section A-A shows a peak flood elevation of 3657.6, therefore, the backwater profile from the culverts would not appreciably alter the high water profile at cross section A-A.

It has been shown that the ten year six hour runoff for Hidden Water Creek does encroach upon portions of the proposed Pit 4 permit area. However, flood waters will not advance to the actual pit areas, and flood prevention structures are not considered necessary.

Quality

Surface water quality samples were collected above the Hidden Water Creek flume (see Monitoring of this section) (Exhibits D6-7 and D6-25) during spring runoff. Streamflow was only observed from mid-March through late April, which restricted the number of samples which could be collected. To be consistent, samples were collected from the middle of the stream channel approximately three meters above the flume. A depth integrated sample was collected each time by facing the mouth of the sample container upstream and by moving the container vertically from the water surface to the channel bottom until the container was filled. Sample preparation, storage, and transport followed Wyoming DEQ Revised Guideline No. 4 and Revised Guideline No. 8.

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All field and analytical lab results are presented in Table D6-36. These data are not unlike observed quality of other ephemeral and intermittent streams flowing into the Tongue River from the Piedmont, with total dissolved solid concentrations typically high. Particularly high for surface water was the mean sulfate concentration. Since Hidden Water Creek flowed only during a relatively short period following snowmelt, comparisons of seasonal and storm runoff changes were not possible.

A comparison of surface water and groundwater quality parameters indicated similar concentrations among the primary cations, anions, and total dissolved solids. These similarities reflect the interaction of the surface and groundwater regimes.

Mining adjacent to Hidden Water Creek should not affect its quality. Referring to the Mine Plan, all groundwater inflow encountered and surface drainage within the permitted boundary will be kept on-site and routed through a total containment settling pond. No water will be discharged into Hidden Water Creek, since water in the settling pond will be used for dust abatement.

Water quality and sediment sampling during spring runoff and significant storm runoff events will continue during mining and after final reclamation. Significant changes will be reported to the DEQ in the Big Horn Mine annual report.

Channel Geometry

Channel geometry was previously discussed under Streamflow, Flood-Study, and Channel Geometry of this section.

Monitoring

Surface water monitoring in the Hidden Water Creek drainage consists of a two-foot Parshall flume fitted with a Stevens continuous recorder. This, along

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Table D6-36. Surface water quality sampling of Hidden Water Creek.

Parameter	Concentration* Date of Sampling 3/22/79	4/9/79	4/16/79	5/2 - Present
Streamflow (cfs)	0.25	0.075	0.025	Dry
Field pH	-	7.6	-	
Field Specific Conductance (umhos/cm)	-	3500	3283	
Field Dissolved Oxygen (ppm)	-	9.9	7.8	
Water Temperature (C^{o})	-	20.0	17.2	
Lab pH	8.2	8.4	8.5	
Turbidity (NTU)	2.3	2.9	3.2	
Total Suspended Solids	5	11	9	
Total Dissolved Solids	3190	3300	3220	
Lab Specific Conductance (umhos/cm)	3340	3400	3220	
Ammonia Nitrogen (as N)	0.01	1.43	0.63	
Total Phosphorus	0.02	0.03	0.02	
Total Alkalinity	228	328	330	
Bicarbonate Alkalinity	278	379	373	
Carbonate	0	10	15	
Fluoride	0.85	0.63	0.61	
Nitrate-Nitrite (as N)	0.15	0.01	0.01	
Sulfate	1922	1970	1940	

*mg/l unless otherwise noted

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Table D6-36. Cont'd.

Parameter	Concentration* Date of Sampling 3/22/79	4/9/79	4/16/79	5/2 - Present
Total Hardness	1867	1950	1930	
Calcium	242	260	251	
Magnesium	307	316	317	
Potassium	2	26	25	
Sodium	186	191	188	
Cations-Anions	0.10	-0.45	-0.47	
Aluminum (D)	0.9	0.2	0.2	
Arsenic (D)	0.005	0.005	0.005	
Cadmium	0.005	0.005	0.005	
Chromium (D)	0.02	0.02	0.02	
Copper (D)	0.02	0.03	0.02	
Iron (T)	0.17	0.10	0.12	
(D)	0.13	0.06	0.05	
Lead (D)	0.02	0.02	0.02	
Manganese (D)	0.03	0.02	0.02	
Mercury (D)	0.002	0.002	0.002	
Nickel (D)	0.02	0.05	0.04	
Selenium (D)	0.005	0.005	0.005	
Zinc (D)	0.03	0.05	0.03	
Barium	0.5	0.5	0.5	
Boron	0.6	0.4	0.5	

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with two crest-stage gages and a three stage sediment sampler, were installed in October 1978 just north of the proposed pit area (Exhibits D6-7 and D6-25 and Addendum D6-1). Figures D6-13 and D6-14 show design of the crest-stage gages and sediment sampler, respectively. The crest-stage gages are based on a U.S.G.S. design as illustrated in Techniques of Water Resources Investigations of the U.S.G.S, chapter A7, page 28. The three stage sediment sampler automatically collects a water sample as each stage is reached by a flow occurrence. Water quality samples were collected as discussed under Quality of this section.

Perspective of Stream Channel to Fluvial System

Basically, Hidden Water Creek is an intermittent stream of insignificance whose flows have not yet reached the Tongue River during the period of record (1978 to present). A more detailed description of the Hidden Water Creek drainage can be found in the Streamflow, Flood-Study, and Channel Geometry section, or in the Alluvial Valley Floor Evaluation section. These accounts can then be compared to the Tongue River fluvial system as presented in the first portion of Surface Water Hydrology of this Appendix, or Appendix D11. Exhibit D6-18 shows the relationship of the Hidden Water Creek drainage area to other drainages in the area.

Alluvial Valley Floor Evaluation

Geomorphology

Surrounding the Pit 4 area are many drainage basins, ranging in size from topographic depressions with no defined channel to large perennial streams with headwaters in the Big Horn Mountains. The Tongue River is one such perennially flowing stream which has a broad actively degradating channel and well defined terraces. Even though the Tongue River is well outside the disturbance area for Pit 4, many old unsaturated Tongue River terrace remnants can be found in the

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Figure: D6-13

CREST - STAGE GAGE

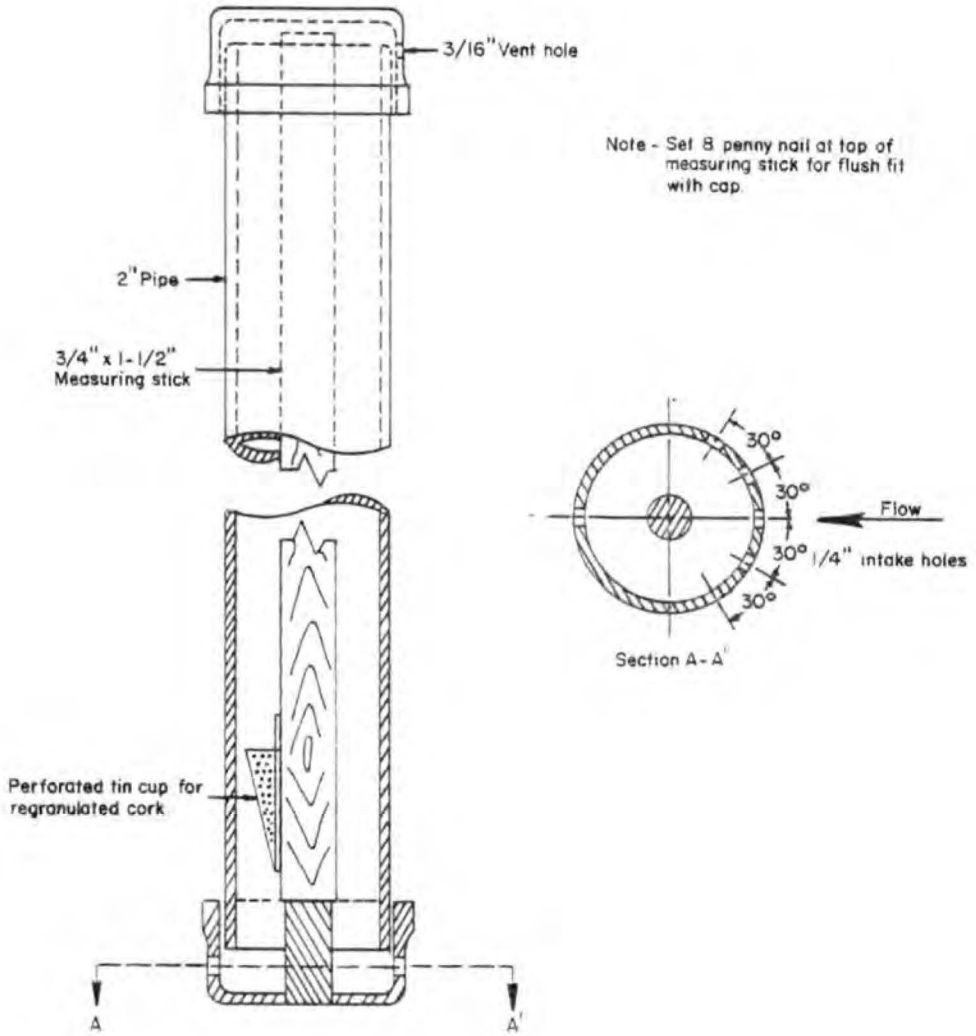

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Figure: D6-14

FIELD SEDIMENT SAMPLER (K.M.E.)

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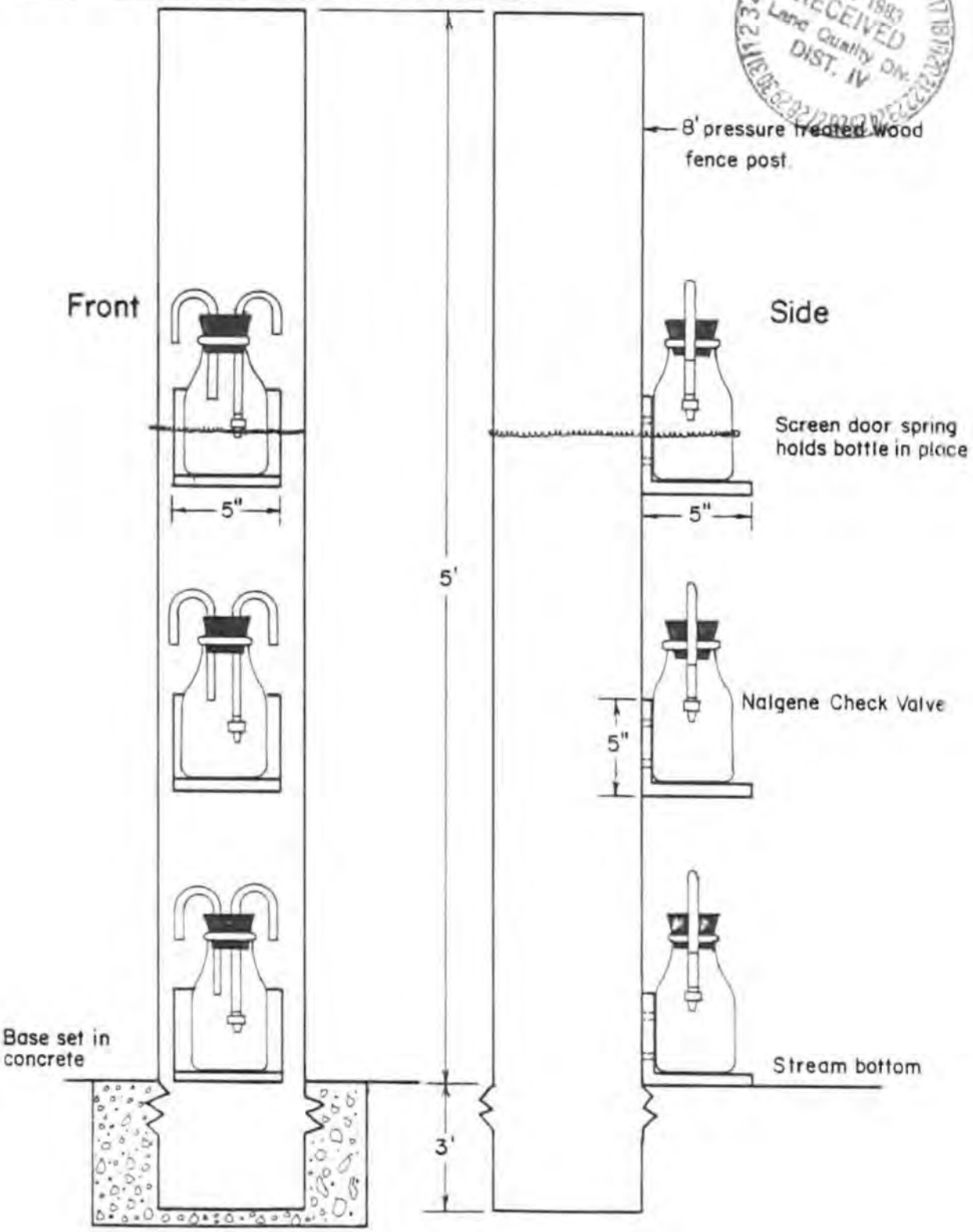

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hills surrounding the proposed pit. These remnants are in no way connected to the current Tongue River terrace system.

Located adjacent to Pit 4 is an intermittently flowing stream which could potentially be influenced by mining Pit 4. This stream, Hidden Water Creek, flows northwest to southeast with the active stream channel (at its closest point) approximately 200 feet from the proposed pit. At no time will the pit intercept or cause Hidden Water Creek to be relocated. This is a well drained, elongated watershed with a present drainage area of approximately 5.4 square miles. Found at the headwaters of this drainage basin are old surface mining pits which act as sinks for surface runoff. Prior to this past disturbance, the drainage area was 8.15 square miles (Exhibit D6-18).

Since Hidden Water Creek is located near the proposed pit, an alluvial valley floor evaluation was made. The definition of an alluvial valley floor is "unconsolidated stream laid deposits holding streams where water availability is sufficient for subirrigation and flood irrigation agricultural activities. . ." (Wyoming Environmental Quality Act). It is inherent in this definition that a detailed study of the fluvial geomorphology of drainages adjacent to or through a proposed mine be made. This study should include an evaluation of the surficial geology, including terrace delineation stratigraphy and extent of stream laid deposits, channel characteristics, and soil/water relationships. In addition, an evaluation of a stream's water availability characteristics will result in a declaration (positive or negative) of an alluvial valley floor. In particular, subirrigation and flood irrigability, which strongly depend on fluvial geomorphology, must be evaluated since most topographic valleys contain alluvium and undifferentiated slopewash deposits.

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Pictorial Survey

As a cursory evaluation, a pictorial survey was made of the drainage to define channel width, texture and roughness of the channel and terrace, and extent of terrace formation. Original pictures were submitted to the DEQ in the original hydrologic assessment. Only xeroxed copies will be submitted in this report.

The first picture (Figure D6-15) is an infrared aerial of Hidden Water Creek and proposed Pit 4 (middle, upper lefthand corner with dirt road bisecting the hill). This photograph was taken on September 14, 1978 at about 10:00 a.m. prior to the first killing frost of the winter. It, along with the surficial geology map (Exhibit D6-10), show the well-defined channel, the active floodplain, and the one terrace (Qt_1) ranging in width from undetectable to approximately 460 feet. Vegetation along the channel and active floodplain was still moderately vigorous, indicating the presence of soil moisture storage or subirrigation.

The remaining color pictures were taken on the ground on June 29, 1979. Picture two (Figure D6-16) depicts the confluence of the relocated channel with the Tongue River. The incision created by a channel diversion around the old Acme No. 1 mine through the TRFU sediments and a Tongue River terrace can be seen in the background.

The next picture in the sequence (Figure D6-17) was taken looking upstream at the two-foot Parshall flume (foreground) with crest gages/sediment sampler in the background. The channel width at this site is five to eight feet, with a channel roughness coefficeint (n) of approximately 0.040. Subangular to rounded scoria and sandstone chips (1-13 cm diameter) armored the channel bottom and sideslopes. The roughness coefficient (n) of the terrace (Qt_1) was estimated to range from 0.035-0.007, due primarily to sagebrush and grass vegetation.

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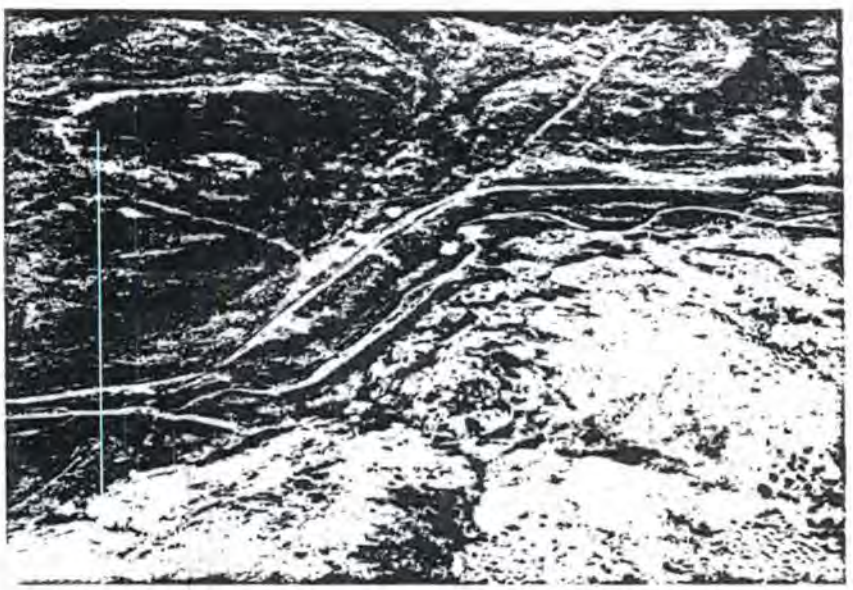

Figure D6-15 Infra-Red aerial view of Hidden Water Creek, Proposed Pit 4 and the surrounding Geomorphology.

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Figure D6-16 Confluences of relocated Hidden Water Creek with the Tongue River.

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Figure D6-17 Hidden Water Creek Parshall Flume, Crest Gauges and Sediment Sampler with Channel Geomorphology in background.

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A closeup of the stream armoring near the flume with a set of keys used for scale, is shown in the following photograph (Figure D6-18). The channel adjacent to Pit 4 is primarily composed of subangular to rounded scoria and sandstone chips of local origin. Tight armoring, as shown here, generally results in stable stream channels.

The following pictures (Figures D6-19 and D6-20) were taken 180 meters upstream from the flume. The man's height in the foreground of the second of these two pictures is 5'7". Here the stream meanders to the east, creating an eroded streambank. The channel bottom was similar to the last picture with a slightly higher "n" value (0.050) and more vegetation. The meander pattern of this stream generally has high value for the period and relatively low amplitude.

Figure D6-21 is a picture taken from the road which parallels Hidden Water Creek looking toward backhoe Pit 9, approximately 425 meters upstream from the flume. In this section of the stream a small channel was evident (three feet wide), but the channel system in whole was eroding a bank to the northeast. Ponded water, but no flow, was evident. Small braided channels were found meandering through the active floodplain, which probably indicates a decreasing stream gradient.

The final picture (Figure D6-22) was taken about 75 meters upstream of backhoe Pit 9. No ponded water was observed with the first evidence of trees along the undisturbed channel.

Extent and Physical Makeup of Unconsolidated Stream Laid Deposits

A surficial geology map (Exhibit D6-10) delineates the extent of terrace formation along Hidden Water Creek. Within the outer boundaries of Qt_1 are proposed unconsolidated stream laid deposits, the extent and thickness of which are

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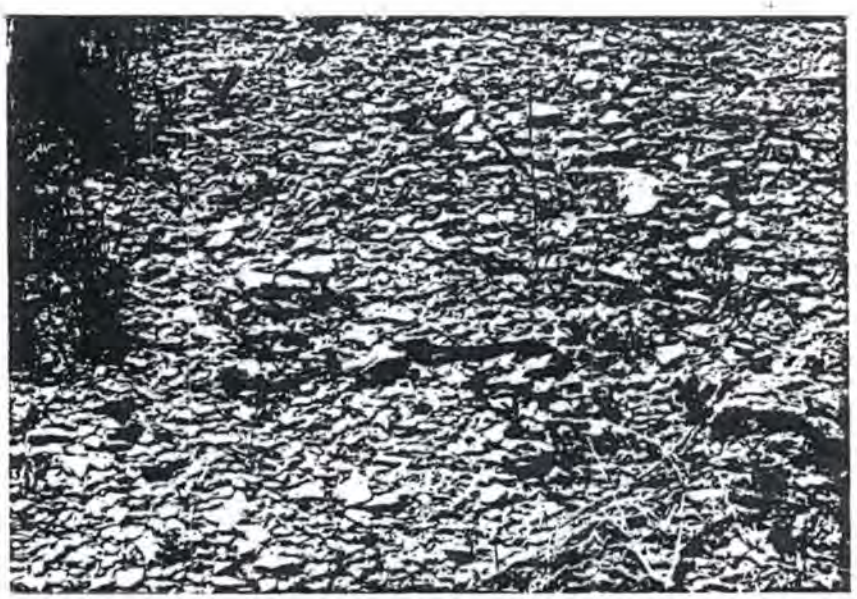

Figure D6-18 Channel texture and armoring, Hidden Water Creek.

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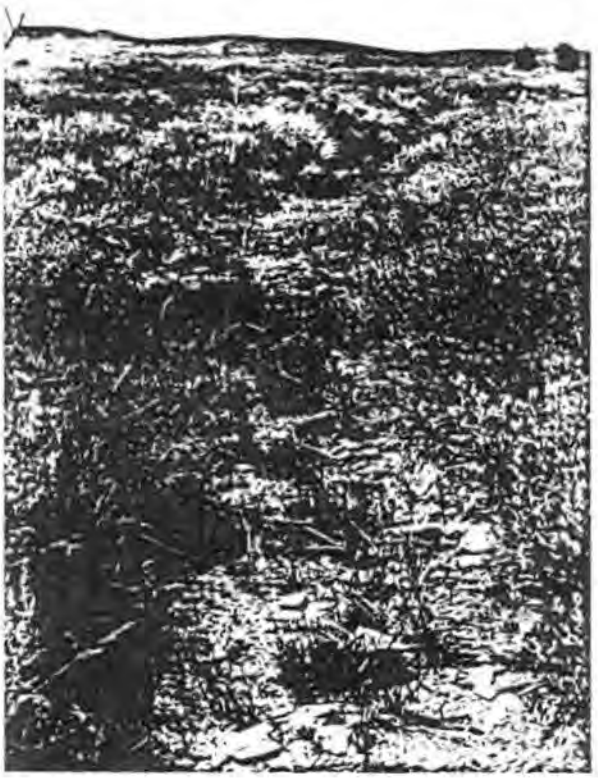

Figure D6-19 Hidden Water Creek Channel, Terrace and Vegetal Species.

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Figure D6-20 Hidden Water Creek Channel June 1979, with Proposed Pit 4 in extreme background.

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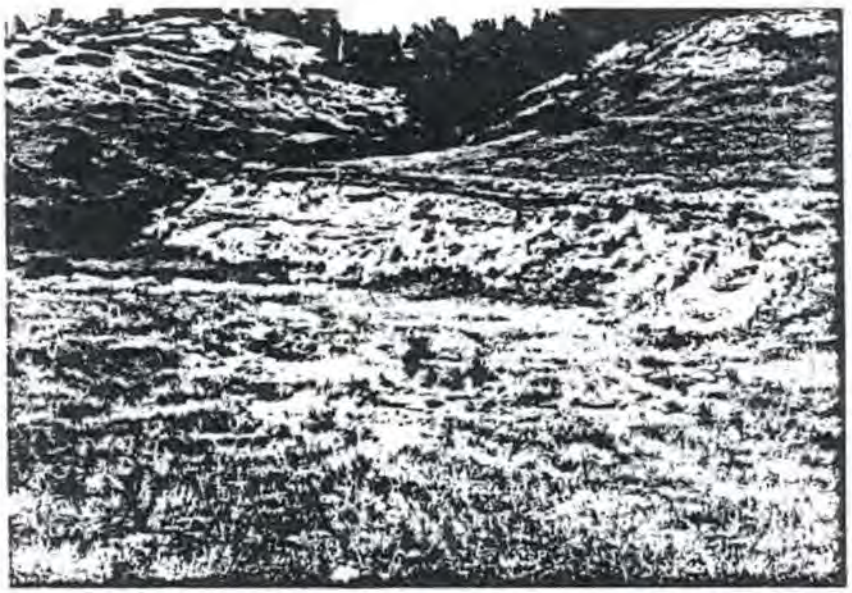

Figure D6-21 Hidden Water Creek bank cutting with Reclaimed Backhoe Pit 9 in foreground.

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Figure D6-22 Hidden Water Creek Channel and Terrace Upstream of Proposed Pit 4.

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shown on an alluvial isopach map (Exhibit D6-11). Hidden Water Creek alluvial deposits interfinger with colluvial sediments originating from hills paralleling the drainage. Because of their interfingering nature and since no attempt was made to separate alluvial and colluvial facies, the map thickness includes both geologic units.

The base level of the alluvium was fairly uniform with no breaks or abrupt changes in alluvial thickness. This would be indicative of a fairly uniform past flow regime with a minimal amount of meandering.

The Tongue River had very little effect on the geomorphic development of Hidden Water Creek's drainage, which postdates the development of the larger perennial stream. The only influence exerted by the larger stream is at the confluence of the undisturbed creek, where the Tongue River controls its stream gradient.

To describe the physical composition of the sediments in the Hidden Water Creek drainage, ten backhoe pits were dug. Eight pits were dug in the Hidden Water Creek terrace or active floodplain, one was dug in colluvial slopewash and one was dug in a residual soil (Exhibit D6-12). These data are enclosed in Addendum D6-10. The pits completed in the alluvium indicated that a change in the energy regime of Hidden Water Creek took place in past geologic times. One to two and one-half feet of fine grained, relatively homogeneous, sediments (silt to very fine sand) overlie coarser, nonhomogeneous, stratified layers of subangular to rounded cobbles and gravel, indicating a decrease in the overall energy environment in more recent times.

Most of these stratified cobbles and gravels were made up of scoria and sandstone chips often with horizontal orientation in a matrix of sand to sandy clay. Weathered coal chips were also evident in some of the stratified layers.

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The conclusion verified from the pit observations is that these deposits are unconsolidated and stream laid. Small isolated patches of colluvium or bedrock can be found throughout the alluvial deposits, but these characteristics do not exclude the deposit from being stream laid.

All eight alluvial backhoe pits were dug in June after the alluvium had been recharged by surface runoff. This was evident in backhoe Pits 6, 7 and 9 completed immediately adjacent to the stream channel where the water table was penetrated. Observed water levels in these pits were 10.85, 12.60 and 1.93, respectively. Standing water was also observed in the channel adjacent to backhoe Pit 9.

Water levels observed in the alluvial/sandstone wells upstream and downstream of backhoe Pit 9 were well below the ground surface (Table D6-37).

Since water levels in wells upstream and in wells and backhoe pits downstream of backhoe Pit 9 were well below levels observed in this pit, it must be concluded that a perched water zone is located adjacent to backhoe Pit 9. This indicates that other perched zones might be found along the Hidden Water Creek drainage. Mining will not effect this perched water zone since mining will take place downstream, downgradient and when the alluvium is not saturated.

The physical composition of backhoe pits not completed in the alluvium (4 and 5) was also examined. Backhoe Pit 4 was not unlike the alluvial pits, but stratified layers were not horizontally oriented. Bedrock shale and coal was intercepted in both pits.

Subirrigation

Potential subirrigation along Hidden Water Creek was examined in each backhoe pit and with the installation of several soil moisture tubes (Exhibit D6-12).

Backhoe pits were dug in early summer after the alluvium was recharged by surface runoff. Several vegetation classes were examined by selective placement

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Table D6-37. Water levels.

Groundwater Level
Observation in Wells
During the Backhoe Pit Study

Well No.	Date	Water Level Below Ground Surface
392	6/29/79	11.83
393	6/29/79	14.96
394	6/29/79	16.74
395	6/29/79	14.31
396	6/29/79	18.74

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of each pit. The total rooting depth was recorded with mean total rooting depths in alluvial pits found to be 6.2 feet. In every pit except No. 9, the groundwater table and associated capillary fringe was either not reached or was well below the total rooting depth. Roots did extend into the groundwater table in backhoe Pit 9 (dug in the active floodplain), which was located in a perched water zone. However, water levels receded later in the summer, observed as water level declines below the base level of the alluvium (Exhibit D6-13).

Preceding the backhoe pit study, nine soil moisture tubes were installed in the vicinity of Pit 4 (Exhibit D6-7). Eight tubes were completed in alluvial sediments, and one was installed in a residual/colluvial soil type. Observations from each core prior to installation of the soil moisture tube is presented in Addendum D6-11.

Vegetation rooting depths observed in each core were defined in terms of numbers of roots per unit of cross sectional area through the horizon and site (USDA - SCS, 1974). The number of roots was divided into three classes: many (M), common (C), and few (F), while the size category was divided into five classes: very coarse-coarse (VC, C), medium (M), fine-very fine (F, VF). For example:

0-0.5	C	F & VF
depth interval	number of roots	size of roots

Gravimetric soil moisture samples were also taken from each core at varying depth intervals representing changes in lithology, number of roots, or apparent variation in moisture content.

Aluminum moisture tube bottoms were capped and installed in each soil core. A neutron probe (manufactured by Campbell Pacific Nuclear Company) was then

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inserted into the tube. The number of slow neutrons returning to the detector was recorded for each depth interval gravimetrically sampled for soil moisture. A best fit regression equation was then developed from these data and used for subsequent neutron probe readings taken later in the year (Table D6-38).

Graphical representations of seasonal moisture profiles, lithology of each soil core, and rooting depths are presented in Figures D6-23 through D6-26. These four figures were developed from moisture tubes located adjacent to the stream channel (8, 12) and on Hidden Water Creek's terrace (39, 41). They are representative of moisture profiles and rooting depths found in the remaining tubes along Hidden Water Creek.

The spring, summer and fall moisture profiles all lead to the conclusion that the area is not subirrigated. Capillarity, shown by an increase of soil moisture with increasing depth, was not found for any tube during the plant growing season. This phenomena, along with the observation discussed in the groundwater section that the alluvium is saturated only for a short period of time, is conclusive evidence that the Hidden Water Creek system could never be subirrigated throughout the entire growing season.

Infiltration

Infiltration rates of the Hidden Water Creek terrace soils were measured with double ring infiltrometers (Appendix D6-11). Mean infiltration rates measured from this study were 0.22 inches per hour for alluvial soils and 0.14 inches per hour for residual/colluvial soils. Infiltration rates in alluvial soils varied depending upon soil type and degree of compaction by cattle grazing and other man-related disturbances.

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Table D6-38. Soil moisture profiles and standard curves for moisture tubes located in the vicinity of the Big Horn Mine.

Site	Best Fit Regression Equation and Correlation Coefficient (1st date basis)	Date	Depth	% Moist.	Count	Date	Depth	% Moist.	Count	Date	Depth	% Moist.	Count
BH8	y=.001059X+7.916	5-15-79	.1*	16.0	1192	8-28-79	.1	8.23	295	9-21-79	.1	8.34	403
	.75		.5	14.5	5834		.5	8.89	919		.5	9.67	1657
			1.0	14.9	6846		1.0	11.29	3185		1.0	11.43	3318
			2.0	14.3	6697		2.0	12.47	4300		2.0	12.40	4231
			4.0	16.3	7366		4.0	13.31	5098		4.0	13.57	5336
			4.5*	15.0	9424		4.5	14.85	6544		4.5	14.79	6490
BH9	y=.0012X+7.503	5-15-79	.1*	32.2	2280	8-28-79	.1	9.43	1655	9-21-79	.1	9.31	1549
	.67		.5	15.8	7473		.5	11.46	3397		.5	12.18	4014
			1.0	15.7	9854		1.0	14.87	6323		1.0	15.65	6996
			2.0	15.4	8513		2.0	15.88	7190		2.0	15.37	6753
			4.0	13.6	5626		4.0	14.33	5860		4.0	13.89	5481
			6.0	15.2	7283		6.0	16.71	7898		6.0	15.96	7260
			8.0	20.8	7726		8.0	18.67	9584		8.0	18.49	9431
			10.0	21.9	10300		10.0	19.57	10354		10.0	19.11	9963
			11.0	21.0	11347		11.0	20.65	11283		11.0	19.69	10456
BH10	y=.00035X+13.84	5-16-79	.1	11.4	699	8-28-79	.1	14.06	635	9-21-79	.1	14.11	763
	.58		.5	16.9	1278		.5	14.45	1750		.5	14.62	2231
			1.0	17.2	6826		1.0	15.35	4289		1.0	15.60	5014
			2.0	16.7	8532		2.0	16.04	6251		2.0	16.10	6421
			4.0	16.3	9103		4.0	16.78	8344		4.0	16.50	7550
BH12	y=.00028X+9.54	5-16-79	.1	9.5	936	8-28-79	.1	9.60	223	9-21-79	.1	9.57	119
	.25		.5	13.8	5124		.5	9.61	248		.5	9.67	477
			1.0	9.8	6403		1.0	10.10	2001		1.0	10.35	2875
			2.0	8.8	6021		2.0	10.96	5019		2.0	10.98	5084
			4.0	12.1	5925		4.0	10.87	4718		4.0	10.88	4754
			6.0	9.1	6703		6.0	11.30	6219		6.0	11.21	5886
			7.0	14.5	7129		7.0	11.14	5646		7.0	11.21	5904

*Point not included in best fit line or equation calculation due to its "outlier" characteristic.

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Table D6-38. Cont'd.

Site	Best Fit Regression Equation and Correlation Coefficient (1st date basis)	Date	Depth	% Moist.	Count	Date	Depth	% Moist.	Count	Date	Depth	% Moist.	Count
BH39	y=.00304X+10.2715 .89	5-15-79	.1*	23.2	2802	8-28-79	.1	0	394	9-21-79	.1	0	838
			.5	17.9	8073		.5	0	1592		.5	0	2875
			1.0	16.5	8761		1.0	5.47	5174		1.0	6.33	3457
			2.0	9.0	6674		2.0	9.50	6499		2.0	9.59	6526
			4.0	21.1	10055		4.0	16.81	8899		4.0	19.87	4906
			6.0	19.0	9961		6.0	19.26	9705		6.0	18.45	9440
			8.0	11.8	7155		8.0	10.79	6923		8.0	11.39	7118
			8.8	12.5	8378		8.8	13.16	7699		8.8	13.60	7846
BH40	y=.000598X+10.42565 .51	5-15-79	.1	13.1	1492	8-28-79	.1	10.75	555	9-21-79	.1	10.68	420
			.5	14.9	4843		.5	11.26	1401		.5	12.57	3582
			1.0	10.6	7091		1.0	13.67	5436		1.0	13.58	5286
			2.0	10.0	5812		2.0	13.46	5082		2.0	13.66	5409
			4.0	14.7	7741		4.0	14.86	7428		4.0	14.56	6924
			6.0	16.5	8394		6.0	15.06	7759		6.0	15.33	8200
			8.0	18.3	9664		8.0	15.52	8518		8.0	15.79	8976
			10.0	21.8	10538		10.0	16.08	9458		10.0	16.18	9634
			11.0	14.2	11812		11.0	16.68	10471		11.0	16.93	10883
BH41	y=.001675X+1.7462419 .66	5-16-79	.1*	20.6	3780	8-28-79	.1	6.39	2770	9-21-79	.1	4.28	1511
			.5	17.6	9198		.5	12.92	6672		.5	8.29	3906
			1.0	15.5	9818		1.0	13.37	6938		1.0	13.26	6872
			2.0	15.1	8661		2.0	11.59	5874		2.0	11.66	5917
			4.0	17.4	7460		4.0	12.47	6400		4.0	11.77	5985
			6.0	20.8	9933		6.0	18.35	9913		6.0	17.41	9349
			8.0	13.9	7519		8.0	14.58	7663		8.0	14.40	7553
			10.0	15.9	8139		10.0	15.33	8108		10.0	15.16	8006
			12.0	11.5	7163		12.0	12.23	6256		12.0	12.61	6485

*Point not included in best fit line or equation calculation due to its "outlier" characteristic.

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FIGURE D6-23 *Soil Moisture Tube BH-8.*

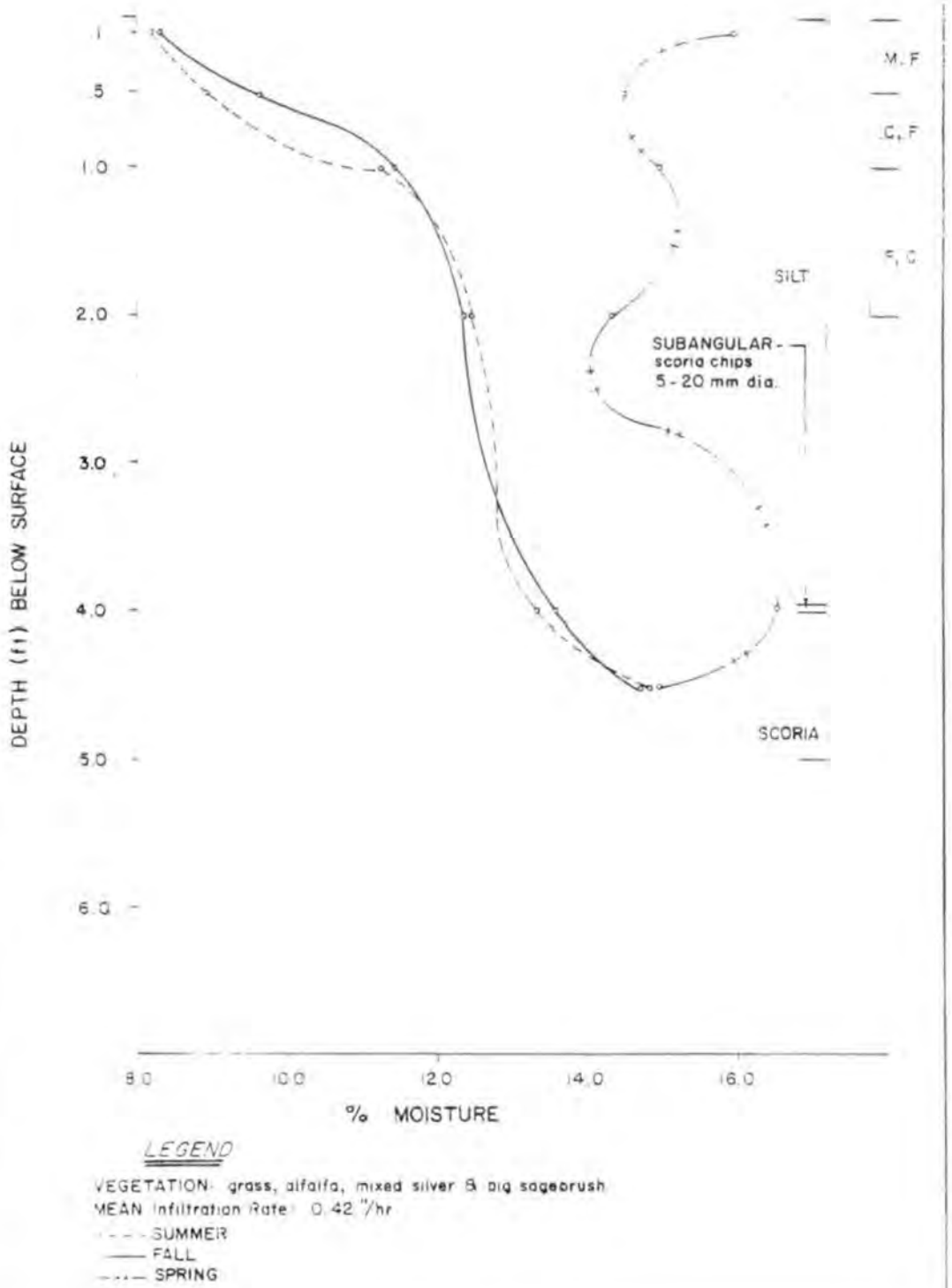

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FIGURE D6-24 *Soil Moisture Tube BH-12.*

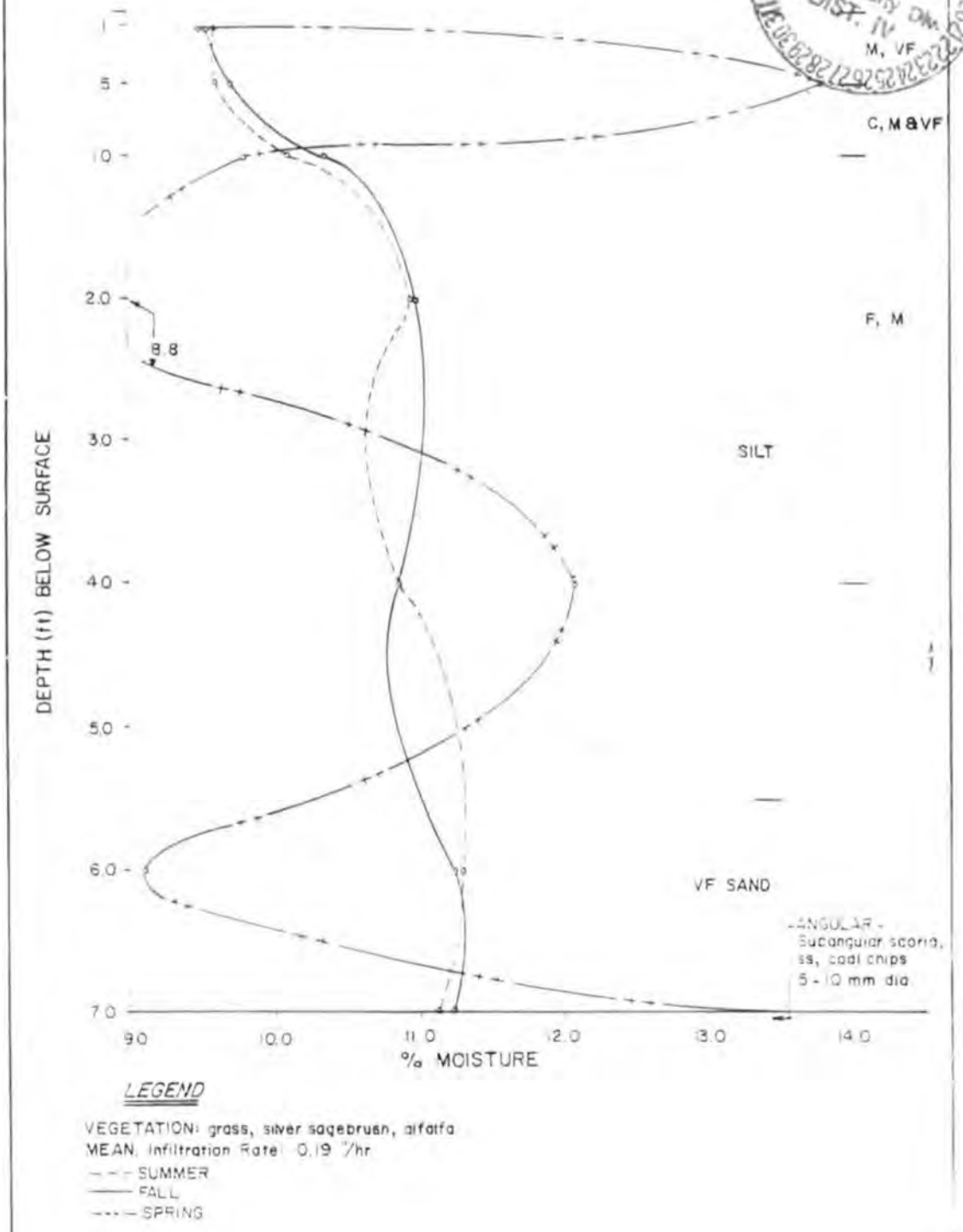

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FIGURE D6-25 *Soil Moisture Tube BH-39*

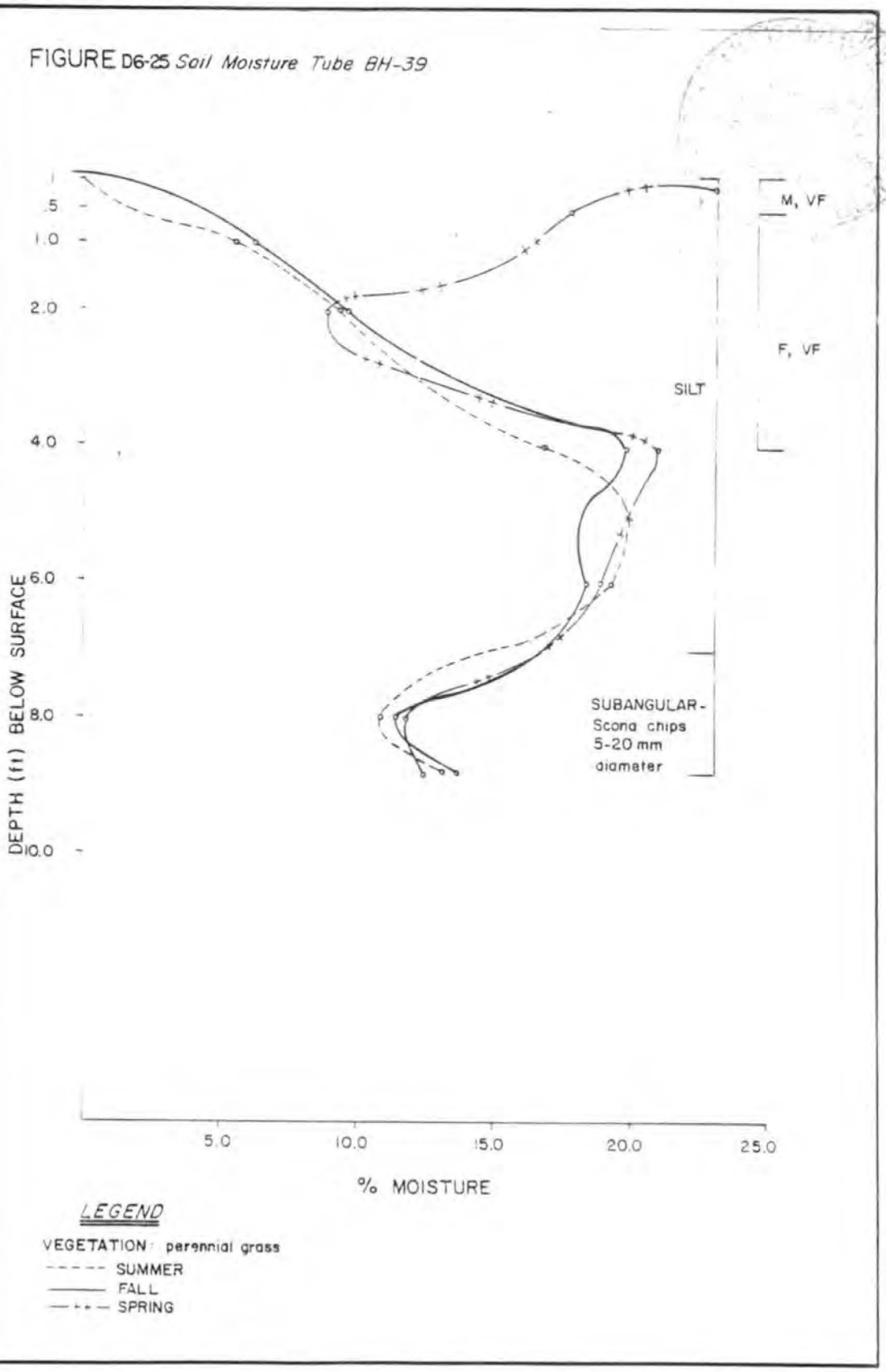

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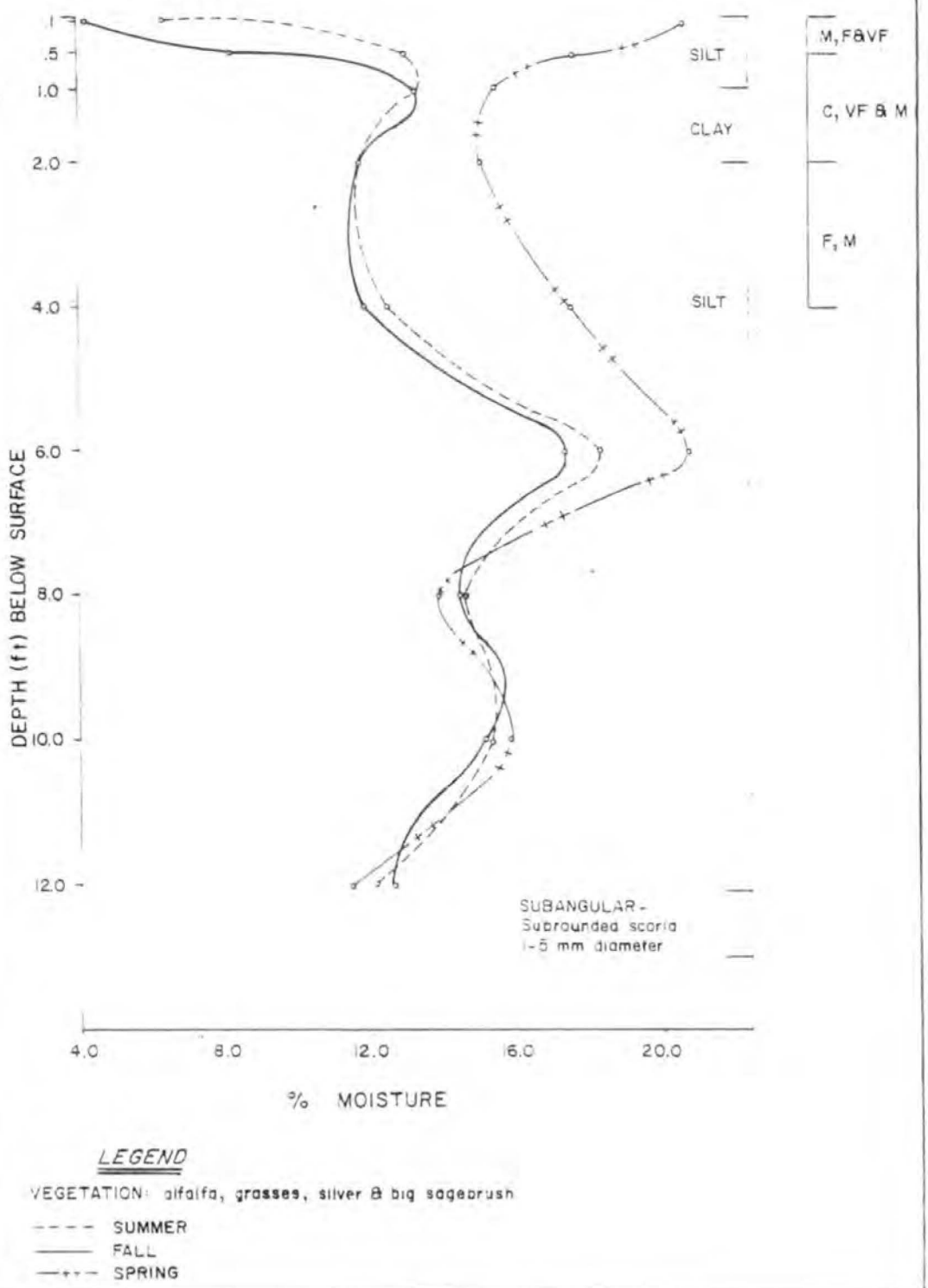
FIGURE D6-26 *Soil Moisture Tube BH-41.*



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Considering the high evaporation rates in this area, the low average annual precipitation, potential plant transpiration, and soil moisture storage, potential vertical recharge to alluvial deposits would be extremely low.

Flood Irrigation

Past and present flood irrigation activities along Hidden Water Creek were examined by a review of surface water appropriations (Water Rights section) and field inspection. No current adjudicated or nonadjudicated water rights were found for Hidden Water Creek in the vicinity of the Pit 4 permit boundary. A field reconnaissance and detailed examination of infrared aerial photographs showed that no diversions or past irrigation activities could be found. Only three stock watering ponds were found along the entire drainage, with one pond in disrepair. These ponds were well upstream of Pit 4 with the closest pond about one and one-half stream miles up from the Hidden Water Creek Parshall flume. With the exception of minor stock watering activities, surface flow in Hidden Water Creek has not presently, or in the past, been put to beneficial use.

Observed flow over the past two water years and the estimation of average annual runoff volume using channel geometry methods is presented in the Surface Runoff section. The potential for flood irrigating the terrace adjacent to Hidden Water Creek was carefully examined by KME hydrologists and qualified personnel from the local SCS office. Soils, water quality, timing and quantity of surface runoff, and diversion structures necessary to flood irrigate were considered. The final recommendation by the District Conservationist (F.S. Smith) was that the area in the vicinity of Pit 4 should not be considered for flood irrigation activities. His letter is enclosed in Addendum D6-12.

A water spreading system was eliminated from consideration due to the timing of surface runoff and the slope of the terrace to be irrigated. Flood

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irrigation was considered adjacent to Pit 4 but ruled out due to the unreliability of streamflow during the critical plant growing season and the extremely high cost of diversion structures. Since the tract of land adjacent to Pit 4 is near the confluence with the Tongue River, the quantity and reliability of flow would be higher than for any other irrigable tract throughout the entire watershed. Since it is not feasible to flood irrigate the terrace near Pit 4, it would then not be feasible to flood irrigate any other portion of the drainage basin.

Conclusions

Unconsolidated stream laid deposits were found, the extent and composition of which were studied in detail. Potential subirrigation and flood irrigability was evaluated along with a survey of possible past irrigation activities. It was concluded that no subirrigation was present during the entire growing season. Also, the reliance and quantity of flow from Hidden Water Creek was not sufficient during the critical plant growing season.

Estimated average annual runoff volume using channel geometry methods was estimated to be 30 acre-feet (Surface Runoff section). Hydrographs from the 1979 and 1980 water years indicate that runoff occurs from local snowmelt runoff in March. No runoff has been measured from precipitation events. Low yield, the timing of runoff, and steep terrace slope lead to the conclusion by the Soil Conservation Service (Addendum D6-12), that flood irrigation is not feasible for this drainage.

If runoff was ponded in March and released in late July or August during plant stress, the potential for irrigation would still be minimal. Assuming a pond 30 acre-feet in size, most of the potential irrigation water would be lost to evaporation or leakage. WRRI (1977) estimated that the May through September pan evaporation at the Sheridan Field Station from 1959-1975 averaged 41.35

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inches. Using a seasonal distribution factor of 65% of annual evaporation for the May-September evaporation, WRRI estimated the annual pan evaporation at Sheridan to be 64 inches and for shallow pond evaporation, 58 inches. Monthly incremental evaporation for shallow ponds in the Sheridan area would be:

Month	Evaporation (inches)
March	1.51
April	4.35
May	7.54
June	7.54
July	8.53
August	8.00
Total six months	37.47

Thus, 3.12 feet of water over the surface of the pond would be lost to evaporation. Depending on the size and depth of the pond, and degree of leakage from the pond bottom, most, if not all, of the potential irrigation water would not be available during plant stress.

Due to the lack of subirrigation and extremely low potential for flood irrigation, Hidden Water Creek is not an alluvial valley floor.

Mining will take place only adjacent to Hidden Water Creek and its associated stream laid deposits and will have no measureable impact on its fluvial geomorphology. Potential mining impacts on the groundwater and surface water hydrological balance will be studied in the following sections.

P5 Draw

Drainage Basin Description

The subwatershed containing the proposed Pit 5 disturbance area drains into an ephemeral first order drainage which shall be called, for purposes of this report, P5 Draw. The P5 Draw drainage basin in relation to neighboring basins is depicted in Exhibit D6-18.

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Geomorphology

In mining the proposed Pit 5 area of Big Horn Coal, the P5 Draw will be disturbed and subsequently relocated. Because of this, a special investigation was conducted to determine the quantitative morphological characteristics of the watershed. Following is a summary of the characteristics and their definitions which were quantified for this particular study:

Stream Order - starting at the head of the watershed, the small unbranching streams first encountered are designated order 1. Two first order streams coming together form a second order stream, two second order streams coming together form a third order stream, etc.

Stream Length - is the length of the main stream channel of a watershed from the outlet to the furthermost point, including all sinuosities.

Maximum Basin Length - is the maximum straight line distance from the outlet to the basin boundary.

Average Basin Width - is the watershed area divided by the length of the main stream from the outlet to the watershed boundary.

Drainage Density - the total length of all channels in the watershed divided by the area, i.e. the channel length per square mile. $D_d = L_{total}/A$.

Form Factor - the ratio of the average width of the watershed to the length of the main stream. $F_f = W_{ave.}/L$.

Compactness Coefficient - the ratio of the perimeter of the watershed to the circumference of a circle having the same area. $K_C = P/2\ (A)^{1/2} = 0.28P(A^{1/2})$.

Circularity Ratio - the ratio of the area of the watershed to the area of a circle having the same perimeter as the watershed.

Elongation Ratio - the ratio of the diameter of a circle of the same area as the watershed to the maximum basin length.

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Ruggedness Number - the product of the relief and drainage density, where both are in the same units.

Mean Elevation - the mean elevation of all points in the watershed. Determined by sampling 100 grid points evenly distributed on the watershed area.

Mean Slope - the mean slope at all points in the watershed.

Method 1 $S = DL/A$ where S = average slope (5), D = contour interval (ft), L = total length of contours (ft), and A = area of the basin in ft^2.

Method 2 Sample the slope at 100 grid points evenly distributed over the watershed.

Length of Overland Flow - the mean distance that water falling on the watershed flows before reaching a channel. May be determined by measuring distance from evenly spaced points on the watershed perimeter to the nearest channel, or from evenly spaced points along the channel to the nearest divide. Is also approximately equal to $0.5\ (1/D_d)$.

Values for these characteristics as calculated for P5 Draw are presented in Table D6-39. It should be noted that this drainage contains only a first order ephemeral stream as identified from the U.S.G.S. 7½ minute quadrangle (Acme Quad.). Stream profile and the slope-area curve for the drainage of concern are presented in Exhibit D6-27 and Figure D6-27, respectively.

Basically, the morphological characteristics examined describe the shape, size, slope, elevation, and general makeup of the watershed. The characteristic of particular interest for the watershed of concern is its shape and resultant characteristics. The shape of the watershed is elongated - long and narrow. This would facilitate a quick buildup of flow with lower peaks spread out over a longer period of time. A typical hydrograph for this type of drainage compared to a circular drainage is depicted in Figure D6-28. An additional noteworthy

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Table D6-39. Morphometric characteristics of P5 Draw.

Drainage Area:	0.85568 mi^2 = 23,855,000 ft^2
Channel Length:	2.71 mi = 14,300 ft
Maximum Basin Length:	2.72 mi = 14,340 ft
Average Basin Width	1536 ft
Drainage Density:	3.17 mi/mi^2 = .0005994 ft/ft^2
Form Factor:	0.108 ft/ft
Perimeter of Watershed:	6.24 mi = 32,938 ft
Compactness Coefficient:	1.9
Circularity Ratio:	0.276
Elongation Ratio:	0.384
Ruggedness Number:	0.329
Mean Elevation:	3879.1 ft
Mean Basin Slope:	37.2%
Mean Length of Overland Flow:	
Method One:	833 ft
Method Two:	835 ft
Channel Slope:	3.4%
Channel Length (extrapolated to basin boundary) Divided by Maximum Basin Length:	1.06 ft/ft

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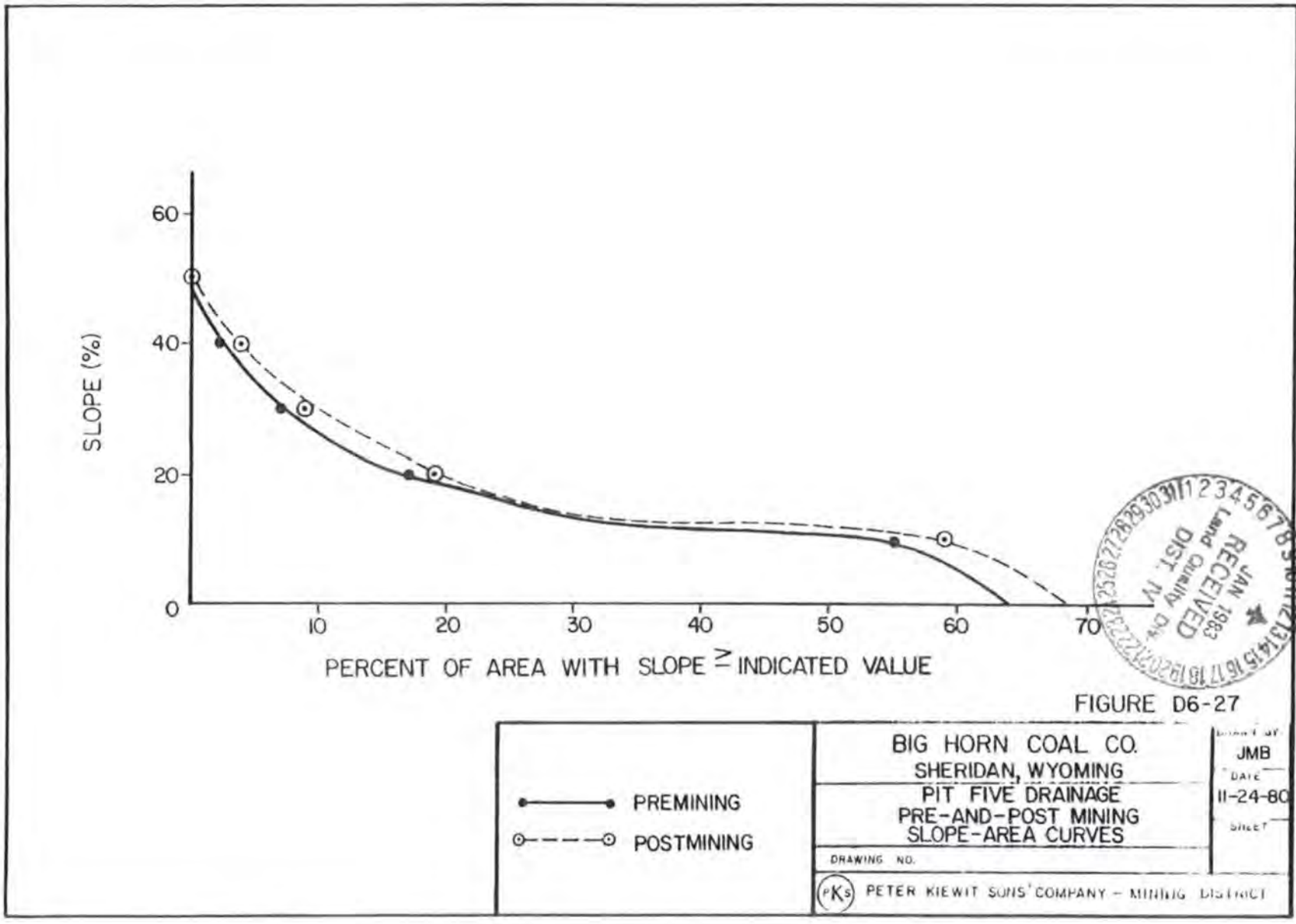

FIGURE D6-27

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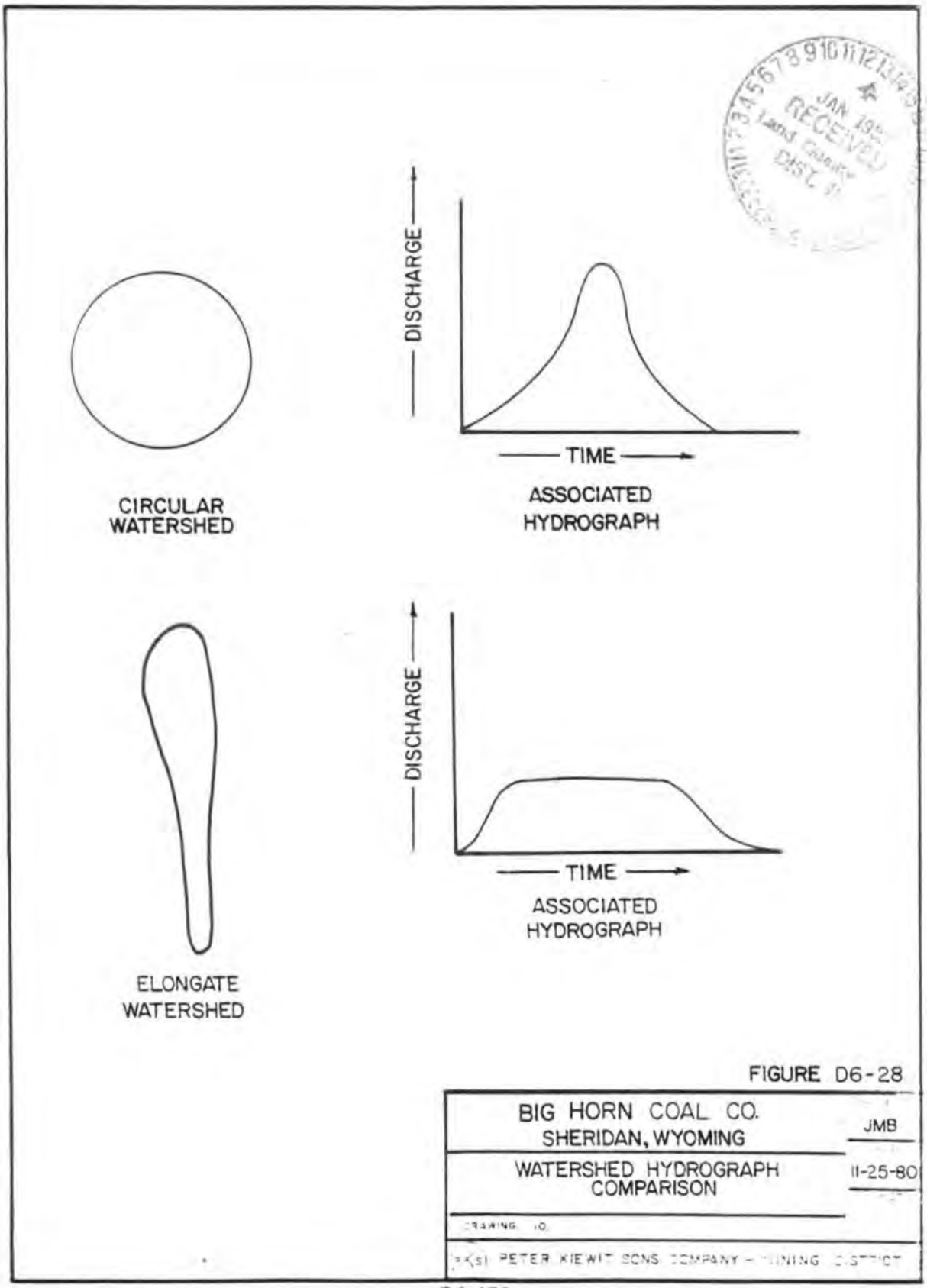

FIGURE D6-28

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WATERSHED HYDROGRAPH COMPARISON	11-25-80
DRAWING NO.	
PREPARED BY PETER KIEWIT SONS COMPANY — MINING DISTRICT	

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characteristic is the ratio of stream channel length (extrapolated to basin boundary) to the maximum straight line basin length. This ratio is 1.06 ft/ft and indicates very little sinuosity occurring in the drainage basin. The drainage is fairly straight as indicated and does not contain a well defined cut channel throughout its length. The predominate description of the waterway is that of a grassed swale drainage. Several sections of the stream, including the area of proposed disturbance, contain heavy armoring of the stream bottom with large sandstone plates. Vegetation comprised primarily of grasses and brush are well established between these sandstone plates. In other areas where the plating is not as pronounced, vegetation, primarily grasses, is well established in a matrix of scoria ranging from soil size to 100 mm. Two headcuts are present in the drainage occurring in areas where the sandstone plating is not predominate. It is immediately downstream from these headcuts where a "well-defined" channel exists. The channels in these particular locations are not, however, representative of typical flows as would normally be carried by a channel of the cut's size, but are actually part of the headcut. As mentioned before, the typical waterway is not a well-defined cut channel, but a grassed swale, frequently containing armoring of sandstone plates and brush in the lower half of the drainage.

Due to the ephemeral nature of the draw, the small area drained (.86 mi^2), and the losing nature of the stream, there is no appreciable amount of alluvium in the draw. Any alluvial deposits are localized only with the stream channel often cutting across bedrock in the areas containing the sandstone plates and armoring. Subsequently, there is no saturated alluvial zone. Due to the predominate makeup of scoria and sandstone of the drainage, the stream is considered a losing stream. It, therefore, acts to some degree as a recharge zone. This function is minimal, however, as flows are all but nonexistent in the draw. Any recharge would be

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through vertical infiltration only. It should be remembered that the high potential for evapotranspiration of the area is greater than the annual precipitation. This would cause any recharge to this groundwater system to be minimal.

As part of the study, an on-site geomorphic photo survey was conducted for the P5 Draw. Site locations are shown on Exhibit D6-28.

Site location numbers, cross section identification, textural characteristics, and general field observations are given in Table D6-40 for each particular site. Slides for sites 1 to 33 as indicated in Table D6-40 are available.

Surface Runoff

Flow Estimates

No flows were observed in P5 Draw during 1980. To aid in determining average annual flow for the P5 Draw, a channel geometry technique as developed by Hedman (1980) was utilized. This incorporates the width of the active channel to calculate the average annual flow. This flow was calculated to be 5.46 acre-feet per year using the Hedman technique.

Channel cross sections were surveyed for the existing channel. These are shown in Exhibits D6-29 through D6-32 and were utilized in conjunction with TR 20 and HEC-2 programs in calculating the 100 year flood map as depicted in Exhibit D6-28. Cross section locations are also shown on this exhibit. The existing stream profile was also surveyed and is depicted on Exhibit D6-27.

Quality

To date, no flow has occurred in P5 Draw and subsequently, no surface water quality data have been obtained.

Channel Geometry

Channel geometry was previously discussed and presented under Flow Estimates (Exhibits D6-29 through D6-32) and Geomorphology (Table D6-40).

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Table D6-40. Geomorphic survey for P5 Draw.

Location*	Roughness Coefficient (n)	Field Observations
Site 1		Uppermost reaches of P5 Drainage looking toward watershed divide.
Site 2		Upper reaches of P5 Draw at point of first tributary confluence.
Site 3		Depicts "channel" at upper end of basin. No well defined cut channel exists.
Site 4		"Channel" is more a grassed swale than a cut channel. Channel area is well vegetated. Burn (scoria) is evident in and along channel.
Site 5		Same as Site 4.
Site 6		Shows second "significant" confluence. Burn evident on side but not in channel bottom. Channel area is well vegetated with no cut channel evident.
Site 7		First headcut encountered from the upstream end of the drainage.
Site 8		Area immediately upstream of headcut. Well vegetated and gently sloped.
Site 9		Area immediately downstream of headcut. Scoria armoring up to one foot diameter evident.
Site 10		Same as Site 9.
Site 11		Stream cut into scoria bank. Channel not well defined here, but gently sloping well vegetated swale with grasses and brush.
Site 12		Area of stockpond and outlet. Pond will back up and store any flows until outlet elevation is reached. No water has been evident in the pond for the last year and a half.
Site 13		Channel at outlet comprised primarily of sandstone and scoria up to 100 mm.

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Table D6-40. Cont'd.

Location*	Roughness Coefficient (n)	Field Observations
Site 14		Area 50 feet downstream from stockpond. This is a depressional area with no well defined channel. Dense grasses and brush are evident in this area.
Cross Section A	.042	Channel undefined, tall grass and sage, slightly irregular.
Site 15		Area of second headcut from the upstream end of the drainage. Grassy swale upstream of headcut, and a cut channel for a short section downstream of the headcut. Channel material downstream of headcut consists of scoria ranging in size from 2 mm to 1 foot, primarily from 5-10 mm.
Cross Section B	.042	Channel undefined, tall grass and sage, slightly irregular.
Site 16		Channel has cut down to sandstone bedrock. Large sandstone plates up to 5 feet in diameter are along the channel bottom and sides. Smaller sandstone and scoria armoring with well established vegetation between are also evident in this area. Site 16 is the beginning of the area to be disturbed.
Site 17		Same as Site 16 depicting plates, fragments, and vegetation between.
Cross Section C	.033	Channel bed same as sides. Tall grass, bushes, some rocks, meandering, slightly irregular.
Site 18		Slope increases slightly here, and there is a greater predominance of pine and juniper adjacent to the drainageway. The third headcut, smaller than the first two, is at this location. Channel bottom is primarily sandstone plates with grass and small bushes between them.
Cross Section D	Channel .062 Sides .056	Very irregular, tall grass, bushes, trees, pools, debris, rocks, boulders.

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Table D6-40. Cont'd.

Location*	Roughness Coefficient (n)	Field Observations
Site 19		Channel well grassed in low slope areas. Where slope steepens, the channel has cut to sandstone bedrock. No well defined channel with cut banks exists.
Site 20		Area showing sandstone plates, scoria, juniper, grasses and brush.
Cross Section E	Channel .038 Sides .050	Channel is very irregular with tall grass, weeds, trees, debris, rocks, and pools. Sides are very irregular with tall grass, weeds, and trees.
Site 21		Drainage slope decreases here and a grassed swale drainage becomes predominate. Between cross sections E and F there are numerous sink holes and subsidence areas from underground mine disturbance.
Cross Section F	Channel .033 Sides .041	Channel very irregular with meanders, pools, weeds, grass and rocks. This is the end of the area to be disturbed.
Cross Section G	Channel .031 Sides .034	Channel is very irregular with rocks, boulders, tall grass, meandering, and pools. Sides have rocks, boulders, tall grasses and bushes.
Site 22		Downcutting is evident into sandstone bedrock.
Site 23		This area continues to exhibit downcutting to sandstone, with sandstone and scoria armoring.
Cross Section H	Channel .049 Sides .036	Channel is irregular with rocks, tall grass, and deep pools. Sides are irregular with rocks and tall grass.
Site 24		This area has a massive scoria talus slope running right to the "channel" bottom.
Site 25		Same as Site 24.

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Table D6-40. Cont'd.

Location*	Roughness Coefficient (n)	Field Observations
Site 26		This area has the crest gages and static water sampler. Vegetation here is very brushy and grassy.
Cross Section I	Channel .050 Sides .043	Channel is irregular with tall grass, rocks, pools, and meanders. Sides very irregular with tall grasses.
Site 27		There are deep depressional areas in the channel bottom which would create deep pools if significant flows ever reached them. Several of the deepest ones have been used as dumps.
Site 28		This is the mouth of the P5 Draw where it enters the Tongue River.
Site 29 through Site 33		This is the Tongue River in the immediate area of the P5 Draw and Tongue River confluence.

*Slides available for Sites 1-33.

General Observation Summary

In summary, the P5 Draw does not exhibit a well defined cut channel for the most part. Instead, it is an ephemeral drainage which runs over sandstone bedrock in the steeper reaches. In the areas of lesser slope, a grassed swale condition is evident. In most areas there is either sandstone or scoria armoring ranging in size from less than 1 mm to 5 foot diameter plates. Vegetation, usually grasses and brush, is established between this material. Due to the nature of the parent material throughout the P5 Draw, that being sandstone and scoria, the P5 drainage is considered a losing stream. An additional characteristic lending to this is the existence of sink holes and subsidence in the area of abandoned underground mines. Because of this losing nature, no flows have been observed in the last year and a half. Any flows will be noted on the crest gage and static water sampler.

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Monitoring

In order to estimate flow occurrences in the P5 Draw, two crest-stage gages were installed. In conjunction with these, a three stage sediment sampler and a channel bottom water quality sampler were installed. Location of this monitoring site is depicted on Exhibit D6-7 and described in Addendum D6-1. Figures D6-23, D6-14 and D6-29 show design of the crest gages, sediment sampler and water quality sampler, respectively. The crest-stage gages are based on a U.S.G.S. design as illustrated in Techniques of Water Resources Investigations of the U.S.G.S., chapter A7, page 28. The three stage sediment sampler automatically collects a water sample as each stage is reached by a flow occurrence. Likewise, the water quality sampler automatically collects a water sample during any flow event.

This particular sampling device was designed to aid in the collection of water quality samples on ephemeral drainages where flow events are all but non-existent. It will ensure that a sample is collected if any flow occurs. This sampler will be checked immediately after any potential flow event occurs ensuring an immediate analysis of the sample. Direct sampling will be the preferred method of collection, if at all possible. To date, no flow has occurred and subsequently no surface water quality has been obtained.

Perspective of Stream Channel to Fluvial System

Basically, the P5 Draw is a first order ephemeral tributary of the Tongue River which has not yet flowed during the period of record. More detailed information regarding this can be found in the previous sections discussed under P5 Draw.

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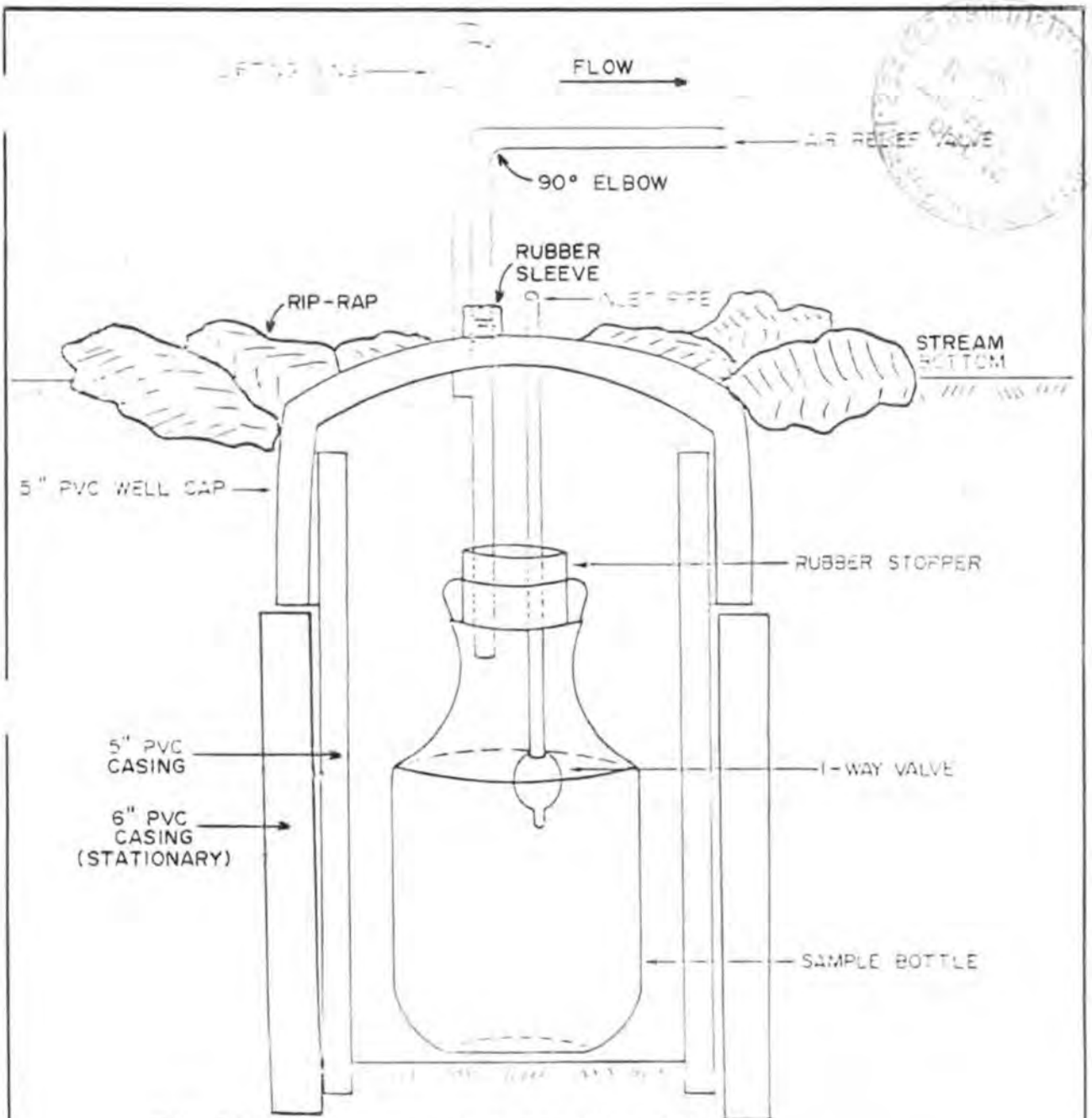

FIGURE Samples checked immediately after every significant precipitation event.

FIGURE D6-29

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SHERIDAN COUNTY, WY

STATE WATER QUALITY SAMPLER

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Alluvial Valley Floors

As previously mentioned in the Geomorphology Section, there is no appreciable amount of alluvium in the P5 Draw. This is largely due to the first order ephemeral nature of the drainage, the small area drained (.86 mi^2), and the losing nature of the stream. Any alluvial deposits are localized only with the stream often cutting across exposed bedrock. Subsequently, there is no saturated alluvial zone. Neither is there an alluvial valley floor.

Amendment One Area

Drainage Basin Description

No perennial, intermittent or ephemeral streams pass through the proposed affected area, however, surface water studies have been performed on the Tongue River whose channel is to be north and south of the pit disturbance area (Exhibits D6-7 and D6-18). These studies have previously been reported in the appendix under Tongue River-Goose Creek System.

Runoff Estimate

The affected area is situated on a hill which is an erosional remnant of the surrounding dissected upland. Since there is no channelized flow within the disturbance area, surface runoff will be in the form of overland or sheet flow. Surface discharge occurring from the area must be the result of atmospheric precipitation in the form of high intensity thunderstorms and is localized into the gullies which radiate outward from the top of the affected hill. The gullies vary in slope as shown on the premining topographic slope condition map in Appendix D6. With the exception of the steepest slopes (greater than 40%), the gullies are well vegetated.

Sheridan Field Station records for the period 1939 to 1978 indicate that the annual precipitation varied from a minimum of 8.23 inches in 1960 to a maximum

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of 24.58 inches in 1944 with a record mean of 15.84 inches (Department of Commerce, 1978). Approximately 50% of the annual precipitation occurs during the April to June period and 73% in the April to September period.

Average annual runoff for the Tongue River drainage varies from greater than 20 inches at the crest of the Big Horn Mountains to a low of 0.2 inches approximately 36 miles downstream of the Big Horn Coal Company Mine. Busby, 1966, estimates that the average annual runoff for the Big Horn Coal mining area is about 1.0 inches per year. Using this estimate and the total affected area of 116 acres, the calculated annual potential runoff is 9.67 acre-feet.

Tongue River 100 Year Flood Study

In order to ascertain whether or not the Tongue River might encroach upon the mining operation, the peak 100 year flow value was generated using the HEC Flood Flow Program as described under Tongue River-Goose Creek System of this appendix. The U.S. Corps of Engineers HEC-2 computer program was then used to route this flow and plot a water surface profile. The HEC-2 uses the Bernoulli equation, Manning's roughness formula, momentum relations and channel cross sections placed perpendicular to the flood flow. Thirteen cross sections were surveyed across the Tongue River valley, their locations are drawn on Exhibit RP-26, which displays the 100 year 24 hour storm floodplain. As can be seen from the map, the Tongue River will not enter the pit upon a 100 year event.

Quality, Channel Geometry, Monitoring and Perspective of Stream Channel to the Fluvial System

Due to the fact that no stream, channel, or predominant drainage exists in the immediate area of concern, the above topics do not apply. The reader is directed, however, to discussion on the Tongue River-Goose Creek System as presented at the beginning of the Surface Water section of this appendix.

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Pit One Area

Drainage Basin Description

No perennial, intermittent or ephemeral streams pass through the proposed affected area, however, surface water studies have been performed on the Tongue River whose channel is to the north of the pit disturbance area (Exhibits D6-7 and D6-18). These studies have previously been reported in this appendix under Tongue River-Goose Creek System.

Runoff Estimate

In the actively mined Pit 1 area, there is no channelized flow within the area of disturbance. Surface runoff will be in the form of overland or sheet flow. Overland flow within areas now actively mined is primarily the result of high intensity thunderstorms and is localized into the rills and gullies which radiate outward from the hill mined at Pit 1. The rills and gullies vary in slope as presented in the Geology section. With the exception of the steepest slopes (greater than 40%), the rills and gullies are well vegetated.

No flood analysis, with the exception of the Tongue River flood analysis previously presented, is necessary for the Pit 1 area.

Quality, Channel Geometry, Monitoring and Perspective of Stream Channel to the Fluvial System

Due to the fact that no stream, channel, or predominant drainage exists in the immediate area of concern, the above topics do not apply. The reader is directed, however, to discussion on the Tongue River-Goose Creek System as presented at the beginning of the Surface Water section of this appendix.

Water Rights

Water rights are contained in Addendum D6-3 and are depicted on Exhibit D6-33.

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REFERENCES

Busby, Mark W., 1966. Annual runoff in the conterminous United States: U.S. Geological Survey Hydrologic Investigation Atlas, HA-212.

Dettmann and Olson, 1977. Argonne National Laboratory, Coal Extraction and Land Reclamation: Assessment of Water Quality Impacts of a Western Coal Mine.

Hedman, E. R., 1980. Streamflow characteristics related to channel geometry in coal-lease areas: progress report (January 1, 1980 to June 30, 1980).

Hydrologic Engineering Center, 1976. HEC-2 Water Surface Profiles Users Manual. U. S. Army Corps of Engineers.

Johnson Division, UOP Incorporated, 1975. Groundwater and wells: Johnson Division UOP Incorporated, Saint Paul, Minnesota.

Komar, C. A., Overbey, W. K. Jr., and Pasini, J. III, 1973. Directional properties of coal and their utilization in underground gasification experiments. U. S. Bureau of Mines and Tech. Report TPR 73, 11 p.

Leopold, L. B. and J. P. Miller, 1954. A post-glacial chronology for some alluvial valleys in Wyoming: U. S. Geological Survey Water Supply Paper 1261.

Linsley, R. K. Jr., M. A. Kohler, J.L.H. Paulus, 1975. Hydrology for Engineers, Second Edition. McGraw-Hill Book Company. Pgs. 338-372.

Lohman, S. W., 1979. Groundwater Hydraulics: U. S. Geological Survey Professional Paper 708.

Lowry, M. E., and T. R. Cummings, 1966. Groundwater Resources of Sheridan County, Wyoming: U. S. Geologic Survey Water Supply Paper 1807, 77 pgs.

Mapel, M. J., 1976. Geologic Map and Coal Sections, Bar N-Draw Quad. Wyoming-Montana: U. S. Geological Survey Water Supply Paper 1807.

McKee and Wolf, 1963. Water Quality Criteria. The Resources Agency of California.

Olson, R. D., and Dettmann, E. H., 1976. Preliminary results from a study of coal mining effects on water quality of the Tongue River, Wyoming: Presented at the Fifty-second Annual Meeting Southwestern and Rocky Mountain Division American Association of the Advancement of Science. Hydrology and Water Resources in Arizona and the Southwest, 6: 59-67.

Peter Kiewit Sons' Co., 1977. Hydrology report, proposed dragline pit area, Big Horn Mine: unpublished report.

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Rehm, B. W., Groenwold, G. H., and Morin, K. A., 1980. Hydraulic Properties of Coal and Related Materials, Northern Great Plains. Ground Water. Volume 18, Number 6.

Schubert, J. P., 1980. Fracture Flow of Groundwater in Coal-Bearing Strata. Symposium of Surface Mining Hydrology, Sedimentation and Reclamation. University of Kentucky, Lexington, Kentucky 40506.

U. S. Department of Agriculture, Soil Conservation Service, 1969. Computer Program TR20-Users Manual.

U. S. Department of Agriculture, Soil Conservation Service, 1974. Definitions and Abbreviations for Soil Descriptions, West Technical Service Center, Portland, Oregon, pgs. 11-12.

U. S. Department of Commerce NOAA Atlas, 1973. Precipitation - frequency atlas of the Western United States: Atlas 2, Vol. II.

U. S. Department of Commerce NOAA, 1978. Local Climatological Data with annual summary and comparative data. Sheridan, Wyoming Field Station.

U. S. Geological Survey. Techniques of Water Resources Investigations of the U.S.G.S., Chapter A7, pg. 28.

Van Voast, W. A., and Hedges, R. B., 1975. Hydrologic aspects of existing and proposed strip coal mines near Decker, southeastern Montana: Montana Bureau Mines and Geology Bull. 97, 31 p.

Van Voast, W. A., Hedges, R. B., and McDermott, J. J., 1978. Strip caol mining and mined-land reclamation in the hydrologic system, southeastern Montana: Montana Bureau Mines and Geology and Montana College of Mineral Science and Technology. The Old West Regional Commission.

Van Voast, W. A., Thompson, K. S., 1982. Estimations of Post-mining Water Quality for the Tongue River, Montana and Wyoming, Upstream from Tongue River Dam. Montana Bureau of Mines and Geology. Open-file Report MBMG 85.

Walton, W. C., 1962. Selected analytical methods for well and aquifer evaluation: Illinois State Water Survey Bull. 49, 81 p.

Water Resources Research Institute, University of Wyoming, 1977. Baseline Study of Selected parameters: Tongue River and its alluvium: Annual report for Peter Kiewit Sons' Co.

Wyoming Department of Environmental Quality - Land Quality Division, Guideline No. 4 (revised 1978). Water Quality.

Wyoming Department of Environmental Quality - Land Quality Division, Guideline No. 8, (1980) Hydrology.

ADDENDUM D6-1
HYDROLOGIC MONITORING SITES
BIG HORN COAL COMPANY

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DEQ Ex. 3-1159

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BIG HORN MINE WATER WELLS

PITS 1, 2 & 3 WELLS

1 No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH198	1,546,187.8N 594,899.3E	SESWSW S. 14 T57N,R84W	3589.4	Alluvium	29'	4"	9 - 29'	Gravel pkd 0 - TD	Continuous Recorder. 1976-PK
BH204	1,547,086.6N 595,261.5E	SWNESW S. 14 T57N,R84W	3591.9	Lower Monarch	150'	4"	120 - 140'	119'	1976 - PKS Record Monthly Water Level.
BH206	1,546,552.5N 595,212.8E	NWSESW S. 14 T57N,R84W	3586.5	Alluvium	27'	4"	7 - 27'	Gravel pkd 0 - TD	1976 - PKS Record Monthly Water Level.
BH207A	1,547,118.3N 594,737.5E	SENWSW S.14 T57N,R84W	3589.8	Alluvium	25'	5"	5 - 25'	Gravel pkd 0 - TD	Continuous Recorder. Water Quality Testing Spring, Summer and Fall Seasons. 1980 - PKS
BH208	1,547,164.9N 595,321.6E	SWNESW S. 14 T57N,R84W	3592.5	Dietz 3/ Upper Monarch	50'	4"	30 - 50'	29'	Record Monthly Water Level. Water Quality Testing Spr., & Fall Seasons. 1976 - PKS
BH371	1,546,386.2N 585,270.8E	NWSESW S. 16 T57N,R84W	3616.0	Alluvium	20'	5"	15 - 20'	Gravel pkd 0 - TD	Record Qtrly. Water Level. Water Quality Testing Fall Season. 1978 - PKS
BH397	1,546,054.32N 594,917.41E	SESWSW S. 14 T57,R84W	3591.49	Alluvium	30'	5"	8 - 24'	Gravel pkd 0 - TD	Record Monthly Water Level. Water Quality Testing Spr., Summer & Fall Seasons. 1978 - PKS
BH496	1,548,860.6N 596,573.6E	SWSWNE S. 14 T57N,R84W	3687.6	Monarch	278'	5"	245 - 270'	243'	Record Monthly Water Level. Water Quality Testing Spr., Summer, Fall & Winter Seasons. 1979 - PKS
BH506	1,548,106.82N 588,007.12E	NENESE S. 16 T57N,R84W	3604.34	Alluvium	14'	5"	9 - 11.5'	Gravel pkd 0 - TD	Record Qtrly. Water Level. 1979 - PKS
BH507	1,547,695.98N 588,038.09E	SENESE S. 16 T57N,R84W	3603.59	Alluvium	15'	5"	4 - 13'	Gravel pkd 0 - TD	Record Qtrly. Water Level. 1979 - PKS

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BIG HORN MINE WATER WELLS

PITS 1, 2 & 3 WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH508	1,547,466.41N 588,057.32E	SENESE S. 16 T57N,R84W	3605.32	Alluvium	13'	6"	2.5 - 10.5'	Gravel pkd 0 - TD	Record Qtrly. Water Levels Water Quality Testing Fall Season. 1979 - PKS
BH509	1,547,416.13N 588,061.00E	SENESE S. 16 T57N,R84W	3605.98	Alluvium	14'	5"	5 - 11.5'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH510	1,547,392.28N 588,063.53E	SENESE S. 16 T57N,R84W	3606.11	Alluvium	15'	5"	1 - 13'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH511	1,547,456.95N 587,983.46E	SENESE S. 16 T57N,R84W	3605.19	Alluvium	19.5'	5"	2 - 17'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH512	1,547,160.58N 588,077.90E	SENESE S. 16 T57N,R84W	3605.07	Alluvium	16.5'	5"	3.5 - 15'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH513	1,546,566.98N 588,121.57E	NESESE S. 16 T57N,R84W	3611.80	Alluvium	15'	5"	7.5 - 11.5'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH514	1,546,036.53N 585,227.99E	SWSESW S. 16 T57N,R84W	3613.88	Alluvium	18.5'	5"	8.5 - 14'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH515	1,546,011.28N 585,230.57E	SWSESW S. 16 T57N,R84W	3614.97	Alluvium	18'	5"	9 - 14.5'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH516	1,545,955.29N 585,241,24E	SWSESW S. 16 T57N,R84W	3614.53	Alluvium	19'	6"	9 - 15'	Gravel pkd 0 - TD	Record Qtrly. Water Levels, 1979 - PKS
BH517	1,545,951.93N 585,164.47E	SESESW S. 16 T57N,R84W	3614.34	Alluvium	18'	5"	3 - 15'	Gravel pkd 0 - TD	Record Qtrly. Water Levels. 1979 - PKS
BH518	1,545,647.31N 585,283.35E	NWNENW S. 21 T57N,R84W	3611.56	Alluvium	16'	5"	3 - 13'	Gravel pkd 0 - TD	Record Qtrly. Water Levels. 1979 - PKS
BH519	1,545,321.79N 585,321.85E	NWNENW S. 21 T57N,R84W	3611.40	Alluvium	14'	5"	2.5 - 10'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS

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BIG HORN MINE WATER WELLS

PITS 1, 2 & 3 WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH520	1,545,941.09N 594,941.28E	SESWSW S. 14 T57N,R84W	3589.87	Monarch	150'	5"	116 - 141'	110'	Record Monthly Water Levels Water Quality Testing Spri Summer, Fall and Winter Seasons. 1979 - PKS
BH522	1,544,781.60N 585,400.12E	SWNENW S. 21 T57N,R84W	3617.14	Alluvium	18'	5"	3 - 14.5'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH523	1,545,202.37N 588,587.84E	NWNWNW S. 22 T57N,R84W	3607.17	Alluvium	19'	5"	7.5 - 16'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1979 - PKS
BH521	1,545,980.06N 584,689.04E	SWSESW S. 16 T57N,R84W	3615.3	Alluvium	23'	5"	3 - 13'	Gravel pkd 0 - TD	Private Padlock Ranch Well. Not Monitored. 1979 - PKS
BH575	1,549,144.4N 596,918.5E	NWSWNE S. 14 T57N,R84W	3682.6	Dietz 3	190'	5"	162 - 182'	158'	Record Monthly Water Levels 1980 - PKS
BH576	1,548,571.4N 598,465.4E	SWSENE S. 17 T57N,R84W	3607.0	Dietz 3	170'	8"0-20' 5"0-TD	140 - 160'	135'	Record Monthly Water Levels 1980 - PKS
BH582	1,546,358.2N 597,972.3E	SWSESE S. 14 T57N,R84W	3614.6	Dietz 3	200'	8"0-20' 5"0-TD	165 - 185'	163'	Record Monthly Water Levels 1980 - PKS
BH584	1,546,627.9N 598,799.3E	NESESE S. 14 T57N,R84W	3618.7	Monarch	340'	8"0-20' 5"0-TD	303 - 327'	300'	Record Monthly Water Levels 1980 - PKS
BH596	1,546,220.0N 599,038.0E	NENESE S. 14 T57N,R84W	3589.9	Dietz 2	120'	5"	96 - 109'	96'	Record Monthly Water Levels 1980 - PKS
BH597	1,548,911.0N 597,284.0E	SESWNE S. 14 T57N,R84W	3666.5	Carney	440'	8"0-11' 5"0-TD	405 - 425'	404'	Record Monthly Water Levels 1980 - PKS
BH623	1,546,643.62N 600,084.10E	NESWSW S.13 T57N,R84W	3581.0	Alluvium	26'	5"	6 - 26'	Gravel pkd 0 - TD	Continuous Water Level Recorder. 1980 - PKS
BH624	1,546,637.28N 600,028.00E	NESWSW S.13 T57N,R84W	3580.2	Alluvium	25.5'	5"	5.5 - 25.5'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS

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BIG HORN MINE WATER WELLS

PITS 1, 2 & 3 WELLS

ell No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH625	1,546,684.92N 599,966.72E	NESWSW S.13 T57N,R84W	3582.8	Alluvium	26'	5"	6 - 26'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH626	1,546,708,98N 599,896.17E	NESWSW S.13 T57N,R84W	3583.0	Alluvium	26.5'	5"	6.5 - 26.5'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH627	1,546,852.23N 599,503.56E	SWNWSW S.13 T57N,R84W	3583.9	Alluvium	20'	5"	0 - 17.5'	Gravel pkd 0 - TD	Continuous Water Level Recorder. 1980 - PKS
BH628	1,546,929.29N 599,294.52E	SWNWSW S.13 T57N,R84W	3584.3	Alluvium	14'	5"	6 - 14'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH629	1,548,762.05N 599,682.59E	SWSWNW S.13 T57N,R84W	3578.0	Alluvium	17'	5"	5 - 15'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH630	1,548,606.24N 599,231.01E	SWSWNW S.13 T57N,R84W	3578.9	Alluvium	14'	5"	2 - 12'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH631	1,546,123.74N 596,164.75E	SWSWNW S.13 T57N,R84W	3590.2	Alluvium	17'	5"	5 - 15'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH632	1,545,909.54N 597,812.26E	SESWSE S.14 T57N,R84W	3582.8	Alluvium	19'	5"	2 - 19'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH633	1,545,692.76N 597,814.31E	NWNWNE S.23 T57N,R84W	3584.0	Alluvium	25'	5"	2 - 17.5'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH634	1,551,352.21N 596,470.55E	SWSWSE S.11 T57N,R84W	3568.3	Alluvium	27'	5"	5 - 25'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH635	1,551,307.47N 596,260.34E	SESESW S.11 T57N,R84W	3567.9	Alluvium	28'	5"	8 - 28'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH636	1,551,149.37N 596,056.25E	SESESW S.11 T57N,R84W	3565.4	Alluvium	18'	5"	0 - 18'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH637	1,551,129.08E 596,098.87E	SESESW S.11 T57N,R84W	3565.9	Alluvium	18'	5"	0 - 18'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS

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BIG HORN MINE WATER WELLS

PITS 1, 2 & 3 WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH638	1,551,165.97N 596,152.35E	SESESW S.11 T57N,R84W	3569.5	Alluvium	21'	5"	0 - 20'	Gravel pkd 0 - TD	Continuous Water Level Recorder. 1980 - PKS
BH639	1,551,178.63N 596,209.06E	SESESW S.11 T57N,R84W	3569.7	Alluvium	22'	5"	0 - 20'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH640	1,550,595.27N 600,321.75E	NENWNW S.13 T57N,R84W	3576.4	Alluvium	26'	5"	6 - 21'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH641	1,546,477.54N 600,545.39E	SESWSW S.13 T57N,R84W	3580.3	Alluvium	26'	5"	0 - 20'	Gravel pkd 0 - TD	Record Monthly Water Levels 1980 - PKS
BH642	1,546,521,21N 600,419.45E	SESWSW S.13 T57N,R84W	3581.1	Alluvium	25.5'	5"	2 - 22'	Gravel pkd 0 - TD	Record Monthly Water Levels. 1980 - PKS
BH643	1,546,597.72N 600,509.89E	NESWSW S.13 T57N,R84W	3580.6	Coal Z1A	35'	8" 0-21.5' 5" 0-35'	23 - 35'	23'	Record Monthly Water Levels 1980 - PKS
BH644	1,551,155,16N 596,089.28E	SESESW S.11 T57N,R84W	3566.2	Alluvium	16.5'	5"	5 - 15'	Gravel pkd 0 - TD	Record Monthly Water Levels. Water Quality Testing Spring Summer, Fall and Winter Seasons. 1980 - PKS
BH645	1,546,659,67N 600,037.71E	NESWSW S.13 T57N,R84W	3579.7	Alluvium	23'	5"	10 - 20'	Gravel pkd 0 - TD	Record Monthly Water Levels. Water Quality Testing Spring Summer, Fall and Winter Seasons. 1980 - PKS
BH653	1,543,156.9N 592,478.9E	SESWNE S.22 T57N,R84W	3800.5	Spoils	300'	5"	260 - 300'	260'	Record Monthly Water Levels. 1981 - PKS
BH654	1,544,349.2N 592,108.7E	NESWNE S.22 T57N,R84W	3739.7	Spoils	220'	5"	180 - 220'	180'	Record Monthly Water Levels. Water Quality Testing Spring Summer, Fall and Winter Seasons. 1981 - PKS

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BIG HORN MINE WATER WELLS

PITS 1, 2 & 3 WELLS

ell No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH655	1,544,292.9N 592,123.1E	NESWNE S.22 T57N, R84W	3740.6	Spoils	220'	5"	172 - 212'	172'	Continuous Water Level Recorder. 1981 - PKS
BH656	1,544,628.5N 591,351.0E	SWNWNE S.22 T57N, R84W	3653.2	Spoils	110'	5"	70 - 110'	70'	Continuous Water Level Recorder. Water Quality Testing Spring, Summer, Fall, Winter Seasons. 1981 - PKS
BH657	1,549,126.2N 593,083.3E	NWSENE S.15 T57N, R84W	3627.8	Spoils	80'	5"	40 - 80'	40'	Record Monthly Water Levels. Water Quality Testing Spring, Summer, Fall, Winter Seasons. 1981 - PKS
WW P1	1,544,039.83N 590,696.10E	NWSENW S.22 T57N, R84W	3625.98	Spoils	60'	2"	10 - 60'	Gravel pkd 0 - TD	Rejuvinated 1981. Record Monthly Water Levels. 1975 Rahn.
WW P5	1,544,039.57N 590,711.50E	NWSENW S.22 T57N, R84W	3624.72	Spoils	60'	2"	10 - 60'	Gravel pkd 0 - TD	Rejuvinated 1981. Record Monthly Water Levels. 1975 Rahn.
WW P9	1,544,109.96N 590,730.38E	NWSENW S.22 T57N, R84W	3624.03	Spoils	60'	2"	10 - 60'	Gravel pkd 0 - TD	Rejuvinated 1981. Record Monthly Water Levels. 1975 Rahn.
WW 745	1,548,366.2N 592,746.1E	SWSENE S.15 T57N, R84W	3633.27	Spoils	84'	5"	64'-84'	60'	Continuous record. Water Quality testing Spring, Summer, Fall, Winter Seasons 1982 - PKS

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BIG HORN MINE WATER WELLS

PITS 1, 2 & 3 WELLS

ll No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
W 746	1,548,411.3N 592,753.9E	SWSENE S.15 T57N, R84W	3633.97	Spoils	83'	5"	64'-84'	none	Monthly Water Levels. 1982 - PKS
ulvert	1,548,297.0 592,417.0	SESWNE S.15 T57N, R84W	3627.0	Spoils	≥80'	3'	?	none	Monthly Water Levels.

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BIG HORN MINE WATER WELLS

SOUTHEAST EXTENSION WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Data
BH461	1,537,831.7N 595,082.8E	NWNWSW S.26 T57N,R84W	3745.54	Dietz 2C	200'	5"	140 - 160'	135'	Record Monthly Water Level 1979 - PKS
BH462	1,539,335.5N 594,959.8E	SENENE S.27 T57N,R84W	3700.05	Monarch	313'	5"	265 - 305'	252'	Record Monthly Water Level 1979 - PKS
BH462a	1,539,386.4N 595,013.6E	SENENE S.27 T57N,R84W	3703.32	Dietz 3AB& Monarch	314'	5"	265 - 304'	255'	Record Monthly Water Level 1979 - PKS
BH463	1,540,166N 600,622E	SENWNW S.25 T57N,R84W	3698.53	Dietz 1AB	243'	8"	185 - 200' 160 - 165'	183' 158'	Record Monthly Water Level 1979 - PKS
BH463a	1,540,109.6N 600,588.7E	SWNWNW S.25 T57N,R84W	3701.71	Dietz 1AB	210'	5"	158 - 170' 185 - 203'	180' 150'	Record Monthly Water Level 1979 - PKS
BH464	1,538,203.9N 598,070.7E	SWSWNE S.26 T57N,R84W	3781.91	Dietz 1B	220'	5"	163 - 180'	156'	Record Monthly Water Level 1979 - PKS
BH465	1,544,255N 597,922E	NWSENE S.23 T57N,R84W	3635.11	Carney	440'	5"	390 - 422'	390'	Record Monthly Water Level Water Quality Testing Spring & Fall Seasons. 1979 - PKS
BH466a	1,542,252.7N 600,391.7E	NWSW S.24 T57N,R84W	3662.41	Dietz 2BC	320'	5"	286 - 304'	285'	Record Monthly Water Level 1979 - PKS
BH467	1,545,078N 599,659E	SWNWNW S.24 T57N,R84W	3619.09	Monarch	380'	5"	343 - 364'	342'	Record Monthly Water Level Water Quality Testing Spring & Fall Seasons. 1979 - PKS
BH468	1,545,523N 599,689E	NWNWNW S.24 T57N,R84W	3605.58	Dietz 3ABC	290'	5"	230 - 270'	228'	Record Monthly Water Level Water Quality Testing Spring & Fall Seasons. 1979 - PKS

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BIG HORN MINE WATER WELLS

SOUTHEAST EXTENSION WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Data
BH469	1,545,247.5N 600,804.1E	NWNENW S.24 T57N,R84W	3614.87	Dietz 2BC	252.5'	5"	227 - 244'	221'	Record Monthly Water Level. Water Quality Testing Spr., Summer, Fall & Winter Seasons. 1979 - PKS
BH524	1,539,399.34N 590,752.07E	SENWNW S.27 T57N,R84W	3620.07	Alluvium	12'	5"	1.5 - 8'	Gravel pkd 0 - TD	Record Monthly Water Level 1979 - PKS
BH525	1,539,393.33N 591,211.67E	SWNENW S.27 T57N,R84W	3622.19	Alluvium	13'	5"	4 - 8.5'	Gravel pkd 0 - TD	Record Monthly Water Level. 1979 - PKS
BH526	1,539,388.35N 591,680.37E	SWNENW S.27 T57N,R84W	3634.67	Alluvium	23'	5"	15 - 20'	Gravel pkd 0 - TD	Record Monthly Water Level. 1979 - PKS
BH527	1,539,579.30N 592,054.19E	SENENW S.27 T57N,R84W	3640.76	Alluvium	30'	5"	22 - 26'	Gravel pkd 0 - TD	Record Monthly Water Level. 1979 - PKS
BH528	1,539,439.22N 592,941.09E	SWNWNE S.27 T57N,R84W	3654.17	Alluvium	30'	5"	15 - 30'	Gravel pkd 0 - TD	Record Monthly Water Level. 1979 - PKS
BH529	1,539,353.92N 593,739.98E	SENWNE S.27 T57N,R84W	3666.66	Alluvium	28'	5"	11.5 - 25'	Gravel pkd 0 - TD	Record Monthly Water Level 1979 - PKS
BH530	1,539,340.88N 594,293.13E	SWNENE S.27 T57N,R84W	3675.25	Alluvium	25'	5"	11.5 - 18.5'	Gravel pkd 0 - TD	Record Monthly Water Level. 1979 - PKS
BH647	1,542,548.62N 600,603.08E	SWNWSW S.24 T57N,R84W	3673.0	Coal Z2B & Z2C	341'	5"	314 - 334'	312'	Record Monthly Water Level. 1980 - PKS
BH647A	1,542,473.29N 600,577.08E	SWNWSW S.24 T57N,R84W	3676.6	Coal Z2B & Z2C	354'	5"	324 - 344'	322'	Record Monthly Water Level. 1980 - PKS

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RECD 10-25-18 Addendum D6-12-199

BIG HORN MINE WATER WELLS

SOUTHEAST EXTENSION WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH659	1,544,555.82N 603,706.52E	SWNENE S.24 T57N,R84W	3864.90	Monarch	795'	5"	755 - 780'	730'	Record Monthly Water Leve 1981 - PKS
BH660	1,543,574.15N 603,781.15E	SESENE S.24 T57N,R84W	3846.99	Dietz 3	667'	5"	640 - 667'	610'&640'	Record Monthly Water Level 1981 - PKS
BH674	1,546,149.17N 597,189.29E	SESWSE S.14 T57N,R84W	3610.98	Dietz 2	90'	5"	60 - 80'	57', 81' & 87'	Record Monthly Water Level 1981 - PKS
BH675	1,538,391.73N 596,815.57E	SESENW S.26 T57N,R84W	3748.51	Dietz 2	225'	5"	202 - 218'	191' & 211'	Record Monthly Water Level 1981 - PKS
BH686	1,541,554.00N 597,375.87E	NWSWSE S.23 T57N,R84W	3695.92	Dietz 2	150'	5"	127 - 141'	106' & 126'	Record Monthly Water Level 1981 - PKS
BH687	1,543,373.60N 598,875.36E	SESENE S.23 T57N,R84W	3668.68	Dietz 2	210'	5"	186 - 203'	165' & 185'	Record Monthly Water Level 1981 - PKS
BH688	1,542,336.42N 601,425.81E	SENESW S.24 T57N,R84W	3719.05	Dietz 1B	280'	5"	245 - 265'	244', 266' & 278'	Record Monthly Water Level 1981 - PKS

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Brook Mine

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BIG HORN MINE WATER WELLS

PITS 4 & 5 WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH390	1,549,564.60N 589,539.24E	NESWNW S.15 T57N, R84W	3709.68	TRFU	110'	5"	75 - 110'	70' & 75'	Record Monthly Water Level 1979 - PKS
BH391	1,549,187.04N 589,542.39E	NESWNW S.15 T57N, R84W	3681.3	TRFU	97'	5"	41 - 97'	40' & 41'	Record Monthly Water Level 1979 - PKS
BH392	1,551,802.2N 587,358.2E	NWSESE S.9 T57N, R84W	3698.5	TRFU	50'	5"	27 - 50'	Gravel pkd 0 - TD	Record Monthly Water Level Water Quality Testing Spring, Summer and Fall Seasons. 1978 - PKS
BH393	1,551,736.9N 587,286.4E	SWSESE S.9 T57N, R84W	3701.3	TRFU	64.5'	5"	46 - 64.5'	Gravel pkd 0 - TD	Record Monthly Water Level 1978 - PKS
BH394	1,551,686.1N 587,227.7E	SWSESE S.9 T57N, R84W	3701.8	TRFU	38.5'	5"	18.5 - 38.5'	Gravel pkd 0 - TD	Record Monthly Water Level 1978 - PKS
BH395	1,550,086.3N 589,209.3E	SENWNW S.15 T57N, R84W	3666.4	TRFU	60'	5"	42 - 60'	Gravel pkd 0 - TD	Record Monthly Water Level 1978 - PKS
BH396	1,549,950.8N 589,212.5E	SENWNW S.15 T57N, R84W	3671.1	TRFU	60'	5"	42 - 60'	Gravel pkd 0 - TD	Record Monthly Water Level 1978 - PKS
BH429	1,554,326.5N 588,459.8E	NESENE S.9 T57N, R84W	3884.8	Carney	280'	8" 0-60' 5" 0-TD	245 - 265'	244'	Private Padlock Ranch Well 1979 - PKS
BH562	1,554,340.4N 589,325.5E	NESWNW S.10 T57N, R84W	3832.3	Monarch	111'	5"	86 - 106'	84'	Record Monthly Water Level Water Quality Tested Spring and Fall Seasons. 1980 - PKS

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Brook Mine

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BIG HORN MINE WATER WELLS

JENSIK HILL WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH385	1,540,926.6N 586,722.3E	SESWSE S.21 T57N,R84W	3836.0	Dietz 2B	106'	5"	92 - 102'	80' & 90'	Record Monthly Water Levels 1978 - PKS
BH386	1,540,595.5N 587,258.4E	SESWSE S.21 T57N,R84W	3823.3	Dietz 3 & Monarch	285'	5"	228 - 280'	224' & 228'	Record Monthly Water Levels Water Quality Tested In Spring & Fall Seasons. 1978 - PKS
BH387	1,541,350.0N 584,861.1E	NWSESW S.21 T57N,R84W	3910.8	Dietz 2B	189'	5"	177 - 187"	176'	Record Monthly Water Levels 1978 - PKS
BH388	1,541,320.4N 584,966.3E	NWSESW S.21 T57N,R84W	3908.7	Dietz 3 & Monarch	335'	5"	276 - 335'	250' & 274'	Record Monthly Water Levels 1978 - PKS
BH389	1,537,885.4N 587,402.8E	NWNWSE S.28 T57N,R84W	3804.8	Dietz 3C, Dietz 3B & Monarch	300'	5"	210 - 230' 265 - 300'	208', 233' & 263'	Record Monthly Water Levels 1978 - PKS
BH398	1,541,841.0N 590,183.5E	SENWSW S.22 T57N,R84W	3619.8	Alluvium	18.5	5"	1 - 18'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1978 - PKS
BH399	1,541,736.3N 590,281.7E	SENWSW S.22 T57N,R84W	3620.5	Alluvium	16'	5"	0 - 16'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1978 - PKS
BH400	1,541,786.2N 590,282.6E	SENWSW S.22 T57N,R84W	3620.2	Alluvium	16'	5"	5 - 16'	Gravel pkd 0 - TD	Record Qtrly. Water Levels. 1978 - PKS
BH401	1,541,830.7N 590,382.8E	SENWSW S.22 T57N,R84W	3620.0	Alluvium	14'	5"	5 - 14'	Gravel pkd 0 - TD	Record Qtrly. Water Levels 1978 - PKS
BH402	1,541,827.1N 590,482.7E	SENWSW S.22 T57N,R84W	3621.0	Alluvium	15'	5"	2 - 15'	Gravel pkd 0 - TD	Record Qtrly. Water Levels. 1978 - PKS
BH403	1,541,835.9N 590,284.0E	SENWSW S.22 T57N,R84W	3619.2	Alluvium	15'	8"	1 - 14'	Gravel pkd 0 - TD	Record Qtrly. Water Levels. Water Quality Tested Spring Summer & Fall Seasons 1978 - PKS

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BIG HORN MINE WATER WELLS

JERSIK HILL WELLS

Well No.	Location PKS Coord.	Location USGS Coord.	Elev.	Completion Zone	Total Depth	Casing Size	Perforation Zone	Packer Depth	Monitoring/Drilling Date
BH404	1,538,838.1N 590,005.2E	NWSWNW S.27 T57N,R84W	3630.6	Alluvium	16.5'	5"	4 - 16.5'	Gravel pkd 0 - TD	Record Qtrly. Water Level. 1978 - PKS
BH405	1,538,793.0N 590,041.8E	NWSWNW S.27 T57N,R84W	3632.7	Alluvium	18.5'	8"	2 - 15'	Gravel pkd 0 - TD	Record Qtrly. Water Level. 1978 - PKS
BH406	1,538,753.3N 590,074.2E	NWSWNW S.27 T57N,R84W	3631.1	Alluvium	19'	5"	8.5 - 19'	Gravel pkd 0 - TD	Record Qtrly. Water Level. 1978 - PKS
BH407	1,538,715.3N 590,106.3E	NWSWNW S.27 T57N,R84W	3631.2	Alluvium	19'	5"	9 - 19'	Gravel pkd 0 - TD	Record Qtrly. Water Level. 1978 - PKS
BH436	1,529,466.0N 586,014.6E	SWNWNE S.4 T56N,R84W	3697.9	Lower Monarch	420'	5"	313 - 337'	280', 308' & 312'	Unused Woolston Water Well. Record Quarterly Level. 1978 - PKS

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SURFACE WATER MONITORING STATIONS

BIG HORN COAL

Site	Location PKS Coord.	Location USGS Coord.	Elevation	Station Type	Mine or Proposed Mine	Comments
Hidden Water Creek (HWC1)	1,550,144.73N 589,475.78E	bbd S.15 T57N, R84W	3661.29	2 ft.Parshall Flume	Big Horn (Pit 4)	Continuous recorder checked monthly (PKS), water quality testing monthly March-July (PKS), two crest gauges and one sediment sampler are located approx. 200' above flume (PKS).
Tongue River at Monarch (TR1)	1,545,963.76N 584,159.58E	ccd S.16 T57N, R84W	3613.94	4 ft. Culvert gauging station	Big Horn	Strip chart changed bi-annually (PKS) water quality testing Winter, Spring Summer and Fall seasons (PKS), stream gaged occasionally Spring and Summer seasons (PKS), sediment sampled 1-2 times a week at Spring runoff and weekly throughout Summer months (PKS).
Turtle Pond Draw Tributary	1,543,525.03N 598,181.00E	adc S.23 T57N, R84W	3614.8	Static Water Sampler	Big Horn Southeast Extension	Water quality sample obtained during runoff events. Crest gage "D" located 5 ft. downstream. Sediment sampler located 230 ft. downstream. Crest gage "B" located 285 ft. downstream.
Country Nite Club Draw	1,539,505.73N 592,929.69E	abc S.27 T57N, R84W	3640.8	Static Water Sampler	Big Horn Southeast Extension	Water quality sample obtained during runoff events. Crest gage "K" located 5 ft. downstream. Sediment sampler located 87.5 ft. downstream. Crest gage "I" located 190 ft. downstream.

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SURFACE WATER MONITORING STATIONS

BIG HORN COAL

Site	Location PKS Coord.	Location USGS Coord.	Elevation	Station Type	Mine or Proposed Mine	Comments
Goose Creek (GCO)	1,536,889.75N 589,743.45E	cbc S.27 T57N, R84W	3633.81	4 ft. culvert gauging station	Big Horn	Strip chart changed bi-annually (PKS) water quality testing Winter, Spring Summer and Fall seasons (PKS), stream gauged occasionally. Spring and Summer seasons (PKS), sediment sampled 1-2 times a week at Spring runoff and weekly throughout Summer months (PKS).
Water Quality Site GC2		cca S.15 T57N, R84W		Water Quality Testing Site	Big Horn	Water quality testing Winter, Spring Summer and Fall seasons (PKS).
Water Quality Site TR5b	1,546,926.23N 593,930.61E	dda S.15 T57N, R84W	3590.11	Water Quality Testing Site (at 2ft. flume)	Big Horn	Water quality testing Winter, Spring Summer and Fall seasons (PKS), 2 ft. flume is maintained by PKS Chemist (discharge point).
Water Quality Site BH003	1,546,949.04N 593,202.16E	dad S.15 T57N, R84W	3587.99	Water Quality Testing Site at 2ft. flume)	Big Horn	Water quality testing Winter, Spring Summer and Fall seasons (PKS), 2 ft. flume is maintained by PKS chemist (discharge point).
Sediment Sampling Site TRBR (below relocation of channel at Big Horn Mine)	1,546,850.66N 593,853.33E	dda S.15 T57N, R84W	3589.39	Sediment Sampling Collection	Big Horn	Sediment samples collected 1-2 times a week during Spring runoff and weekly throughout Summer months (PKS).

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SURFACE WATER MONITORING STATIONS

BIG HORN COAL

Site	Location PKS Coord.	Location USGS Coord.	Elevation	Station Type	Mine or Proposed Mine	Comments
Pit Five Draw	1,552,936.82N 594,796.01E	dbc S.11 T57N, R84W	3583.1	Crest gage & Static Water Sampler	Big Horn (Pit 5)	A single crest gage with a static water sampler five feet upstream of gage.
Water Quality Site TR2b	1,552,118.08N 595,531.02E	cdb S.11 T57N, R84W	3565.5	4 ft. culvert gaging station	Big Horn	Strip chart changed bi-annually (PKS) water quality testing four seasons (PKS). Stream gaged throughout year (PKS). Sediment sampled 1-2 times a week at Spring runoff and weekly throughout Summer months.
Runoff Plot No. 1	1,544,048.87N 590,434.55E	bdb S.22 T57N, R84W	3654.01	4 ft. x 10.8 ft. rectangular catchment area	Reclaimed Plachek Pit Area	Surface water runoff collected, measured and analyzed for sediment concentration after each event. Water quality tested bi-annually, precip. gage nearby.
Runoff Plot No. 2	1,544,047.77N 590,457.76E	bdb S.22 T57N, R84W	3652.81	4 ft. x 11.1 ft. rectangular catchment area.	Reclaimed Plachek Pit Area	See R.P. No. 1 Comments.
Runoff Plot No. 3	1,544,016.70N 590,488.13E	bdb S.22 T57N, R84W	3645.35	4 ft. x 10.9 ft. rectangular catchment area	Reclaimed Plachek Pit Area	See R.P. No. 1 Comments.

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SURFACE WATER MONITORING STATIONS

BIG HORN COAL

Site	Location PKS Coord.	Location USGS Coord.	Elevation	Station Type	Mine or Proposed Mine	Comments
Runoff Plot No. 4	1,544,022.46N 590,502.19E	bdb S.22 T57N, R84W	3645.69	4 ft. x 11.1 ft. rectangular catchment area	Reclaimed Plachek Pit Area	See R.P. No. 1 Comments.
Runoff Plot No. 5	1,542,095.98N 591,959.64E	cad S.22 T57N, R84W	3696.53	4 ft. x 11.1 ft. rectangular catchment area	Reclaimed Pit One Area	See R.P. No. 1 Comments.
Runoff Plot No. 6	1,542,084.72N 591,978.41E	cad S.22 T57N, R84W	3697.23	4 ft. x 11.0 ft. rectangular catchment area	Reclaimed Pit One Area	See R.P. No. 1 Comments.
Runoff Plot No. 7	1,541,718.07N 592,141.69E	cda S.22 T57N, R84W	3668.55	4 ft. x 11.2 ft. rectangular catchment area	Reclaimed Pit One Area	See R.P. No. 1 Comments.
Runoff Plot No. 8	1,541,711.92N 592,158.71E	cda S.22 T57N, R84W	3669.26	4 ft. x 11.3 ft. rectangular catchment area	Reclaimed Pit One Area	See R.P. No. 1 Comments.
Runoff Plot No. 9	1,544,975.84N 597,374.90E	abd S.23 T57N, R84W	3615.70	4 ft. x 11.2 ft. rectangular catchment area	Undisturbed Pit One Area	See R.P. No. 1 Comments.

D6-206

DEQ Ex. 3-1176

SURFACE WATER MONITORING STATIONS

BIG HORN COAL

Site	Location PKS Coord.	Location USGS Coord.	Elevation	Station Type	Mine or Proposed Mine	Comments
Runoff Plot No. 10	1,544,985.14N 597,377.82E	abd S.23 T57N, R84W	3614.92	4 ft. x 11.2 ft. rectangular catchment area	Undisturbed Pit One Area	See R.P. No. 1 Comments.
Runoff Plot No. 11	1,545,014.53N 597,433.48E	abd S.23 T57N, R84W	3606.09	4 ft. x 11.3 ft. rectangular catchment area	Undistrubed Pit One Area	See R.P. No. 1 Comments.
Runoff Plot No. 12	1,545,028.23N 597,439.18E	abd S.23 T57N, R84W	3604.63	4 ft. x 11.2 ft. rectangular catchment area	Undisturbed Pit One Area	See R.P. No. 1 Comments.

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ADDENDUM D6-2

WATER QUALITY ANALYSIS OF WELLS IN THE DIETZ 2 COAL, DIETZ 3 COAL, MONARCH COAL, CARNEY COAL, ALLUVIAL AND RECLAIMED SPOILS AQUIFERS

D6-208
TFN 6 2/025

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. BH 576 FORMATION Dietz 3 AREA Big Horn - Pit Three

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
15/80	11:15	Bondar Araas	cold snowy	pumped	14.0	8.0	7.52	2120	2500	1510	29.04	81	15	9

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. BH 576 FORMATION Dietz 3 AREA Big Horn - Pit Three

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
584	15	27.31-26.92	1290	1570	0	0	31	2.34	0.17	13	-

D6-208b
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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. BH 576 FORMATION Dietz 3 AREA Big Horn - Pit Three

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	4.96	0.4	<0.005	0.1	0.5	<0.005	<0.02	<0.01	0.06	-	0.02	<0.02

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. BH 576 FORMATION Dietz 3 AREA Big Horn - Pit Three

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<0.02	<0.001	<0.01	<0.005	-	0.04			-	-	-	-	-	

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. BH 596 FORMATION Dietz 2 AREA Big Horn - Pit Three

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
/13/80	1300	Volk Bondar	cool	pumped	14.0	7.9	7.03	2120	1800	1390	36.26	46	8	6

D6-208e

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. BH 596 FORMATION Dietz 2 AREA Big Horn - Pit Three

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
562	9	-0.19	1240	1520	0	0	29	2.33	0.02	5	0.12

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. BH 596 FORMATION Dietz 2 AREA Big Horn - Pit Three

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	3.70	<0.1	<0.005	<0.1	<0.5	<0.005	<0.02	0.02	<0.05	0.32	<0.02	<0.02

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JUN 6 2025
RECD 10-25-18

Scanned, 02/26/2020

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. BH 596 FORMATION Dietz 2 AREA Big Horn - Pit Three

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<0.02	<0.001	0.02	<0.005	-	0.02			-	-	-	-	-	

D6-208h

TFN 6 2/025

REC'D 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 469 FORMATION DZ2 AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
)/22/79	1525	Veenstra Bondar	cool	pump	11.0	7.9	7.44	1920	2300	1180	---	50	8	8
'21/80	1310	Gentry Bondar	warm	pump	17.0	8.1	7.30	1970	2000	1230	---	54	11	7
./5/80	1015	Volk Bondar	cool	pump	12.0	7.8	7.09	1820	1550	1220	---	41	8	5
20/81	1400	Volk Lyden	cold	pump	14.2	8.0	7.60	1910	3000	1120	---	36	6	5
'6/81	0900	Anderson Bondar	warm	pump	13.0	7.6	7.70	1910	880	1170	---	45	8	6
10/81	1430	Jones Anderson	warm	pump	14.0	7.8	7.90	1870	2000	1200	---	36	7	5
/3/81	1403	Jones Anderson	cool	pump	14.0	7.8	8.15	1930	1788	1170	---	44	9	5
'14/82	1400	Jones Anderson	warm	pump	13.0	8.0	6.80	1940	1767	1210	31.40	44	8	5.9
).					11.0	7.8	7.09	1820	880	1120	31.40	36	6	5
.					14.2	8.1	8.15	1970	3000	1230	31.40	54	11	8
n					13.5	7.9	7.50	1919	1911	1188	31.40	44	8	6
).					1.8	.2	.44	.46	607	35	0.00	6	1	1

D6-2209

JAN 6 2025
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October 2018

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 469 FORMATION DZ2 AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
473	8	.23	1020	1250	0	--	40	2.96	.04	2	--
486	8	-.45	1040	1270	0	--	38	2.86	<.01	49	--
492	8	.23	1040	1270	0	--	42	2.78	.01	5	--
480	2	-.39	1040	1270	0	--	40	2.87	<.01	3	--
487	8	.54	1030	1250	0	--	40	3.13	2.56	4	.07
474	10	.39	1030	1260	0	--	39	2.75	.10	3	.08
471	8	.39	1030	1260	0	--	37	.40	<.01	12	--
478	7.4	-.26	1040	1270	0	--	39	3.10	<.01	3.3	.11
471	2	.23	1020	1250	0	--	37	.40	<.01	2	.07
492	10	.54	1040	1270	0	--	42	3.13	2.56	49	.11
480	7	.09	1034	1263	0	--	39	2.61	--	10	.09
8	3	.39	7	9	0	--	2	.90	--	16	.02

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Addendum D6-12-219

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 469 FORMATION DZ2 AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	2.8	<.1	<.005	<.1	<.5	<.005	<.02	<.02	.04	2.53	<.02	<.02
---	---	3.6	<.1	<.005	<.1	<.5	<.005	<.02	<.01	.05	.79	<.02	<.02
---	---	2.95	<.1	<.005	<.1	<.5	<.005	<.02	.05	.08	.33	<.02	.06
---	---	3.41	<.1	<.005	<.1	<.5	<.005	<.02	<.01	.12	.16	<.02	<.02
---	---	3.57	<.1	<.005	<.1	<.5	<.002	<.02	<.01	.73	.73	<.02	<.02
---	---	.08	.1	<.005	<.1	<.5	<.002	<.02	.02	<.05	.08	<.02	<.02
---	---	3.60	<.1	<.005	<.1	.6	<.002	<.02	<.02	.05	2.99	<.02	<.02
---	---	2.72	.2	<.005	.11	<.5	<.002	<.02	<.01	.07	2.43	<.02	<.02
---	---	.08	<.1	<.005	<.1	<.5	<.002	<.02	<.01	.04	.08	<.02	<.02
---	---	3.60	.2	<.005	.11	.6	<.005	<.02	.05	.73	2.99	<.02	.06
---	---	2.84	--	----	---	--	----	---	---	.15	1.26	---	---
---	---	1.17	---	----	---	--	----	---	---	.24	1.19	---	---

D6-211

RECD 10-25-18

Addendum D6-12-220

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 469 FORMATION DZ2 AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
---	<.001	<.01	<.005	---	.06								
<.02	<.001	<.01	<.005	---	<.01								
---	<.001	.03	<.005	---	.44								
<.02	<.001	<.01	<.005	---	.04								
<.02	<.001	<.01	<.005	---	.02								
<.02	<.001	<.01	<.005	---	.13								
<.02	<.001	<.01	<.005	---	<.01								
<.02	.0005	<.01	<.005	---	.07								
<.02	.0005	<.01	<.005	---	<.01								
<.02	<.001	.03	<.005	---	.44								
---	----	---	----	---	---								
---	----	---	----	---	---								

D6-212

RECD 10-25-18 IFR 6 2/025

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 208 FORMATION DZ3 AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
-5-78	1115	Ogle Veenstra	warm	thief	12.0	7.5	-	1820	1850	1510	-	790	121	119
-12-78	1315	Bowlby	cool	thief	12.0	8.1	6.91	1780	1900	1470	-	740	116	109
-3-79	1015	Bondar Bowlby	cool	thief	9.0	8.2	7.75	1890	2000	1560	-	830	125	126
-24-79	1430	Bowlby Bondar Veenstra	cool	pump	14.0	7.5	7.04	1870	2000	1150	-	816	124	123
-21-80	1050	Bondar Gentry	cool	thief	10.0	7.8	6.50	1730	1440	1440	-	678	108	99
1-6-80	1010	Volk Bondar	cool	thief	11.0	7.3	7.03	1550	1250	1250	-	606	86	95
-16-81	1045	Wolf Bondar	cool	thief	11.0	7.5	6.50	1610	1450	1170	-	605	105	84
-11-81	1100	Andersen Jones	cool	thief	10.0	8.0	6.60	1230	1552	1200	-	650	109	92
-11-82	1015	Andersen Jones	warm	theif	10.0	7.4	6.60	1770	1594	1260	2.34	683	110	100
					9.0	7.3	6.50	1230	1440	1150	2.34	605	86	84
					14.0	8.2	7.75	1890	2000	1560	2.34	830	125	126
					11.0	7.7	6.87	1694	1671	1334	2.34	711	112	105
					1.5	.3	.42	207	274	159	-	87	12	15

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Brook Mine

October 2018

Addendum D6-12-223

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 208 FORMATION DZ3 AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
141	18	-.05	303	369	0	-	10	<.01	.7	772	.10
133	22	-.13	253	308	0	-	13	.15	.12	760	.04
153	20	-.43	307	375	0	-	13	.45	1.92	840	.05
142	20	-.39	325	396	0	-	14	.54	.94	789	4.08
154	19	-.31	310	377	0	-	12	.33	.41	695	.15
144	17	-.04	312	381	0	-	10	.28	.16	592	.04
142	17	.32	301	368	0	-	9	.35	.30	581	.24
141	17	.23	299	365	0	-	11	.52	.57	644	-
141	17	.20	304	371	0	-	9.9	.32	.21	675	.06
133	17	-.43	253	308	0	-	9	<.01	.12	581	.04
154	22	.32	325	396	0	-	14	.54	1.92	789	4.08
143	19	.07	302	368	0	-	11	.33	.59	705	.60
6	2	.28	20	24	0	-	2	.17	.57	91	1.41

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 208 FORMATION DZ3 AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	3.9	<.1	<.005	-	<.5	<.005	<.02	<.01	.43	.89	<.02	.13
-	-	1.39	.1	<.005	.1	<.5	<.005	<.02	.02	.58	.64	<.02	.13
-	-	<.10	<.1	<.005	.2	<.5	<.005	<.02	.02	.05	.60	<.02	.02
-	-	2.87	.3	<.005	.4	<.5	<.005	<.02	<.02	.11	218.00	<.02	.18
-	-	.77	<.1	<.005	.1	<.5	<.005	<.02	<.01	<.05	.57	<.02	.04
-	-	1.62	<.1	<.005	.1	<.5	<.005	<.02	<.02	.18	.18	<.02	.08
-	-	.82	<.1	<.005	<.1	<.5	<.002	<.02	.01	<.05	5.67	<.02	<.02
-	-	1.22	<.1	<.005	<.1	<.5	<.002	<.02	.02	.14	3.59	<.02	.13
-	-	.49	<.1	<.005	.15	<.5	<.002	<.02	<.01	<.05	1.27	<.02	<.07
		.10	<.1	<.005	<.1	<.5	<.002	<.02	<.01	<.05	.18	<.02	<.02
		2.87	.3	.005	.4	.5	.005	.02	.02	.58	218.00	.02	.18
		1.46	--	----	--	--	----	---	---	---	25.71	---	.09
		1.21	--	----	--	--	----	---	---	---	22.13	---	.06

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 208 FORMATION DZ3 AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
-	<.001	<.01	<.005	-	<.01								
-	<.001	.02	<.005	-	<.01								
-	<.001	<.01	<.005	-	.17								
-	<.001	<.01	<.005	-	.02								
<.02	<.001	<.01	<.005	-	.04								
<.02	<.001	.02	<.005	-	.02								
<.02	<.001	<.01	<.005	-	.09								
<.02	<.001	<.01	<.005	-	.07								
<.02	<.0002	<.01	<.005	-	.02								
<.02	<.0002	<.01	<.005	-	<.01								
<.02	<.001	.02	<.005	-	.17								
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October 2018

TFN 9 2/025

RECD 10-25-18

Addendum D6-12-225

Brook Mine

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 468 FORMATION DZ3 AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
-22-79	1210	Bowlby Veenstra Bondar	cool	pump	14.0	7.7	7.21	1470	1650	934	-	41	7	5
15-80	1600	Bondar Gentry	cool	pump	16.0	7.8	7.24	1850	1640	1110	-	38	8	5
6-80	1040	Volk Bondar	cool	pump	13.0	7.9	7.12	1820	1600	1120	-	32	7	4
20-81	1300	Volk Lyden	cold	pump	8.5	7.8	7.80	1790	2200	1070	-	36	7	4
21-81	0900	Lyden Andersen	cool	pump	12.0	7.6	7.1	1790	1450	1110	-	33	7	4
-3-81	1235	Andersen Jones	cool	pump	14.0	7.5	7.9	1680	1469	984	-	44	9	5
-14-82	1215	Andersen Jones	warm	pump	14.0	7.6	6.7	1760	1635	1080	31.30	37	8.1	4.1
).					3.5	7.5	6.7	1470	1450	934	31.30	32	7	4
<.					16.0	7.9	7.9	1850	2200	1120	31.30	44	9	5
an					13.1	7.7	7.3	1737	1663	1058	31.30	37	8	4
).					2.4	.1	.4	129	251	72	0	4	1	1

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 468 FORMATION DZ3 AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
378	8	.28	796	971	0	-	32	1.54	.03	18	.07
450	10	-.24	984	1200	0	-	39	1.71	<.01	2	.16
455	9	-.06	983	1200	0	-	39	1.57	.01	<1	.08
458	<1	.11	970	1180	0	-	38	1.73	<.01	3	.11
454	9	-.31	991	1210	0	-	37	1.90	.02	<1	.04
411	8	0.00	896	1090	0	-	34	.62	<.01	2	-
438	7.8	-.11	935	1160	0	-	36	1.76	<.01	2.1	.08
378	<1	-.24	796	971	0	-	32	.62	<.01	<1	.04
458	10	.28	991	1210	0	-	39	1.90	.03	18	.16
435	8	-.05	936	1144	0	-	36	1.55	--	--	.09
30	3	.20	71	87	0	-	3	.43	--	--	.04

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RECD 10-25-18

RAMACO

Brook Mine

October 2018

Addendum D6-12-228

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 468 FORMATION DZ3 AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	3.40	<.1	<.005	.1	<.5	<.005	<.02	<.02	.16	.36	<.02	<.02
-	-	3.88	.3	<.005	< .1	.6	<.005	<.02	.01	.19	.39	<.02	<.02
-	-	3.80	<.1	<.005	< .1	<.5	<.005	<.02	.04	<.05	.22	<.02	<.02
-	-	3.90	<.1	<.005	< .1	.5	<.005	<.02	<.01	.22	.22	<.02	<.02
-	-	3.31	0	<.005	< .1	<.5	<.002	<.02	<.01	.18	1.13	<.02	<.02
-	-	2.50	<.1	<.005	< .1	.6	<.002	<.02	<.01	.24	.26	<.02	<.02
-	-	3.18	<.1	<.005	.14	<.5	<.002	<.02	<.01	.16	.22	<.02	<.02
-	-	2.50	<.1	<.005	<.1	<.5	<.002	<.02	<.01	<.05	.22	<.02	<.02
-	-	3.90	.3	<.005	.14	.6	<.005	<.02	.04	.24	1.13	<.02	<.02
-	-	3.42	--	----	---	--	----	---	---	.17	.40	---	---
-	-	.50	--	----	---	--	----	---	---	.06	[illegible]	--	---

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 468 FORMATION DZ3 AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
-	<.001	<.01	<.005	-	.02								
<.02	<.001	<.01	<.005	-	.01								
<.02	<.001	.02	<.005	-	.05								
<.02	<.001	<.01	<.005	-	.02								
<.02	<.001	<.01	<.005	-	.08								
<.02	<.001	<.01	<.005	-	.04								
<.02	<.0002	<.01	<.005	-	.17								
<.02	<.002	<.01	<.005	-	.01								
<.02	<.001	.02	<.005	-	.17								
---	----	---	----	-	.06								
---	----	---	----	-	.06								

TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 467 FORMATION Monarch AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
1-22-79	1430	Bowlby Bondar	cool	pump	12.0	7.8	7.09	1750	2050	1080	---	56	12	6
26-80	1300	Araas Bondar	cold	pump	10.0	7.5	7.59	1900	2200	1120	---	52	12	5
21-80	1200	Gentry Bondar	warm	pump	12.0	8.1	6.90	1740	1720	1060	---	52	12	5
25-80	1055	Volk Bondar	cool	pump	13.0	7.7	7.17	1600	1320	986	---	46	10	5
20-81	1130	Volk Lyden	cold	pump	13.5	7.7	7.36	1610	1850	986	---	48	11	5
21-81	1130	Anderson Lyden	cool	pump	12.0	7.5	7.30	1590	1375	958	---	49	12	5
-3-81	1115	Jones Anderson	cool	pump	16.0	7.4	7.06	1850	1827	1100	---	59	13	6
25-82	1415	Jones Andersen	warm	pump	16.0	7.7	7.36	1970	1766	1120	27.40	54	14	4.4
.					10.0	7.4	6.90	1590	1322	958	27.40	46	10	4.4
.					16.0	8.1	7.59	1970	2200	1120	27.40	59	14	6
n					13.1	7.7	7.23	1751	1764	1051	27.40	52	12	5
.					2.1	.2	.22	146	301	65	0.00	4	1	1

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JAN 8 2025

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 467 FORMATION Monarch AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
432	10	.37	941	1150	0	------	31	1.21	.03	3	.12
428	11	-.18	960	1170	0	------	31	1.50	.06	2	---
410	9	0.0	905	1100	0	------	34	1.27	<.01	2	.12
395	9	-.04	870	1060	0	------	32	1.16	.01	2	.08
405	4	-.04	888	1080	0	------	32	1.37	<.01	2	.03
394	10	-.19	878	1070	0	------	31	1.43	<.01	1	.04
446	11	.43	1020	1240	0	------	33	.18	<.01	<1	---
464	10	.06	1020	1250	0	------	34	1.11	<.01	2.1	.05
394	4	-.19	870	1060	0	------	31	1.11	<.01	<1	.03
464	11	.43	1020	1250	0	------	34	1.50	.06	3	.12
422	9	.05	935	1140	0	------	32	1.15	-	2	.07
25	2	.23	61	75	0	------	1	.42	-	1	.04

RECD 10-25-18
IFN 8 2/025

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 467 FORMATION Monarch AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	4.2	<.1	<.005	.1	<.5	<.005	<.02	<.02	.06	1.36	<.02	<.02
---	---	4.04	<.1	<.005	.2	<.5	<.002	<.02	<.01	.21	----	<.02	<.02
---	---	4.1	<.1	<.005	.1	.6	<.005	<.02	<.01	<.05	.13	<.02	.02
---	---	3.63	<.1	<.005	.1	<.5	<.005	<.02	.02	<.05	.26	<.02	.03
---	---	4.23	<.1	<.005	< .1	.6	<.005	<.02	<.01	.65	1.08	<.02	<.02
---	---	3.52	<.1	<.005	.2	.6	<.002	<.02	<.01	.74	.77	<.02	.03
---	---	2.34	<.1	<.005	< .1	.8	<.002	<.02	<.01	<.05	<.05	<.02	<.02
---	---	2.30	<.1	<.005	.08	<.5	<.002	<.02	<.01	.37	.89	<.02	<.02
---	---	2.30	<.1	<.005	.08	<.5	<.002	<.02	<.01	<.05	<.05	<.02	<.02
---	---	4.23	<.1	<.005	.2	.8	<.005	<.02	.02	.74	1.36	<.02	.03
---	---	3.55	--	----	---	--	----	---	---	---	.65	---	---
---	---	.80	--	----	---	--	----	---	---	---	.51	---	---

TEN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 467 FORMATION Monarch AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
---	<.001	<.01	<.005	---	.01								
---	<.001	<.01	<.005	---	.01								
<.02	<.001	<.01	<.005	---	.07								
<.02	<.001	.02	<.005	---	.04								
---	<.001	<.01	<.005	---	.03								
<.02	<.001	<.01	<.005	---	.05								
<.02	<.001	<.01	<.005	---	.07								
<.02	<.0002	<.01	<.005	---	.09								
<.02	<.0002	<.01	<.005	---	.01								
<.02	<.001	.02	<.005	---	.09								
---	-----	---	----	---	.05								
---	-----	---	----	---	.03								

D6-224

TFN 6 2/025

RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 496 FORMATION Monarch AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
-9-79	1101	Bowlby Bondar	cool	pump	15.0	7.7	7.69	1410	1400	896	-	36	8	4
3-80	1315	Araas Bondar	cool	pump	15.0	7.3	6.60	1420	1500	898	-	33	6	5
14-80	1150	Gentry Bondar	cool	pump	10.0	7.8	7.29	1450	1800	932	-	34	8	3
5-80	1125	Volk Bondar	warm	pump	16.0	7.8	7.17	1500	1470	938	-	35	7	4
16-81	1230	Volk Bondar	cold	pump	17.0	7.8	7.45	1570	1400	980	-	86	13	13
29-81	1430	Lyden Andersen	cool	thief	14.0	7.8	7.30	1530	1350	916	-	46	9	6
29-81	0928	Jones Andersen	warm	pump	14.0	7.7	7.1	1560	1680	970	-	47	13	4
-10-81	1100	Bondar Andersen	cold	pump	16.0	7.7	6.9	1470	1100	870	-	94	9	18
-14-82	1545	Jones Andersen	warm	pump	14.0	7.7	6.95	1580	1379	924	27.10	36	7.9	4
n.					10.0	7.3	6.6	1410	1100	870	27.10	33	6	4
x.					17.0	7.8	7.69	1570	1800	980	27.10	94	13	18
an					11.2	5.4	7.16	1499	1453	925	27.10	50	9	7
D.					5.3	3.5	.32	65	200	35	0	24	2	5

RECEIVED DEQ Water Quality Div. DIST. IV

October 2018 Addendum D6-12-234 Brook Mine

D6-225 JAN 6 2025 RECD 10-25-18

DEQ Ex. 3-1203

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 496 FORMATION Monarch AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
358	9	.23	794	969	0	-	14	1.43	.02	2	1.03
360	10	.21	800	977	0	-	12	1.62	.05	1	-
370	11	.13	827	1010	0	-	13	1.45	.01	<1	.16
374	10	-.15	846	1030	0	-	15	1.44	.01	1	.10
369	10	-.22	844	1030	0	-	13	.14	.04	4	.13
382	10	-.04	869	1060	0	-	14	1.56	<.01	<1	.07
394	14	.26	882	1080	0	-	16	1.73	5.72	7	-
348	10	.33	825	1010	0	-	13	1.58	.05	<1	-
373	8.6	-.23	849	1040	0	-	12	1.56	<.01	2.9	.09
348	8.6	-.23	794	969	0	-	12	.14	<.01	<1	.07
394	14	.26	882	1080	0	-	16	1.73	5.72	7	1.03
370	10	.06	837	1023	0	-	14	1.39	--	-	.26
14	2	.22	29	36	0	-	1	.48	--	-	.38

TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 496 FORMATION Monarch AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	.9	<.1	<.005	.1	<.5	<.005	<.02	<.01	<.05	.83	<.02	<.02
-	-	4.08	<.1	<.005	.1	<.5	<.002	<.02	<.01	.12	-	<.02	<.02
-	-	4.17	<.1	<.005	<.1	<.5	<.005	<.02	.02	.08	.15	<.02	<.02
-	-	3.97	<.1	<.005	<.1	<.5	<.005	<.02	.03	<.05	.07	<.02	<.02
-	-	5.08	<.1	<.005	.1	<.5	<.005	<.02	<.01	<.05	.24	<.02	.03
-	-	3.28	<.1	<.005	<.1	<.5	<.002	<.02	<.01	<.05	.57	<.02	<.02
-	-	4.42	<.1	<.005	<.1	.6	<.002	<.02	<.01	.07	.09	<.02	.03
-	-	4.18	<.1	<.005	<.1	<.5	<.002	<.02	<.01	<.05	-	<.02	<.02
-	-	3.72	<.1	<.005	.14	<.5	<.002	<.02	<.01	.09	.14	<.02	<.02
-	-	.9	<.1	<.005	<.1	<.5	<.002	<.02	<.01	<.05	.07	<.02	<.02
-	-	5.08	<.1	<.005	.14	<.5	<.005	<.02	.03	.12	.83	<.02	.03
-	-	3.76	--	----	---	--	----	---	---	---	.30	---	---
-	-	1.18	--	----	---	--	----	---	---	---	.29	---	---

RECD 10-25-18 IFN 6 2/025

Scanned, 02/26/2020

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 496 FORMATION Monarch AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
-	<.001	.01	<.005	-	.04								
-	<.001	<.01	<.005	-	.01								
<.02	<.001	<.01	<.005	-	.02								
<.02	<.001	.02	<.005	-	.05								
<.02	<.001	.01	<.005	-	.10								
<.02	<.001	<.01	<.005	-	.02								
<.02	<.001	<.01	<.005	-	.29								
<.02	<.001	<.01	<.005	-	.04								
<.02	<.0002	<.01	<.005	-	.06								
<.02	<.0002	<.01	<.005	-	.01								
<.02	<.001	.02	<.005	-	.29								
---	-----	---	----	-	.07								
---	-----	---	----	-	.09								

TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 520 FORMATION Mn AREA Big Horn

PARAMETERS

ATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
8/81	1220	Volk Bondar	cold	thief	9.0	8.2	7.50	1440	1580	870	---	50	10	6
6/81	1230	Volk Bondar	cool	pump	14.0	7.8	7.15	1580	1410	1020	---	50	12	5
3/81	1410	Wolf Bondar	warm	pump	12.0	8.0	8.40	1690	2000	1030	---	53	14	4
/81	1540	Jones Andersen	cold	pump	13.0	7.9	6.7	1620	1571	1060	---	50	12	5
25/82	1115	Jones Andersen	warm	pump	12.0	7.7	7.1	1720	1509	986	21.70	51	14	3.7
in.					9.0	7.7	6.7	1440	1410	870	21.70	50	10	3.7
ax.					14.0	8.0	8.40	1720	2000	1060	21.70	53	14	6
ean					12.0	7.9	7.4	1610	1614	993	21.70	51	12	5
D.					1.9	.2	.6	110	226	74	0.00	1	2	1

D6-229

RECD 10-25-18 TEN 9 2/025

DEQ Ex. 3-1207

Scanned, 02/26/2020

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 520 FORMATION Mn AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
337	9	-.26	631	770	0	---	7	1.80	.12	156	.11
354	10	-.31	568	693	0	---	6	1.40	.01	257	.08
378	19	.31	479	584	0	---	9	1.00	4.73	388	---
379	12	.33	522	636	0	---	10	2.13	.89	348	---
354	8.5	-.20	541	660	0	---	9.5	1.42	.03	275	.04
337	8.5	-.31	479	584	0	---	6	1.00	.01	156	.04
379	19	.33	631	770	0	---	10	2.13	4.73	388	.11
360	12	-.03	548	669	0	---	8	1.55	1.16	285	.08
18	4	.32	57	69	0	---	2	.43	2.03	90	.04

D6L230

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1208

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 520 FORMATION Mn AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	3.56	<.1	<.005	<.1	<.5	<.005	<.02	<.01	<.05	.23	<.02	<.02
---	---	3.21	<.1	<.005	.1	<.5	<.002	<.02	.01	<.05	2.09	<.02	<.02
---	---	2.88	<.1	<.005	<.1	<.5	<.002	<.02	.04	.16	.51	<.02	<.02
---	---	3.63	<.1	<.005	.1	<.5	<.002	<.02	<.01	<.05	< .05	<.02	<.02
---	---	2.49	<.1	<.005	.06	<.5	<.002	<.02	<.01	<.05	.21	<.02	<.02
---	---	2.49	<.1	<.005	.06	<.5	<.002	<.02	<.01	<.05	.05	<.02	<.02
---	---	3.63	<.1	<.005	.01	<.5	<.005	<.02	.04	.16	2.09	<.02	<.02
---	---	3.15	--	----	---	--	----	---	---	---	.62	---	---
---	---	.48	--	----	---	--	----	---	---	---	.84	---	---

D6L731

RECD 10-25-18 FEB 6 2/025

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 520 FORMATION Mn AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.001	<.01	<.005	---	.03								
<.02	<.001	<.01	<.005	---	.02								
<.02	<.001	.01	<.005	---	.05								
<.02	<.001	.01	<.005	---	.08								
<.02	<.0002	<.01	<.005	---	.07								
<.02	<.0002	<.01	<.005	---	.02								
<.02	<.001	.01	<.005	---	.08								
---	-----	---	----	---	---								
---	-----	---	----	---	---								

D6-12-241

TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 465 FORMATION Carney AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
)-12-79	0930	Collier Araas	warm	thief	12.0	7.9	8.4	1620	1408	1060	-	82	18	9
)-18-79	1030	Veenstra Bondar	warm	pump	17.0	7.8	5.8	1470	1600	950	-	48	10	6
)-15-80	1430	Bondar Gentry	cool	pump	18.0	7.8	7.15	1590	1490	988	-	50	10	6
-5-80	1350	Volk Bondar	cool	pump	17.0	7.7	7.41	1560	1580	966	-	46	10	5
.-21-81	1050	Volk Lyden	cold	pump	15.5	7.8	7.35	1560	1580	932	-	49	9	6
)-20-81	1230	Lyden Andersen	cool	pump	12.0	7.7	6.70	1550	1525	956	-	48	9	6
1-4-81	1010	Jones Andersen	cool	pump	13.0	7.7	7.02	1570	1636	782	-	67	11	10
5-24-82	1500	Jones Andersen	warm	pump	12.0	7.9	7.40	1590	1609	958	24.40	49	10	5.8
Min.					12.0	7.7	5.8	1470	1408	782	24.40	46	9	5
Max.					18.0	7.9	8.4	1620	1636	1060	24.40	82	18	10
Mean					14.6	7.8	7.15	1564	1554	949	24.40	55	11	7
S.D.					2.6	.1	.73	44	75	78	0.00	13	3	2

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RECD 10-25-18

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 465 FORMATION Carney AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
400	12	-.19	910	1100	0	-	25	1.71	.46	25	-
382	10	.09	832	1020	0	-	30	1.68	.03	12	.62
390	10	-.10	871	1060	0	-	23	1.78	<.01	13	.16
382	10	.03	835	1020	0	-	26	1.51	.01	16	.08
387	3	.05	838	1020	0	-	27	1.73	<.01	16	.11
394	9	.38	840	1020	0	-	25	1.83	.01	15	.05
370	9	.32	840	1030	0	-	28	1.68	<.01	14	-
390	9.5	-.15	865	1060	0	-	25	1.74	.23	16	.06
370	3	-.19	832	1020	0	-	23	1.51	<.01	12	.05
400	12	.38	910	1100	0	-	30	1.83	.46	25	.62
387	7	.05	854	1041	0	-	26	1.71	-	16	.18
9	5	.21	27	29	0	-	2	.09	-	4	.22

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TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 465 FORMATION Carney AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	3.03	.2	<.005	.2	<.5	<.005	<.02	<.01	.1	-	<.02	.03
-	-	3.68	<.1	<.005	.2	<.5	<.005	<.02	<.02	<.05	8.59	<.02	<.02
-	-	3.52	<.1	<.005	.1	<.5	<.005	<.02	.03	.13	.40	.02	<.02
-	-	3.21	<.1	<.005	.1	<.5	<.005	<.02	.03	<.05	.08	<.02	<.02
-	-	3.49	<.1	<.005	<.1	<.5	<.005	<.02	<.01	.15	.15	<.02	<.02
-	-	3.24	<.1	<.005	.1	<.1	<.002	<.02	<.01	.15	.20	<.02	<.02
-	-	3.17	<.1	<.005	.1	.6	<.002	<.02	<.01	.20	.21	<.02	<.02
-	-	1.74	<.1	<.005	.08	<.5	<.002	<.02	<.01	.21	.21	<.02	<.02
-	-	1.74	<.1	<.005	.08	<.1	<.002	<.02	<.01	<.05	.08	<.02	<.02
-	-	3.68	.2	<.005	.2	.6	<.005	<.02	.03	.21	8.59	.02	.03
-	-	3.14	--	----	.1	--	----	---	---	---	1.66	---	---
-	-	.60	--	----	.1	--	----	---	---	---	3.13	---	---

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RECD 10-25-18

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 465 FORMATION Carney AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
-	<.001	<.01	<.005	-	1.89								
-	<.001	<.01	<.005	-	.01								
<.02	<.001	<.01	<.005	-	.01								
<.02	<.001	.02	<.005	-	.05								
<.02	<.001	<.01	<.005	-	.01								
<.02	<.001	<.01	<.005	-	.02								
<.02	<.001	<.01	<.005	-	.05								
<.02	<.0002	<.01	<.005	-	.06								
<.02	<.0002	<.01	<.005	-	.01								
<.02	<.001	.02	<.005	-	1.89								
---	-----	---	----	-									
---	-----	---	----	-									

RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 371 FORMATION Qal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
24/79	---	Bondar Bowlby	---	pump	---	8.1	---	3740	---	3142	---	1293	171	210
22/79	1129	Bowlby Araas	warm cloudy	pump	18.0	7.5	6.7	2810	2600	2150	---	1160	162	185
23/79	1410	Bowlby Bondar	cool	pump	15.0	7.7	7.6	2120	3000	1650	---	949	136	148
23/80	1345	Bondar Gentry	---	pump	10.0	7.6	6.9	1710	1800	1180	---	657	98	100
22/80	1100	Bondar Lyden	---	pump	16.5	7.6	7.1	1550	1600	1080	---	656	93	103
30/80	1220	Volk Bondar	---	pump	12.5	7.6	7.5	1410	1220	1030	---	637	99	103
15/81	1330	Bondar Volk	---	pump	10.1	7.3	7.0	1211	1100	772	---	540	65	92
13/81	1000	Bondar Lyden	---	pump	12.0	7.6	7.4	1060	1125	652	---	481	61	81
05/81	1415	Andersen Jones	---	pump	14.0	7.4	7.0	1160	1054	736	---	531	112	61
n.					10.1	7.3	6.7	1060	1054	652	---	481	61	61
ix.					18.0	8.1	7.5	3740	3000	3142	---	1293	171	210
ean					13.5	7.6	7.2	1863	1687	1377	---	767	111	120
D.					2.9	.2	.3	893	742	817	---	295	39	50

DEQ Ex. 3-1215

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 371 FORMATION Qal AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
488	15	0.43	550	671	0	---	205	0.83	11.90	1453	0.40
267	10	0.58	561	684	0	---	149	0.46	1.17	914	0.36
183	8	-0.51	545	665	0	---	84	0.39	1.72	684	0.21
141	6	-0.01	459	560	0	---	45	0.39	0.05	432	0.01
120	6	-0.20	468	571	0	---	34	0.42	0.05	401	0.02
99	<1	-0.19	458	559	0	---	24	0.29	0.18	353	0.14
84	6	0.18	420	512	0	---	19	0.47	0.18	261	0.04
89	4	0.28	410	500	0	---	15	0.44	0.18	226	---
70	6	0.12	402	491	0	---	16	0.79	<0.01	259	---
70	<1	-0.51	402	491	0	---	15	.29	<.01	226	.01
488	15	.58	561	684	0	---	205	.83	11.9	1453	.40
171	---	.08	475	579	0	---	66	.50	---	554	.17
134	---	.34	62	76	0	---	68	.19	---	405	.16

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DEQ Ex. 3-1216

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 371 FORMATION Oal AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	0.56	0.50	<0.005	0.40	<0.50	<0.005	<0.02	0.03	<0.05	607	<0.02	1.13
---	---	<0.01	0.40	<0.005	0.20	<0.50	<0.005	<0.02	<0.01	0.08	12.6	<0.02	0.78
---	---	0.20	0.30	<0.005	0.20	<0.50	<0.005	<0.02	<0.02	0.06	6.07	<0.02	0.67
---	---	0.17	<0.10	<0.005	0.10	<0.50	<0.005	<0.02	<0.01	0.12	10.1	<0.02	0.61
---	---	0.27	<0.10	<0.005	0.20	<0.50	<0.005	<0.02	<0.01	0.11	0.93	<0.02	0.56
---	---	0.28	<0.10	<0.005	0.20	<0.50	<0.005	<0.02	0.03	0.09	1.37	<0.02	0.55
---	---	0.14	<0.10	<0.005	0.20	<0.50	<0.002	<0.02	<0.01	0.10	2.37	<0.02	0.41
---	---	0.02	0.20	<0.005	<0.10	<0.50	<0.002	<0.02	0.02	0.16	0.22	<0.02	<0.02
---	---	0.18	<0.10	<0.005	0.20	<0.50	<0.002	<0.02	<0.01	0.15	0.74	<0.02	0.54
---	---	<.01	<.10	<.005	<.10	<.50	<.002	<.02	<.01	<.05	0.22	<.02	<.02
---	---	.56	.50	<.005	.40	<.50	<.005	<.02	.03	.16	607	<.02	1.13
---	---	---	---	----	---	---	----	---	---	---	71.3	---	---
---	---	---	---	----	---	---	----	---	---	---	201.0	---	---

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 371 FORMATION Qal AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
---	<0.002	0.05	<0.005	---	0.11								
---	<0.001	0.01	<0.005	---	0.14								
---	<0.001	<0.01	<0.005	---	0.04								
<0.02	<0.001	<0.01	<0.005	---	0.02								
<0.02	<0.001	<0.01	<0.005	---	0.06								
<0.02	<0.001	0.02	<0.005	---	0.04								
<0.02	<0.001	<0.01	<0.005	---	0.05								
<0.02	<0.001	<0.01	<0.005	---	0.06								
<0.02	<0.001	<0.01	<0.005	---	0.30								
<.02	<.001	<.01	<.005	---	.02								
<.02	<.002	.05	<.005	---	.30								
---	----	---	----	---	.09								
---	----	---	----	---	.09								

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 508 FORMATION Qal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
'22/79	1230	Bowlby Araas	Warm P.C.	pump	12.0	7.8	8.2	490	530	238	---	230	58	21
'23/79	1500	Bowlby Veenstra Bondar	Cool	pump	15.0	7.5	7.3	490	540	300	---	237	58	22
'13/80	1315	Bondar Gentry	---	pump	11.0	7.7	6.5	520	540	316	---	243	60	22
'22/80	1040	Bondar Gentry Lyden	---	pump	17.0	7.8	7.3	437	400	246	---	206	50	20
'30/80	1145	Volk Bondar	---	pump	14.0	7.8	7.0	476	400	314	0.39	236	63	19
18/81	1100	Volk Bondar	---	bailed	8.0	7.9	7.4	456	470	284	---	214	51	21
'15/81	1430	Lyden Andersen	P.C. Warm	pump	9.9	7.6	7.5	460	395	266	---	226	43	29
13/81	1100	Lyden	Cool	pump	13.0	7.8	7.2	439	510	240	---	218	53	21
'05/81	1500	Andersen Jones	Cold	pump	14.5	7.5	7.1	459	442	288	---	210	72	7
n.					8.0	7.5	6.5	437	395	238	.39	206	43	7
x.					17.0	7.9	8.2	520	540	316	.39	243	72	29
an					12.7	7.7	7.3	470	470	277	.39	224	56	20
D.					2.8	.2	.5	27	62	31	---	13	8	6

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 508 FORMATION Qal AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
15	2	0.10	214	260	0	---	1	0.20	0.01	44	0.04
15	2	0.07	202	246	0	---	2	0.19	0.02	61	0.02
16	1	0.14	190	231	0	---	2	0.17	0.01	76	0.01
13	2	-0.10	200	245	0	---	1	0.20	0.01	37	0.01
14	<1	<0.01	201	245	0	---	1	0.13	0.03	61	0.11
13	3	-0.06	176	215	0	---	2	0.25	0.04	67	0.04
13	2	0.08	175	213	0	---	2	0.21	0.06	71	0.02
20	4	0.01	218	265	0	---	<1.0	0.18	0.17	46	---
12	2	0.05	198	242	0	---	2	0.40	0.21	38	---
12	<1	-.10	175	213	0	---	<1	.13	.01	37	.01
20	4	.14	218	265	0	---	2	.40	.21	76	.11
15	---	---	197	240	0	---	---	.21	.06	56	.04
2	---	---	15	18	0	---	---	.08	.07	15	.04

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 508 FORMATION Qal AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	<0.01	<0.10	<0.005	<0.1	<0.50	<0.005	<0.02	<0.01	1.03	1.03	<0.02	0.41
---	---	<0.10	<0.10	<0.005	<0.1	<0.50	<0.005	<0.02	<0.02	1.37	1.45	<0.02	0.40
---	---	<0.05	0.1	<0.005	<0.1	<0.50	<0.005	<0.02	<0.01	1.31	1.96	<0.02	0.41
---	---	0.14	0.1	<0.005	<0.1	<0.50	<0.005	<0.02	<0.01	<0.05	2.33	<0.02	0.34
---	---	0.06	<0.1	<0.005	<0.1	<0.50	<0.005	<0.02	0.02	0.48	1.53	<0.02	0.36
---	---	0.11	<0.1	<0.005	<0.1	<0.50	<0.005	<0.02	0.02	<0.05	22.90	<0.02	0.37
---	---	0.13	<0.1	<0.005	<0.1	<0.50	<0.002	<0.02	<0.01	0.76	2.87	<0.02	0.41
---	---	<0.01	<0.1	<0.005	0.2	<0.50	<0.002	<0.02	0.01	1.19	1.45	<0.02	0.72
---	---	0.21	<0.1	<0.005	<0.1	<0.50	<0.002	<0.02	<0.01	<0.05	1.49	<0.02	0.79
---	---	<.01	<.1	<.005	<.1	<.5	<.002	<.02	<.01	<.05	1.03	<.02	.34
---	---	.21	<.1	<.005	.2	<.5	<.005	<.02	.02	1.37	22.9	<.02	.79
---	---	---	--	----	--	--	----	---	---	---	4.1	---	.47
---	---	---	--	----	--	--	----	---	---	---	7.1	---	.17

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 508 FORMATION Qal AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
---	<0.001	<0.01	<0.005	---	0.02								
---	<0.001	<0.01	<0.005	---	0.02								
---	<0.001	<0.01	<0.005	---	0.04								
---	<0.001	<0.01	<0.005	---	0.05								
---	<0.001	0.02	<0.005	<1.0	0.03								
<0.02	<0.001	<0.01	<0.005	---	0.12								
<0.02	<0.001	<0.01	<0.005	---	0.03								
<0.02	<0.001	<0.01	<0.005	---	0.02								
<0.02	<0.001	<0.01	<0.005	---	0.24								
<.02	<.001	<.01	<.005	<1.0	.02								
<.02	<.001	.02	<.005	<1.0	.24								
---	----	---	----	---	.06								
---	----	---	----	---	.07								

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 403 FORMATION Qal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
30/79	1210	Bowlby Bondar	cool	pump	9.0	7.9	6.80	960	1000	666	---	437	85	54
22/79	1012	Araas Bondar	warm	pump	12.0	7.7	7.05	810	980	482	---	374	75	45
/23/79	0955	Veenstra Bondar	cool	pump	13.0	7.3	7.29	750	1200	472	---	342	68	42
2/80	1200	Gentry Bondar	warm	pump	17.0	7.7	7.20	684	700	426	---	317	62	40
/30/80	1430	Volk Bondar	cool	pump	14.1	7.7	7.97	717	690	520	.66	358	78	40
16/81	0900	Andersen Lyden	cool	pump	12.0	7.7	5.90	752	700	470	---	356	73	42
31/81	1000	Jones Andersen	warm	thief	13.0	7.4	6.80	660	700	410	---	286	29	26
/10/81	1130	Jones Andersen	cold	pump	13.0	8.0	7.4	622	687	494	---	350	71	42
/11/82	0830	Jones	warm	pump	7.5	7.6	6.85	760	670	458	.73	357	71	44
/ 6/82	1035	Andersen Jones Bondar	hot	pump	13.0	7.6	6.70	676	480	360	.75	311	59	40
n.					7.5	7.3	5.90	622	480	360	.66	286	29	26
x.					17.0	8.0	7.97	960	1200	666	.75	437	85	44
an					12.4	7.7	7.0	739	781	476	.71	349	67	42
D.					2.6	.21	.54	96	212	81	.05	41	15	

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 403 FORMATION Oal AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
52	2	-.06	291	354	0	---	7	.23	.03	245	.05
39	3	.02	273	332	0	---	6	.27	.06	173	.33
33	2	.13	255	311	0	---	4	.26	.03	146	.03
28	2	-.21	261	319	0	---	4	.28	.03	118	.02
29	<1	-.06	248	302	0	---	6	.19	<.01	161	.11
27	2	.06	250	304	0	---	4	.24	.01	153	.01
3	7	.21	235	287	0	---	2	.35	.32	112	---
28	3	.04	238	291	0	---	6	.52	.51	158	---
32	2.1	.09	263	320	0	---	5.9	.26	.01	146	.05
30	2.4	.20	271	330	0	---	3.8	.29	.12	90	.02
3	<1	-.21	235	287	0	---	2	.19	<.01	90	.01
52	7	.21	291	354	0	---	7	.52	.51	245	.33
30	---	.04	259	315	0	---	4.9	.29	---	150	.08
12	---	.13	17	20	0	---	1.5	.09	---	42	.11

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 403 FORMATION Qal AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	.22	<.1	<.005	.1	<.5	<.005	<.02	<.01	.42	1.97	<.02	.70
---	---	<.01	<.1	<.005	.1	<.5	<.005	<.02	<.01	.15	15.60	<.02	.53
---	---	.3	.1	<.005	.1	<.5	<.005	<.02	<.02	.22	.62	<.02	.47
---	---	.43	<.1	<.005	<.1	<.5	<.005	<.02	<.01	<.05	1.90	<.02	.75
---	---	.12	<.1	<.005	.1	<.5	<.005	<.02	.02	<.05	.50	<.02	.71
---	---	.21	<.1	<.005	<.1	<.5	<.002	<.02	<.01	.15	.33	<.02	.54
---	---	.26	<.1	<.005	.1	<.5	<.002	<.02	.03	.17	.18	<.02	1.00
---	---	.39	<.1	<.005	.1	<.5	<.002	<.02	.02	.35	5.42	<.02	.70
---	---	.20	<.1	<.005	.14	<.5	<.002	<.02	<.01	.11	1.53	<.02	.87
---	---	.56	<.1	<.005	.02	<.5	<.002	<.02	<.01	.12	.53	<.02	.61
---	---	<.01	<.1	<.005	.02	<.5	<.002	<.02	<.01	<.05	.18	<.02	.47
---	---	.43	.1	<.005	.14	<.5	<.005	<.02	.03	.42	15.60	<.02	1.00
---	---	---	--	----	---	--	----	---	---	---	2.86	---	.69
---	---	---	--	----	---	--	----	---	---	---	4.74	---	.16

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 403 FORMATION Qal AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
---	<.001	<.01	<.005	---	.01								
---	<.001	<.01	<.005	---	.04								
---	<.001	<.01	<.005	---	.02								
<.02	<.001	<.01	<.005	---	.05								
<.02	<.001	.02	<.005	<1	.04								
<.02	<.001	<.01	<.005	---	.04								
.05	<.001	.02	<.005	---	.04								
<.02	<.001	.02	<.005	---	.05								
<.02	<.0002	<.01	<.005	---	.11								
<.02	.0004	<.01	<.005	---	.08								
<.02	<.0002	<.01	<.005	<1	.01								
.05	<.001	.02	<.005	<1	.11								
---	----	---	----	---	.05								
---	----	---	----	---	.03								

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 207A FORMATION Oal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
5-21-80	1520	Gentry Bondar	cool	pump	10.0	7.9	6.20	840	1750	536	-	387	60	58
3-12-80	0840	Lyden Bondar	warm	pump	17.0	7.6	7.20	740	650	450	-	326	51	48
0-30-80	1350	Volk Bondar	warm	thief	13.0	7.7	7.70	734	730	540	.86	367	63	51
6-16-81	1000	Wolf Bondar	cool	pump	12.0	7.6	5.90	834	825	518	-	384	64	55
3-14-81	0900	Andersen Bondar	warm	pump	7.0	7.7	8.85	788	950	468	-	355	57	52
1-13-81	1100	Jones Andersen	cool	pump	12.5	7.9	6.50	869	782	480	-	365	59	53
5-11-82	0945	Jones Andersen	warm	pump	10.0	7.6	6.30	900	861	568	.76	431	69	63
8- 5-82	1245	Jones Bondar	warm	pump	12.0	7.5	6.90	963	700	546	.77	414	68	60
Min.					7.0	7.5	5.90	734	650	450	.76	326	51	51
Max.					17.0	7.9	8.85	963	1750	568	.86	431	69	63
Mean					11.7	7.7	6.94	834	906	513	.80	379	61	55
S.D.					2.9	.2	.97	79	354	42	.06	33	6	5

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 207A FORMATION Qal AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
43	9	-.01	309	377	0	-	4	.35	<.01	171	.04
36	9	-.20	280	342	0	-	3	.37	.10	136	.02
38	8	-.03	283	345	0	-	3	.27	.07	167	.81
38	11	.23	291	355	0	-	3	.42	.13	164	.21
34	10	.03	283	345	0	-	3	.33	.20	148	-
32	10	.08	282	344	0	-	3	.52	<.01	150	-
36	9.3	.13	316	385	0	-	2.9	.31	.02	187	.03
36	8.6	.16	316	385	0	-	2.9	.31	<.01	169	.02
32	8	-.20	280	342	0	-	2.9	.27	<.01	136	.02
43	11	.23	316	385	0	-	4	.51	.20	187	.81
37	9	.05	295	360	0	-	3	.36	-	162	.19
3	1	.13	16	19	0	-	1	.08	-	16	.31

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RECEIVED JUN 19 Land Quality DIST. 1

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 207A FORMATION Qal AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	.31	<.1	<.005	.1	<.5	<.005	<.02	<.01	1.20	2.91	<.02	<.02
-	-	.11	<.1	<.005	.2	<.5	<.005	<.02	<.01	.15	2.51	<.02	.16
.03	-	.24	<.1	<.005	.2	<.5	<.005	<.02	.05	.06	41.95	<.02	.20
-	-	.11	<.1	<.005	.2	<.5	<.002	<.02	.02	.61	11.25	<.02	.17
-	-	.12	<.1	<.005	<.1	<.5	<.002	<.02	.01	1.05	1.20	<.02	.17
-	-	.11	<.1	<.005	.2	<.5	<.002	<.02	.02	1.33	2.22	<.02	.18
-	-	.10	<.1	<.005	.21	<.5	<.002	<.02	<.01	1.08	-	<.02	.16
-	-	.27	<.1	<.005	.08	<.5	<.002	<.02	.01	.99	1.48	<.02	.14
.03	-	.10	<.1	<.005	.08	<.5	<.002	<.02	<.01	.06	1.20	<.02	<.02
.03	-	.31	<.1	<.005	.2	<.5	<.005	<.02	.05	1.33	41.95	<.02	.20
.03	-	.17	--	----	.2	--	----	---	---	.81	9.07	---	.15
.00	0	.09	--	----	.1	--	----	---	---	.48	14.91	---	.06

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 207A FORMATION Qal AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.001	<.01	<.005	-	<.01								
<.02	<.001	<.01	<.005	-	.05								
<.02	<.001	.02	<.005	<1	.06								
<.02	<.001	<.01	<.005	-	.04								
<.02	<.001	.03	<.005	-	.07								
<.02	<.001	<.01	<.005	-	.03								
<.02	<.0002	<.01	<.005	-	.06								
<.02	<.0002	<.01	<.005	-	.06								
<.02	<.0002	<.01	<.005	<1	<.01								
<.02	<.001	.03	<.005	<1	.07								
---	-----	---	----	-	.05								
---	-----	---	----	-	.02								

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 397 FORMATION Qal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
13-79	-	Bowlby	-	pump	11.64	7.7	7.75	1430	900	1060	-	735	115	109
30-79	1335	Bondar Bowlby	-	pump	9.0	7.8	6.9	1370	1500	1050	-	711	131	93
22-79	1445	Bowlby Araas	clear warm	pump	12.0	7.7	7.62	980	1150	606	-	482	94	60
24-79	1330	Bowlby Veenstra Bondar	cool	pump	12.0	7.4	7.36	910	1100	566	-	429	87	51
14-80	1400	Bondar Gentry	cool	pump	11.0	7.6	6.89	750	820	532	-	369	74	45
12-80	0910	Bondar Gentry Lyden	clear warm	pump	16.5	7.6	7.2	796	730	496	-	384	75	48
-30-80	1410	Bondar Volk	cool	pump	14.0	7.6	8.0	840	770	604	-	446	92	52
16-81	1145	Bondar Wolf	cool	pump	11.0	7.7	6.75	798	725	488	-	384	80	45
13-81	1325	Andersen Jones	cool	pump	11.0	7.6	8.10	778	950	468	-	374	73	47
-10-81	1400	Andersen Jones	cool	pump	13.0	7.7	7.3	1250	903	606	-	446	87	56

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 397 FORMATION Oal AREA Big Horn

PARAMETERS

ATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
0-82	1530	Jones Andersen	warm	pump	8.5	7.6	7.0	1000	881	642	.89	468	101	52
6-82	0940	Jones Bondar	hot	pump	11.0	7.5	6.6	1200	860	828	1.03	593	119	72
					8.5	7.4	6.6	750	725	468	.89	369	73	45
					16.5	7.8	8.10	1430	1500	1060	1.03	735	131	109
					11.7	7.6	7.3	1009	941	662	.96	485	94	61
					2.1	.1	.5	243	219	206	.10	127	19	20

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 397 FORMATION Qal AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
73	4	.33	450	550	0	-	5	.16	.31	408	.32
72	5	.07	453	553	0	-	6	.14	.4	391	.02
40	4	.22	357	435	0	-	5	.14	.03	191	.03
34	4	.12	344	420	0	-	10	.13	.01	138	.03
28	3	-.17	298	364	0	-	7	.14	.01	129	.12
30	3	-.17	310	378	0	-	4	.16	.01	140	.04
27	<1	.11	311	379	0	-	3	.09	.03	177	.13
31	3	.20	301	367	0	-	2	.20	.01	134	.03
48	6	.16	320	390	0	-	3	.19	.14	145	-
36	4	.25	325	397	0	-	5	.37	<.01	200	-

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 397 FORMATION Qal AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
44	3.8	.09	327	399	0	<1	4.8	.13	.02	221	.03
58	4.5	.19	346	423	0	-	8.1	.2	.12	343	.02
27	<1	-.17	298	364	0	-	2	.09	<.01	129	.02
73	6	.25	453	553	0	-	10	.37	.4	408	.32
43	3	.12	345	421	0	-	5	.17	.09	218	.08
16	1	.15	53	65	0	-	2	.07	.13	103	.09

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TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 397 FORMATION Qal AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	.31	<.1	<.005	-	<.5	<.005	<.02	.02	.68	1.65	<.02	.85
-	-	.52	<.1	<.005	.2	<.5	<.005	<.02	.01	.22	.24	<.02	.82
-	-	<.01	<.1	<.005	.1	<.5	<.005	<.02	<.01	.24	.31	<.02	.55
-	-	.05	.2	<.005	.1	<.5	<.005	<.02	<.02	.24	.4	<.02	.51
-	-	<.05	<.1	<.005	< .1	<.5	<.005	<.02	<.01	.19	.45	<.02	.31
-	-	.10	<.1	<.005	.1	<.5	<.005	<.02	<.01	<.05	.57	<.02	.60
.02	-	.07	<.1	<.005	.2	<.5	<.005	<.02	.03	.16	.19	<.02	.56
-	-	<.05	<.1	<.005	.1	<.5	<.002	<.02	.02	.11	.67	<.02	.42
-	-	.01	<.1	<.005	< .1	<.5	<.002	<.02	.03	<.05	.11	<.02	.57
-	-	.12	<.1	<.005	< .1	<.05	<.002	<.02	<.01	.07	.11	<.02	.70

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RECD 10-25-18 2/025

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 397 FORMATION Qal AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	.06	.2	<.005	.13	<.5	<.002	<.02	<.01	.27	.34	<.02	.39
-	-	.27	<.1	<.005	.04	<.5	<.002	<.02	.01	.07	.29	<.02	.61
-	-	<.01	<.1	<.005	.04	<.05	<.002	<.02	<.01	<.05	.11	<.02	.31
-	-	.52	.2	<.005	.2	<.5	<.005	<.02	.03	.68	1.65	<.02	.85
-	-	---	--	----	---	---	----	---	---	---	.44	---	.57
-	-	---	--	----	---	---	----	---	---	---	.42	---	.16

TFN 6 2/025
REC'D 10-25-13

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA -

WELL NO. 397 FORMATION Qal AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
-	<.0002	.03	<.005	-	.05								
-	<.001	<.01	<.005	-	.02								
-	<.001	<.01	<.005	-	.02								
-	<.001	<.01	<.005	-	.01								
-	<.001	<.01	<.005	-	<.01								
<.02	<.001	<.01	<.005	-	.05								
<.02	<.001	.02	<.005	<1.0	.04								
<.02	<.001	<.01	<.005	-	.04								
<.02	<.001	.05	<.005	-	.04								
<.02	<.001	.01	<.005	-	<.01								

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 397 FORMATION Qal AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.0002	<.01	<.005	-	.06								
<.02	<.0002	<.01	<.005	-	.14								
<.02	<.0002	<.01	<.005	<1.0	<.01								
<.02	<.001	.05	<.005	<1.0	.14								
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RECEIVED JAN 1983 Land Quality Div. DIST. IV

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 644 FORMATION Qal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
11-3-80	1350	Volk Bondar	cool	pump	13.8	7.5	7.36	880	890	590	-	502	107	57
1-20-81	1000	Volk Lyden	cold	pump	8.8	7.8	7.09	785	810	470	-	406	87	46
4-21-81	1500	Andersen Bondar	cold	pump	8.0	7.1	7.40	720	625	454	-	344	73	39
7-10-81	1300	Lyden Andersen	warm	pump	8.0	7.4	7.40	828	1100	522	-	475	100	55
11-10-81	1315	Jones Andersen	cool	pump	13.5	7.6	7.20	764	970	594	-	480	103	54
5-10-82	1330	Jones Andersen	warm	pump	7.0	7.5	6.80	740	642	454	.65	342	74	38
8- 6-82	1410	Bondar Andersen	warm	pump	13.0	7.4	6.60	971	750	576	.60	506	108	58
Min.					7.0	7.1	6.60	720	625	454	.40	342	73	38
Max.					13.8	7.8	7.40	971	1100	594	.65	506	108	58
Mean					10.3	7.5	7.12	813	827	523	.55	436	93	50
S.D.					3.0	.2	.31	88	173	64	.13	72	15	9

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 644 FORMATION Qal AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
20	<1	.24	405	493	0	-	3	.19	.05	119	.29
24	<1	-.05	321	391	0	-	5	.20	.02	127	.02
31	3	-.04	281	343	0	-	4	.29	.03	123	.02
25	2	.22	398	486	0	-	11	.22	.36	100	-
28	2	.15	424	517	0	-	2	.40	.35	119	-
28	1.6	.11	271	331	0	-	3.9	.21	.02	117	.03
31	3.6	.22	436	532	0	-	1.9	.22	1.22	123	.02
20	<1	-.05	271	331	0	-	1.9	.19	.02	100	.02
31	3.6	.24	436	532	0	-	3.9	.40	1.22	127	.29
27	-	.12	362	442	0	-	4	.25	.29	118	.08
4	-	.12	70	85	0	-	3	.07	.44	9	.12

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 644 FORMATION Qal AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	.06	<.1	<.005	<.1	<.5	<.005	<.02	.04	.36	2.30	<.02	.16
-	-	.04	<.1	<.005	<.1	<.5	<.005	<.02	<.01	.76	5.60	<.02	.10
-	-	.10	<.1	<.005	<.1	<.1	<.002	<.02	<.01	.20	9.94	<.02	.13
-	-	.26	.1	<.005	<.1	<.5	<.002	<.02	.02	<.05	.38	<.02	.04
-	-	.08	<.1	<.005	.1	<.5	<.002	<.02	.02	.61	.85	<.02	.06
-	-	.06	<.1	<.005	.11	<.5	<.002	<.02	<.01	.87	1.20	<.02	.08
-	-	.28	<.1	<.005	.04	<.5	<.002	<.02	.01	.26	.65	<.02	.02
-	-	.04	<.1	<.005	.04	<.1	.002	<.02	<.01	<.05	.38	<.02	.02
-	-	.26	.1	<.005	.11	<.5	.005	<.02	.04	.87	9.94	<.02	.16
-	-	.13	--	----	---	--	----	---	---	.44	2.99	---	.08
-	-	.10	--	----	---	--	----	---	---	.31	3.55	---	.05

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 644 FORMATION Qal AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.001	.03	<.005	-	.05								
<.02	<.001	<.01	<.005	-	.07								
<.02	<.001	<.01	<.005	-	.02								
<.02	<.001	.02	<.005	-	.05								
<.02	<.001	<.01	<.005	-	.03								
<.02	<.0002	<.01	<.005	-	.06								
<.02	<.0002	<.01	<.005	-	.09								
<.02	<.0002	<.01	<.005	-	.02								
<.02	<.001	.03	<.005	-	.09								
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---	-----	---	----	-	.02								

JAN 1982 RECEIVED Land Quality DIST IV

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RECD 10-25-13

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 645 FORMATION Qal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
1-3-80	1115	Volk Bondar	cool	pump	11.8	7.6	7.29	880	780	628	--	441	100	46
-16-81	1300	Bondar Volk	cold	pump	11.0	7.6	7.09	879	775	590	--	400	89	43
-15-81	1030	Wolf Bondar	cold	pump	9.0	7.3	6.90	897	800	574	--	402	73	54
10-81	1030	Lyden Andersen	warm	pump	8.0	7.6	7.80	910	1100	650	--	464	105	49
-10-81	1215	Jones Andersen	cool	pump	13.0	8.0	7.40	807	916	724	--	477	106	51
10-82	1400	Jones Andersen	warm	pump	8.0	7.6	6.90	1020	930	720	1.10	474	108	49
6-82	1305	Jones Bondar	warm	pump	13.0	7.5	6.70	1130	810	714	1.24	481	108	51
n.					8.0	7.3	6.70	807	775	574	.87	400	73	43
x.					13.0	8.0	7.80	1130	1100	724	1.24	481	108	54
an					10.5	7.6	7.15	932	873	657	1.07	448	98	49
D.					2.2	.2	.37	108	118	63	.19	35	13	4

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 645 FORMATION Qal AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
42	2	.19	298	363	0	-	6	.13	.04	210	.14
48	3	-.15	282	344	0	-	4	.15	.70	217	.10
49	3	.19	288	351	0	-	5	.16	.17	199	.02
50	4	.12	300	366	0	-	13	.16	.44	241	-
51	5	0.00	289	352	0	-	5	.30	.46	284	-
55	3.3	.05	275	335	0	-	6	.14	.19	299	.03
62	3.7	.17	297	363	0	-	5.6	.17	.29	296	.02
42	2	-.15	275	335	0	-	4	.13	.04	199	.02
62	5	.19	300	366	0	-	13	.30	.70	299	.14
51	3	.08	290	353	0	-	6	.17	.33	249	.06
6	1	.13	9	11	0	-	3	.06	.22	43	.05

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 645 FORMATION Qal AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	.47	<.1	<.005	<.1	<.5	<.005	<.02	.04	.15	2.73	<.02	.62
-	-	.22	<.1	<.005	<.1	<.5	<.005	<.02	<.01	.35	1.08	<.02	.34
-	-	.44	<.1	<.005	<.1	<.5	<.002	<.02	<.01	.23	.86	<.02	.30
-	-	.02	.1	<.005	<.1	<.5	<.002	<.02	.06	< .05	.14	<.02	.25
-	-	.48	<.1	<.005	<.1	<.5	<.002	<.02	.01	.43	.36	<.02	.33
-	-	.29	<.1	<.0005	.10	<.5	<.002	<.02	<.01	.38	.62	<.02	.24
-	-	.75	<.1	<.0005	<.01	<.5	<.002	<.02	.01	.36	.68	<.02	.2
-	-	.02	<.1	<.0005	<.01	<.5	<.002	<.02	<.01	<.05	.14	<.02	.2
-	-	.75	.1	<.005	.10	<.5	<.005	<.02	.06	.43	2.73	<.02	.62
-	-	.38	--	-----	---	--	----	---	---	.28	.92	---	.33
-	-	.23	--	-----	---	--	----	---	---	.14	.85	---	.14

D6-267
IFR 6 2/025
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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 645 FORMATION Qal AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.001	.03	.005	-	.04								
<.02	<.001	<.01	<.005	-	.05								
<.02	<.001	<.01	<.005	-	.03								
<.02	<.001	.02	<.005	-	.27								
<.02	<.001	.02	<.005	-	.04								
<.02	<.0002	<.01	<.005	-	.05								
<.02	<.0002	<.01	<.005	-	.09								
<.02	<.0002	<.01	<.005	-	.03								
<.02	<.001	.03	<.005	-	.27								
---	-----	---	----	-	.08								
---	-----	---	----	-	.09								

D6-277

RECD 10-25-18 IPN 6 2/025

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 654 FORMATION Spoils AREA Big Horn

PARAMETERS

ATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
7/81	1400	Volk Bondar	cold	thief	15.0	7.3	6.57	3990	4500	3620	---	2060	411	251
0/81	1130	Andersen Lyden	cool	thief	11.0	6.6	5.5	3920	3600	3730	---	2210	412	288
0/81	1130	Jones Andersen	warm	pump	13.0	6.6	8.7	3820	5100	3460	---	2160	444	256
9/81	1340	Jones Andersen	cold	pump	18.0	6.9	6.2	3650	3547	3530	---	2180	417	277
14/82	1005	Jones Andersen	warm	pump	13.5	7.4	6.5	1840	1670	1260	3.82	546	115	63
5/82	1130	Jones Bondar	hot	pump	17.0	6.3	6.2	4110	3050	3510	2.29	2150	405	278
n.					11.0	6.3	5.5	1840	1670	1260	2.29	546	115	63
x.					18.0	7.4	8.7	4110	5100	3730	3.82	2210	444	288
an					14.6	6.9	6.6	3555	3578	3185	3.06	1884	367	236
D.					2.6	.4	1.1	855	1191	948	1.08	658	124	86

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 654 FORMATION Spoils AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
284	40	-.23	504	615	0	---	21	.40	.03	2110	.08
272	30	-.29	710	866	0	---	16	.29	<.01	2040	.01
255	31	.97	649	792	0	---	16	.18	3.06	2030	.02
243	30	.85	694	847	0	---	16	.41	.23	1990	---
205	16	-.12	402	490	0	---	9.3	.82	.04	579	.68
244	29	-1.06	708	864	0	---	20	.19	<.01	1950	.06
205	16	-1.06	402	490	0	---	9.3	.18	<.01	579	.01
284	40	.97	710	866	0	---	21	.82	3.06	2110	.68
251	29	.02	611	746	0	---	16.4	.38	---	1783	.17
27	8	.77	129	157	0	---	4.1	.24	---	592	.29

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 654 FORMATION Spoils AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	.79	.3	<.005	.2	<.5	<.005	.02	.04	1.60	73.40	<.02	1.33
---	---	7.28	<.1	.005	.1	<.5	<.002	<.02	<.01	3.49	34.30	<.02	1.12
---	---	8.00	<.1	<.005	.2	<.5	<.002	.04	.03	<.05	3.03	<.02	1.27
---	---	.41	<.1	<.005	.2	<.5	<.002	<.02	.02	<.05	2.94	<.02	1.78
---	---	4.89	<.1	<.005	.15	<.5	<.002	<.02	<.01	.14	82.20	<.02	.16
---	---	11.2	<.1	<.005	.12	<.5	<.002	.05	.02	3.28	4.05	<.02	.9
---	---	.41	<.1	<.005	.1	<.5	<.002	<.02	<.01	<.05	2.94	<.02	.16
---	---	11.2	.3	<.005	.2	<.5	<.005	.05	.04	3.49	82.20	<.02	1.78
---	---	5.43	--	----	.16	--	----	---	---	---	33.32	---	1.09
---	---	4.25	--	---	.04	--	----	---	---	---	36.59	---	.54

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 654 FORMATION Spoils AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.001	.05	<.005	---	.43								
<.02	<.001	<.01	<.005	---	.23								
<.02	.001	.02	<.005	---	.68								
<.02	<.001	.05	<.005	---	4.59								
<.02	<.0002	<.01	<.005	---	1.53								
<.02	<.0005	.02	<.005	---	2.10								
<.02	<.0002	<.01	<.005	---	.23								
<.02	.001	.05	<.005	---	4.59								
---	----	---	----	---	1.59								
---	----	---	----	---	1.63								

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 656 FORMATION Spoils AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
7/81	1210	Volk Bondar	cold	thief	12.0	7.8	7.15	1480	1200	972	---	305	62	36
0/81	1000	Andersen Lyden	cool	pump	10.0	7.5	5.0	1680	1600	1190	---	515	93	69
0/81	1300	Jones Andersen	warm	pump	23.0	7.7	8.8	1850	1900	1270	---	552	112	66
9/81	1140	Jones Andersen	cold	pump	15.0	7.5	6.6	1750	1646	1260	---	531	110	62
14/82	0930	Jones Andersen	warm	pump	13.0	7.5	6.4	1790	1610	1210	4.06	520	110	60
5/82	1245	Jones Bondar	hot	pump	19.0	7.3	6.8	1800	1500	1200	3.82	534	102	68
n.					10.0	7.3	5.0	1480	1200	972	3.82	305	62	36
x.					23.0	7.8	8.8	1850	1900	1270	4.06	552	112	69
an					15.3	7.6	6.8	1725	1576	1184	3.94	493	98	60
D.					4.8	.2	1.2	133	227	109	.17	93	19	12

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 656 FORMATION Spoils AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
208	16	-.14	335	409	0	---	9	1.01	.05	416	.04
204	18	.32	385	469	0	---	9	.80	.01	544	<.01
229	19	.38	457	558	0	---	9	.66	.20	598	---
203	17	.40	393	479	0	---	9	1.07	1.16	578	---
213	16	-.40	439	535	0	---	8.5	.78	<.01	549	.11
203	15	-.29	418	510	0	---	10.0	.85	.01	552	1.0
203	15	-.40	335	409	0	---	8.5	.66	<.01	416	<.01
229	19	.40	457	558	0	---	10.0	1.07	1.16	598	1.0
210	17	.05	405	493	0	---	9.1	.86	---	540	---
10	1.5	.36	44	53	0	---	.5	.15	---	64	---

TFN's 2/025
RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 656 FORMATION Spoils AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	.54	<.1	<.005	<.1	<.5	<.005	<.02	.02	<.05	23.50	<.02	.11
---	---	5.83	<.1	<.005	.1	<.5	<.002	<.02	<.01	.12	139.00	<.02	.25
---	---	6.10	<.1	<.005	.1	<.5	<.002	.02	.03	.06	22.31	<.02	.19
---	---	1.07	<.1	<.005	<.1	<.5	<.002	<.02	<.01	.45	51.40	<.02	.12
---	---	5.29	<.1	<.005	.14	<.5	<.002	<.02	<.01	.37	43.30	<.02	.09
---	---	8.97	<.1	<.005	.06	<.5	<.002	<.02	<.01	.13	46.00	<.02	.07
---	---	.54	<.1	<.005	.06	<.5	<.002	<.02	<.01	<.05	22.31	<.02	.07
---	---	8.97	<.1	<.005	.14	<.5	<.005	.02	.03	.45	139.00	<.02	.25
---	---	4.63	--	----	---	--	----	---	---	---	54.25	---	.14
---	---	3.23	--	----	---	--	----	---	---	---	43.23	---	.07

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 656 FORMATION Spoils AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.001	<.01	<.005	---	.07								
<.02	<.001	<.01	<.005	---	.05								
<.02	.0017	.02	<.005	---	1.70								
<.02	<.001	.01	<.005	---	1.69								
<.02	<.0002	<.01	<.005	---	.31								
<.02	.0004	<.01	<.005	---	.35								
<.02	<.0002	<.01	<.005	---	.05								
<.02	.0017	.02	<.005	---	1.7								
---	-----	---	----	---	.70								
---	-----	---	----	---	.78								

D6-276
TFN 3 2/025
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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 657 FORMATION Spoils AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. °C	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
6/81	1530	Andersen Lyden	cool	pump	18.0	7.5	6.6	2920	3150	2484	---	1430	436	84
20/82	1430	Andersen	cool	thief	14.0	7.0	6.5	6140	5363	5950	2.77	3890	443	676
10/82	1300	Collier Bowlby	hot	pump	24.0	6.8	6.4	4770	5500	4280	4.29	2260	353	336
n.					14.0	6.8	6.4	2920	3150	2484	2.77	1430	353	84
x.					18.0	7.5	6.6	6140	5500	5950	4.29	3890	443	676
ean					18.7	7.1	6.5	4610	4671	4238	3.53	2527	411	365
D.					5.0	.4	.1	1616	1319	1733	1.07	1251	50	297

TFN 6 2/025
RECD 10-25-18

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 657 FORMATION Spoils AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
289	29	.61	735	897	0	---	20	.60	4.72	1235	---
397	32	.87	1350	1650	0	---	89	.44	2.73	3220	.72
470	34	.06	1100	1340	0	---	59	.40	.17	2060	.08
289	29	.06	735	897	0	---	20	.40	.17	1235	.08
470	34	.87	1350	1650	0	---	89	.60	4.72	3220	.72
385	32	.51	1062	1296	0	---	56	.48	2.54	2172	.40
91	3	.41	309	378	0	---	35	.11	2.28	997	.45

RECD 10-25-13

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 657 FORMATION Spoils AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
---	---	7.46	.1	<.005	.1	<.5	<.002	.03	.01	.10	*1360	<.02	.73
---	---	.83	<.1	<.005	.39	<.5	<.002	.06	.03	.17	74.7	<.02	1.05
---	---	7.54	<.1	<.005	.29	<.5	<.002	.02	.03	.12	2.71	<.02	.22
---	---	.83	<.1	<.005	.1	<.5	<.002	.02	.01	.10	2.71	<.02	.22
---	---	7.54	.1	<.005	.39	<.5	<.002	.06	.03	.17	74.7	<.02	1.05
---	---	5.28	--	----		--	----	.04	.02	.13	38.7	---	.67
---	---	3.85	--	----		--	----	.02	.01	.04	50.9	---	.42

* Due to extremely low transmissivity sample was very difficult to obtain.

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RECD 10-25-18

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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 657 FORMATION Spoils AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.001	<.01	<.005	---	.05								
<.02	<.0002	.11	<.005	---	.16								
<.02	.0004	.02	<.005	---	2.43								
<.02	<.0002	<.01	<.005	---	.05								
<.02	<.001	.11	<.005	---	2.43								
---	-----	.05	----	---	.88								
---	-----	.06	----	---	1.34								

RECD 10-25-18
IFN 6 2/025

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 745 FORMATION Spoils AREA Big Horn

PARAMETERS

ATE	TIME	SAMPLERS	WEATHER	SAMPLE TECH.	FIELD TEMP. OC	LAB pH	FIELD pH	LAB COND.	FIELD COND.	TDS	SAR	TOTAL HARDNESS	CALCIUM	MAGNESIUM
-9-82	1500	Andersen Collier	warm	pump		7.3		3390		2990	1.27	1970	339	272

D6-281
TFN 6 2/025
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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 745 FORMATION Spoils AREA Big Horn

PARAMETERS

SODIUM	POTASSIUM	CATIONS ANIONS	TOTAL ALKALINITY as CaCO3	BICARBONATE as HCO3	CARBONATE as CO3	ACIDITY	CHLORIDE	FLUORIDE	NO2+NO3 as "N"	SULFATE	TOTAL PHOS.
129	31	-.69	481	587	0	0	16	.37	<.01	1740	.12

D6-282
2/025
RECD 10-25-18

GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 745 FORMATION Spoils AREA Big Horn

PARAMETERS

ORTHO PHOS.	ORGANIC PHOS.	AMMONIA NIT. as N	Al	As	B	Ba	Cd	Cr	Cu	Fe DISSOLVED	Fe TOTAL	Pb	Mn
-	-	3.36	<.1	<.005	.22	<.05	<.002	<.02	<.01	.86	12.3	<.02	.68

D6-283
TFN 6 2/025
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GROUNDWATER QUALITY - COMBINED REQUIREMENTS FOR WYOMING AND MONTANA

WELL NO. 745 FORMATION Spoils AREA Big Horn

PARAMETERS

Mo	Hg	Ni	Se	V	Zn			OIL & GREASE	ORGANIC NIT. as "N"	CHLOROPHYLL a	TOTAL ORGANIC C	KJELDAHL NIT. as "N"	COMMENTS
<.02	<.0002	.02	<.005	-	.47								

D6-284
TFN 6 2/025
RECD 10-25-13

ADDENDUM D6-3

WATER RIGHTS

TFN S 2/025
RECD 10-25-18

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Appendix D6- Hydrology
Addendum D6-3 Water Rights

The following pages can be found in Volume 1, Appendices A & B:

1.) D6-286 thru D6-291 Water Rights Within The Permit Area

2.) D6-292 thru D6-297 Permitted, Unpermitted and Unregistered Water Wells Within the Big Horn Permit Area

3). D6-298 thru D6-300 Water Rights Within ½ Mile of the Permit Area and 3 Miles Downstream

4) D6-302 thru D6-312 Permitted, Unpermitted and Unregistered Water Wells Within A 3 Mile Radius of the Big Horn Permit Area

APR 1994

TFN 6 2/025
RECD 10-25-18

ADDENDUM D6-4

DATA LOG SHEETS OF AQUIFER PUMP TESTS

WITH RESPECTIVE GRAPHS OF DATA POINTS

AND AQUIFER COEFFICIENT CALCULATIONS

D6-313
TFR 6 2/025
RECD 10-25-18

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DIETZ - 1

COAL WELLS

TFN 6 2/025

DEQ Ex. 3-1266

RECD 10-25-18

AQUIFER TEST DATA

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 25 WELL NO. 463

Panel Bondar - Gentry Test type: 1. Single well drawdown (3.) Drawdown with obs. well 5. Other (specify)
2. Single well recovery (4.) Recovery with obs. well

Owner PKS Address Box 3049 Sheridan, WY

Driller D. Fudge Method drilled: (A.) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Depth 243 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen perforation slots Interval of screen or perforation 160'-165', 185'-200' Pump hp. & type 3/4 Teel Pump depth 190 ft.

Water bearer Dietz 1AB Aquifer lithology coal

Altitude of land surface 3698.5' How determined surveyed MP Above Below LSD Altitude MP

MP from MP 87.44' How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
6-9-80	0910	87.44	0			0
	11	99.45	1			12.01
	13	111.74	3			24.30
	16	125.15	6			37.71
	20	140.00	10			52.56
	25	151.36	15			63.92
	30	155.27	20			67.83
	40	160.22	30			72.78
	50	162.90	40			75.46
	1000	164.55	50			77.11
	15	166.17	65			78.73
	30	167.68	80			80.24
	45	169.03	95			81.59
	1100	170.11	110			82.67
	15	171.62	125			84.18
	30	173.06	140			85.62
	50	174.15	160			86.71
	1210	174.76	180			87.32
	1230	175.30	200			87.86
	1250	175.54	220			88.10
	1310	175.76	240			88.32
	1330	176.20	260			88.76
	1359	176.58	289			89.14
OFF	1400	176.58	290	0	0	89.14
	1401	167.33	291	1	291	79.89
	1403	151.96	293	3	97.67	74.52
	1406	156.58	296	6	49.33	69.14
	1412	147.50	302	12	25.17	60.06

D6-315
TFN 6 2/025
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GROUNDWATER EVALUATION AQUIFER TEST DATA

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 25 WELL NO. 463 (cont)

anel Bondar - Gentry Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well

wner PKS Address Box 3049 Sheridan, WY

r D. Fudge Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

wc pth 243 ft. Well diameter 7 7/8 in.

g diameter 5 in. Casing type PVC

of screen perforation slots Interval of screen or perforation 160'-165', 185'-200' Pump hp. & type 3/4 Teel Pump depth 190 ft.

er Dietz 1AB Aquifer lithology coal

de of land rface 3698.5' How determined surveyed MP Above Below LSD Altitude MP

from MP How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
6-9-80	35	121.04	325	35	9.28	33.60
	45	113.39	335	45	7.44	25.95
	1500	105.48	350	60	5.83	18.04
	15	100.25	365	75	4.87	12.81
	30	96.82	380	90	4.22	9.38
	45	94.90	395	105	3.76	7.46

TFN 8 2/025
RECD 10-25-18

WATER WELL 463

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
6-9-80	0913	35.20	5.11	3.00	3	15.33
	16	36.80	4.89	3.00	3	14.67
	20	39.00	4.62	3.00	4	18.48
	25	52.30	3.44	3.00	5	17.20
	30	67.00	2.69	3.00	5	13.45
	40	68.30	2.64	3.00	10	26.40
	50	73.20	2.46	3.00	10	24.60
	1000	75.00	2.40	3.00	10	24.00
	15	75.30	2.39	3.00	15	35.85
	30	75.80	2.37	3.00	15	35.55
	45	75.20	2.39	3.00	15	35.85
	1100	75.50	2.38	3.00	15	35.70
	15	77.40	2.33	3.00	15	34.95
	30	76.80	2.34	3.00	15	35.10
	50	78.40	2.30	3.00	20	46.00
	1210	78.50	2.29	3.00	20	45.80
	30	76.70	2.35	3.00	20	47.00
	50	77.50	2.32	3.00	20	46.40
	1310	78.00	2.31	3.00	20	46.20
	30	79.20	2.27	3.00	20	45.40
	1400	80.50	2.24	3.00	30	67.20
					290	711.13

Average Q = 711.13 gal / 290 min = 2.45 gpm

specific capacity = 2.45 gpm / 89.14 ft = 0.03 gpm / ft.

TFN 6 2/025

BCSD 10-25-18

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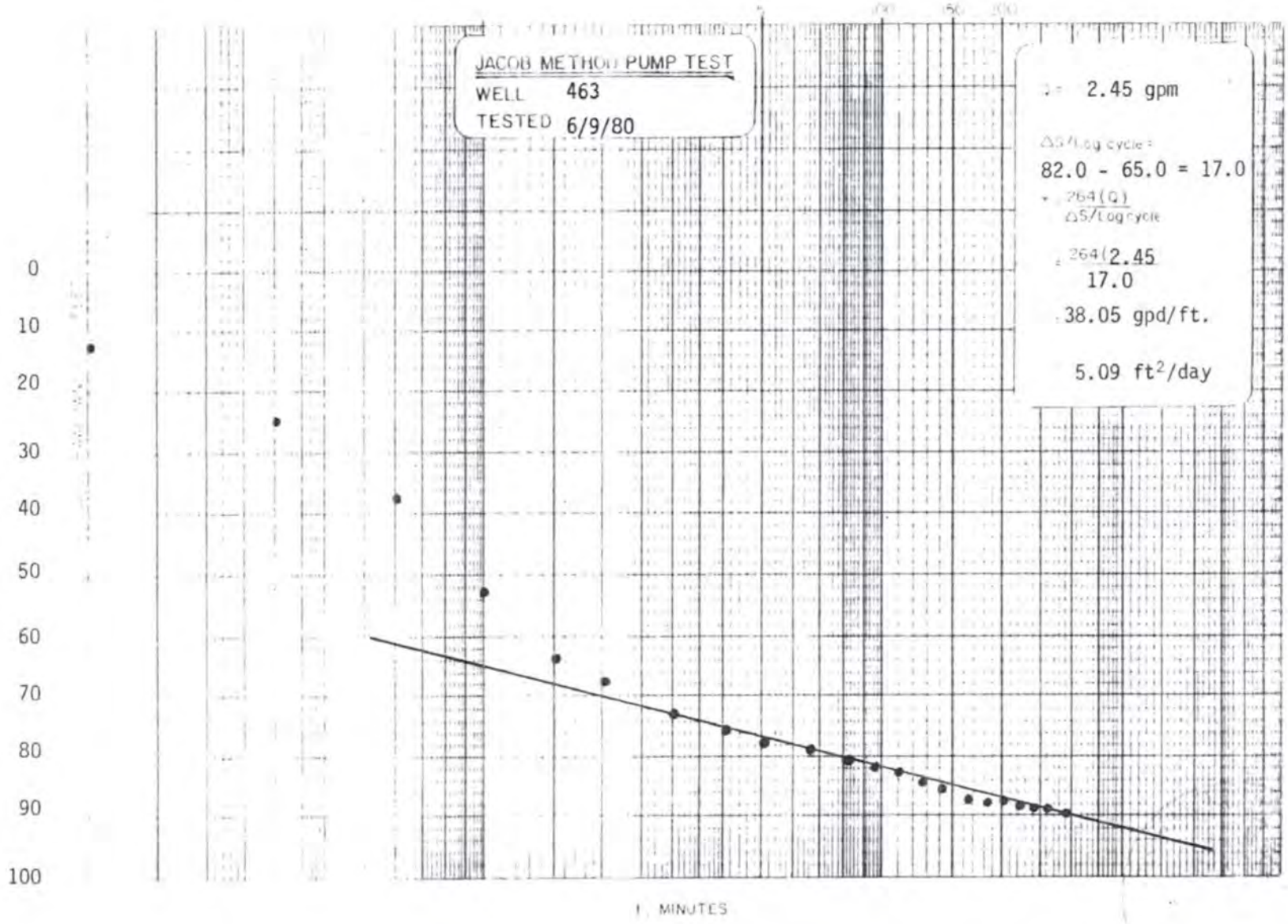
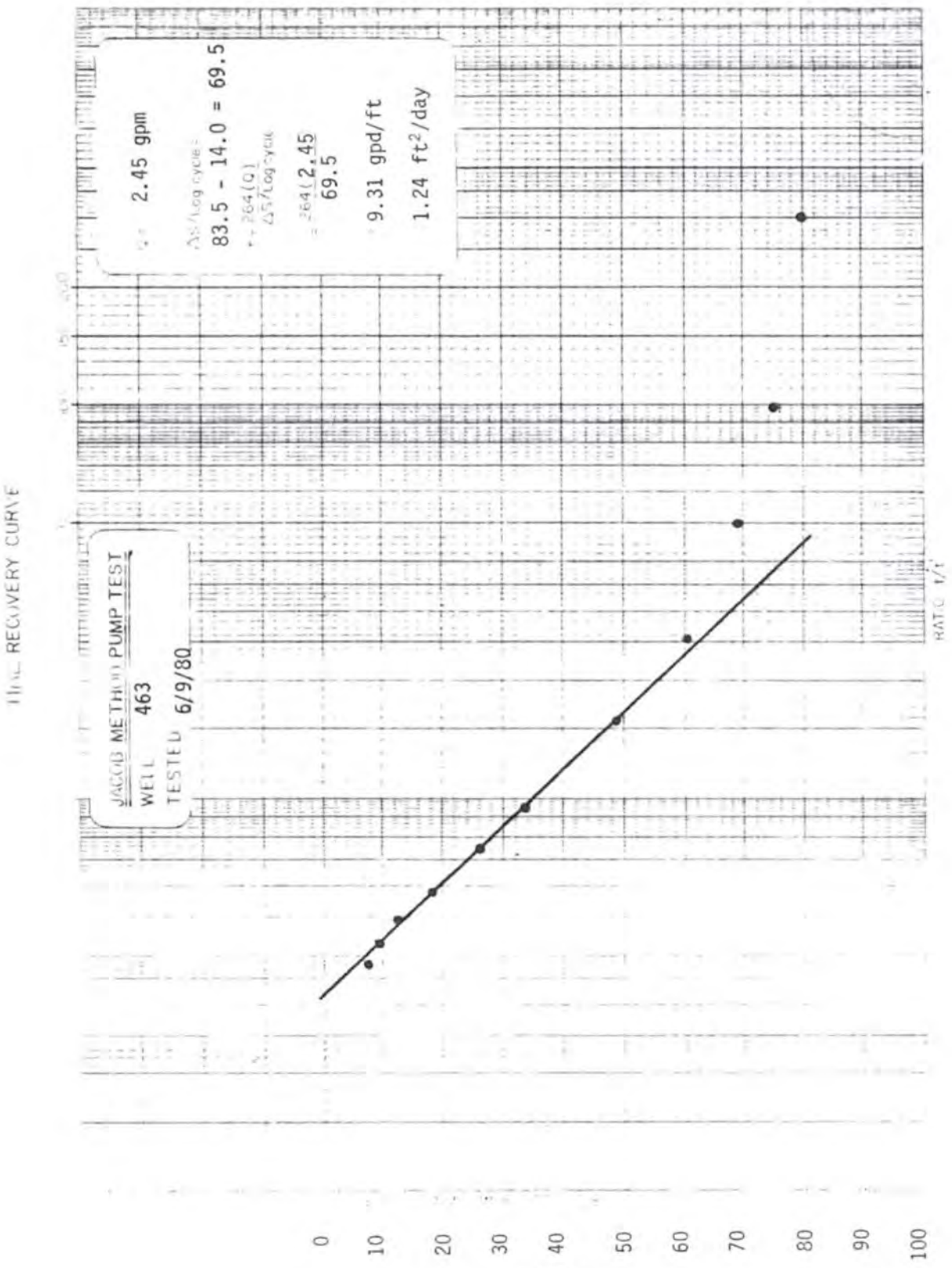
TIME DRAWDOWN CURVE



D6-318 2/025
RECD 10-25-18

DEQ Ex. 3-1270



D6-319
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1271

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. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

Wyoming County Sheridan T. 57 (N.) S. R. 84 (E.) W. Sec. 25 WELL NO. obs. 463A

nnel Bondar, Gentry Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well

wner PKS Address Box 3049 Sheridan, WY

r D. Fudge Method drilled: (A.) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

w th 210 ft. Well diameter 7 7/8 in.

g diameter 5 in. Casing type PVC

of screen perforation saw slots Interval of screen or perforation 158-170', 185-203' Pump hp. & type _____ Pump depth _____ ft.

er Dietz 1AB Aquifer lithology coal

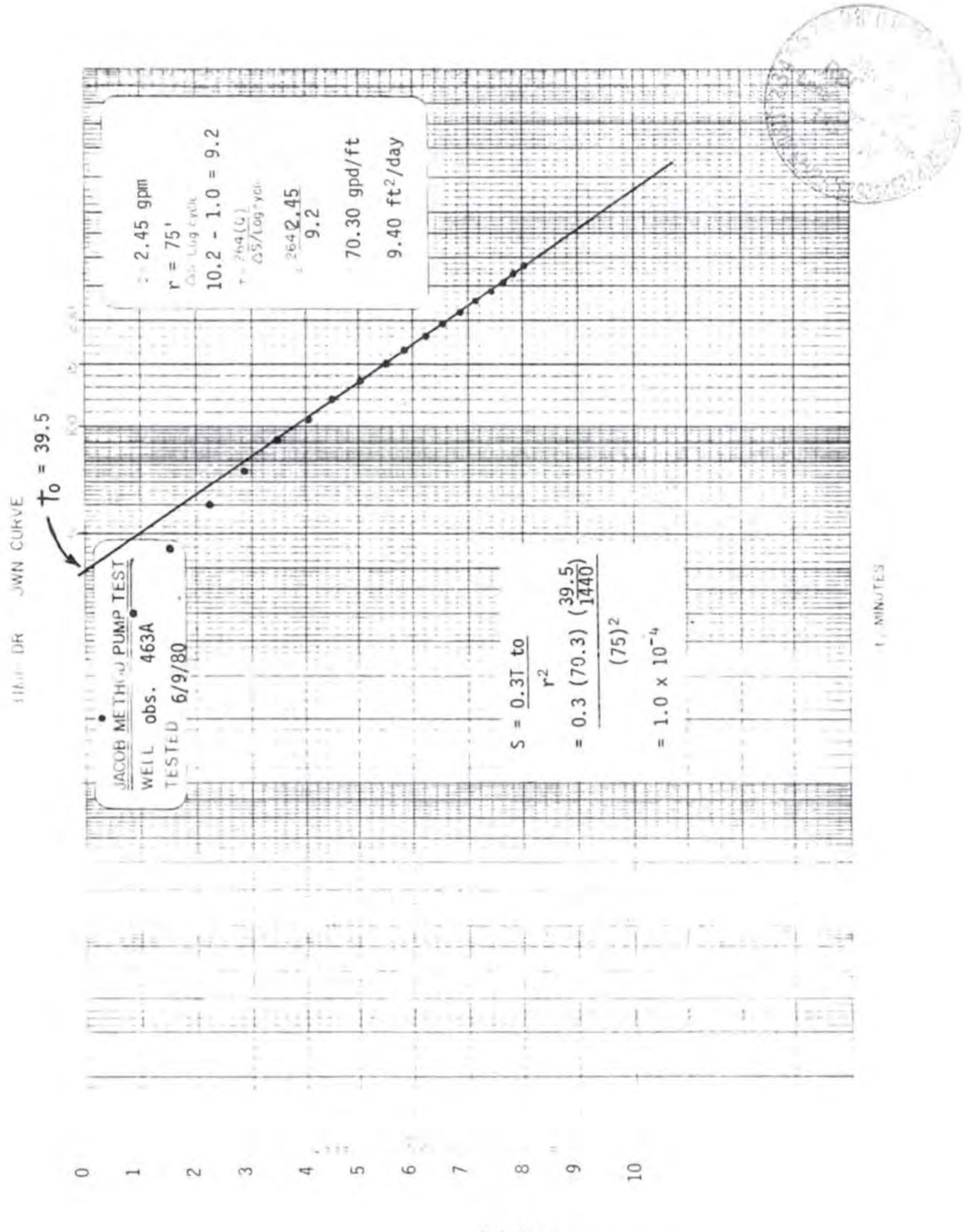
ide of land rface 3701.7' How determined surveyed MP Above Below LSD _____ Altitude MP _____

from MP 79.70' How measured Galvanometer - continuous recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
5-9-80	0910	79.70	0			0
	0925	80.02	15			0.32
	0940	80.51	30			0.81
	0955	81.22	45			1.52
	1010	81.91	60			2.21
	1025	82.52	75			2.82
	1040	83.17	90			3.47
	1055	83.74	105			4.04
	1110	84.27	120			4.57
	1125	84.72	135			5.02
	1140	85.18	150			5.48
	1155	85.55	165			5.85
	1210	85.95	180			6.25
	1225	86.26	195			6.56
	1240	86.54	210			6.84
	1255	86.84	225			7.14
	1310	87.10	240			7.40
	1325	87.31	255			7.61
	1340	87.50	270			7.80
	1355	87.71	285			8.01
OFF	1400	87.77	290	0		8.07
	1410	87.85	300	10	30	8.15
	1425	87.87	315	25	12.60	8.17
	1440	87.71	330	40	8.25	8.01
	1455	87.41	345	55	6.27	7.71
	1510	87.07	360	70	5.14	7.37
	1525	86.67	375	85	4.41	6.97
	1540	86.24	390	100	3.90	6.54
	1555	85.80	405	115	3.52	6.10

JAN 1982 RECEIVED Land Quality Div. Dist. IV

D6-320
TFN 6 2/025
REDD 10-25-18

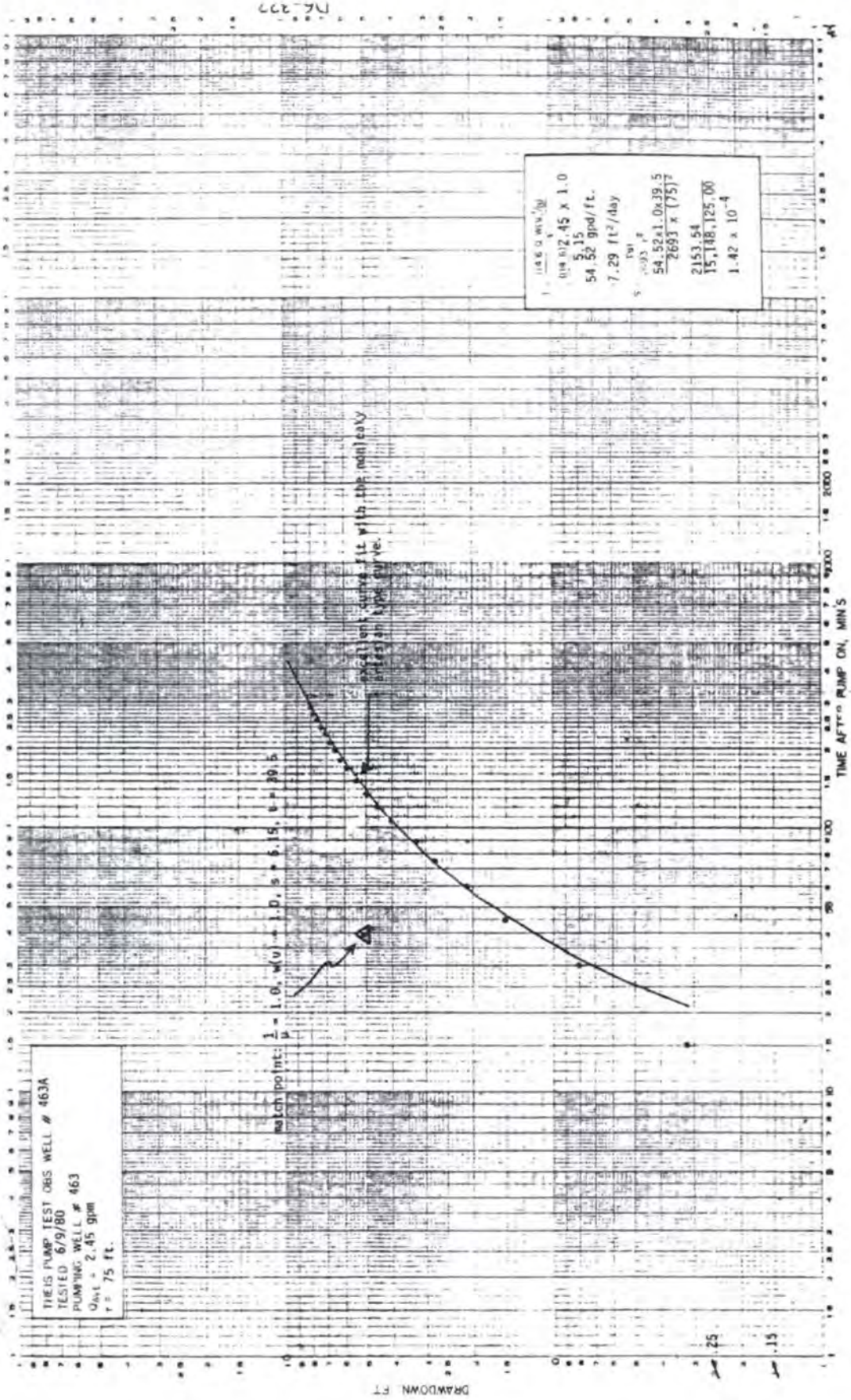


D6-321

TFN 6 2/025

RECD 10-25-18

DEQ Ex. 3-1273



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DEQ Ex. 3-1274

TFN 6 2/025
RECD 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N), R. 84 (W), Sec. 26 WELL NO. 464

Personnel Bondar - Gentry

Test Type: (1) Single well drawdown (2) Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner PKS

ss Sheridan, WY Box 3049 Driller R. Reed

Method drilled: (A) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slots Interval of screen or perforation 163' - 180'

Pump hp & type 3/4 Teel Pump depth 210 ft. Aquifer Dietz 1B

Aquifer lithology coal Altitude of land surface 3781.9

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 107.12 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
6-11-80	0900	107.12	0			0
	02	122.15	2			15.00
	05	137.25	5			30.13
	15	164.09	15			56.97
	25	169.60	25			62.48
	35	174.13	35			67.01
	45	175.88	45			68.76
	1000	175.58	60			68.46
	15	182.00	75			74.88
	30	181.82	90			74.70
	45	183.06	105			75.94
	1100	183.36	120			76.24
	20	183.62	140			76.50
	40	183.54	160			76.42
	1200	186.12	180			79.00
	20	190.95	200			83.83
	40	188.40	220			81.32
	1300	188.05	240			80.93
	20	189.00	260			81.88
	40	190.32	280			83.20
OFF						

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

e Wyoming County Sheridan T. 57 (N.) R. 84 (E.W.) Sec. 26 WELL NO. 464

onnel Bondar - Gentry Test (1.) Single well drawdown 3. Drawdown with obs. well 5. Other (specif
type: (2.) Single well recovery 4. Recovery with obs. well

owner PKS Address Box 3049 Sheridan, WY

ler R. Reed Method drilled: (A.) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

l pth 220 ft. Well diameter 7 7/8 in.

ng diameter 5 in. Casing type PVC

e of screen r perforation slots Interval of screen or perforation 163'-180' Pump hp. & type 3/4 Teel Pump depth 210 ft.

ifer Dietz 1B Aquifer lithology Coal

tude of land surface 3781.9 How determined surveyed MP Above Below LSD Altitude MP

. from MP 107.12 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
	51	184.91	291	1	291	77.79
	53	176.99	293	3	97.66	69.87
	56	173.39	296	6	49.33	66.27
	1400	171.38	300	10	30.00	64.26
	05	169.03	305	15	20.33	61.91
	15	165.00	315	25	12.60	57.88
	30	159.70	330	40	8.25	52.58

D6-324

WATER WELL 464

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
6-11-80						
	05	49.00	3.67	3.00	5	18.35
	15	155.00	1.16	3.00	10	11.60
	35	190.00	.95	3.00	20	19.00
	45	358.00	.50	3.00	10	5.00
	1000	358.00	.50	3.00	15	7.50
	15	137.00	1.31	3.00	15	19.65
	30	350.00	.51	3.00	15	7.65
	45	312.00	.58	3.00	15	8.70
	1120	335.00	.54	3.00	35	18.90
	40	335.00	.54	3.00	20	10.80
	1200	230.00	.78	3.00	20	15.60
	20	230.00	.78	3.00	20	15.60
	40	460.00	.39	3.00	20	7.80
	1300	325.00	.55	3.00	20	11.00
	20	330.00	.55	3.00	20	11.00
	40	325.00	.55	3.00	30	16.50
				TOTALS	290.00	204.65
	Average	Q = 204.65 gal. / 290.00 min.	.71 gpm			
		specific capacity = .71 gpm / 83.75ft.	= .01 gpm/ft			

D6-325
TFN 6 2/025
RECD 10-25-18

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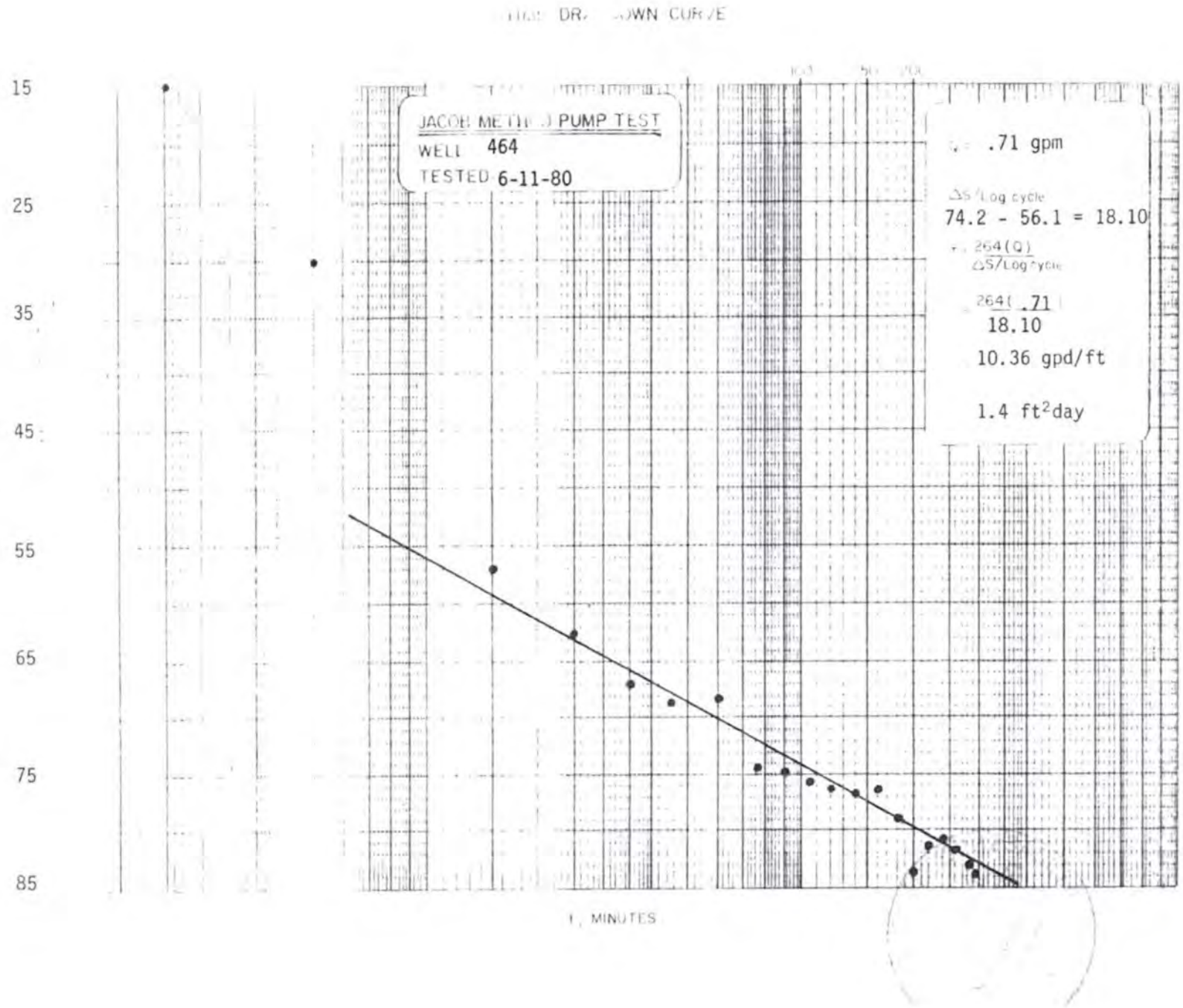
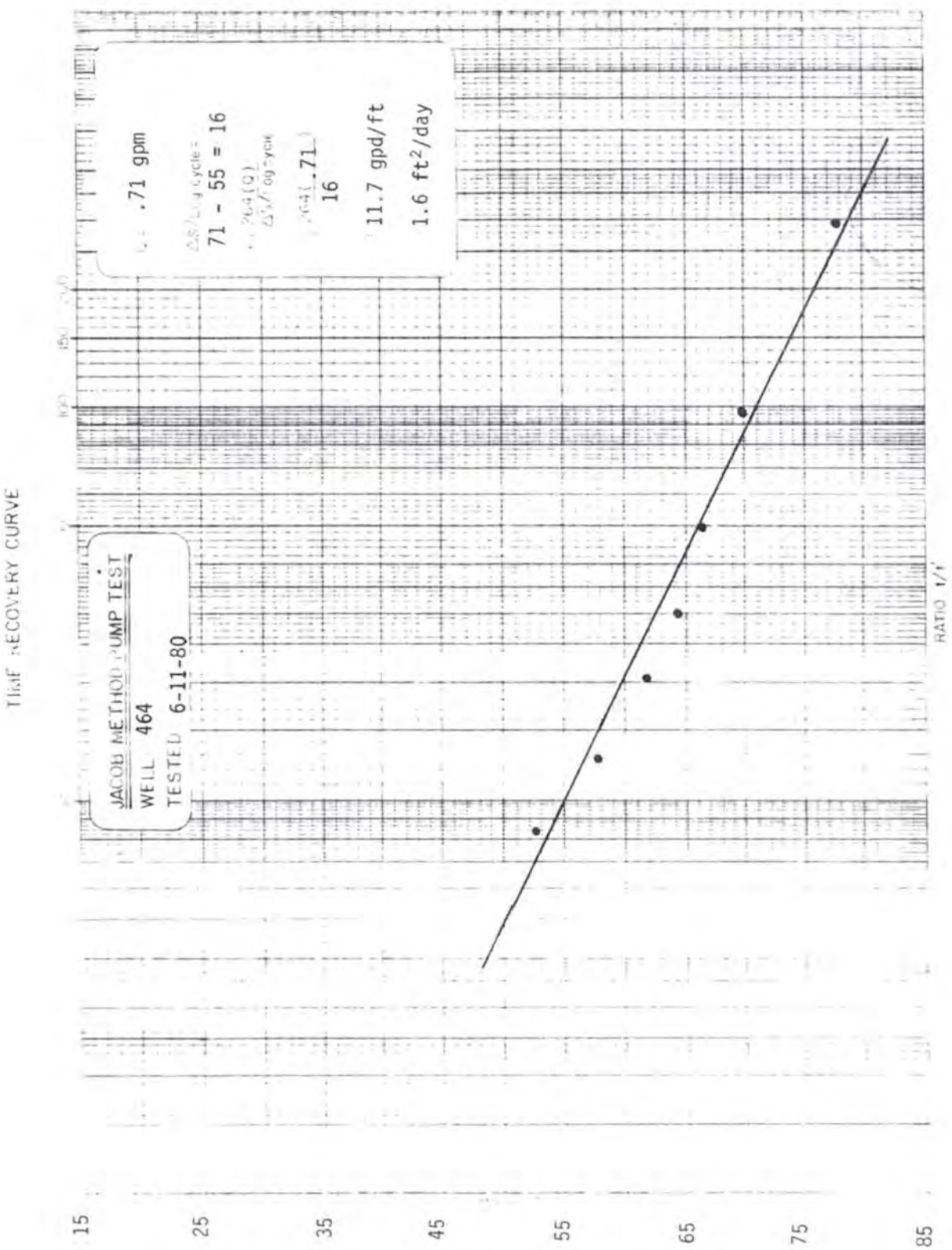


DFR826 2/025
RECD 10-25-18

DEQ Ex. 3-1278



D6-327

TEN 9 2/025
RECD 10-25-18

DEQ Ex. 3-1279

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RAMACO

Brook Mine

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 W., Sec. 24 WELL NO. BH 688

Personnel Collier

Test Type: (1) Single well drawdown (2) Single well recove
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner PKS

Address Sheridan, Wyoming

Driller D. Fudge

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 280 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 245' - 265'

Pump hp & type ½ red jacket Pump depth 250 ft. Aquifer Dietz 1B

Aquifer lithology coal Altitude of land surface 3719'

How determined surveyed MP Above Below LSD Altitude MP 3720.3'

WL from MP 119.59 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
11-13-81						
PUMP ON	0920	119.59	0			0
	0921	126.95	1			7.36
	0924	139.51	4			19.92
	0926	145.82	6			26.23
	0930	150.01	10			30.42
	0933	152.74	13			33.15
	0941	154.30	21			34.71
	0950	156.48	30			36.89
	1000	158.17	40			38.58
	1015	159.00	55			39.41
	1031	161.40	71			41.81
	1050	162.23	90			42.64
	1115	163.21	115			43.62
	1145	164.25	145			44.66
PUMP OFF	1230	165.33	190	0		45.74
	1231	158.20	191	1	191	38.61
	1232	153.02	192	2	96	33.43
	1233	148.77	193	3	64.33	29.1
	1234	145.55	194	4	48.50	25
	1235	143.00	195	5		

TFN 6 2/025
RECD 10-25-18

AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S. R. 84 E. W. Sec. 24 WELL NO. BH 688

Personnel Collier

Test Type: (1) Single well drawdown (2) Single well recove
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner PKS

ress Sheridan, Wyoming Driller D. Fudge

hod drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 280 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 245' - 265'

Pump hp & type ½ red jacket Pump depth 250 ft. Aquifer Dietz 1B

Aquifer lithology Coal Altitude of land surface 3719'

How determined Surveyed MP Above Below LSD Altitude MP 3720.3'

WL from MP 119.59 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
11-13-81	1240	134.40	200	10	20.00	14.81
	1245	131.05	205	15	13.67	11.46
	1255	128.13	215	25	8.60	8.54
	1310	126.50	230	40	5.75	6.91
	1330	125.40	250	60	4.17	5.81
	1453	123.87	333	143	2.33	4.28

TFN 6 2/025
RCVD 10-25-18

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WATER WELL BH 688

PUMPING RATE DATA

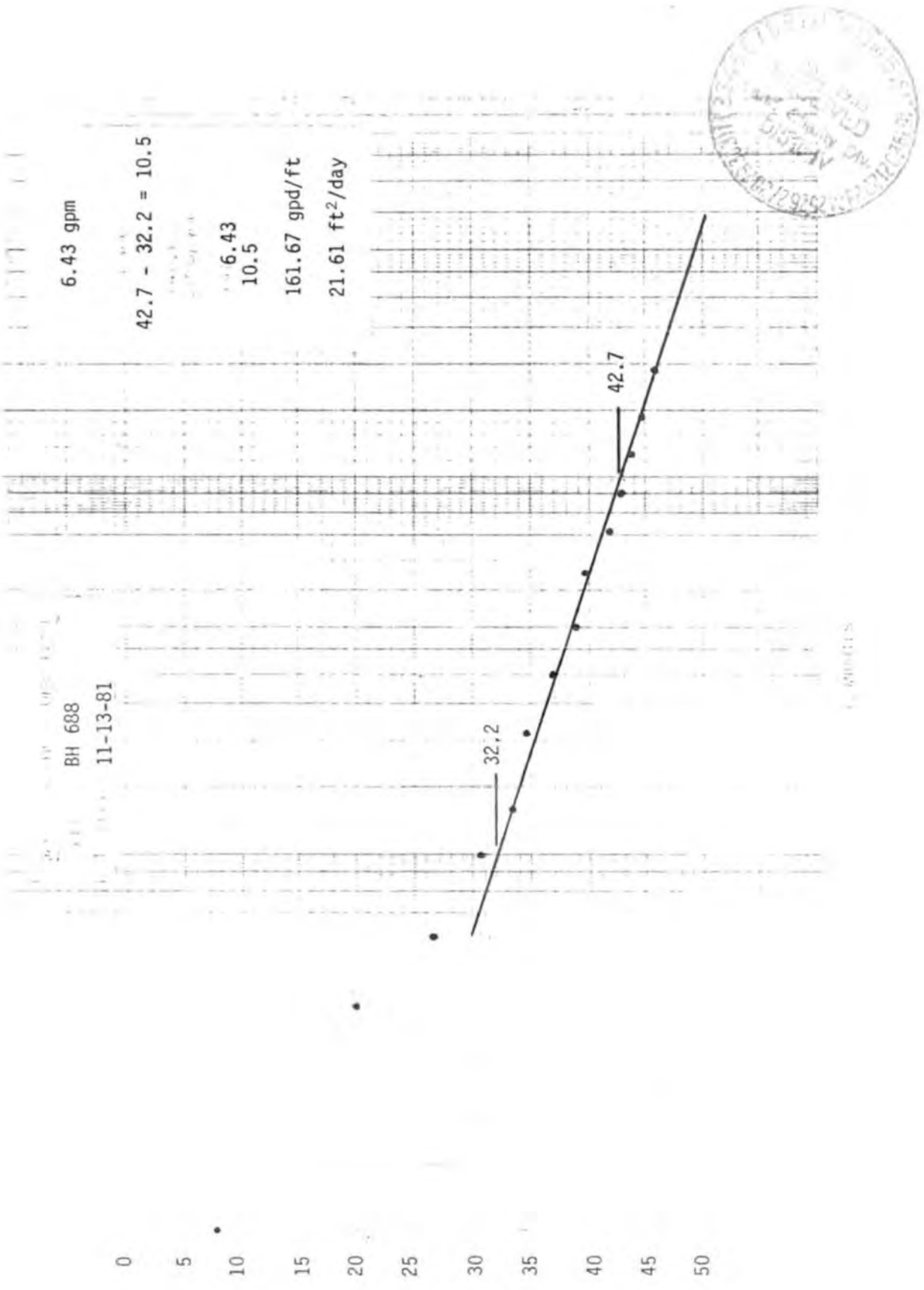
JAN 1983 RECEIVED Land Quality Div. DIST. IV

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
11-13-81	0921	42	7.14	5	1	7.14
	0924	44	6.82	5	3	20.46
	0933	45	6.67	5	9	60.03
	0941	46	6.52	5	8	52.16
	0950	46	6.52	5	9	58.68
	1015	45	6.67	5	25	166.75
	1050	46.5	6.45	5	35	225.75
	1115	46.5	6.45	5	25	161.25
	1145	48	6.25	5	30	187.50
	1230	48	6.25	5	45	281.25
				TOTALS =	190	1220.97

Average Q = $\frac{1220.97}{190}$ = 6.43 gpm

Specific Capacity = $\frac{6.43 \text{ gpm}}{45.74 \text{ ft}}$ = .14 gpm/ft

D6-330
TFN 6 2/025
REGD 10-25-18



D6-331
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1283

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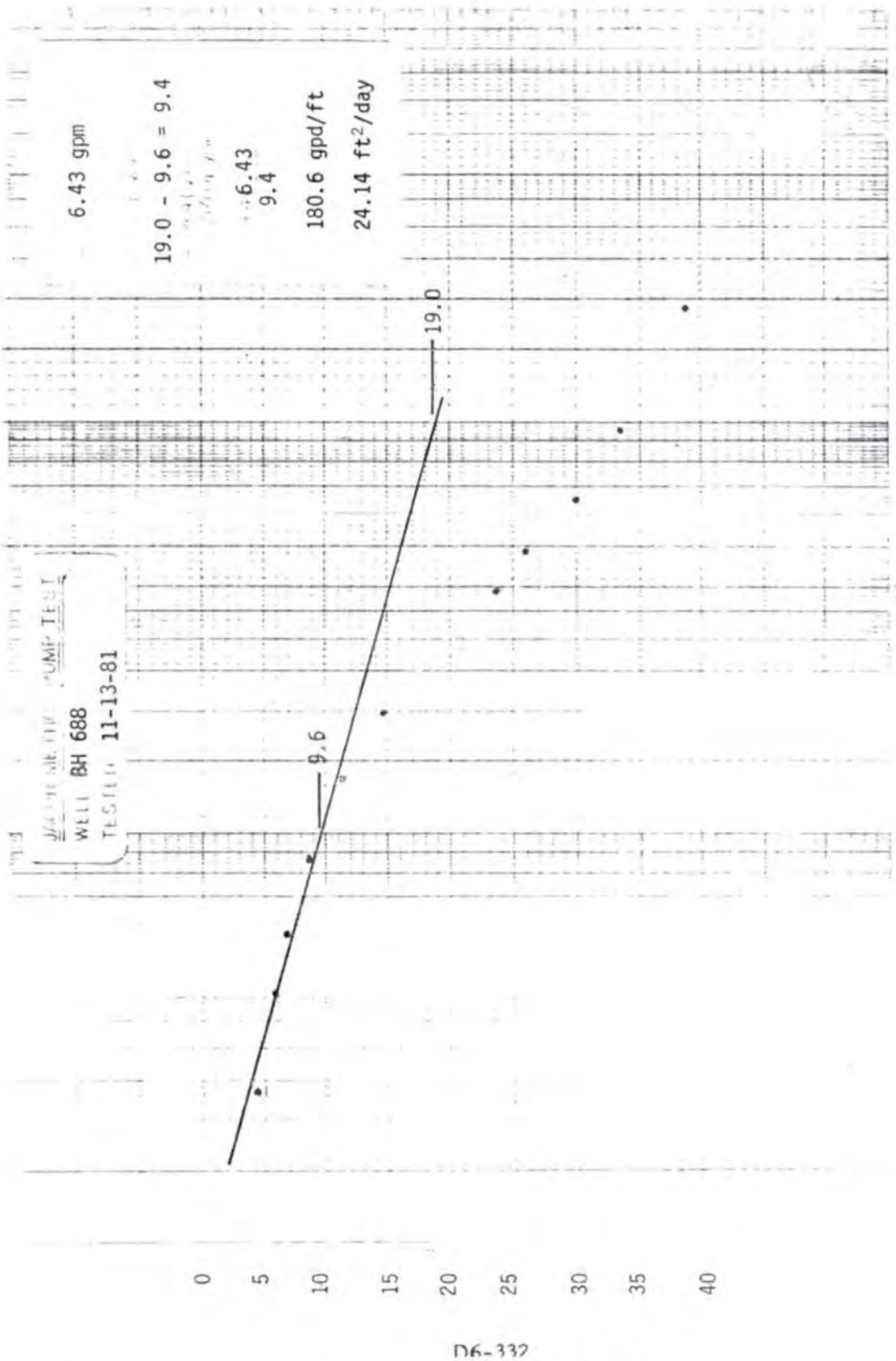

DEQ Ex. 3-1284

D6-332
YFN 6 2/025
RECD 10-25-18

DIETZ - 2

COAL WELLS

D6-333

TFN 8 2/025
RECD 10-25-18

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RAMACO
GEOLOGY AND EXPLORATION

Brook Mine

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO. 469

nel Bondar

Test type: (1) Single well drawdown (2) Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify)

wner PKS Address Box 3049 Sheridan, WY

R Reed

Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

th 253 ft. Well diameter 7 7/8 in.

diameter 5 in. Casing type PVC

of screen perforation slots Interval of screen or perforation 227 - 244'

Pump hp. & type 3/4 Teel Pump depth 200 ft.

r Dietz 2BC Aquifer lithology Coal

de of land face 3614.9 How determined Surveyed MP Above Below LSD Altitude MP

rom MP 33.78 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
-3-80	0840	33.78	0			0
	41	44.18	1			10.40
	43	54.65	3			20.87
	46	66.46	6			32.68
	50	76.15	10			42.37
	55	81.84	15			48.06
	0900	84.35	20			50.57
	10	86.76	30			52.98
	20	87.58	40			53.80
	30	88.17	50			54.39
	45	89.13	65			55.35
	1000	89.74	80			55.96
	15	90.53	95			56.75
	30	91.23	110			57.45
Pump Off	48		128	0		
	49	79.25	129	1	129	45.47
	51	74.23	131	3	43.66	40.45
	54	68.32	135	6	22.50	34.54
	1100	58.86	141	12	11.75	25.08
	10	47.60	151	22	6.86	13.82
	20	41.44	161	32	5.03	7.66
	30	38.19	171	42	4.07	4.41
	40	36.55	181	52	3.48	2.77
	55	35.56	196	67	2.92	1.78
	1210	35.10	211	92	2.29	1.32
	25	34.90	226	107	2.11	1.12
	45	34.69	246	127	1.93	.91
	1305	34.55	266	147	1.80	.77
	[illegible]	34.43	291	172	1.70	.65

D6-334

FEB 6 2025

RECD 10-25-18

WATER WELL 469

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7-3-80	0800					
	0843	30.00	6.00	3.00	3	18.00
	50	46.50	3.90	3.00	7	27.30
	0900	56.40	3.20	3.00	10	32.00
	10	60.50	3.00	3.00	10	30.00
	20	61.00	3.00	3.00	10	30.00
	30	66.40	2.71	3.00	10	27.10
	45	60.00	3.00	3.00	15	45.00
	1000	61.40	2.93	3.00	15	43.95
	15	65.00	2.77	3.00	15	41.55
	30	63.60	2.83	3.00	15	42.45
				TOTALS	110	337.55

Total average Q = 337.55 gals = 3.38 gpm
110 min.

specific capacity = 3.38 gpm = 0.059 gpm/ft
57.45ft

D6-335

TFN 6 2/025

REC'D 10-25-18

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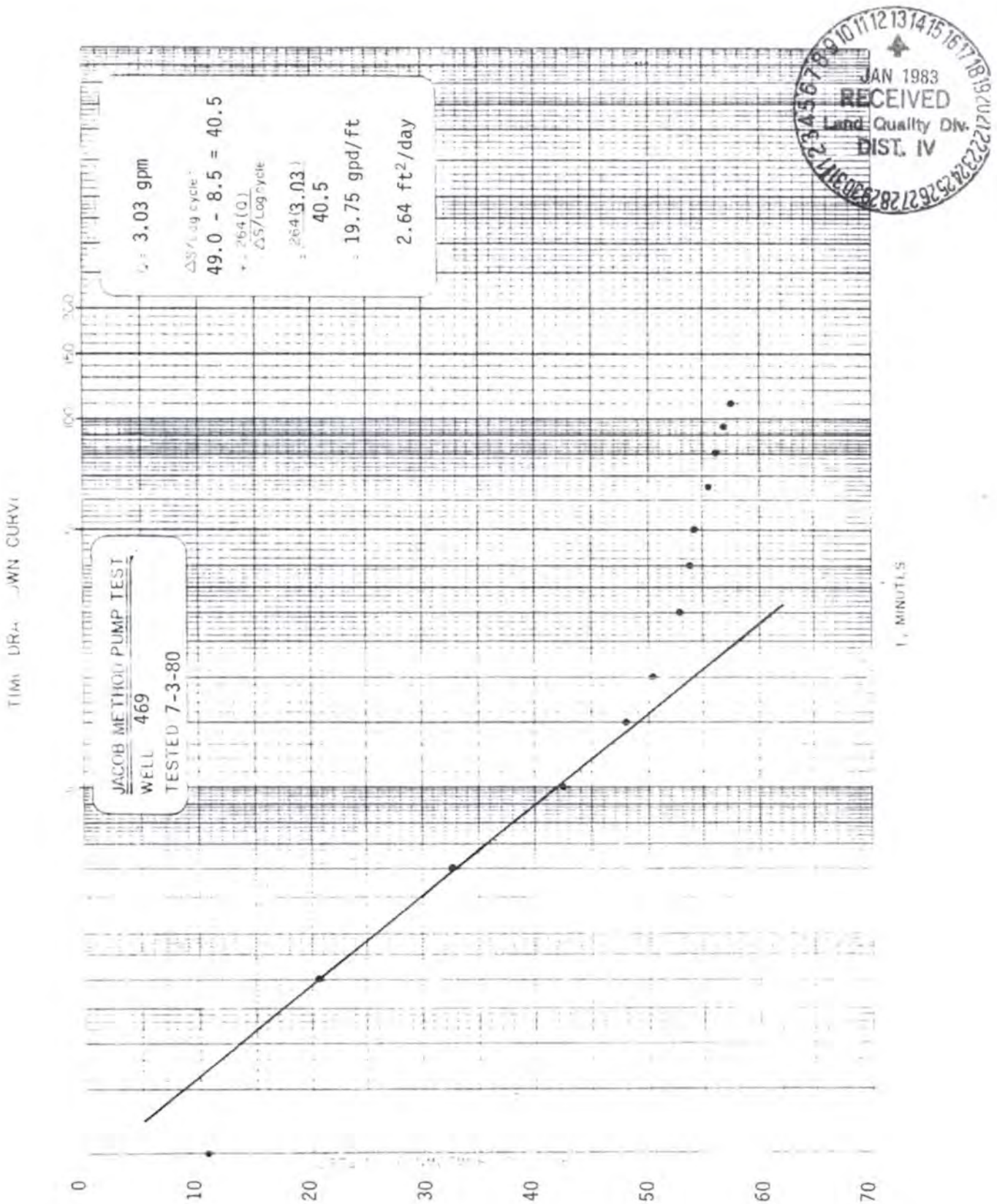

JAN 1983
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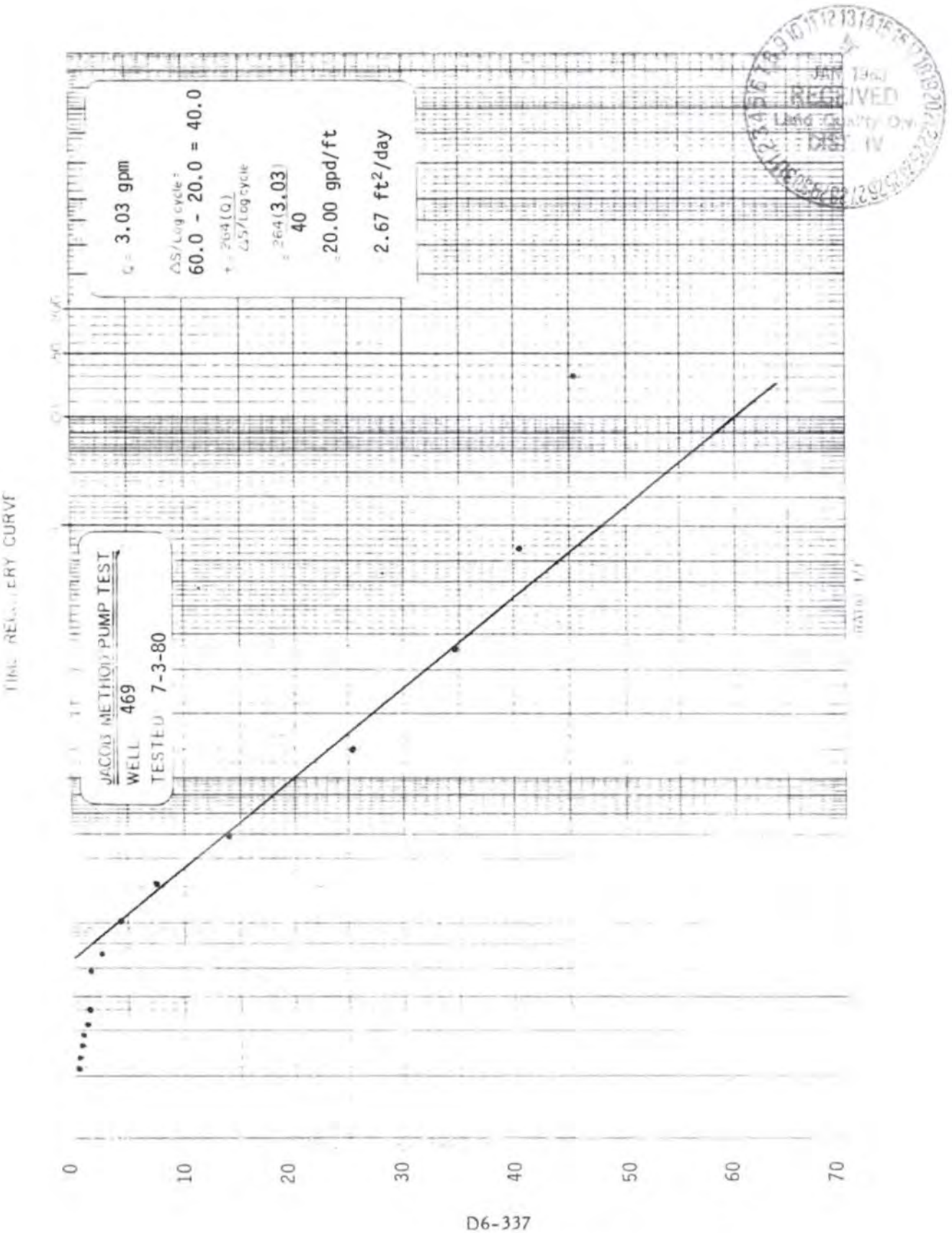
Land Quality Div.
DIST. IV

DEQ Ex. 3-1288

D6-336
TFN 6 2/025
RECD 10-25-18



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Land Quality Div.
Reg. IV

DEQ Ex. 3-1289

TFN 0 2/025
RECD 10-25-18

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Wyoming County Sheridan T. 57 (N.) S. R. 84 (E.) W. Sec. 14 WELL NO. 596

nnel Bondar, Halcolm Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
(2) Single well recovery 4. Recovery with obs. well

owner PKS Address Box 3049 Sheridan, WY

r R. Reed Method drilled: (A) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

h 120 ft. Well diameter 7 7/8 in.

g diameter 5 in. Casing type PVC

of screen slots Interval of screen or perforation 96 - 109' Pump hp. & type 3/4 Teel Pump depth 115 ft.

fer Dietz 2BC Aquifer lithology coal

ude of land urface 3590' How determined surveyed MP Above Below LSD Altitude MP

from MP 23.91' How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
-19-81	0935	23.91	0			0
	36	39.06	1			15.15
	38	52.25	3			28.34
	41	56.67	6			32.76
	45	60.23	10			36.32
	50	64.21	15			40.30
	1000	67.84	25			43.93
	15	70.60	40			46.69
	30	72.08	55			48.17
	45	74.55	70			50.64
	1100	76.43	85			52.52
	20	77.80	105			53.89
	40	79.07	125			55.16
	1200	80.25	145			56.34
	20	81.68	165			57.77
	40	82.54	185			58.63
ump Off	1300	83.39	205	0		59.48
	01	69.37	206	1	206	45.46
	03	53.85	208	3	69.33	29.94
	06	44.47	211	6	35.17	20.56
	10	39.80	215	10	21.50	15.89
	15	37.00	220	15	14.67	13.09
	20	35.40	225	20	11.25	11.49
	30	33.33	235	30	7.83	9.42
	45	31.62	250	45	5.56	7.71
	1400	30.54	265	60	4.42	6.63
	20	29.63	285	80	3.56	5.72
	40	29.05	305	100	3.05	5.14
	1500	28.55	325	120	2.71	4.64

D6-338
TFN 6 2/025

WATER WELL 596

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
6-19-81	0936	16.10	19.75	5.30	1	19.75
	0938	17.10	18.60	5.30	2	37.20
	0941	19.70	16.14	5.30	3	48.42
	0945	18.60	17.10	5.30	4	68.40
	0950	18.10	17.57	5.30	5	87.85
	1000	18.20	17.47	5.30	10	174.70
	1015	18.60	17.10	5.30	15	256.50
	1030	20.10	15.82	5.30	15	237.30
	1045	19.60	16.22	5.30	15	243.30
	1100	18.60	17.17	5.30	15	257.77
	1120	19.48	16.32	5.30	20	326.40
	1140	20.21	15.73	5.30	20	314.60
	1200	20.16	15.77	5.30	20	315.40
	1220	20.05	15.86	5.30	20	317.20
	1240	20.85	15.25	5.30	20	305.00
	1300	20.24	15.71	5.30	20	314.20
				TOTALS	205	3323.99
			Total Average Q =	3323.99 gal / 205 min = 16.21	gpm	
			Specific capacity	= 16.21 gpm / 59.48 ft = 0.27	gpm/ft	

D6-339
TFN G 2/025
DEQR 10-25-13

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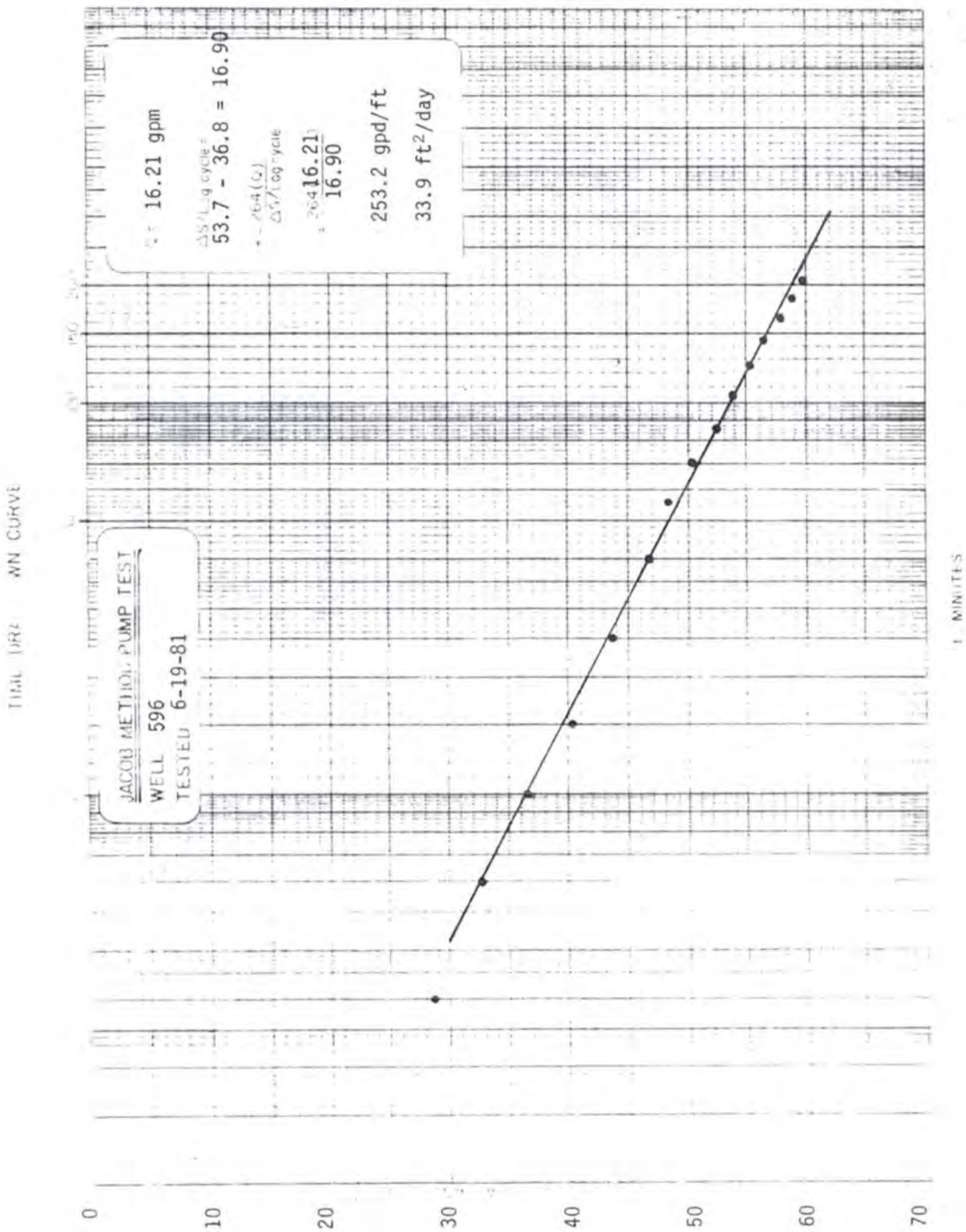
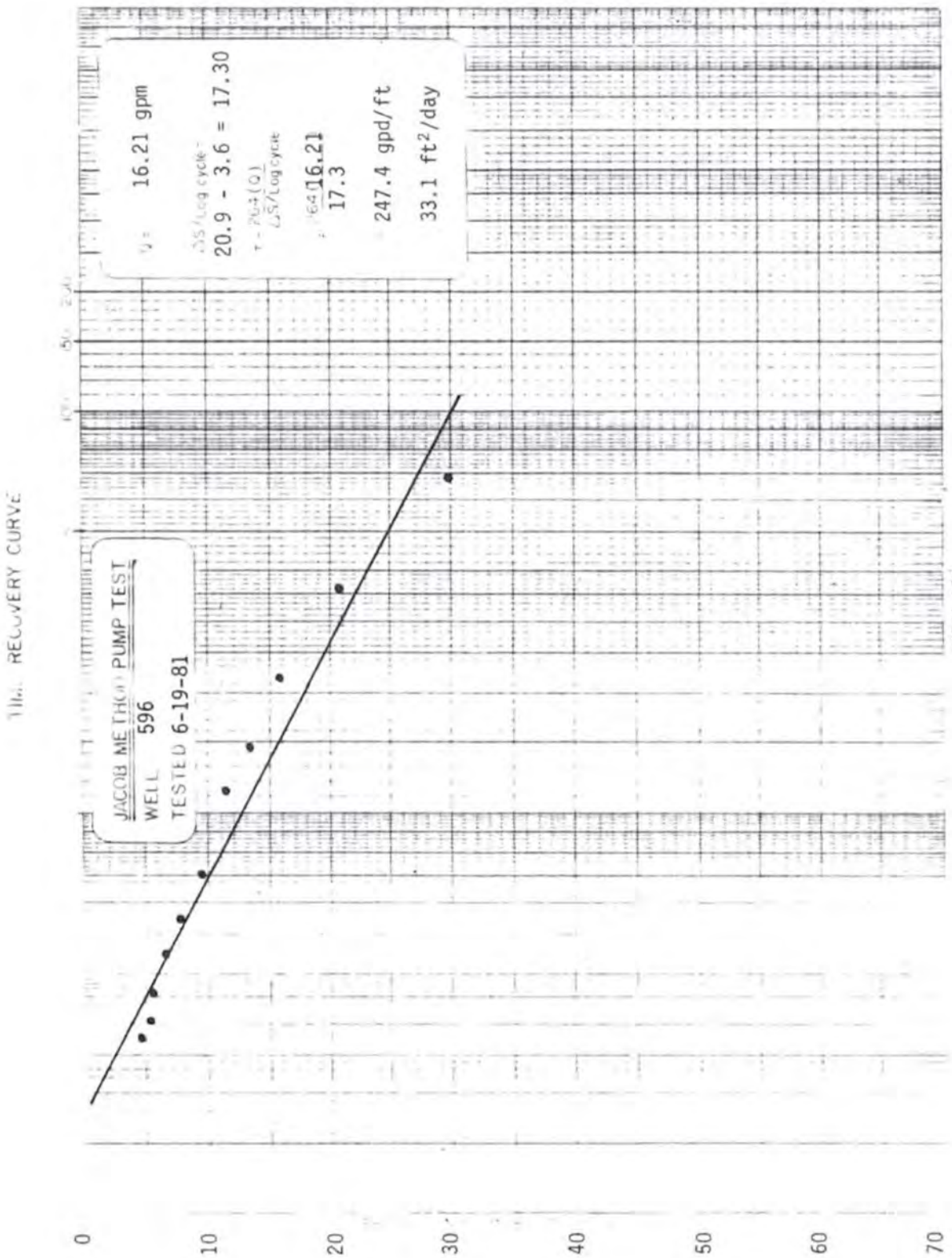


DEQ Ex. 3-1292

D6-340
TFR S 2/025
RECD 10-25-18



D6-341

TFN 5 2/025
RECD 10-25-13

DEQ Ex. 3-1293

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te Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO. BH647

sonnel Bondar - Volk Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specif 2. Single well recovery 4. Recovery with obs. well

l owner PKS Address Box 3049 Sheridan, WY

ler Reed R. Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

al pth 341 ft. Well diameter 7 7/8 in.

ing diameter 5 in. Casing type PVC

e of screen or perforation slots Interval of screen or perforation 314 - 334' Pump hp. & type 3/4 Teel Pump depth 150 ft.

ifer Dietz 2BC Aquifer lithology Coal

tude of land surface 3673' How determined surveyed MP Above Below LSD Altitude MP

from MP 77.20 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
1-2-81	1035	77.20	0			0
	1036	81.22	1			4.02
	38	Galv.	3			---
	41	Malfunct.	6			---
	45		10			---
	50		15			---
	55	95.00	20			17.8
	1100	96.36	25			19.16
	05	96.90	30			19.70
	10	98.98	35			21.78
	20	100.56	45			23.36
	30	104.03	55			26.83
	45	105.56	70			28.36
	1200	105.90	85			28.70
	20	106.65	105			29.45
	40	106.74	125			29.54
	1300	105.37	145			28.17
	20	112.50	165			35.30
	40	112.84	185			35.64
	1400	112.30	205			35.10
	20	111.38	225			34.18
	40	113.95	245			36.75
	1500	115.55	265			38.35
	20	115.77	285			38.57
	30	115.53	295			38.33
Pump at	45	117.13	310			39.93

TFN 6 2/025
DEQ Ex. 3-1294
RECD 10-25-18

Wyoming County Sheridan T. 57 (N) S., R. 84 (E.) (W.) Sec. 24 WELL NO. BH647

nnel Bondar - Volk

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well

owner PKS Address Box 3049 Sheridan, WY

r R. Reed Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Driven with Other

w th 341 ft. Well diameter 7 7/8 in.

g diameter 5 in. Casing type PVC

of screen

perforation slots Interval of screen or perforation 314 - 334' Pump hp. & type 3/4 Teel Pump depth 1150 ft.

fer Dietz 2BC Aquifer lithology Coal

ude of land urface 3673' How determined surveyed MP Above Below LSD Altitude MP

from MP 77.20 How measured Galvanometer

RECEIVED Land Quality Div. DIST. IV

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
1-2-81	1545	117.13	310	0		39.93
	46	112.29	311	1	311	35.09
	48	103.58	313	3	104.3	26.38
	51	94.43	316	6	52.7	17.23
	55	87.62	320	10	32	10.42
	1600	84.47	325	15	21.7	7.27
	10	82.39	335	25	13.4	5.19
	20	81.72	345	35	9.9	4.52
	30	81.22	355	45	7.9	4.02
	1700	80.63	385	75	5.1	3.43
	1730	80.11	415	105	4.0	2.91
	1800	79.82	445	135	3.3	2.62
	1830	79.59	475	165	2.9	2.32
	1900	79.42	505	195	2.6	2.22
	1930	79.25	535	225	2.4	2.05

TFN 9 2/025

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WATER WELL BH647

PUMPING RATE DATA

JAN 1983
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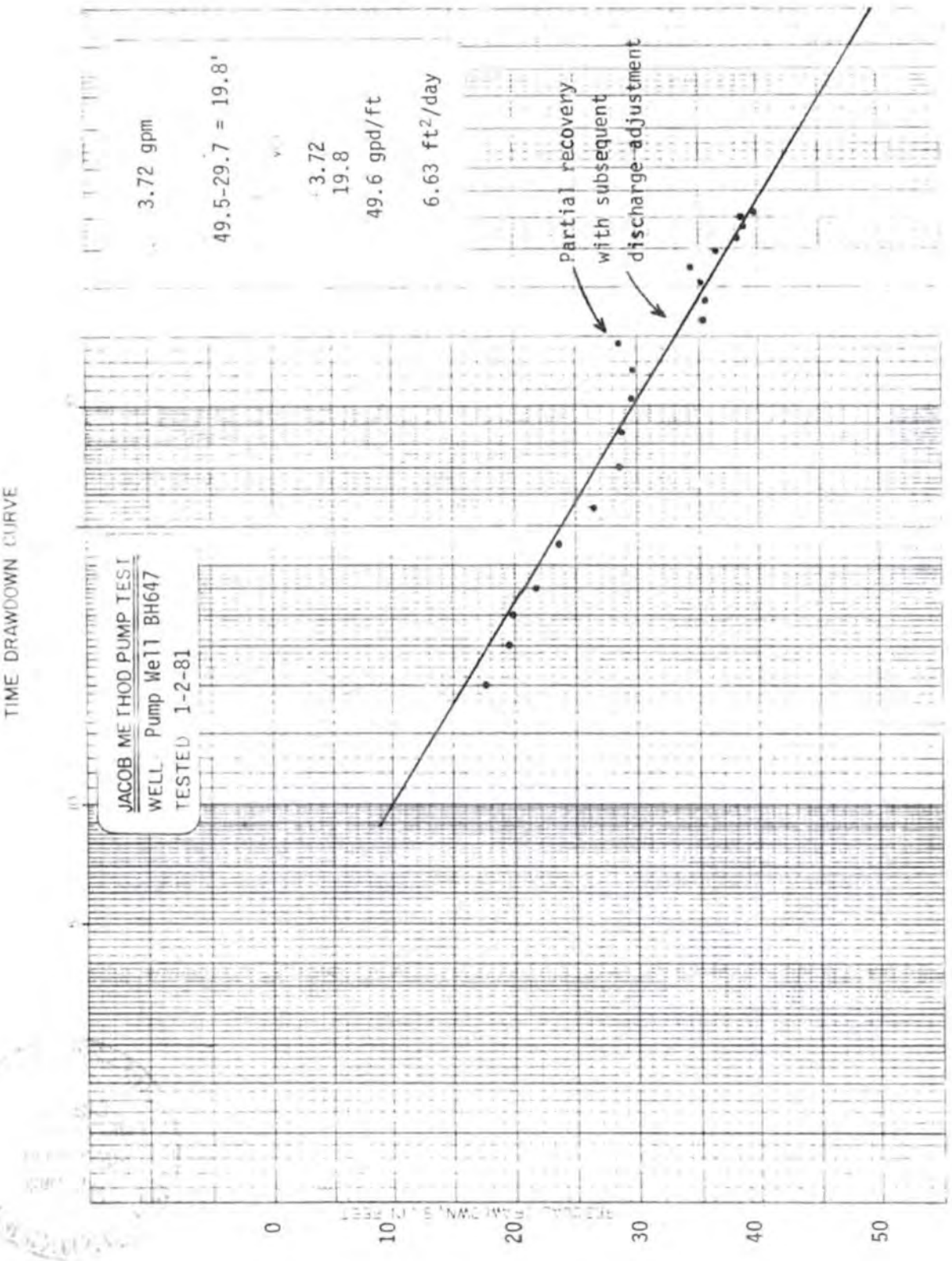
Land Quality Div.
DIST. IV

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
1-2-81	1035	138 (ice in hose - do not use 1035 data)				
	1055	65	2.70	2.92	5	13.50
	1100	63.5	2.76	2.92	5	13.8
	1105	64	2.74	2.92	5	13.7
	1110	57.4	3.05	2.92	10	30.5
	1120	57.7	3.04	2.92	10	30.4
	1130	49	3.58	2.92	15	53.7
	1145	49.5	3.54	2.92	15	53.10
	1200	51.3	3.42	2.92	20	68.4
	1220	48.5	3.61	2.92	20	72.2
	1240	54	3.24	2.92	20	64.8
	1300	42	4.17	2.92	20	83.4
	1320	43.3	4.05	2.92	20	81.0
	1340	44	3.98	2.92	20	79.6
	1400	45.5	3.85	2.92	20	77.0
	1420	46	3.81	2.92	20	76.2
	1440	42	4.17	2.92	10	41.7
	1450	45	3.89	2.92	10	38.9
	1500	42.5	4.12	2.92	20	82.4
	1520	42	4.17	2.92	25	104.25
				TOTAL =	290	1,078.55
				$\bar{Q} = \frac{1078.55}{290} = 3.72$ gpm		
				spec. cap. = $\frac{3.72}{39.93ft}$ = 0.1 gpm/ft.		

D6-344

TFN 6 2/025
DEQ Ex. 3-1296
RECD 10-25-18

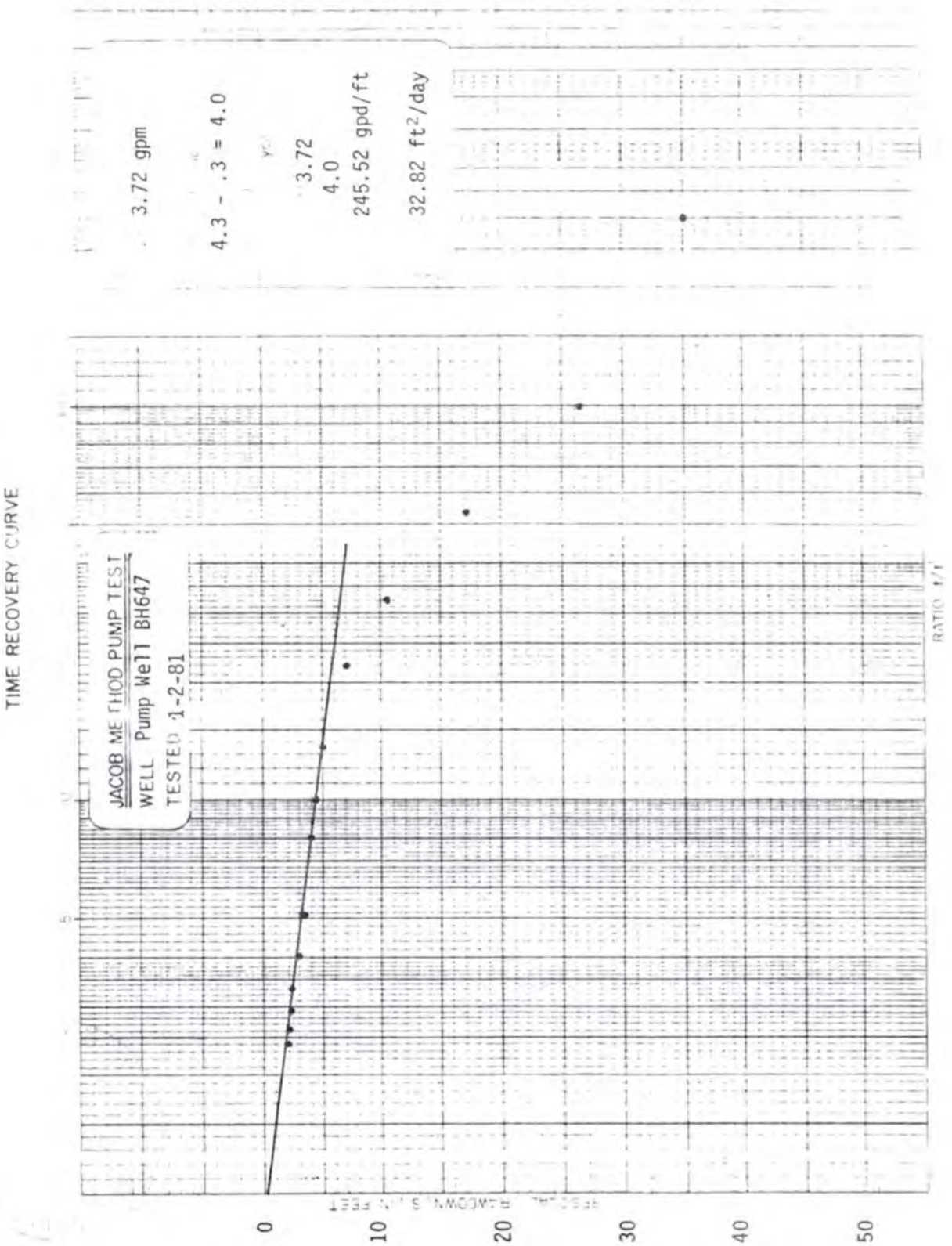
D6-345



DEQ Ex. 3-1297

TFR 5 2/025
RECD 10-25-18

D6-346



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DEQ Ex. 3-1298

TFN 6 2/025
RECD 10-25-18

5. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO obs BH466

Personnel Bondar - Volk Test type: 1. Single well drawdown 3. Drawdown with obs. well (5) Other (specify) 2. Single well recovery 4. Recovery with obs. well

Owner PKS Address Box 3049 Sheridan, WY obs-Well Drawdown

Driller R. Reed Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 320 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation slots Interval of screen or perforation 289 - 304' Pump hp. & type N/A Pump depth ____ ft.

Aquifer Dietz 2BC Aquifer lithology coal

Altitude of land surface 3660.5' How determined surveyed MP Above Below LSD ____ Altitude MP ____

Measured from MP 68.0 How measured Steven's Recorder & Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
1-2-81	1035	68.0	0			0
	50	68.01	15			.01
	1105	68.08	30			.08
	1120	68.17	45			.17
	35	68.28	60			.28
	1205	68.56	90			.56
	1235	68.82	120			.82
	1305	69.06	150			1.06
	1335	69.27	180			1.27
	1405	69.49	210			1.49
	1505	69.85	270			1.85
	1535	70.02	300			2.02
Pump off	1545	70.04	310			2.04

D6-347

TFN 6 2/025

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Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO. Obs BH466

nnel Bondar - Volk Test type: 1. Single well drawdown 3. Drawdown with obs. well (5.) Other (specify) 2. Single well recovery 4. Recovery with obs. well

owner PKS Address Box 3049 Sheridan, WY Obs Well Recovery

r Reed Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

h 320 ft. Well diameter 7 7/8

g diameter 5 in. Casing type PVC

of screen perforation slots Interval of screen or perforation 289 - 304' Pump hp. & type N/A Pump depth ____ ft.

fer Dietz 2RC Aquifer lithology coal

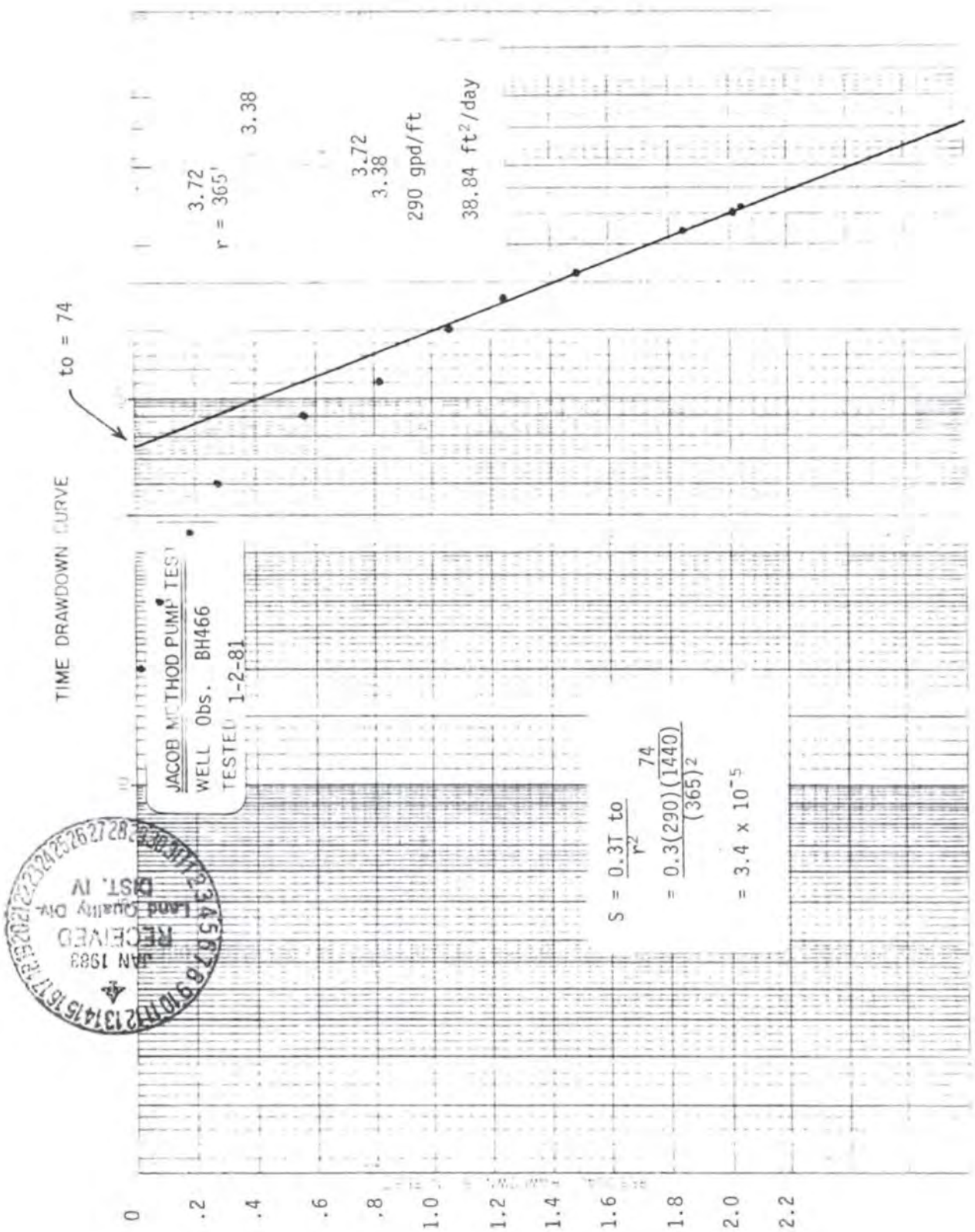
ade of land urface 3660.5' How determined surveyed MP Above Below LSD ____ Altitude MP ____

from MP 68.0 How measured Steven's Recorder & Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
1-2-81	1545	70.04	310	0	0	2.04
	1550	70.09	315	5	63	2.09
	1558	70.12	323	13	24.85	2.12
	1612	70.12	337	27	12.48	2.12
	1620	70.10	345	35	9.86	2.10
	1635	70.02	360	50	7.20	2.02
	1705	69.83	390	80	4.88	1.83
	1805	69.50	450	140	3.21	1.50
	1905	69.26	510	200	2.55	1.26
	2005	69.10	570	260	2.19	1.10
	2105	68.98	630	320	1.97	.98
	2205	68.87	690	380	1.82	.87
	2305	68.79	750	440	1.70	.79
1-3-81	2405	68.72	810	500	1.62	.72
	105	68.65	870	560	1.55	.65
	205	68.59	930	620	1.50	.59
	305	68.54	990	680	1.46	.54
	405	68.50	1050	740	1.42	.50
	505	68.46	1110	800	1.39	.46
	605	68.42	1170	860	1.36	.42
	705	68.39	1230	920	1.34	.39
	740	68.36	1290	955	1.35	.36

D6-348
TFN 6 2/025
RECD 10-25-18

D6-349



DEQ Ex. 3-1301

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RECD 10-25-18

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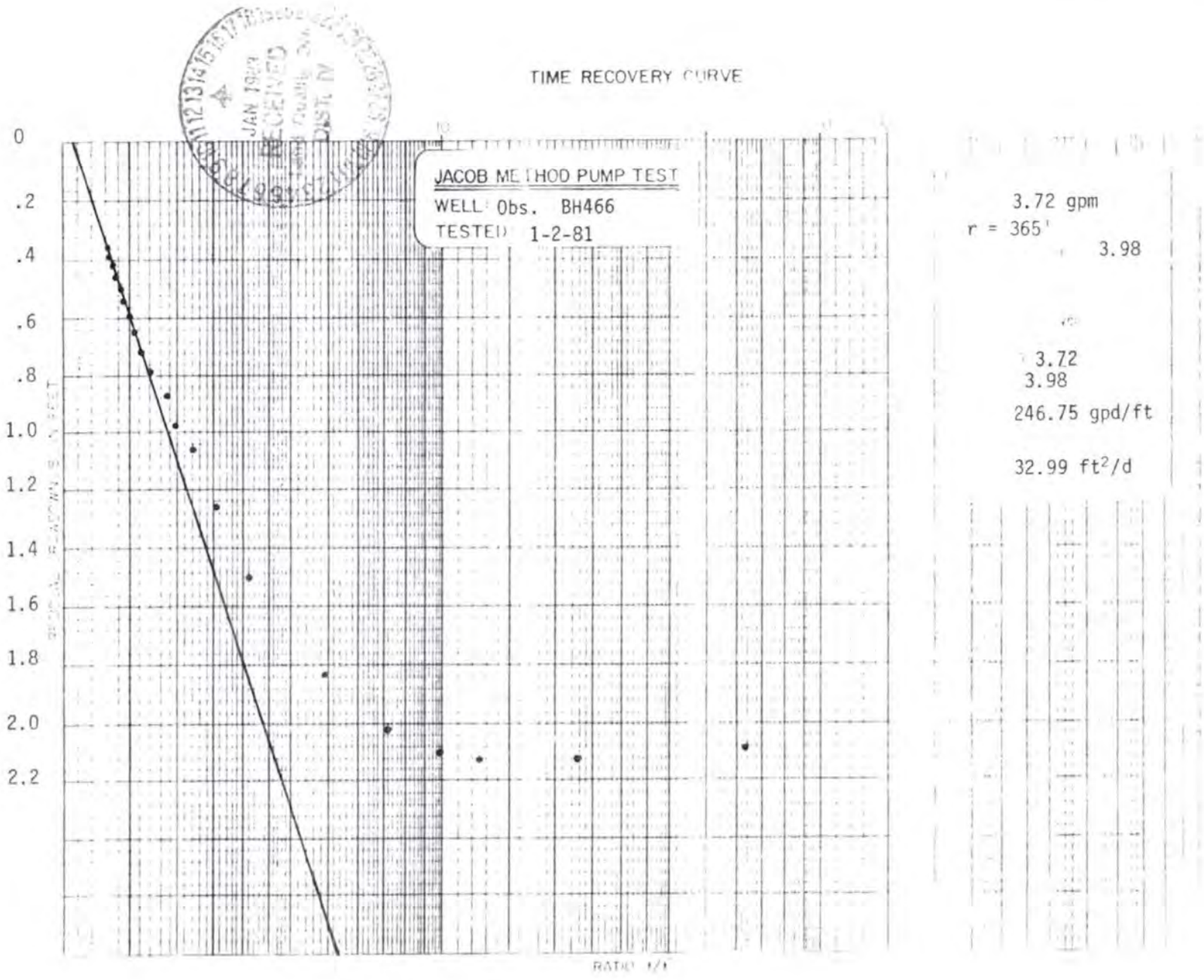
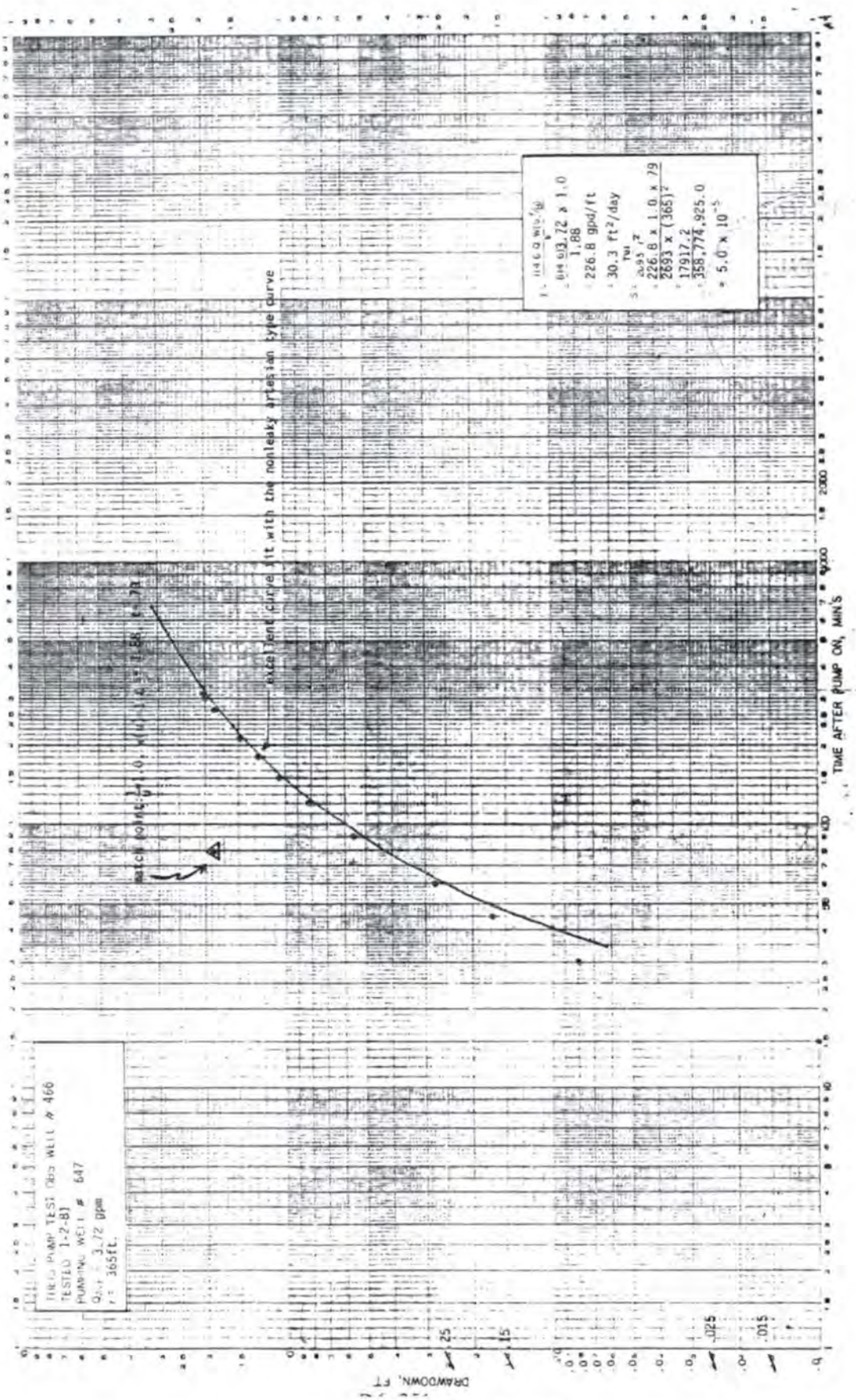


JAN 1982 RECEIVED DIST. IV

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1302



DEQ Ex. 3-1303

TFN G 2/025
RECD 10-25-18

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JAN 1983
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Land Quality DIV.
DIST. IV

SPOIL WELLS

D6-352
N S 2/025
RECD 10-25-18

State Wyoming County Sheridan T. 57 N., R. 84 W., Sec. 22 WELL NO. obs. 655

Personnel Bondar & Gentry

Test Type: 1. Single well drawdown 2. Single well recovery (3.) Drawdown with obs. well (4.) Recovery with obs. well 5. Other (Specify)

Well Owner PKS

Address Box 3049 Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H.) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 172' - 212'

Pump hp & type Pump depth ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 183.80 How measured Galvanometer - Stevens Recorder

RECEIVED JAN 1990 Land Quality

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7/21/81	0800	183.80	0			0
	0815	184.09	15			0.29
	0830	184.20	30			0.40
	0845	184.26	45			0.46
	0900	184.30	60			0.50
	0915	184.32	75			0.52
	0930	184.35	90			0.55
	0945	184.38	105			0.58
	1000	184.40	120			0.60
	1015	184.42	135			0.62
	1030	184.45	150			0.65
	1045	184.47	165			0.67
	1100	184.49	180			0.69
	1115	184.50	195			0.70
	1130	184.52	210			0.72
	1145	184.53	225			0.73
	1200	184.54	240			0.74
	1215	184.55	255			0.75
	1230	184.56	270			0.76
	1245	184.57	285			0.77
	1300	184.58	300			0.78

D6-353

TFN 6 2/025

DEQ 10-25-18

Scanned, 02/26/2020

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 (E) W., Sec. 22 WELL NO. obs. 655

Personnel Bondar and Gentry Test Type: 1. Single well drawdown 2. [illegible] recovery (3) Drawdown with obs. well (4) Recovery with obs. well 5. Other (Specify)

Well Owner PKS

Address Box 3049 Sheridan, WY Driller R. Reed

How drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 172' - 212'

Pump hp & type Pump depth ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 183.80 How measured galvanometer - Steven's Recorder

JAN 1983 RECEIVED Land Quality Div. DIST. 1

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1315	184.59	315			0.79
	1330	184.60	330			0.80
	1345	184.61	345			0.81
Pump Off	1400	184.62	360	0		0.82
	1415	184.28	375	15	25.00	0.48
	1430	184.20	390	30	13.00	0.40
	1445	184.16	405	45	9.00	0.36
	1500	184.13	420	60	7.00	0.33
	1515	184.11	435	75	5.80	0.31
	1530	184.09	450	90	5.00	0.29
	1545	184.07	465	105	4.43	0.27
	1600	184.05	480	120	4.00	0.25
	1615	184.04	495	135	3.67	0.24
	1630	184.02	510	150	3.40	0.22
	1645	184.01	525	165	3.18	0.21
	1700	183.99	540	180	3.00	0.19
	1730	183.97	570	210	2.71	0.17
	1800	183.95	600	240	2.50	0.15
	1830	183.94	630	270	2.33	0.14
	1900	183.93	660	300	2.20	0.13
	1930	183.92	690	330	2.09	0.12

DEQ 2/2025

State Wyoming County Sheridan T. 57 (N) S, R. 84 (E) W, Sec. 22 WELL NO. obs. 655

Personnel Bondar and Gentry

Test Type: (1) Single well drawdown (2) Single well recover (3) Drawdown with obs. well (4) Recovery with obs. well 5. Other (Specify)

Well Owner PKS

Address Box 3049 Sheridan, WY Driller R. Reed

d drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 172' - 212'

Pump hp & type Pump depth ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 183.80 How measured galvanometer - Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	2000	183.91	720	360	2.00	0.11
	2030	183.90	750	390	1.92	0.10
	2100	183.89	780	420	1.86	0.09
	2200	183.88	840	480	1.75	0.08
	2300	183.87	900	540	1.67	0.07
/81	2400	183.86	960	600	1.60	0.06
	0100	183.85	1020	660	1.55	0.05
	0200	183.85	1080	720	1.50	0.05
	0300	183.84	1140	780	1.46	0.04
	0400	183.84	1200	840	1.43	0.04
	0500	183.83	1260	900	1.40	0.03
	0600	183.83	1320	960	1.38	0.03
	0700	183.82	1380	1020	1.35	0.03
	0800	183.82	1440	1080	1.33	0.02
	0900	183.82	1500	1140	1.32	0.02
	1000	183.82	1560	1200	1.30	0.02

JAN 1982 DIST.

FEB 3 2025

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WATER WELL 654

PUMPING RATE DATA

3/4 h.p. Gould set at 220'. Could not measure drawdown with galvanometer

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7/21/81	0801	9.6	33.13	5.3	1	33.13
	0803	9.9	32.12	5.3	3	96.36
	0806	9.6	33.13	5.3	3	99.39
	0810	9.0	35.33	5.3	4	141.32
	0815	9.6	33.13	5.3	5	165.65
	0820	9.8	32.45	5.3	5	162.25
	0830	9.0	35.33	5.3	10	353.30
	0845	9.2	34.57	5.3	15	518.55
	0900	9.0	35.33	5.3	15	529.95
	0920	9.0	35.33	5.3	20	706.66
	0940	9.0	35.33	5.3	20	706.66
	1000	8.8	36.14	5.3	20	722.80
	1030	8.8	36.14	5.3	30	1084.20
	1100	8.4	37.86	5.3	30	1135.80
	1130	8.3	38.31	5.3	30	1149.30
	1200	8.3	38.31	5.3	30	1149.30
	1230	8.4	37.86	5.3	30	1135.80
	1300	8.2	38.78	5.3	30	1163.40
	1330	8.3	38.31	5.3	30	1149.30
	1400	8.3	38.31	5.3	30	1149.30
				TOTALS	361	13352.42

Total Avg. Q = $\frac{13{,}352.42 \text{ gal.}}{361 \text{ min}}$ = 36.99 gal/min

Specific Capacity, unknown

D6-356

TFN 6 2/025

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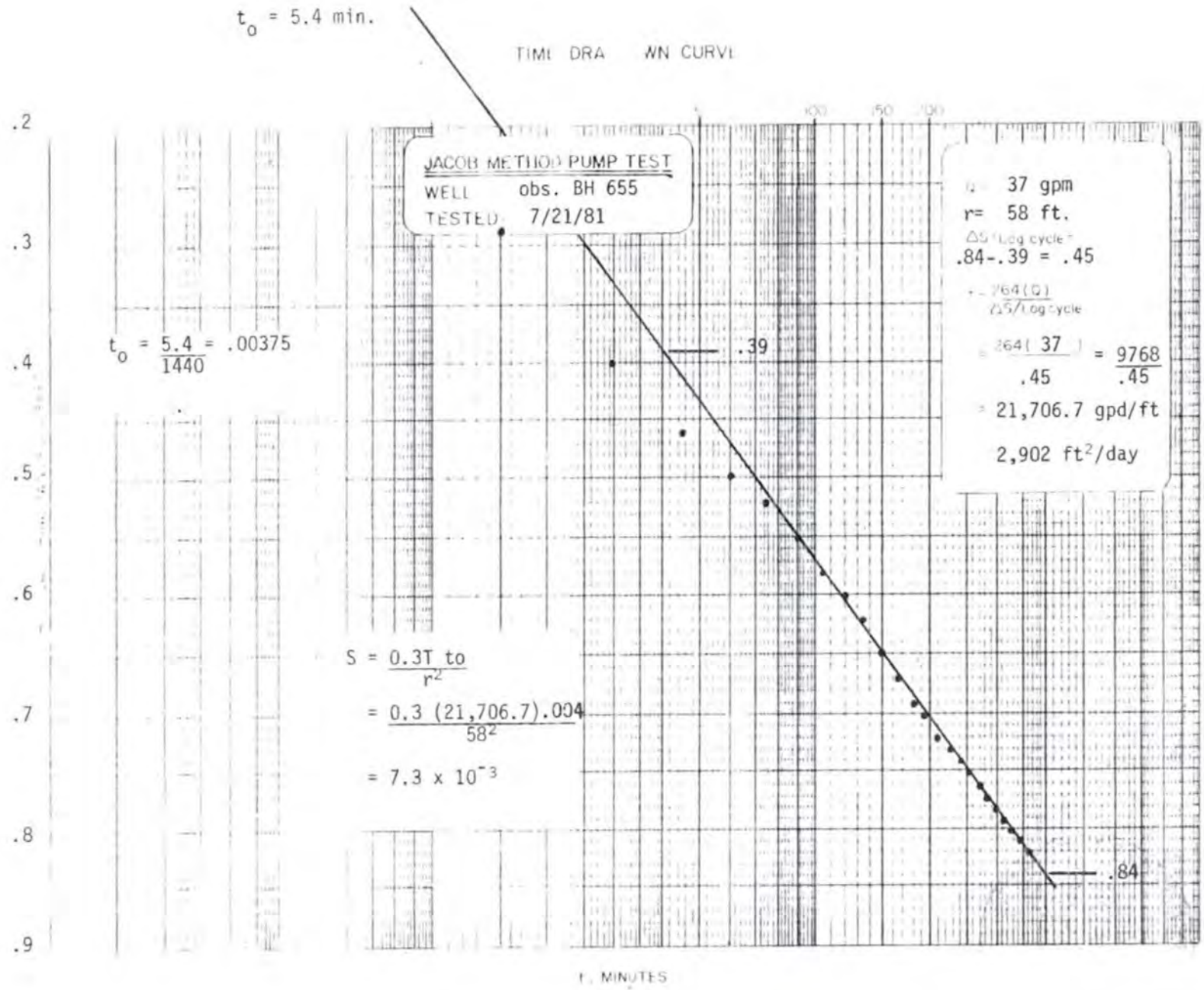

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TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1309

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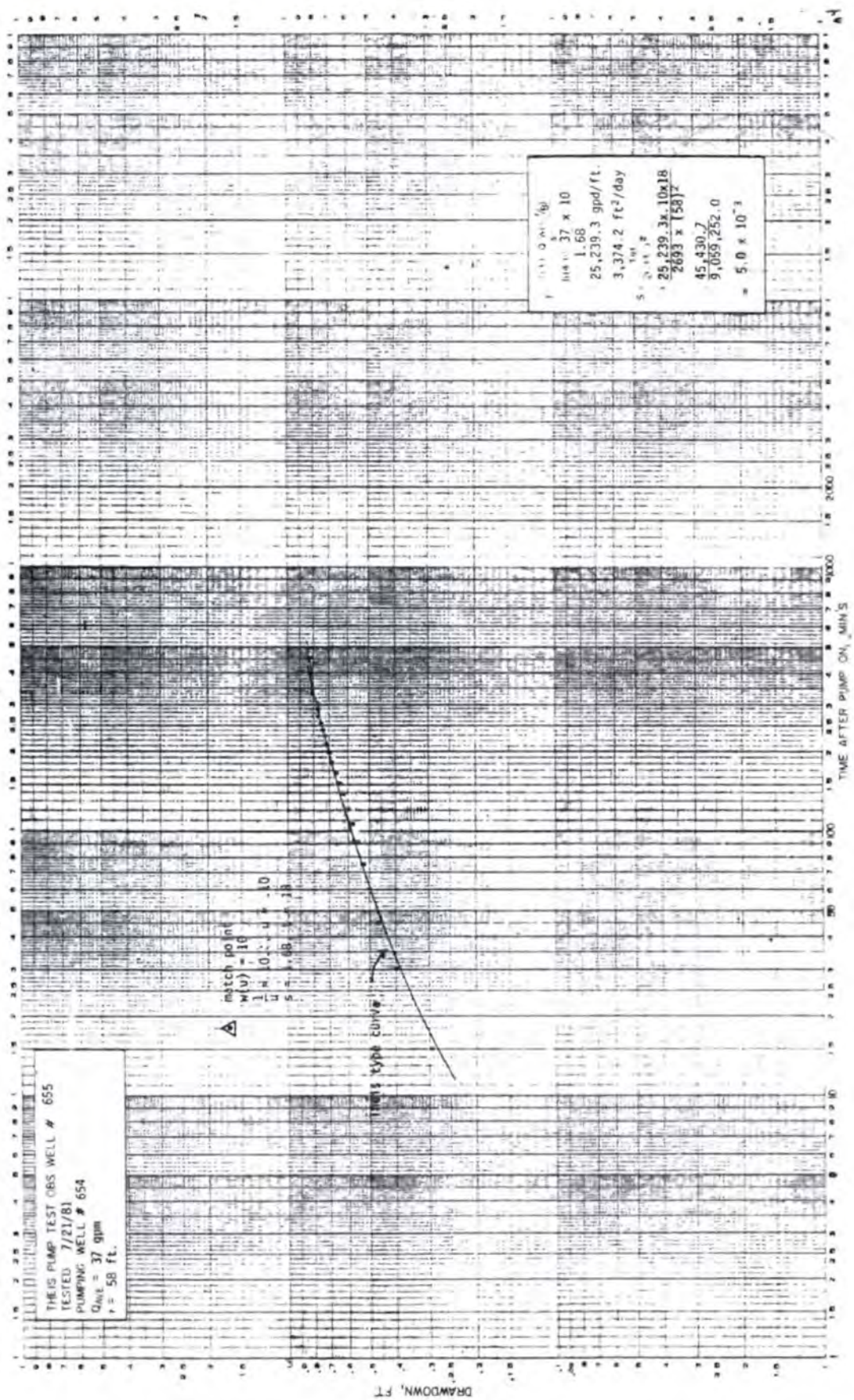

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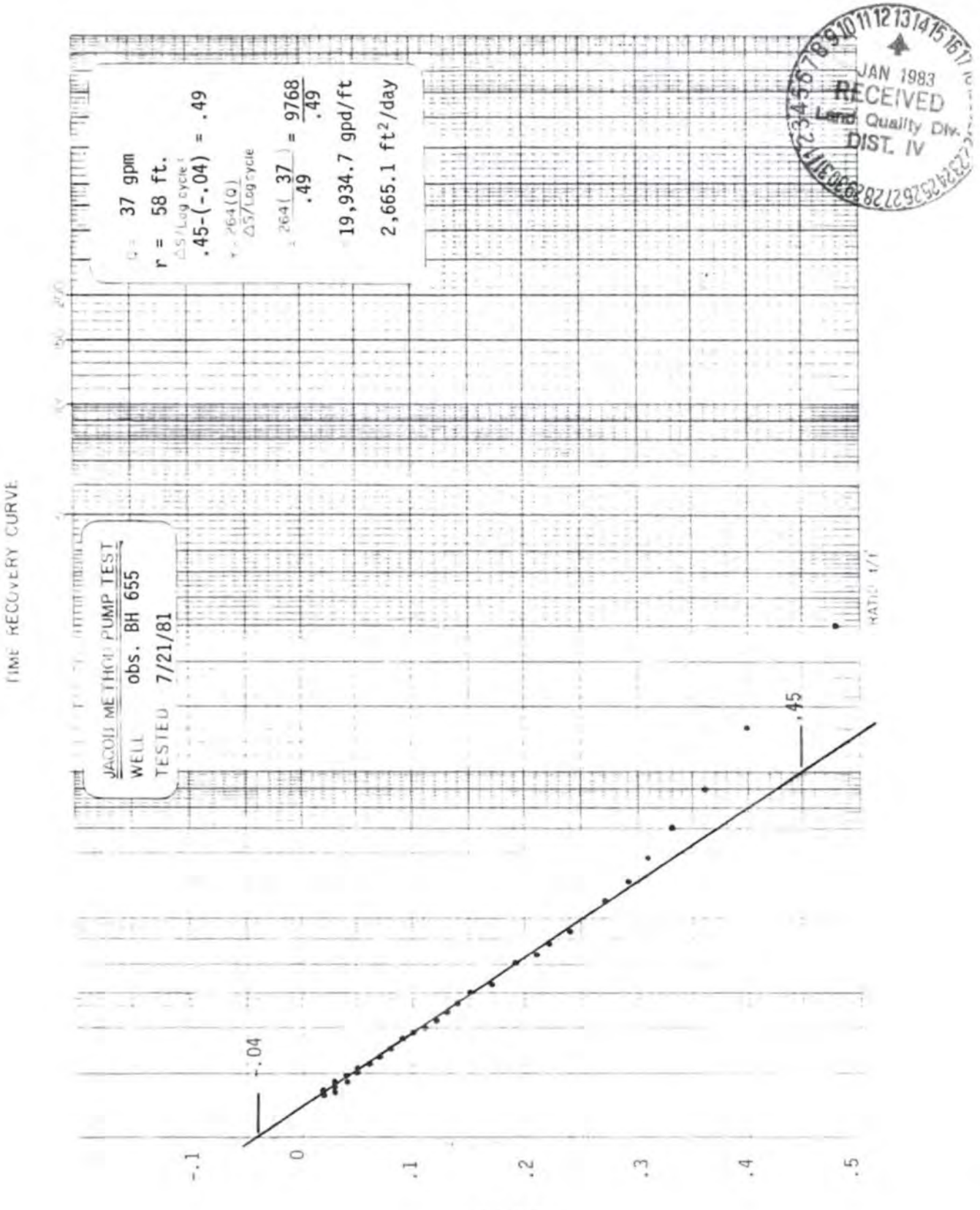
TFN 6 2/025
RECD 10-25-18



JAN 1983
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Land Quality Div.
DIST. IV

DEQ Ex. 3-1311

D6-359
TFN 6 2/025
RECD 10-25-18

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AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S. R. 84 (W) E. Sec. 22 WELL NO. obs. BH-655

Personnel Bondar and Gentry Test Type: (1) Single well drawdown (2) Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well

Well Owner PKS 5. Other (Specify)

Ac P. O. Box 3049 - Sheridan, WY 82801 Driller R. Reed

Meth... drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 172' - 212'

Pump hp & type Pump depth ft. Aquifer spoils

Aquifer lithology mixed shales Altitude of land surface 3740.6

How determined surveyed MP Above / Below LSD Altitude MP

WL from MP How measured galvanometer - Steven's Recorder

DATE	TIME	s, FT. EXTENDED DRAWDOWN	s', FT. RESIDUAL DRAWDOWN	TIME SINCE PUMP OFF t', MIN.		s - s', FT. CALCULATED RECOVERY
7-21-81	1400	.820	.82	0		
	1415	.830	.48	15		.35
	1430	.835	.40	30		.44
	1445	.842	.36	45		.48
	1500	.850	.33	60		.52
	1515	.850	.31	75		.55
	1530	.863	.29	90		.57
	1545	.870	.27	105		.60
	1600	.878	.25	120		.63
	1615	.882	.24	135		.64
	1630	.890	.22	150		.67
	1645	.896	.21	165		.69
	1700	.901	.19	180		.71
	1730	.910	.17	210		.74
	1800	.918	.15	240		.77
	1830	.925	.14	270		.79
	1900	.932	.13	300		.80
	1930	.938	.12	330		.82
	2000	.941	.11	360		.83
	2030	.945	.10	390		.85
	2100	.949	09	D6-360 420		86

TFN 6 2/025

AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 22 WELL NO. obs. BH-655

Personnel Bondar and Gentry Test Type: (1) Single well drawdown (2) Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well

Well Owner PKS 5. Other (Specify)

Add P. O. Box 3049 - Sheridan, WY 82801 Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slot Interval of screen or perforation 172' -212'

Pump hp & type Pump depth ft. Aquifer spoils

Aquifer lithology mixed shales Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP How measured galvanometer - Steven's Recorder

DATE	TIME	s, FT. EXTENDED DRAWDOWN	s', FT. RESIDUAL DRAWDOWN	TIME SINCE PUMP OFF t', MIN.		s - s', FT. CALCULATED RECOVERY
	2200	.953	.08	480		.87
	2300	.956	.07	540		.89
7-22-81	2400	.962	.06	600		.90
	0100	.965	.05	660		.92
	0200	.970	.05	720		.92
	0300	.972	.04	780		.93
	0400	.973	.04	840		.93
	0500	.975	.03	900		.95

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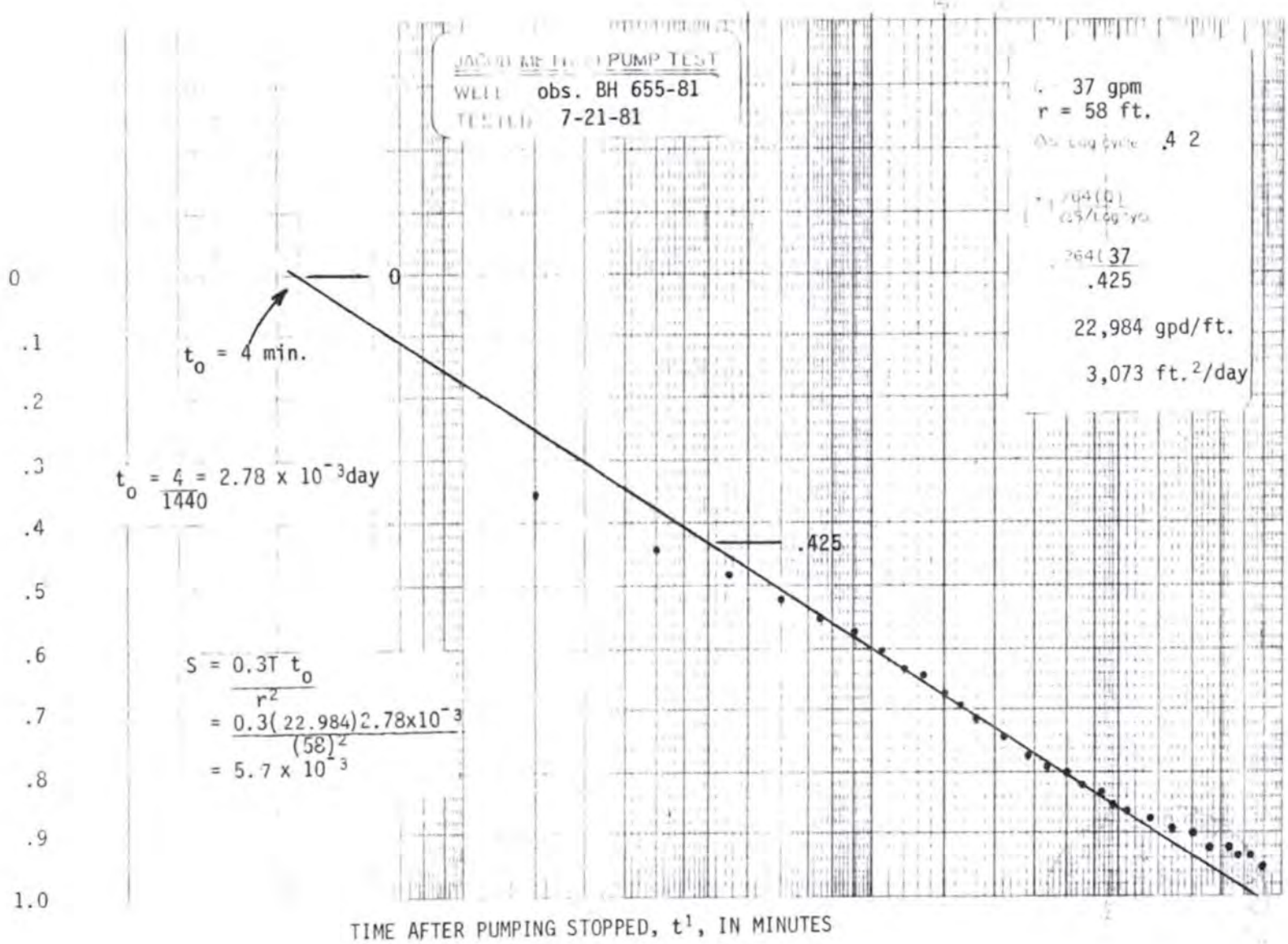
RECOVERY CURVE



D6-362
REC'D 2/025
REC'D 10-25-18

DEQ Ex. 3-1314

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S, R. 84 (W) E, Sec. 22 WELL NO. 656

Personnel Bondar and Gentry Test Type: (1) Single well drawdown (2) Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well

Well Owner PKS 5. Other (Specify)

Address Box 3049 Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 110 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 70' - 110'

Pump hp & type 3/4 Gould Pump depth 108 ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3653.2

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 75.50 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7/14/81	0910	75.50	0			0
	0911	78.25	1			2.75
	0913	81.10	3			5.60
	0916	85.15	6			9.65
	0920	88.72	10			13.25
	0925	91.63	15			16.13
	0930	91.82	20			16.32
	0935	92.23	25			16.73
	0940	92.49	30			16.99
	0950	94.07	40			18.57
	1000	95.15	50			19.65
	1010	96.31	60			20.81
	1020	97.06	70			21.56
	1030	99.00	80			23.50
	1040	101.85	90			26.35
Pump Off	1041	101.28	91	0		25.78
	1043	100.15	93	2	46.50	24.65
	1046	98.44	96	5	19.20	22.94
	1050	97.00	100	9	11.11	21.50
	1055	96.30	105	14	7.50	20.80
	1100	95.27	110	19	5.79	19.77

TFN 5 2/025

RECD 10-25-18

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RAMACO

Brook Mine

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N), R. 84 (W), Sec. 22 WELL NO. 656

Personnel Bondar and Gentry

Test Type: (1) Single well drawdown (2) Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner PKS

Address Box 3049 Sheridan, WY

Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 110 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 70' - 110'

Pump hp & type 3/4 Gould Pump depth 108 ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3653.2

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 75.50 How measured galvanometer

JAN 1983
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DIST. IV

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1110	92.12	120	29	4.14	16.62
	1120	90.25	130	39	3.33	14.75
	1130	89.10	140	49	2.86	13.60
	1145	87.45	155	64	2.42	11.95
	1200	85.74	170	79	2.15	10.24
	1220	84.35	190	99	1.92	8.85
	1240	83.50	210	119	1.76	8.00
	1300	82.22	230	139	1.65	6.72
	1320	81.40	250	159	1.57	5.90
	1340	80.27	270	179	1.51	4.77
	1400	79.67	290	199	1.46	4.17
	1420	79.40	310	219	1.42	3.90
	1440	79.23	330	239	1.38	3.73
	1500	79.16	350	259	1.35	3.66

D6-364

TFN 6 2/025
RECD 12-25-18

WATER WELL 656

PUMPING RATE DATA

JAN 1983
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Land Quality Div.
DIST. IV

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7-14-81	0913	45.00	7.07	5.3	3	21.21
	0916	75.00	4.24	5.3	3	12.72
	0920	107.00	2.97	5.3	4	11.76
	0925	107.00	2.97	5.3	5	14.85
	0930	414.00	0.77	5.3	5	3.85
	0935	414.00	0.77	5.3	5	3.85
	0940	414.00	0.77	5.3	5	3.85
	0950	81.00	0.74	1.0	10	7.40
	1000	80.00	0.75	1.0	10	7.50
	1010	81.00	0.74	1.0	10	7.40
	1020	81.00	0.74	1.0	10	7.40
	1030	82.00	0.73	1.0	10	7.30
	1040	83.00	0.72	1.0	10	7.20
				TOTALS	90	116.29

TOTAL AVG. Q = $\frac{116.29 \text{ gal.}}{90 \text{ min.}}$ = 1.29 gpm

SPECIFIC CAPACITY = $\frac{1.29 \text{ gpm}}{25.78 \text{ ft}}$ = 0.05 gpm/ft.

D6-365

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10-25-18

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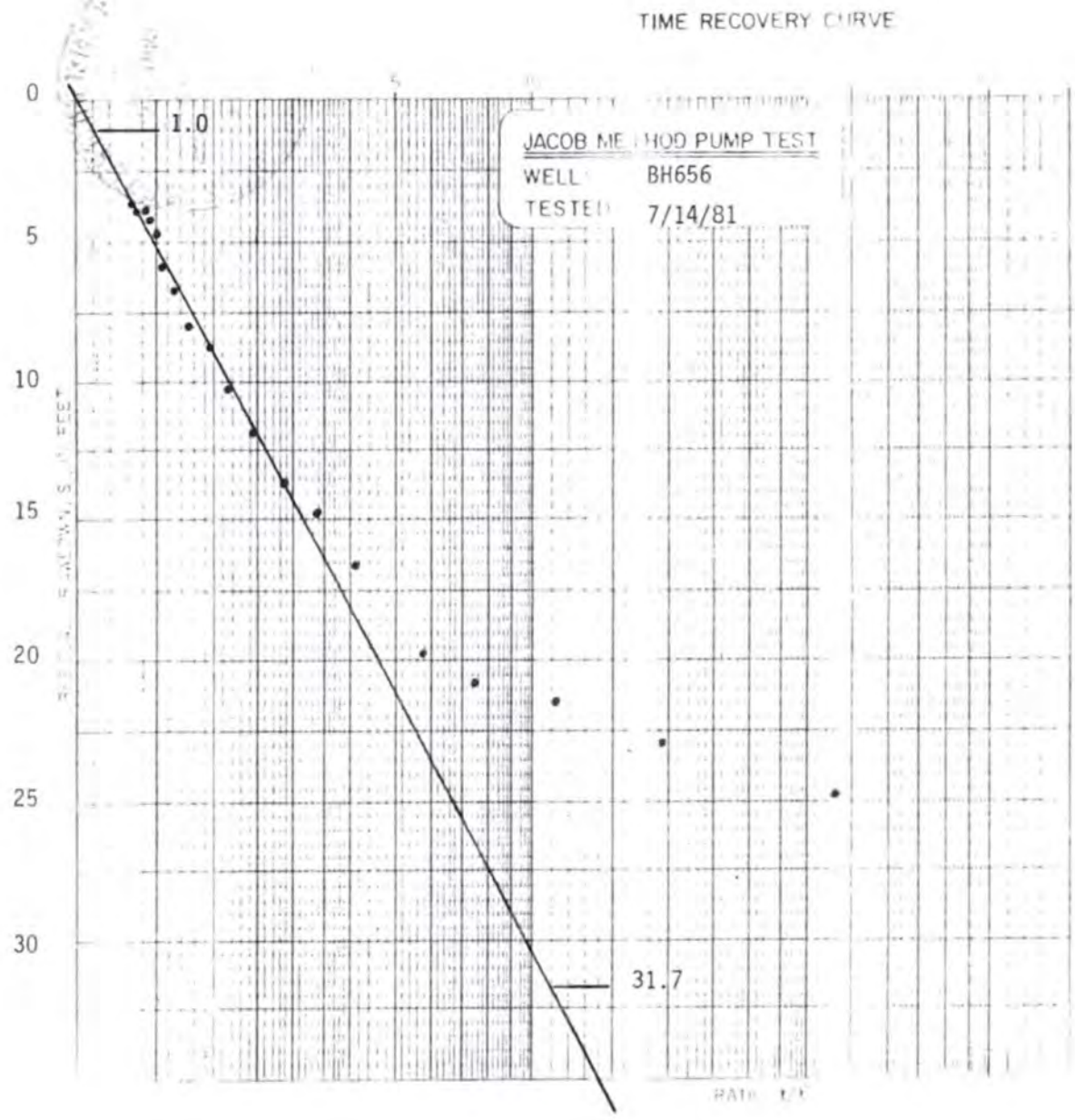

1.3 gpm

31.7 - 1.0 = 30.7

1.3

30.7

11.18 gpd/ft.

1.49 ft^2/day

D6-349

TFN 6 2/025
RECD 10-25-18

PKS RESOURCE DEVELOPMENT

AQUIFER TEST
SLUG METHOD

State Wyoming County Sheridan T. 57 (N) S., R. 84 (E) W., Sec. 15 Well No. BH 657-81

Well Owner PKS Test Personnel Collier, Jones

Address Sheridan, WY Driller R. Reed

Well Depth 80 Ft. Well Diameter 7 7/8 in. Casing Diameter 5 in. Casing Type PVC

Type of Screen Perforation saw slots Interval of Screen Perforation 40' - 80'

Volume injected/removed 10.6 gal. Pump hp & type 1 hp. Gould's Pump Depth 75 Ft.

Aquifer reclaimed spoils Aquifer Lithology mixed shales

Altitude of Land Surface 3627.8 How Determined surveyed

SWL from MP 67.40 How Measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP OFF, t, min.	TIME SINCE PUMP OFF, t, sec.	H $H=SWL_j-SWL_t$	H/Ho
10-6-81	1351	77.75	0	0	10.35	1.00
	1352	76.77	1	60	9.37	.91
	1353	76.38	2	120	8.98	.87
	1354	75.87	3	180	8.47	.82
	1356	74.79	5	300	7.39	.71
	1358	73.80	7	420	6.40	.62
	1400	72.96	9	540	5.56	.54
	1403	72.10	12	720	4.70	.45
	1406	71.39	15	900	3.99	.39
	1410	70.64	19	1140	3.24	.31
	1415	70.11	24	1440	2.71	.26
	1425	69.45	34	2040	2.05	.20
	1443	69.12	52	3120	1.72	.17
	1503	68.93	72	5184	1.53	.15
	1526	68.68	95	5700	1.28	.12

DEQ 327
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DEQ 10-25-18

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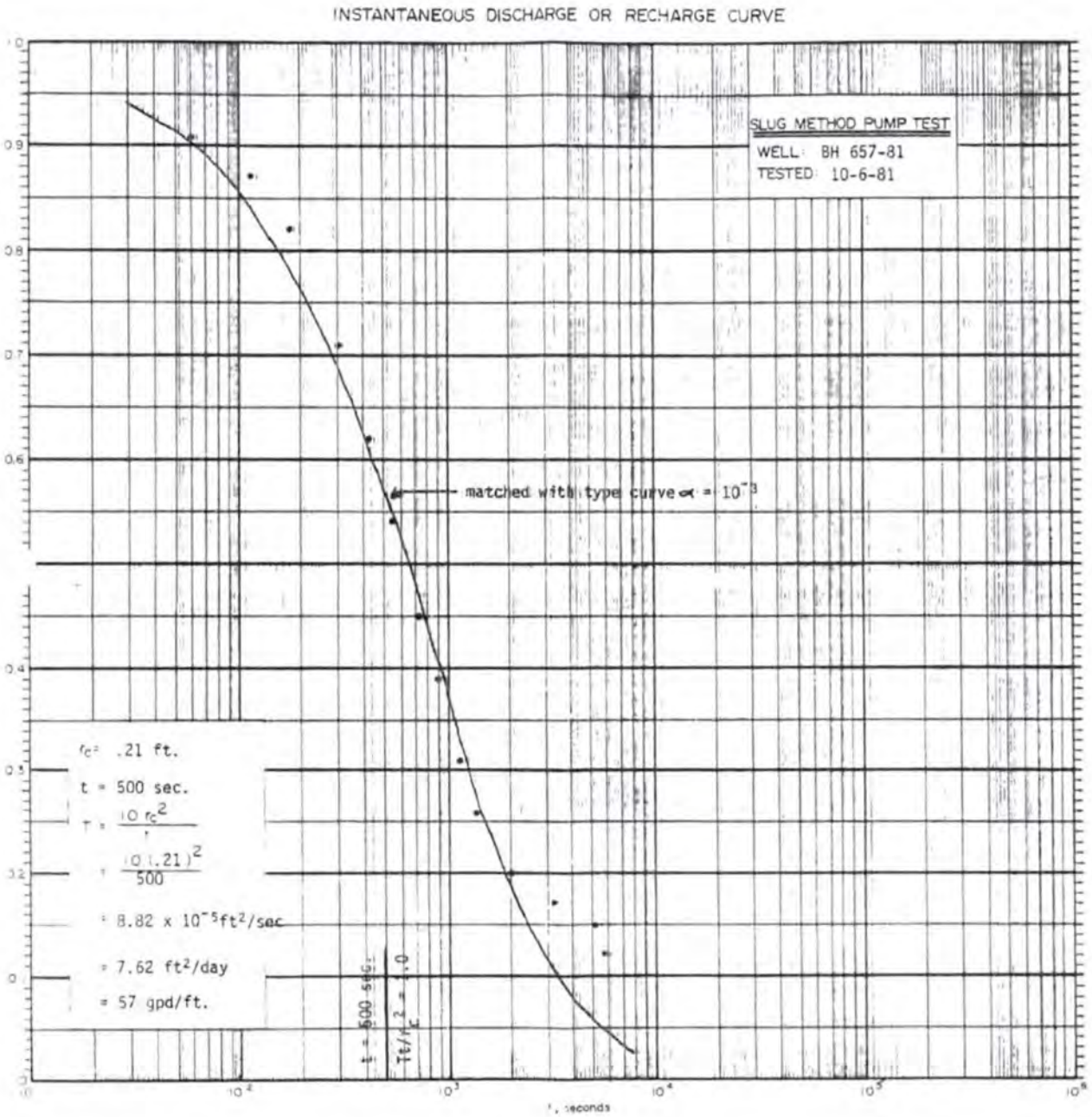

TFN 6 2/025
DEQ Ex. 3-1320 10-25-18

AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 (W) E., Sec. 15 WELL NO. BH 657-81

Personnel Collier, Bowlby Test Type: (1) Single well drawdown (2) Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner PKS

Address Sheridan, Wyoming Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 80 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 40' - 80'

Pump hp & type ½ Goulds Pump depth 78 ft. Aquifer reclaimed spoils

Aquifer lithology shales Altitude of land surface 6627.8

How determined surveyed MP Above / Below LSD Altitude MP

WL from MP 70.05 How measured galvanometer

JAN 1982 RECEIVED Land Quality DIST. IV

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
B-10-82	1230	70.05	0			0
	1232	71.54	2			1.49
	1233	71.71	3			1.66
	1234	71.85	4			1.80
	1235	72.03	5			1.98
	1237	72.22	7			2.17
	1240	72.46	10			2.41
	1245	72.90	15			2.85
	1250	72.99	20			2.94
	1305	73.05	35			3.00
	1315	73.34	45			3.29
	1324	74.00	54			3.95
	1341	74.43	71			4.38
	1400	74.71	90			4.66
	1430	75.02	120			4.97
'UMP OFF	1507	75.33	157	0	-	5.28
	1508	74.95	158	1	158	4.90
	1512	73.25	162	5	32.40	3.20
	1514	72.80	164	7	23.43	2.75
	1518	72.20	168	11	15.27	2.15

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AQUIFER TEST DATA
CONTINUATION SHEET

Well No. BH 657-81
Test Date 8-10-82

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1524	71.68	174	17	10.24	1.63
	1530	71.27	180	23	7.83	1.22
	1537	70.92	187	30	6.23	0.87
	1545	70.57	195	38	5.13	0.52

DEQ Ex. 3-1322 2/025 10-25-18

WATER WELL BH 657-81

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
8-10-82	1240	454	.70	5.3	10	7.00
	1245	46	.65	0.5	5	3.23
	1305	566	.53	5.3	20	10.60
	1324	42	.71	0.5	19	13.57
	1341	46	.65	0.5	17	11.05
	1400	46	.65	0.5	19	12.35
	1430	46	.65	0.5	30	19.50
	1507	46	.65	0.5	37	24.05
				TOTALS	157	101.35

Average Q = $\frac{101.35}{157}$ = 0.65 gpm

Specific capacity - $\frac{0.65 \text{ gpm}}{5.28 \text{ ft.}}$ = .12 gpm/ft.

D6-371

TFN 6 2/025

DEQD 10-25-18

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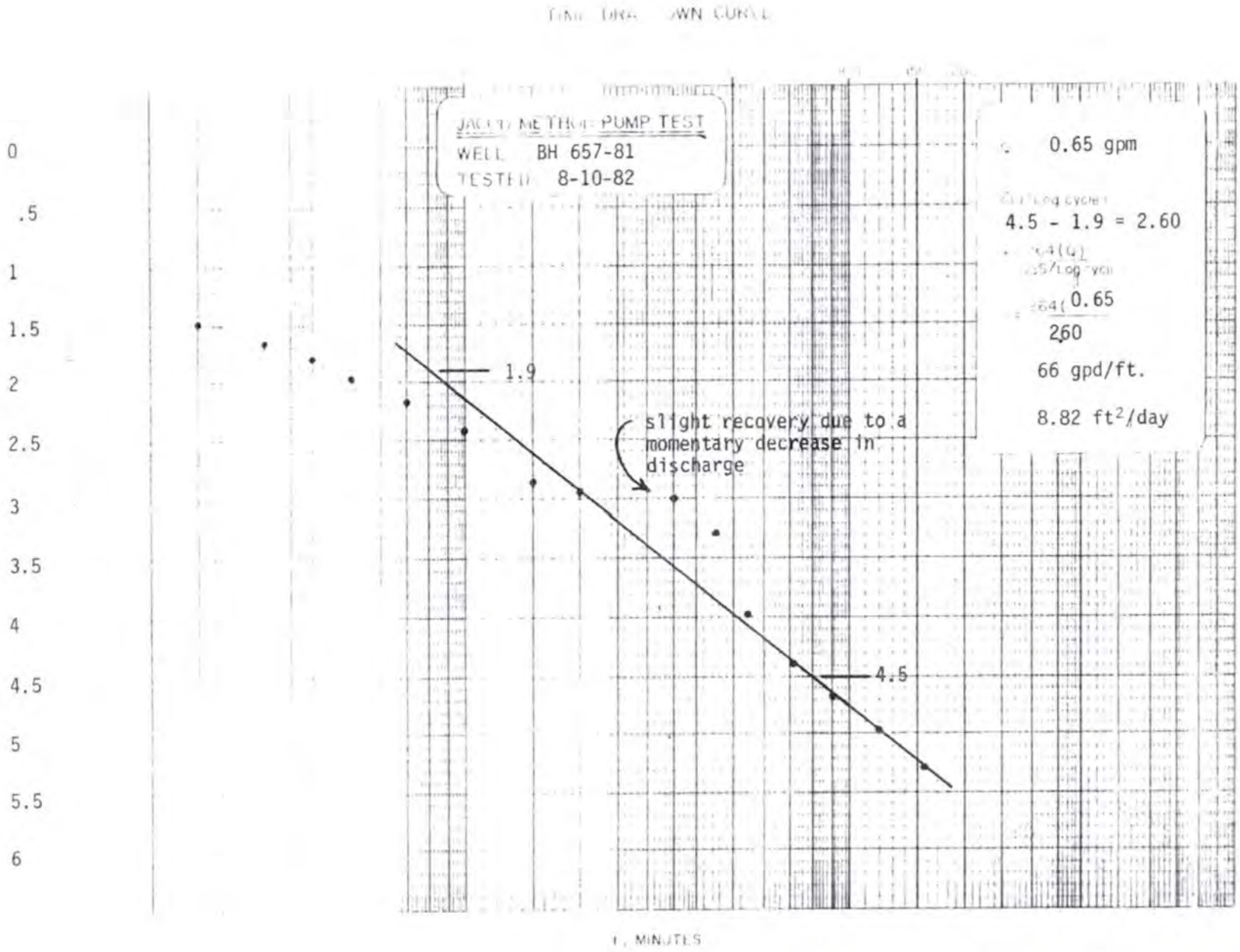

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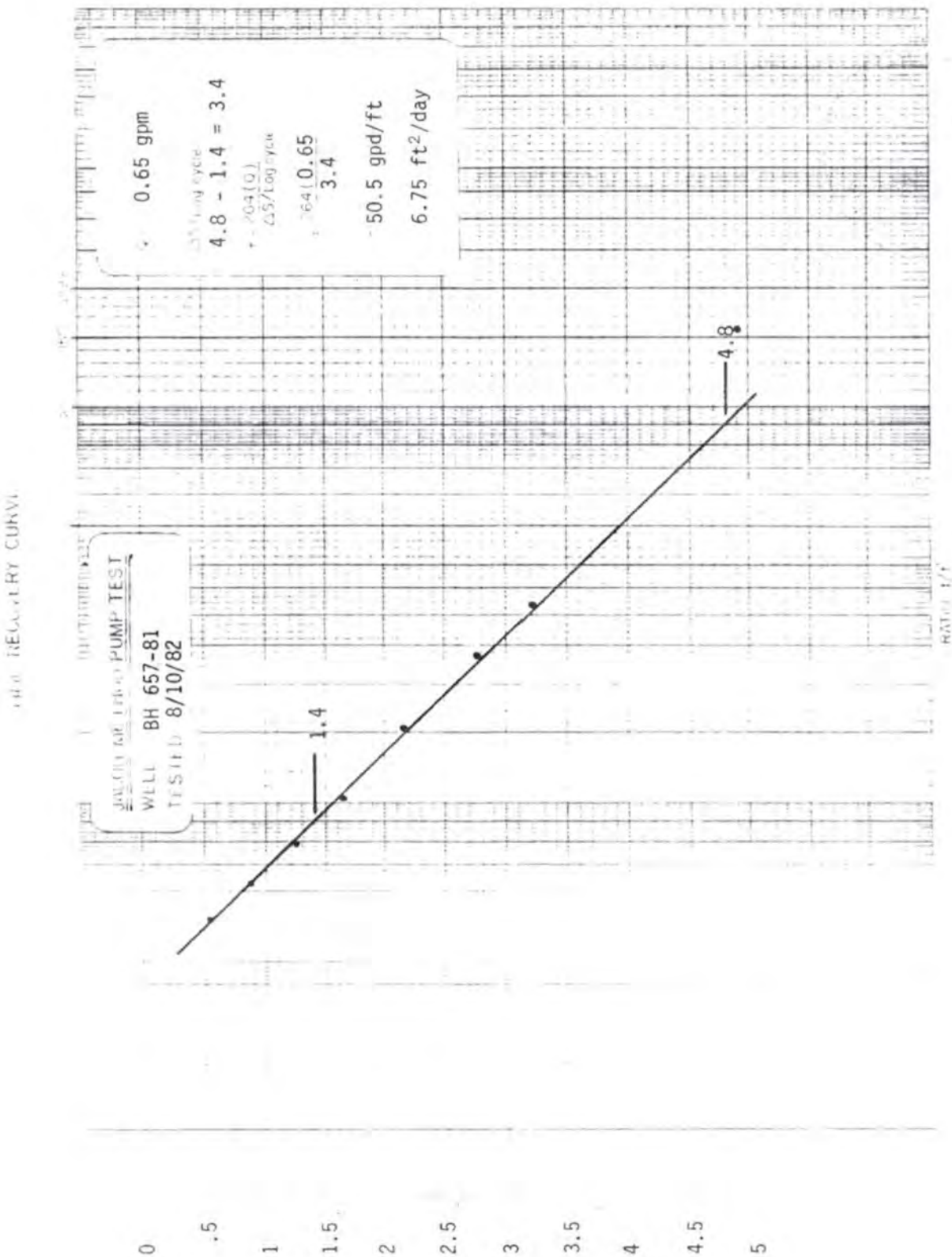
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1324



D6-373

IFR 6 2/025

RECD 10-25-13

DEQ Ex. 3-1325

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PKS RESOURCE DEVELOPMENT

AQUIFER TEST
SLUG METHOD

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 15 Well No. BH 658-81

Well Owner PKS Test Personnel Collier, Jones

Address Sheridan, Wyoming Driller R. Reed

Total Well Depth 80 Ft. Well Diameter 7 7/8 in. Casing Diameter 5 in. Casing Type PVC

Type of Screen Perforation saw slots Interval of Screen Perforation 40' - 80'

Volume injected/removed 13.1 gal Pump hp & type 1 hp Goulds Pump Depth 75 Ft.

Aquifer reclaimed spoils Aquifer Lithology mixed shales

Altitude of Land Surface 3622.5 How Determined surveyed

SWL from MP 64.17 How Measured galvanometer

JAN 1983
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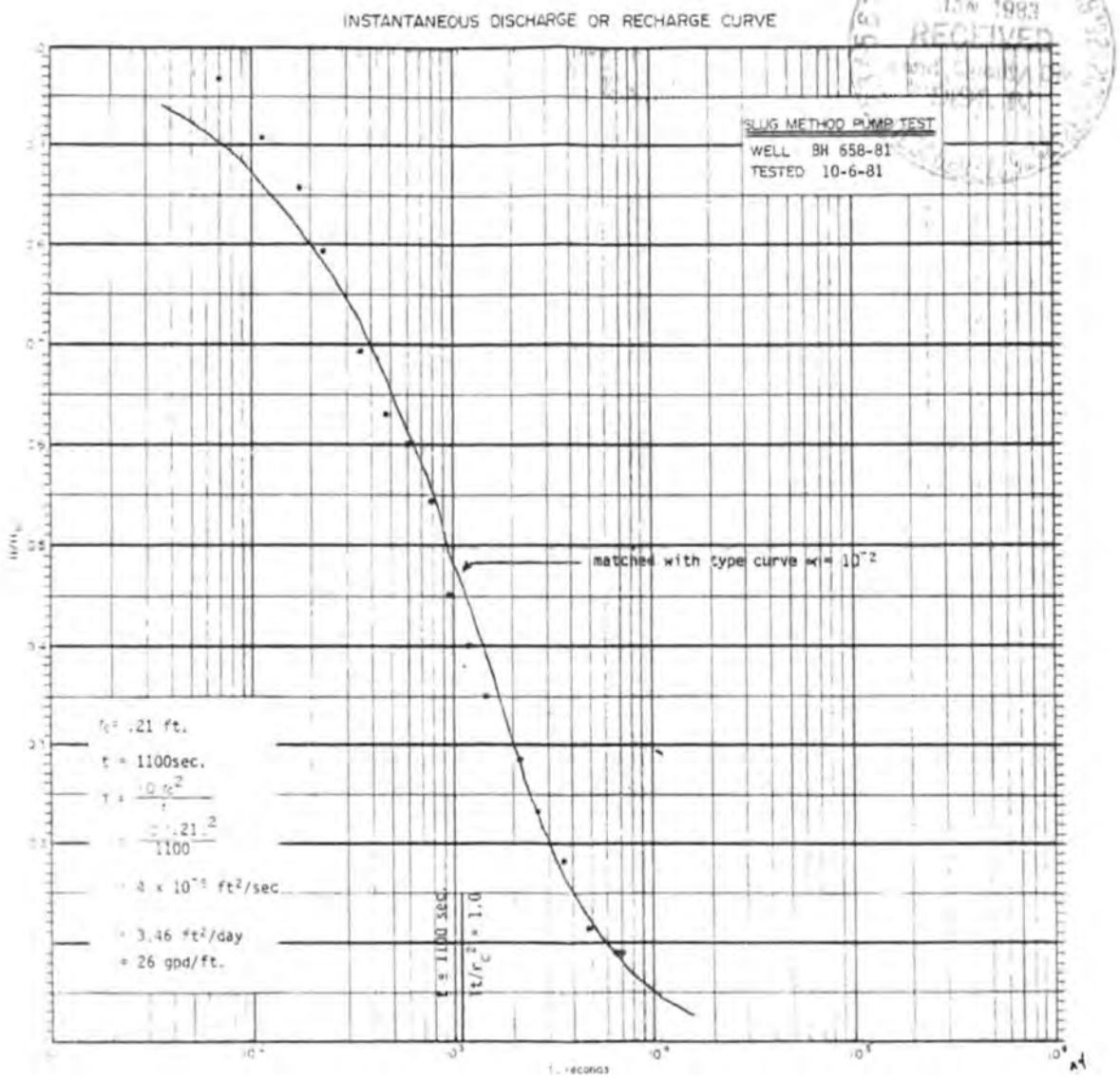
Land Quality Div.
DIST. IV

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP OFF, t, min.	TIME SINCE PUMP OFF, t, sec.	H $H=SWL_j-SWL_t$	H/Ho
10-6-81	1120	76.99	0	0	12.82	1.00
	1121	76.64	1	60	12.47	.97
	1122	75.87	2	120	11.70	.91
	1123	75.14	3	180	10.97	.86
	1124	74.33	4	240	10.16	.79
	1126	73.04	6	360	8.87	.69
	1128	72.20	8	480	8.03	.63
	1130	71.85	10	600	7.68	.60
	1133	71.10	13	780	6.93	.54
	1136	69.97	16	960	5.80	.45
	1140	69.31	20	1200	5.14	.40
	1145	68.68	25	1500	4.51	.35
	1155	67.75	35	2100	3.58	.28
	1205	67.13	45	2700	2.96	.23
	1220	66.49	60	3600	2.32	.18
	1240	65.77	80	4800	1.60	.12
	1310	65.35	110	6600	1.18	.09
	1315	65.29	115	6900	1.12	.09

2/025
10-25-13



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AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. BH 745-82

Personnel Collier, Andersen Test Type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well

Well Owner PKS 5. Other (Specify)

Ad Sheridan, Wyoming Driller D. Fudge

Met.. drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 84 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation Saw slots Interval of screen or perforation 64' - 84'

Pump hp & type 3/4 Goulds Pump depth 78 ft. Aquifer reclaimed spoils

Aquifer lithology shales Altitude of land surface

How determined MP Above Below LSD Altitude MP

WL from MP 58.50 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7- 9-82	0955	58.50	0			0
	0955:30	59.55	0.5			1.05
	0956	59.78	1			1.28
	0957	59.85	2			1.35
	0959	60.11	4			1.61
	1001	60.51	6			2.01
	1004	60.81	9			2.31
	1008	60.94	12			2.44
	1013	60.82	17			2.32
	1020	60.89	24			2.39
	1030	60.90	34			2.40
	1045	61.09	49			2.59
	1115	61.29	79			2.70
	1200	61.22	124			2.72
	1300	61.27	184			2.77
Pump Off	1400	61.22	244	0	-	2.72
	1400:30	60.29	244.5	0.5	489	1.79
	1401	59.66	245	1	245	1.16
	1402	58.83	246	2	123	0.33
	1403	58.55	247	3	82.33	0.05

IFN G 2/025

AQUIFER TEST DATA
CONTINUATION SHEET

Well No. BH 745-82
Test Date 7- 9-82

Page 2 of 2 .

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1405:30	58.55	249.5	5.5	45.36	0.05
	1406:30	58.55	250.5	6.5	38.54	0.05
	1410	58.54	254	10	25.40	0.04
	1420	58.53	264	20	13.20	0.03
	1440	58.52	284	40	7.10	0.02

IFR 5 2/025

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WATER WELL BH 745-81

PUMPING RATE DATA

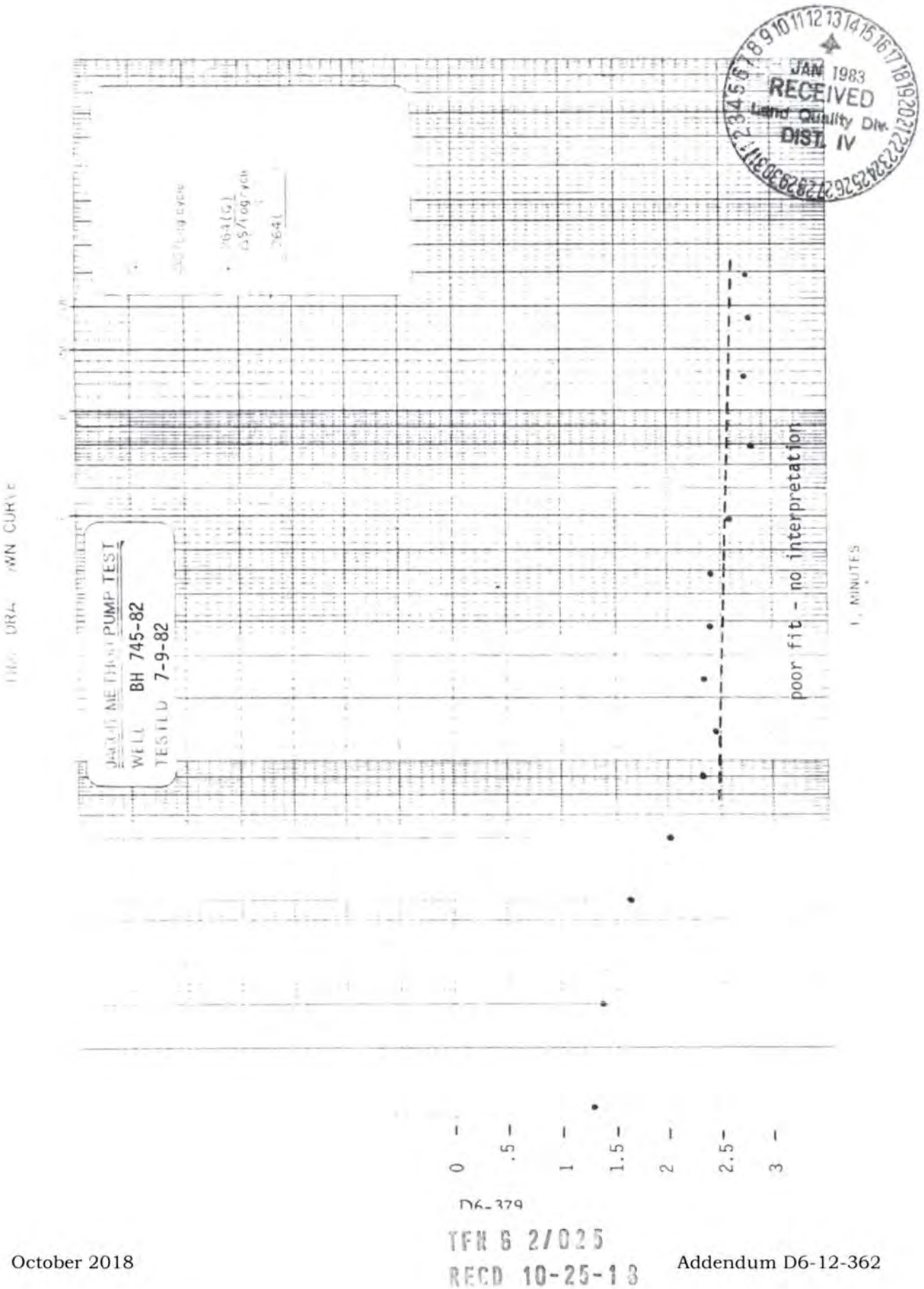
DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7- 9-82	0955:30	23	1.30	0.5	0.5	0.65
	0959	17	1.76	0.5	3.5	6.16
	1004	16	1.88	0.5	5.0	9.40
	1008	19	1.58	0.5	4.0	6.32
	1017	19	1.58	0.5	9.0	14.22
	1030	18	1.67	0.5	13.0	21.71
	1045	18	1.67	0.5	15.0	25.05
	1115	18	1.67	0.5	30.0	50.10
	1200	18	1.67	0.5	45.0	75.15
	1300	18	1.67	0.5	60.0	100.20
	1400	18	1.67	0.5	60.0	100.20
				TOTALS	245	409.16

Average Q = $\frac{409.16}{245}$ = 1.67 gpm

Specific capacity = $\frac{1.67 \text{ gpm}}{2.77 \text{ ft.}}$ = .60 gpm/ft.

D6-378

TFN 6 2/025
DEQ Ex. 3-1330
RECD 10-25-18



D6-379

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1331

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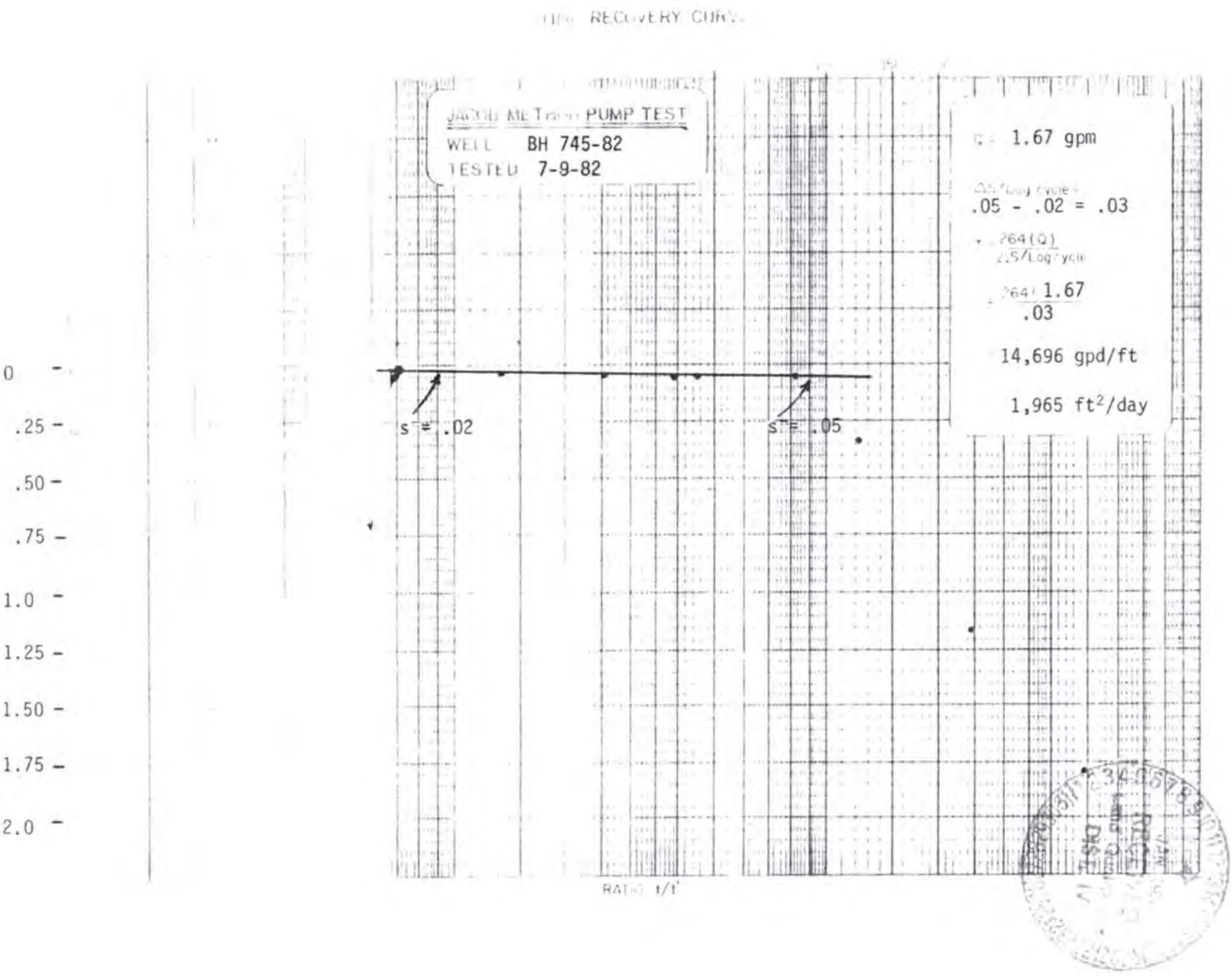

D6-380

RECD 10-25-18
TFN 6 2/025

DEQ Ex. 3-1332

AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. obs. BH 746-81

Personnel Collier - Andersen Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5) Other (Specify) obs. well drawdown

Well Owner PKS

Rig Sheridan, Wyoming Driller D. Fudge

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 83 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 63' - 83'

Pump hp & type N/A Pump depth -- ft. Aquifer reclaimed spoils

Aquifer lithology shales Altitude of land surface

How determined MP Above Below LSD Altitude MP

WL from MP 60.32 How measured Galvanometer and Stevens Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7- 9-82	0956	60.340	1			0.020
	0957	60.348	2			0.028
	1000	60.358	5			0.038
	1005	60.369	10			0.049
	1010	60.372	15			0.052
	1015	60.375	20			0.055
	1020	60.376	25			0.056
	1025	60.378	30			0.058
	1030	60.379	35			0.059
	1035	60.380	40			0.060
	1040	60.380	45			0.060
	1045	60.381	50			0.061
	1050	60.381	60			0.061
	1155	60.382	120			0.062
	1255	60.383	180			0.063
Pump off	1400	60.384	244			0.064

D6-381

TFN 5 2/025

RECD 10-25-18

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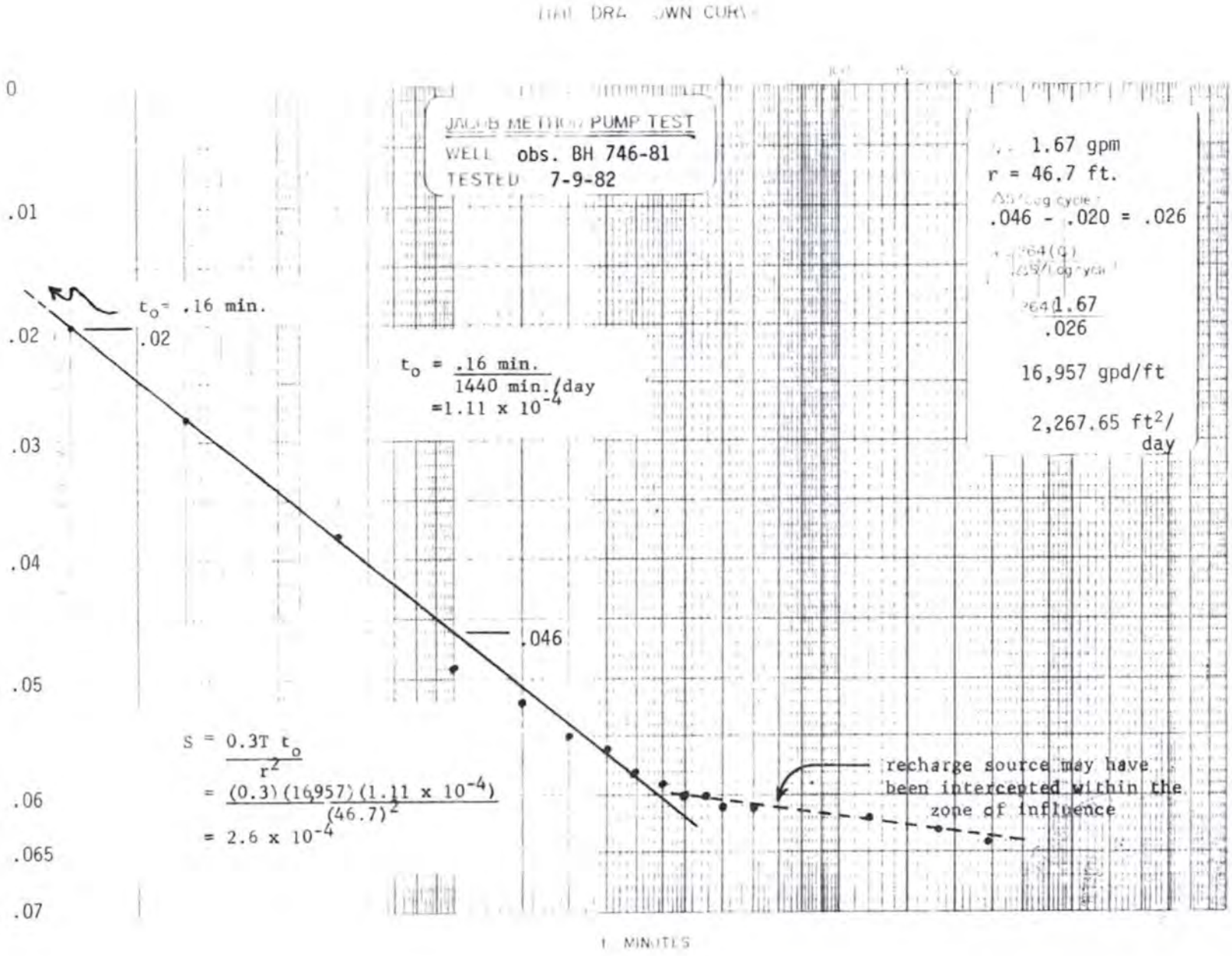

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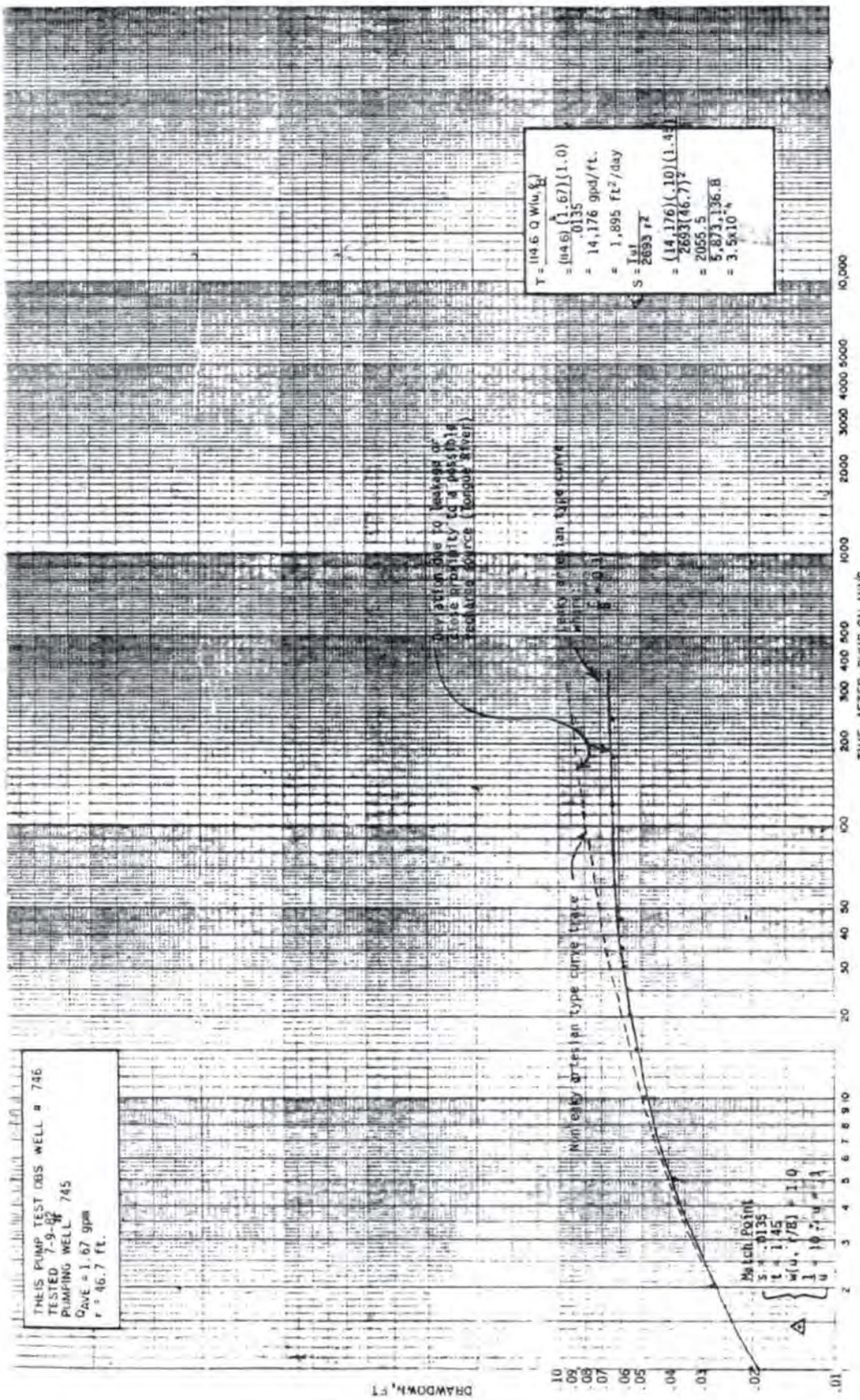
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1334



DEQ Ex. 3-1335

TFN 6 2/025
RECD 10-25-13

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AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. obs. BH 746-81

Personnel Collier - Anderson

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5) Other (Specify) obs. well recovery

Well Owner PKS

Address Sheridan, WY Driller D. Fudge

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 83 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 63' - 83'

Pump hp & type N/A Pump depth - ft. Aquifer reclaimed spoils

Aquifer lithology shales Altitude of land surface

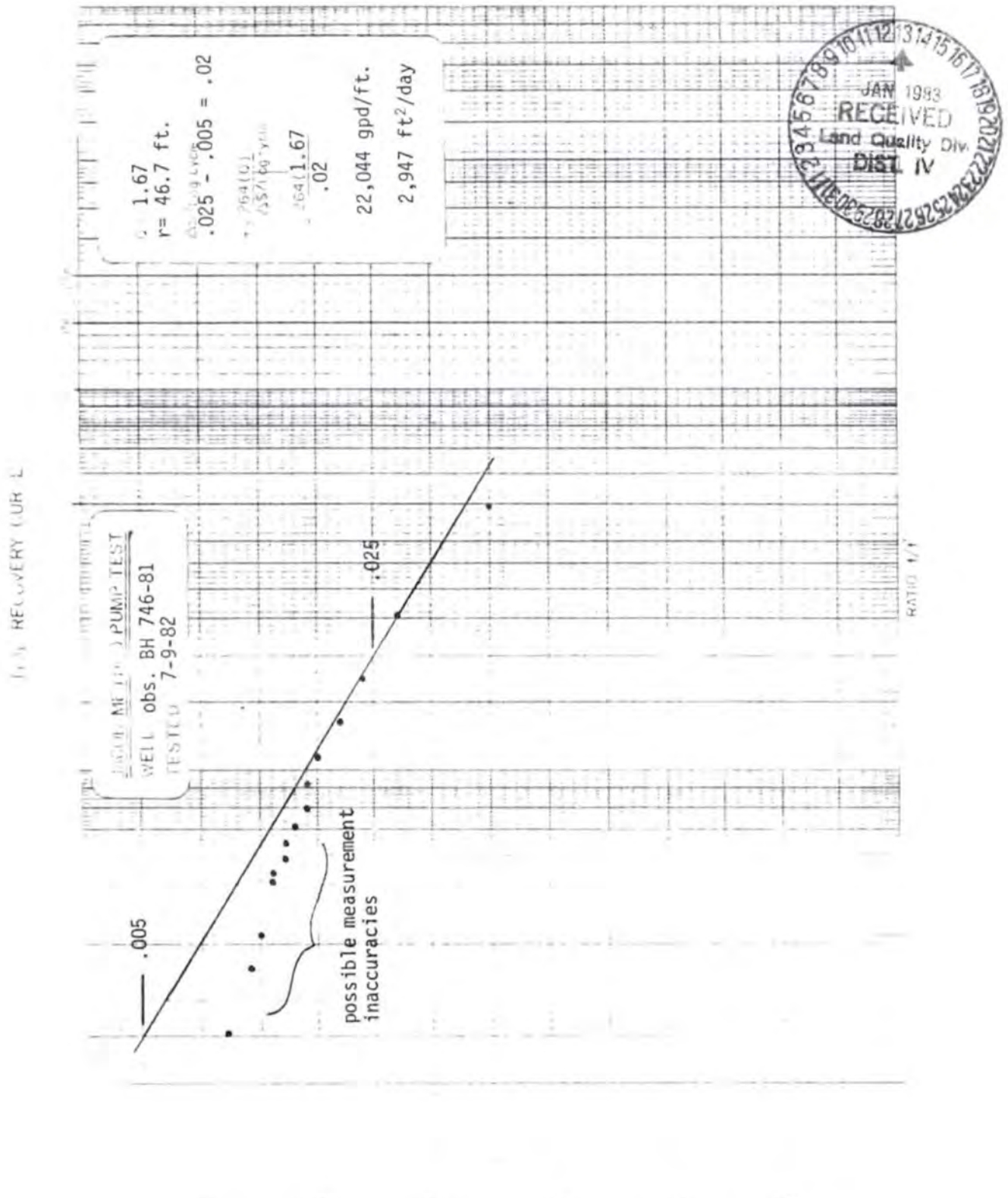
How determined MP Above Below LSD Altitude MP

WL from MP How measured Galvanometer and Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7-9-82	1400	60.384	244	0	-	0.064
	1405	60.355	249	5	49.80	0.035
	1410	60.347	254	10	25.40	0.027
	1415	60.344	259	15	17.27	0.024
	1420	60.342	264	20	13.20	0.022
	1425	60.340	269	25	10.76	0.020
	1430	60.339	274	30	9.13	0.019
	1435	60.339	279	35	7.97	0.019
	1440	60.338	284	40	7.10	0.018
	1445	60.337	289	45	6.42	0.017
	1450	60.337	294	50	5.88	0.017
	1455	60.336	299	55	5.44	0.016
	1500	60.336	304	60	5.07	0.016
	1530	60.335	334	90	3.71	0.015
	1600	60.334	364	120	3.03	0.014
	1800	60.332	484	240	2.02	0.012

DC 394

TFN 6 2/025
REC'D 10-25-18



D6-385
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1337

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AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. obs. BH 746-81

Personnel Collier - Andersen

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well (4) Recovery with obs. well 5. Other (Specify)

Well Owner PKS

Add Sheridan, Wyoming Driller D. Fudge

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 83 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 63' - 83'

Pump hp & type N/A Pump depth -- ft. Aquifer reclaimed spoils

Aquifer lithology shales Altitude of land surface

How determined MP Above Below LSD Altitude MP

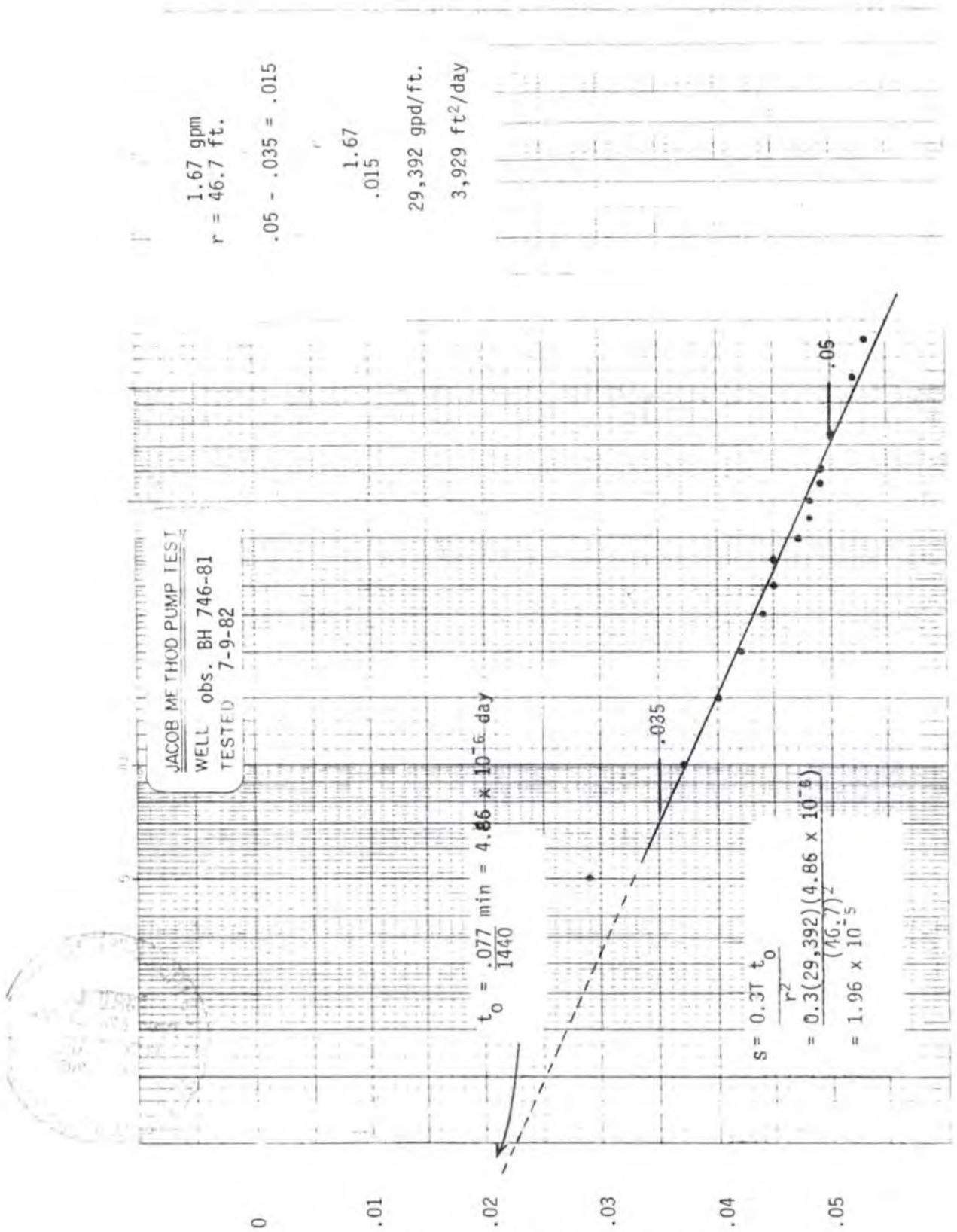
WL from MP How measured Galvanometer and Steven's Recorder

DATE	TIME	s, FT. EXTENDED DRAWDOWN	s', FT. RESIDUAL DRAWDOWN	TIME SINCE PUMP OFF t', MIN.		s - s', FT. CALCULATED RECOVERY
7-9-82	1400	.064	.064	0		-
	1405	.064	.035	5		.029
	1410	.064	.027	10		.037
	1415	.064	.024	15		.040
	1420	.064	.022	20		.042
	1425	.064	.020	25		.044
	1430	.064	.019	30		.045
	1435	.064	.019	35		.045
	1440	.065	.018	40		.047
	1445	.065	.017	45		.048
	1450	.065	.017	50		.048
	1455	.065	.016	55		.049
	1500	.065	.016	60		.049
	1515	.065	.015	75		.050
	1545	.066	.014	105		.052
	1615	.066	.013	135		.053

D6-386

RECD 10-25-18

D6-187



DEQ Ex. 3-1339

TRN 6 2/025
RECD 10-25-18

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DIETZ - 3

COAL WELLS

TER 6 2/025
RECD 10-25-18

N.S. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State WY County Sheridan T. 57 N S. R. 84 E W Sec. 14 WELL NO. 582

Personnel Bondar & Araas Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

Well owner P.K.S. R. Reed Address Sheridan, WY

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 200 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type P.V.C.

Type of screen or perforation saw slots Interval of screen or perforation 165' - 185' Pump hp. & type 3/4 Teel Pump depth 170 ft.

Aquifer Dietz 3 Aquifer lithology coal

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP 81.20 How measured Galvonometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
3/27/80	11:00	81.20	0			0
	11:01	93.44	1			12.24
	11:03	106.11	3			24.91
	11:06	123.84	6			42.64
	11:10	135.98	10			54.78
	11:15	140.89	15			59.69
	11:20	145.33	20			64.13
	11:30	149.00	30			67.80
	11:40	149.47	40			68.27
	11:50	149.50	50			68.30
	12:00	149.82	60			68.62
	12:15	150.18	75			68.98
	12:30	150.38	90			69.18
	12:50	150.38	110			69.18
	13:10	150.46	130			69.26
	13:30	150.46	150			69.26
	14:00	150.38	180			69.18
	14:30	150.41	210			69.21
OFF	14:45	150.38	225	0	0	69.18
	14:46	134.68	226	1	226	53.48
	14:48	117.82	228	3	76	36.62
	14:51	107.20	231	6	38.5	26.00
	14:55	96.96	235	10	23.5	15.76
	15:00	91.01	240	15	16.0	9.81
	15:10	85.92	250	25	10.0	4.72
	15:20	84.24	260	35	7.43	3.04
	15:30	84.03	270	45	6.00	2.83
	15:45	83.67	285	60	4.75	2.47

D6-389

TFN 6 2/025

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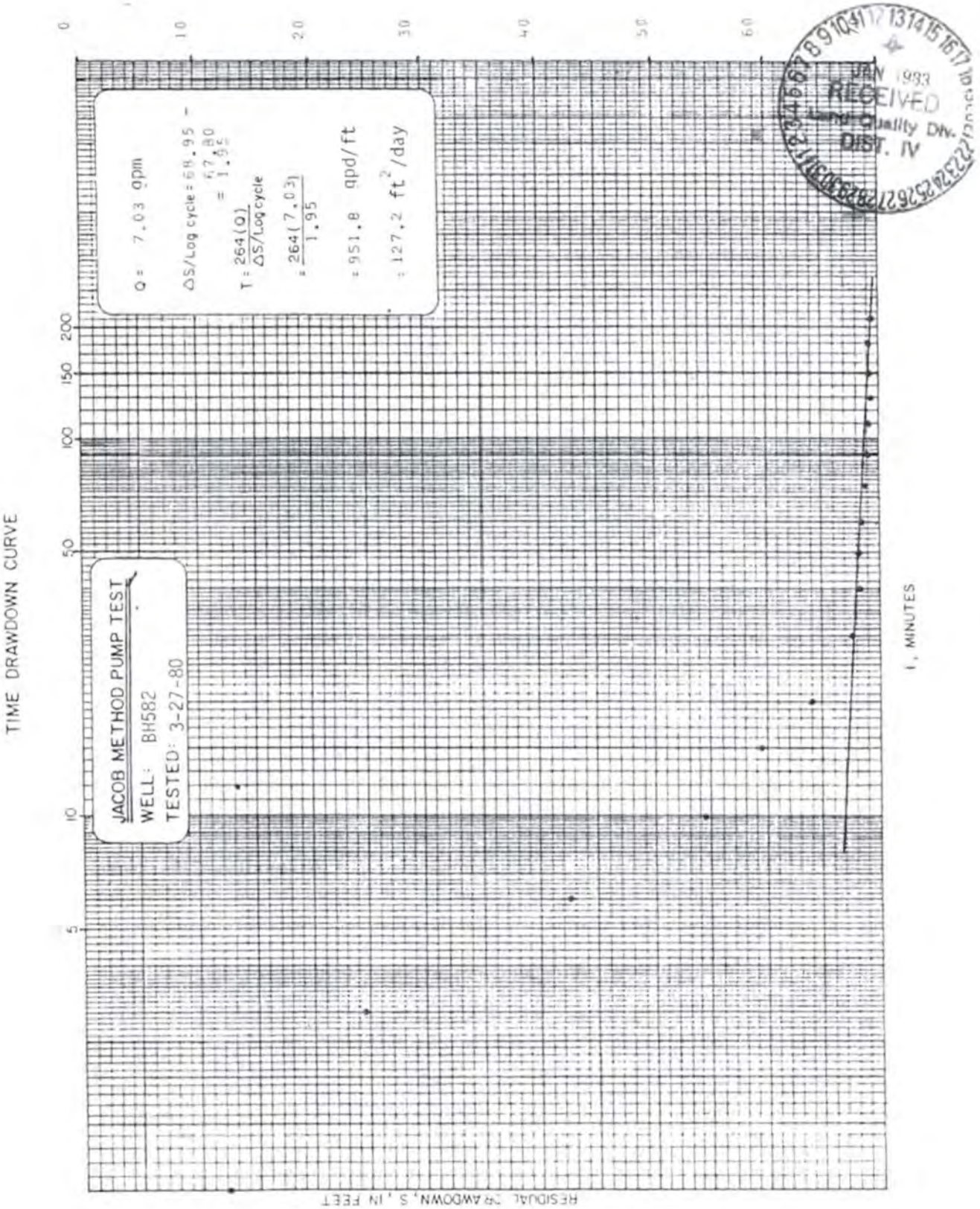
WATER WELL BH - 582

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
3/27/80	11:03	25.00	8.23	3.43	3	24.69
	11:10	23.00	8.95	3.43	7	62.65
	11:15	27.50	7.48	3.43	5	37.40
	11:20	31.00	6.63	3.43	5	33.15
	11:30	35.50	5.80	3.43	10	58.00
	11:40	29.50	6.97	3.43	10	69.70
	11:50	30.50	6.74	3.43	10	67.40
	12:00	29.20	7.04	3.43	10	70.40
	12:30	28.50	7.22	3.43	30	216.60
	12:50	28.50	7.22	3.43	20	144.40
	13:10	30.00	6.86	3.43	20	137.20
	13:30	30.00	6.86	3.43	20	137.20
	14:00	30.00	6.86	3.43	30	205.80
					180	1264.59
				1264.59/180 =7.03		
				TOTAL AVE. Q. = 7.03 gpm		
				Specific capacity = 7.03		
					69.21 = .10 gpm/ft.	

TFN S 2/025

RECD 10-25-18



DEQ Ex. 3-1343

D6-381

APN 6 2/025
RECD 10-25-18

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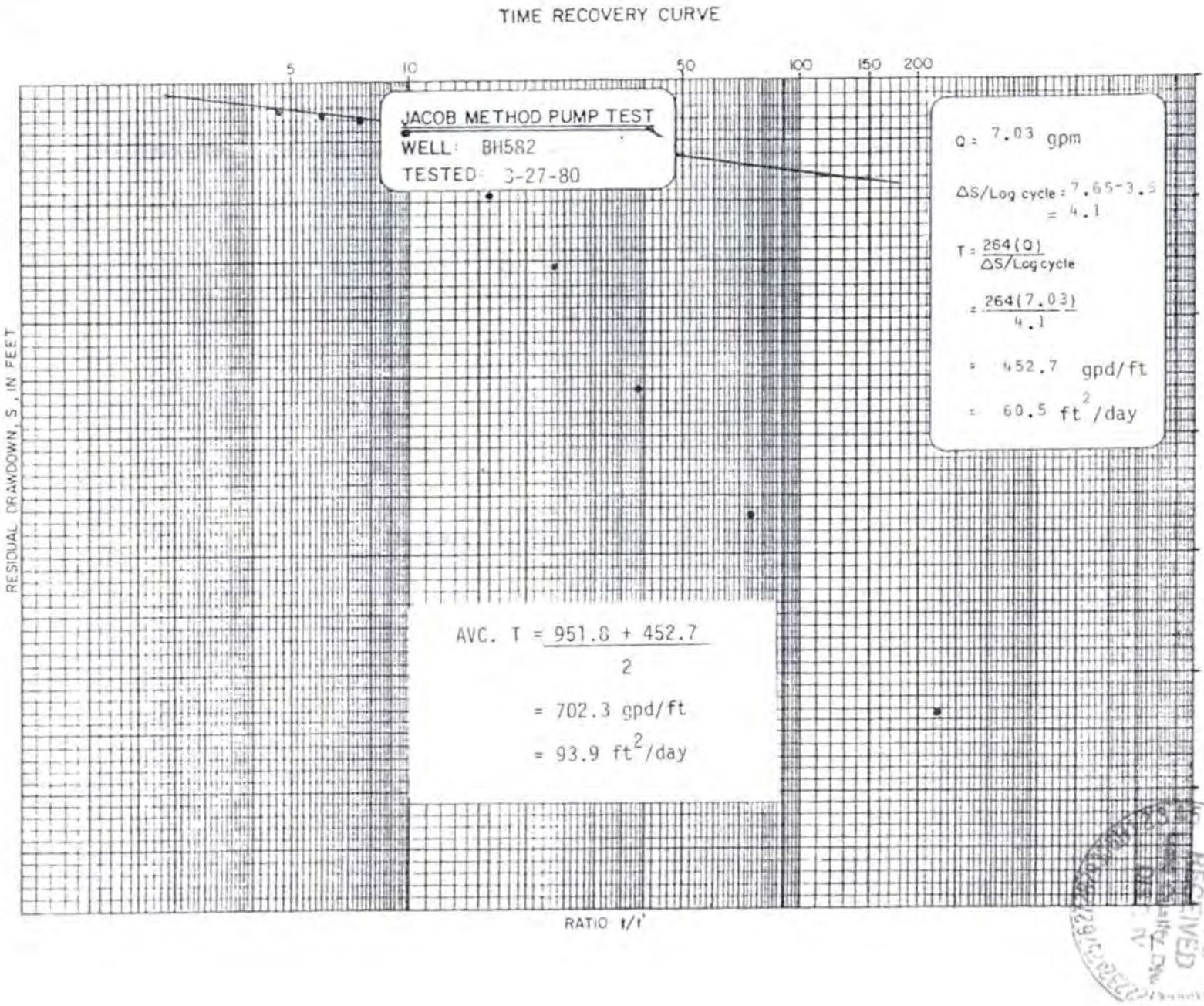

D6-397
TFN 6 2/025
RECD 10-25-13

DEQ Ex. 3-1344

State WY County Sheridan T. 57 N. R. 84 E. W. Sec. 14 WELL NO. 468

Personnel ARAAS & Bondar Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
(2) Single well recovery 4. Recovery with obs. well

Well owner PKS Address Sheridan, WY
R. Reed Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total depth 290 ft. Well diameter 7 7/8 in.
Casing diameter 5 in. Casing type PVC
Type of screen or perforation saw slots Interval of screen or perforation 230' - 270' Pump hp. & type 3/4 teel Pump depth 250 ft.
Aquifer Dietz 3 Aquifer lithology coal
Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____
WL from MP 68.46 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT RESIDUAL DRAWDOWN
2/22/80						
ON	10:30	68.46	0			0
	10:33	88.90	3			20.44
	10:36	101.10	6			32.64
	10:40	106.35	10			37.89
	10:50	110.50	20			42.04
	11:00	112.37	30			43.91
	11:30	113.06	60			44.60
	12:30	113.52	120			45.06
	13:00	113.97	150			45.51
	13:30	114.54	180			46.08
	14:00	115.29	210			46.83
	14:30	116.35	240			47.89
OFF	15:00	116.50	270	0		48.04
	15:01	-	271	1	271	-
	15:03	96.25	273	3	91	27.79
	15:06	85:53	276	6	46	17.07
	15:10	78.90	280	10	28	10.44
	15:15	75.20	285	15	19	6.74
	15:20	73:41	290	20	14.50	4.95
	15:25	72.80	295	25	11.80	4.34
	15:30	72:30	300	30	10	3.84
	15:40	71.78	310	40	7.75	3.32
	15:50	71.42	320	50	6.40	2.96
	16:00	71.17	330	60	5.50	2.71
	16:10	71.00	340	70	4.90	2.54

D6-393

TFH 6 2/025

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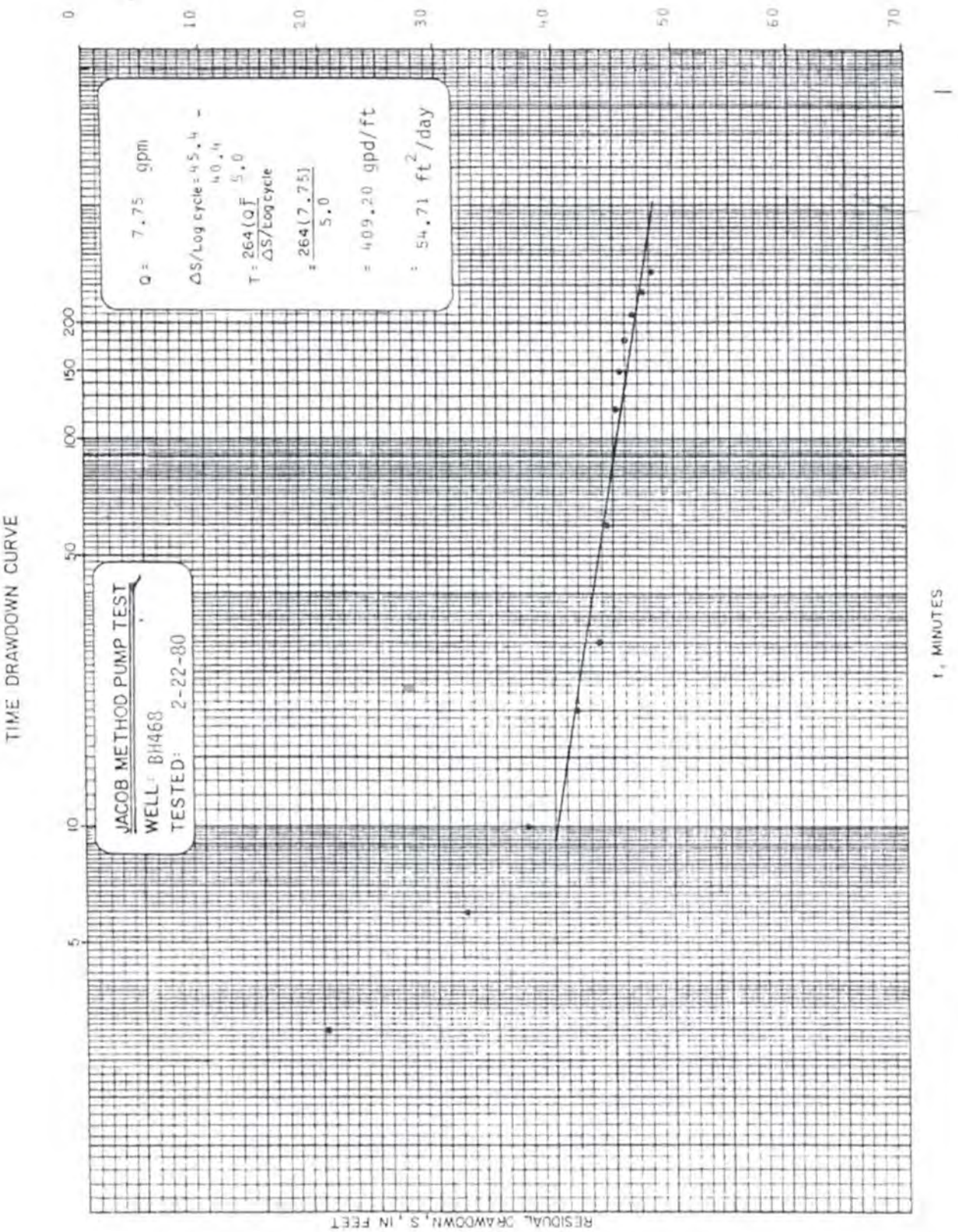
WATER WELL BH - #468

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
2/22/80	10:31	22.00	9.35	3.43	1	9.35
	10:33	23.50	8.76	3.43	2	17.52
	10:36	22.20	9.27	3.43	3	27.81
	10:40	28.70	7.17	3.43	4	28.68
	10:50	26.10	7.88	3.43	10	78.80
	11:00	27.30	7.54	3.43	10	75.40
	11:15	27.30	7.54	3.43	15	113.10
	11:30	26.90	7.65	3.43	15	114.75
	12:00	28.10	7.32	3.43	30	219.60
	12:30	26.70	7.71	3.43	30	231.30
	13:00	26.10	7.88	3.43	30	236.40
	13:30	27.20	7.56	3.43	30	226.80
	14:00	26.23	7.84	3.43	30	235.20
	14:30	26.30	7.82	3.43	30	234.60
	15:00	25.40	8.10	3.43	30	243.00
					270	2092.31
				2092.31/270 = 7.75		
				Total AVE. Q = 7.75 gpm		
				Specific Capacity	= 7.75	
					48.04	= .16 gpm/ft

TFN 6 2/025

REC'D 10-25-18



DEQ Ex. 3-1347

D6-395
TFN 6 2/025
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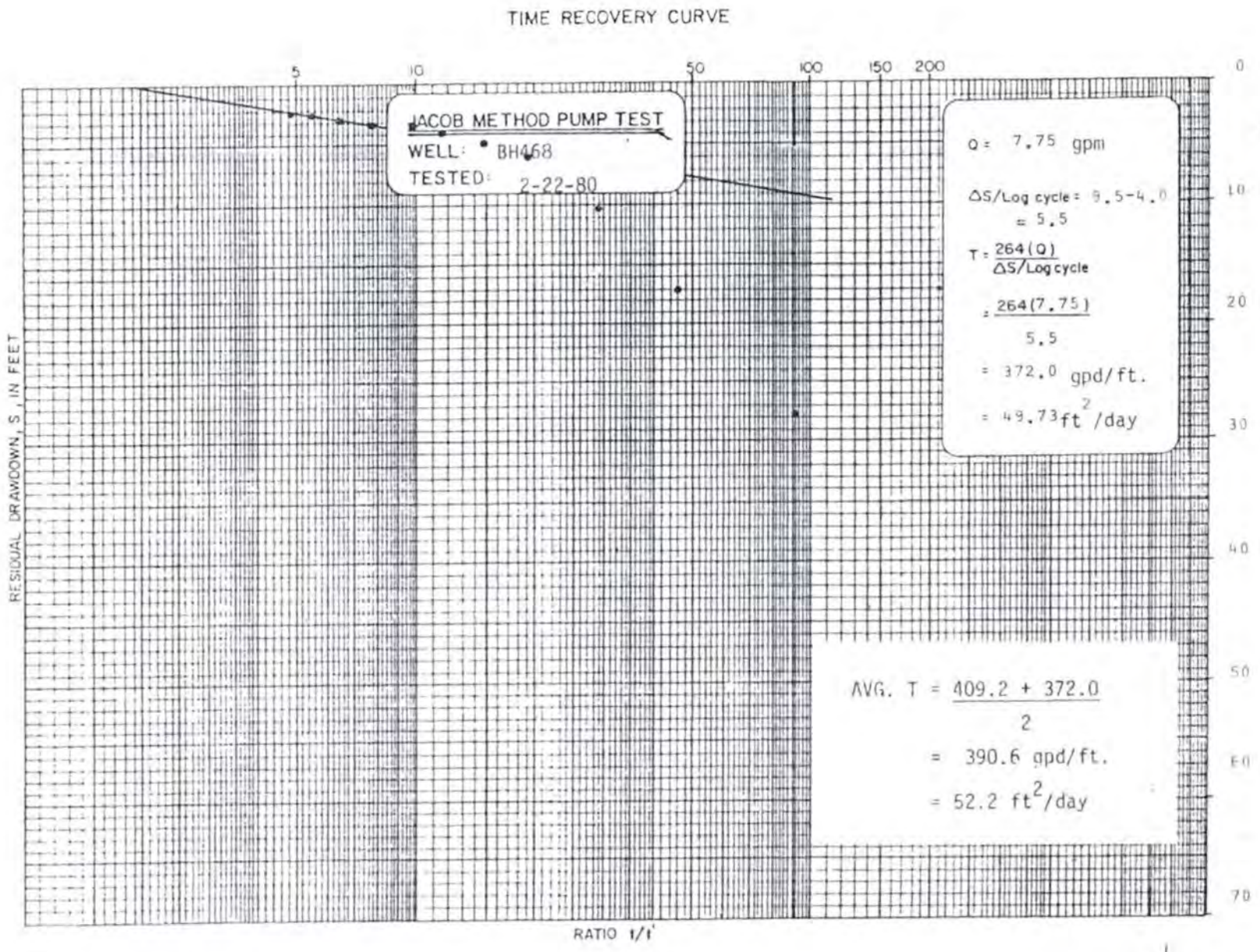

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DEQ Ex. 3-1348

...LOGY AND EXPLORATION — AQUIFER TEST DATA — Page 1 of 2

...WYO — County Sheridan — T. 57 (N) S. — R. 84 (E) W — Sec. 14 — WELL NO. 576

...sonnel BONDAR — Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

...ell owner PKS — Address SHERIDAN, WY

R REED — Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven B. Bored or augered (H) Hyd.-rotary R. Rev.-rotary W. Drive-wash C. Cable-tool J. Jetted T. Trenching Z. Other

...depth 170 ft. — Well diameter 7 7/8 in.

...sing diameter 5 in. — Casing type PVC

...ype of screen — Interval of screen

or perforation saw slots — or perforation 140-160' — Pump hp. & type 3 Teel — Pump depth 155 ft.

...quifer Z3 — Aquifer lithology coal

...titude of land surface — How determined — MP Above Below LSD — Altitude MP

WL from MP 73.43 — How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT RESIDUAL DRAWDOWN
5/8/80	1000	73.43	0			0
	1001	77.02	1			3.59
	1003	72.47	3			0.96
	1006	77.60	6			4.17
	1010	85.0	10			11.57
	1015	93.82	15			20.39
	1020	99.69	20			26.26
	1025	103.83	25			30.40
	1030	106.46	30			33.03
	1040	103.24	40			29.81
	1050	101.91	50			28.48
	1100	108.65	60			35.22
	1110	122.62	70			39.19
	1120	110.72	80			37.19
	1130	109.33	90			35.90
	1140	112.70	100			39.27
	1150	114.65	110			41.22
	1200	116.15	120			42.72
	1215	117.57	135			44.14
	1230	118.33	150			44.90
	1250	119.13	170			45.70
	1320	119.36	200			45.90
	1350	119.61	230			46.18
	1430	120.43	270			47.00
	15.00	120.45	300			47.02
OFF	1530	120.45	330			49.02
	1531	117.74	331	1	331.00	44.31
	1533	113.00	333	3	111.00	39.57
	1536	107.0	336	6	56.00	33.57

D6-397

IFN 6 2/025

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RAMACO

Brook Mine

R.S. GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

ate _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO. 576

ersonnel _____ Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify)

ner _____ Address _____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Wire-wash Z. Other

l depth _____ ft. Well diameter ____ in.

sing diameter _____ in. Casing type _____

pe of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth _____ ft.

quifer _____ Aquifer lithology _____

titude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

VL from MP _____ How measured _____

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DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
	1540	100.00	340	10	34.00	26.57
	1545	92.78	345	15	23.00	19.35
	1550	87.23	350	20	17.50	13.80
	1600	78.95	360	30	12.00	5.52
	1615	73.45	375	45	8.33	0.02

TFR 6 2/025
RECD 10-25-18

WATER WELL 576

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
5/8/80	10:06	70.30	2.60	3.00	6	15.60
	10:15	88.80	2.03	3.00	9	18.27
	10:20	89.50	2.01	3.00	5	10.05
	10:25	94.10	1.91	3.00	5	9.55
	10:30	96.50	1.90	3.00	5	9.50
	10:40	150.00	1.20	3.00	10	12.00
	10:50	150.00	1.20	3.00	10	12.00
	11:00	93.10	1.93	3.00	10	19.30
	11:10	95.00	1.90	3.00	10	19.00
	11:20	124.00	1.45	3.00	10	14.50
	11:30	126.60	1.42	3.00	10	14.20
	11:40	100.09	1.80	3.00	10	18.00
	10:50	102.80	1.75	3.00	10	17.50
	12:00	103.00	1.75	3.00	10	17.50
	12:15	103.50	1.74	3.00	15	26.10
	12:30	106.50	1.69	3.00	15	25.30
	12:50	104.50	1.72	3.00	20	34.40
	13:20	105.00	1.71	3.00	30	51.30
	13:50	104.20	1.73	3.00	30	51.90
	14:30	103.70	1.74	3.00	40	69.60
	15:00	106.00	1.70	3.00	30	51.00
	15:30	106.30	1.70	3.00	30	51.00
	-				330	567.57
	-			567.57/330 = Total	Ave. Q =	1.72
				Spec. Cap. = 1.72/47.02 = .04 gpm/ft.		

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REC'D 10-25-18

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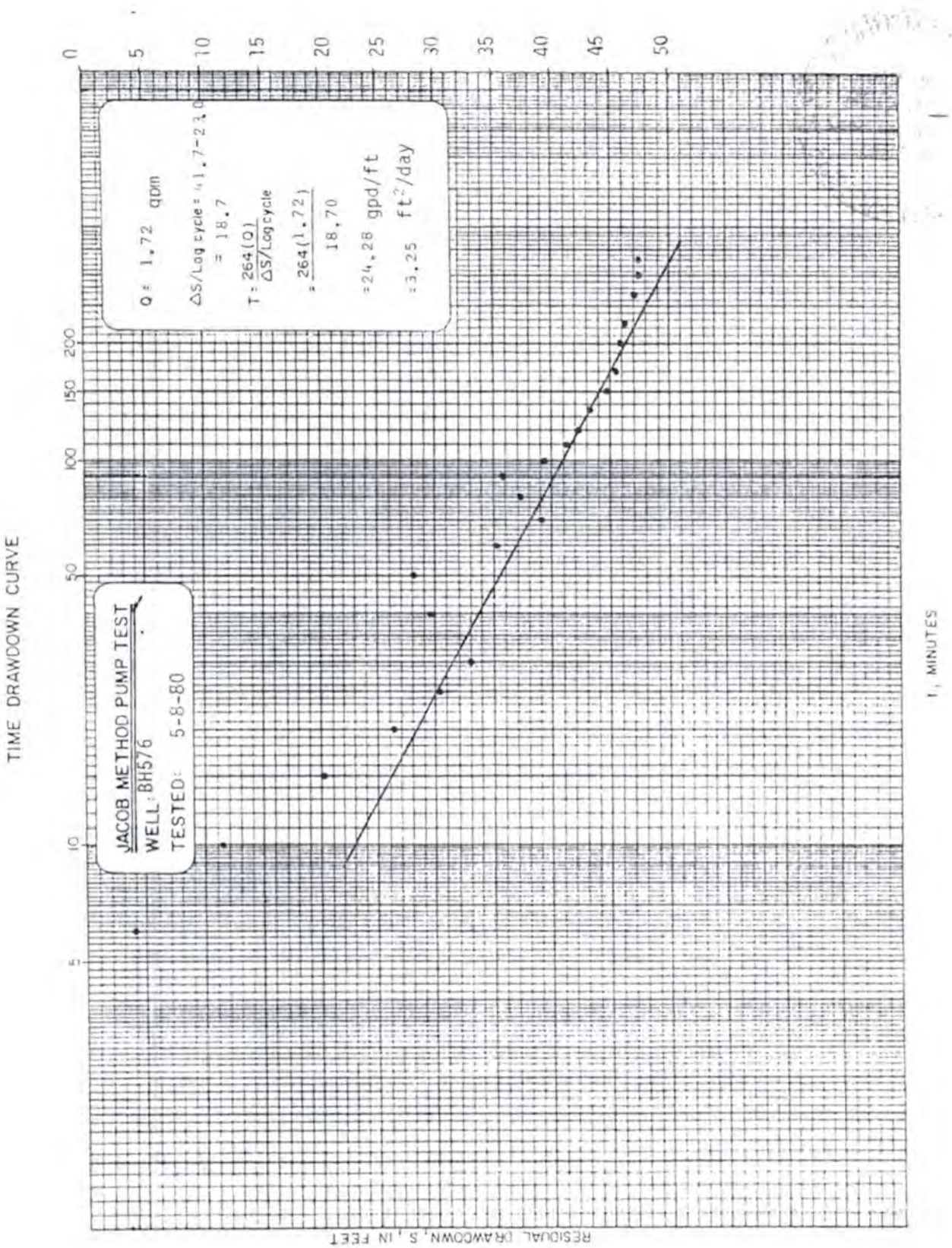

DEQ Ex. 3-1352

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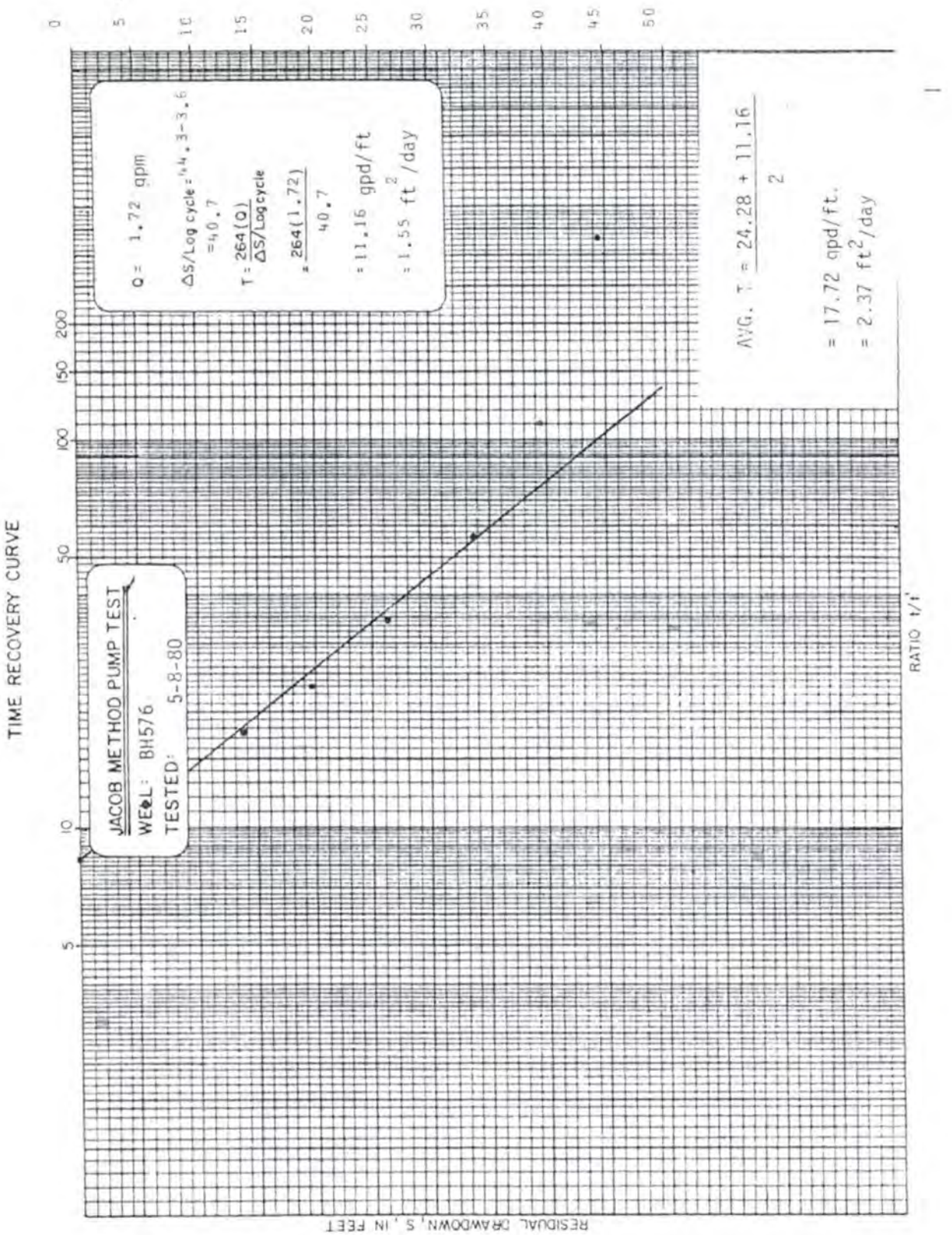
RECD 10-25-18



DEQ Ex. 3-1353

D6-401

IFR 6 2/025
RECD 10-25-18

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BAILER TEST

Date 3/26/80 Personnel Araas & Bondar S.W.L. 132.26 Well # 575-80

Bailer Volume 2.68 gallons

TIME	BAILER VOLUME (GALS.)	TIME IN	TIME OUT (t)	RESIDUAL DRAWDOWN (s')	ELAPSED TIME TO S' (min)	1/t to S' (Day)
Start 1100	2.68	1100	1104		296.00	4.87
	2.68	1104 ½	1106 3/4		293.25	4.91
	2.68	1107	1109 ½		290.50	4.96
	2.68	1110	1112 ½		287.50	5.01
	2.68	1113	1115 ½		284.50	5.06
	2.68	1116	1118 ½		281.50	5.12
	2.68	1119	1121 2/3		278.34	5.17
	2.68	1122	1124 2/3		275.34	5.23
	2.68	1125	1127 3/4		272.25	5.29
	2.68	1128	1130 5/6		269.17	5.35
	2.68	1131 ½	1134 ¼		265.75	5.42
	2.68	1134 3/4	1137 ½		262.50	5.49
	2.68	1138	1140 5/6		259.17	5.56
	2.68	1141 ¼	1144 1/6		255.84	5.63
	2.68	1144 3/4	1147 2/3		252.34	5.71
	0	1148	1151		249.00	5.78
	2.68	1151 ¼	1154 1/3		245.67	5.86
	0	1154 2/3	1157 3/4		242.25	5.94
						96.36

Stop 1157 3/4

1202	172.67
1215	172.34
1230	172.22
1300	171.78
1400	162.54
1500	149.88
1600	141.57

D6-402

IFR 6 2/025
REC 10-25-18

$$T = \frac{V}{12.57\ (S')}\left[\frac{1}{t_1} + \frac{1}{t_2} + \frac{1}{t_3} + \ldots \frac{1}{tn}\right]$$

Where: $S' = 141.57' - 132.26' = 9.31'$ at 300 mins.

and $\left[\frac{1}{t_1} + \frac{1}{t_2} + \frac{1}{t_3} \ldots \frac{1}{tn}\right] = 96.36$

so, $T = \frac{2.68}{12.57\ (9.31)}\ [96.36] = 2.21$ gpd/ft $= .30\ ft^2/day$

Ave. $Q = \frac{2.68 \text{ gals} \times 16}{57.75 \text{ min.}} = \frac{42.88 \text{ gal.}}{57.75 \text{ min.}} = .743$ gpm.

Total Residual Drawdown = 172.67' - 132.26' = 40.41'

∴specific capacity = .743 gpm/40.41' = .02 gpm/ft.

IFR 6 27025

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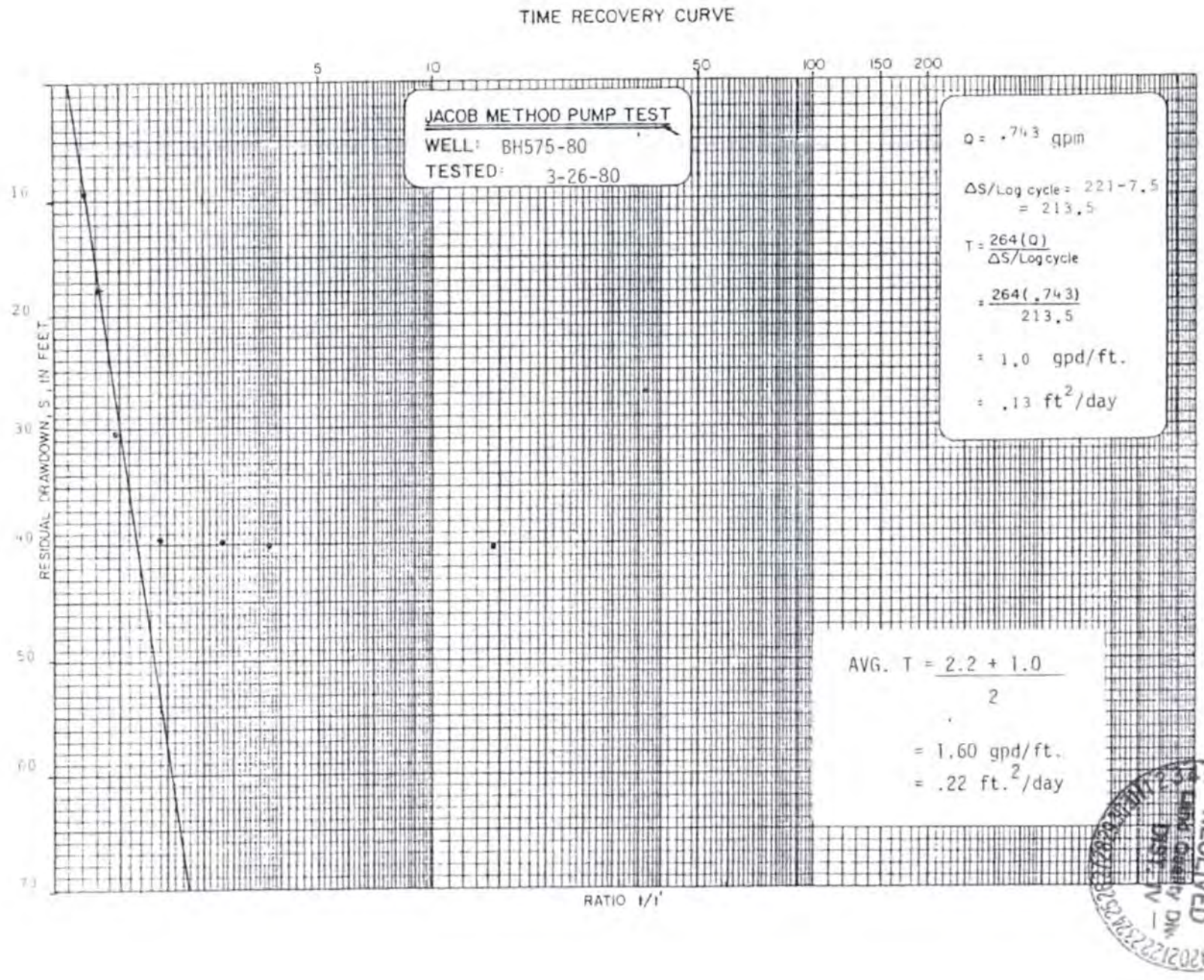

IEN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1356

P.K.S. GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S. R. 84 (E) W Sec. 27 WELL NO. BH 462 A

Personnel Bondar, Hill

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify)
2. Single well recovery (4) Recovery with obs. well

Well owner PKS Address Sheridan, WY

R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Well depth 314 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation Saw slots Interval of screen or perforation 265' - 304' Pump hp. & type 3 Teel Pump depth 200 ft.

Aquifer Dietz 3/Mn Aquifer lithology Coal

Altitude of land surface How determined MP Above Below LSD Altitude MP

SWL from MP 169.81 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
5-9-80	10:00	169.21				
			Galvanometer stuck in hose line, no data from pumping well.			

D6-405

RECD 2/025

RECD 10-25-18

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WATER WELL BH 462A

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
5/9/80	1003	14.75	12.20	3	3	36.60
	1020	15.25	11.80	3	17	200.60
	1035	16.00	11.25	3	15	168.75
	1050	16.00	11.25	3	15	168.75
	1100	10.60	16.98	3	10	169.80
	1115	10.70	16.82	3	15	252.30
	1135	11.70	15.38	3	20	307.60
	1140	8.00	22.50	3	5	112.50
	1200	9.00	20.00	3	20	400.00
	1230	8.50	21.18	3	30	635.40
	1300	9.00	20.00	3	30	600.00
	1330	8.50	21.18	3	30	635.40
	1400	8.50	21.18	3	30	635.40
	1430	8.50	21.18	3	30	635.40
	1500	8.50	21.18	3	30	635.40
	1505	8.00	22.50	3	5	112.50
	1530	8.00	22.50	3	25	562.50
	1600	8.00	22.50	3	30	675.00
OFF	1620	8.00	22.50	3	20	450.00
					380.00	7393.90

7393.9/380 = 19.46

Total Ave. Q = 19.46 gpm

D6-406

TFN 6 2/025

DEQ 12-25-13

RAMACO

Brook Mine

R.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA — observation well

tate WY County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 27 , WELL NO. BH 462

ersonnel Bondar, Hill — Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify) 2. Single well recovery (4) Recovery with obs. well

ell owner PKS Address Sheridan, WY

R. Reed — Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

o. , depth 313 ft. Well diameter 7 7/8 in.

asing diameter 5 in. Casing type PVC

ype of screen or perforation saw slots Interval of screen or perforation 265' - 305' Pumping well 74' away Pump hp. & type N/A Pump depth ____ ft.

quifer Dietz 3/Mn Aquifer lithology coal (pumping well # BH 462 A)

ltitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP 166.12 How measured Stevens F-68 continuous recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-9-80						
On	10:00	166.12	0			
	10:15	169.19	15			3.07
	10:30	170.10	30			3.98
	10:45	170.57	45			4.45
	11:00	171.20	60			5.08
	11:15	172.51	75			6.39
	11:30	172.95	90			6.83
	11:45	173.44	105			7.32
	12:00	174.71	120			8.59
	12:15	175.21	135			9.09
	12:30	175.70	150			9.58
	12:45	176.15	165			10.03
	13:00	176.40	180			10.28
	13:15	176.64	195			10.52
	13:30	176.88	210			10.76
	13:45	177.12	225			11.00
	14:00	177.36	240			11.24
	14:15	177.53	255			11.41
	14:30	177.69	270			11.57
	14:45	177.85	285			11.73
	15:00	178.01	300			11.89
	15:15	178.16	315			12.04
	15:30	178.32	330			12.20
	15:45	178.47	345			12.35
	16:00	178.58	360			12.46
	16:15	178.64	375			12.52
Off	16:20	178.65	380			12.53

D6-407

TFN 6 2/025

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RAMACO

Brook Mine

...S. GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

observation well

State WY County Sheridan T. 57 (N) R. 84 (W) Sec. _____ WELL NO. BH 462

Personnel Bondar, Hill

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify _____
2. Single well recovery (4) Recovery with obs. well

Well owner PKS Address Sheridan, WY

R. Reed Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

...ll depth _____ ft. Well diameter ____ in.

Casing diameter 5 in. Casing type PVC Pumping well 74' away

Type of screen or perforation saw slots Interval of screen or perforation _____ Pump hp. & type N/A Pump depth _____ ft.

Aquifer Dietz 3/Mn Aquifer lithology Coal (Pumping well # BH 462A)

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens F-68 continuous reorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
5-9-80	1620	178.65	380, OFF	0	0	12.53
	1630	177.57	390	10	39	11.45
	1637.5	174.68	397.5	17.5	22.71	8.56
	1645	173.10	405.0	25	16.20	6.98
	1652.5	172.15	412.5	32.5	12.69	6.03

D6-408

IFR 6 2/025

DEQ Ex. 3-1360

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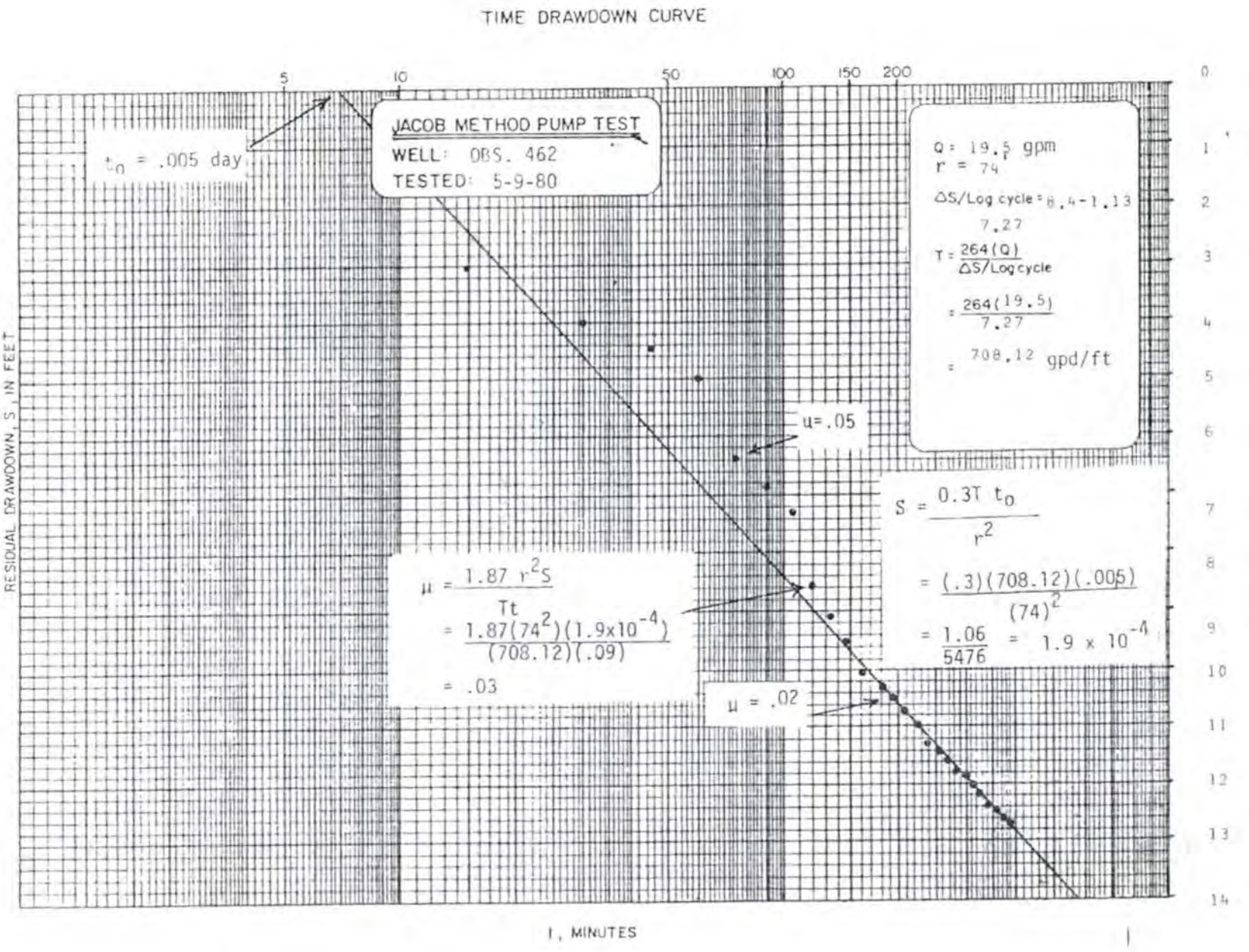

D6-409
TEN 9 2/025
RECD 10-25-18

DEQ Ex. 3-1361

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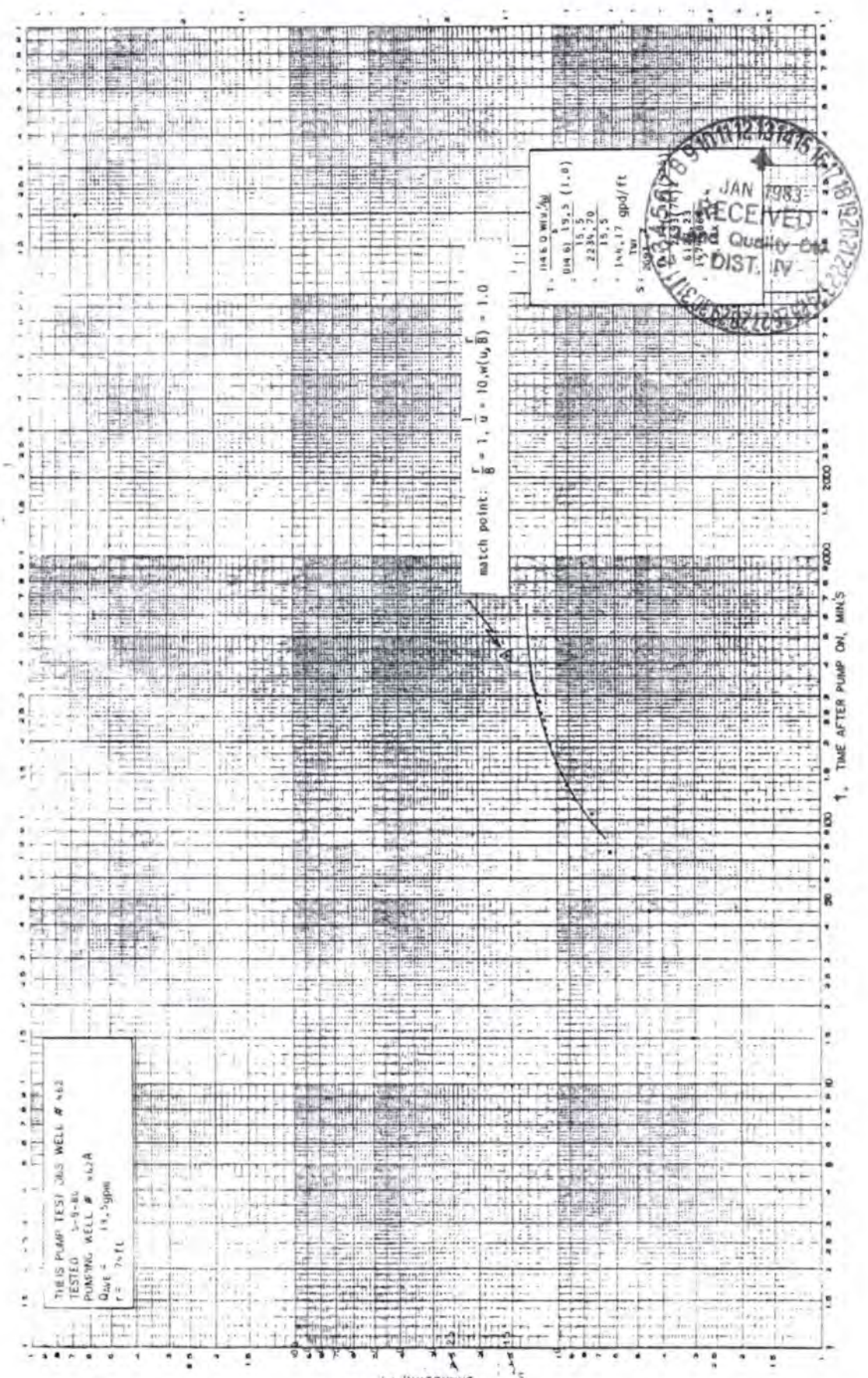

DEQ Ex. 3-1362

D6-410
TFN 6 2/025
RECD 10-25-18

MONARCH COAL

WELLS

TFN 6 2/025
RECD 10-25-13

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E.R.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WYO County Sheridan T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. 231

Personnel Gerlach-Wolf

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
(2) Single well recovery 4. Recovery with obs. well

Well owner Big Horn Coal Address ____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

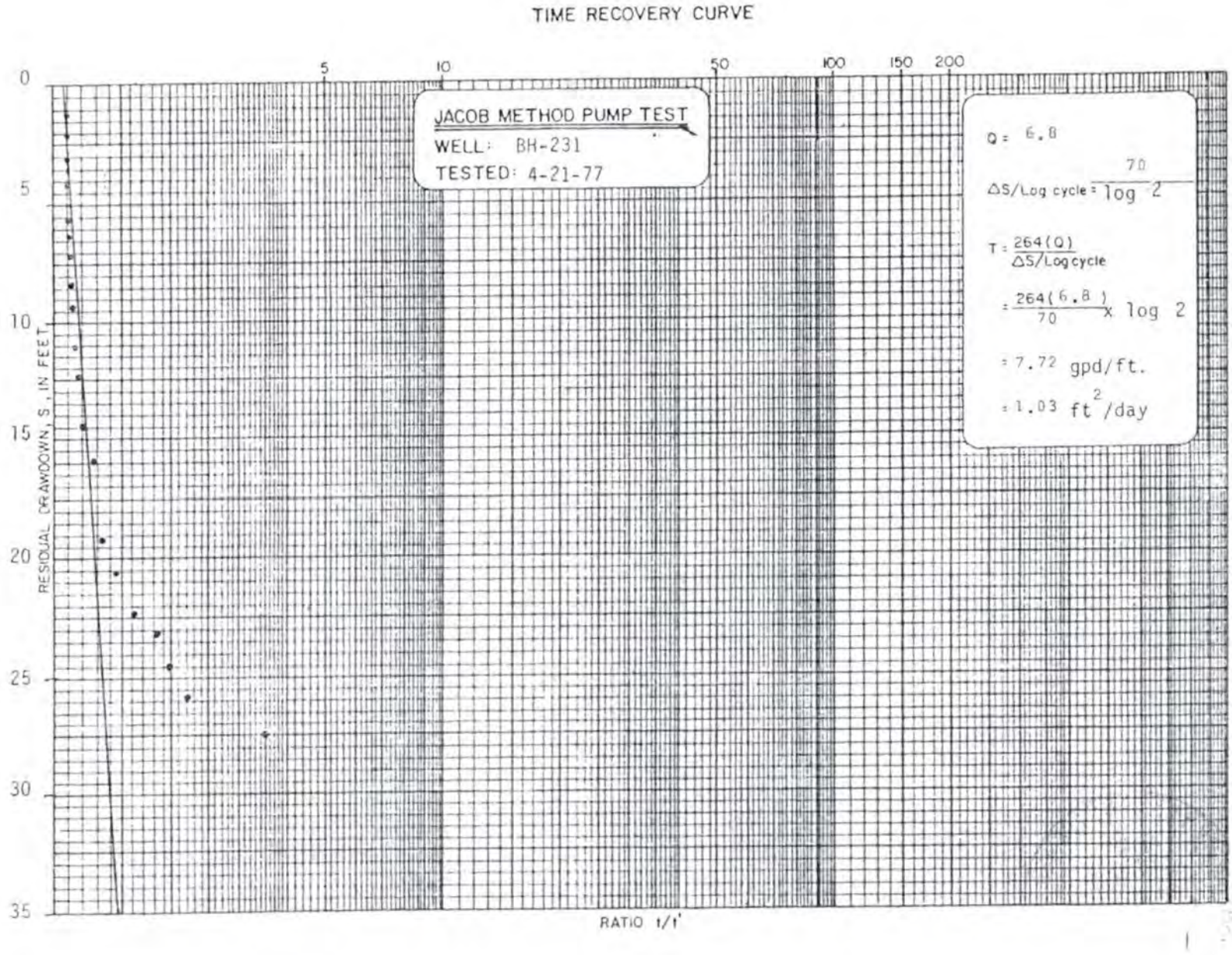
Total depth 85 ft. Well diameter 7 7/8 in.
Casing diameter 5 in. Casing type PVC
Type of screen or perforation Saw Slot Interval of screen or perforation 65-85
Pump hp. & type Teel ½ hp Pump depth 60 ft.
Aquifer Lower Monarch Coal Aquifer lithology Coal
Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____
WL from MP top casing How measured galvanometer (casing 1.78' above ground)

DATE/ HOUR	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
4/21/77 9	45	31.95	-	-	-	-
9	50		-	-	-	-
9	52		0	-	-	-
9	55		3	-	-	-
9	57	Pump Dry-Off	5	0	0	0
9	59	59.45	7	2	3.50	27.50
10	01	57.79	9	4	2.25	25.84
10	02	56.51	10	5	2.0	24.56
10	03	55.52	11	6	1.83	23.57
10	05	54.33	13	8	1.63	22.38
10	08	52.54	16	11	1.45	20.59
10	10	51.24	18	13	1.38	19.29
10	15	48.35	23	18	1.28	16.40
10	20	46.38	28	23	1.22	14.43
10	25	44.40	33	28	1.18	12.45
10	30	43.08	38	33	1.15	11.13
10	35	41.33	43	38	1.13	9.38
10	40	40.37	48	43	1.12	8.42
10	45	39.16	53	48	1.10	7.21
10	50	38.33	58	53	1.094	6.30
10	55	37.52	63	58	1.086	5.57
11	05	36.00	73	68	1.074	4.05
11	15	35.00	83	78	1.064	3.05
11	30	34.02	98	93	1.054	2.07
11	48	33.16	116	111	1.045	1.21

Q = 6.8 gpm

Specific Capacity = 6.8gpm/27.50 = .25 gpm/ft.

TFR 6/2/025
RECD 10-25-18



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DEQ Ex. 3-1365

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RAMACO

Brook Mine

U.S. GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

State WY County Sheridan T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. 232

Personnel Gerlach - Wolf

Test type: (1.) Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify)

Well owner Big Horn Coal Co. Address ____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H.) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 98 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation Saw slot Interval of screen or perforation 78-98 Pump hp. & type Teel 1/2 hp. Pump depth 70 ft.

Aquifer Low. monarch Aquifer lithology coal

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

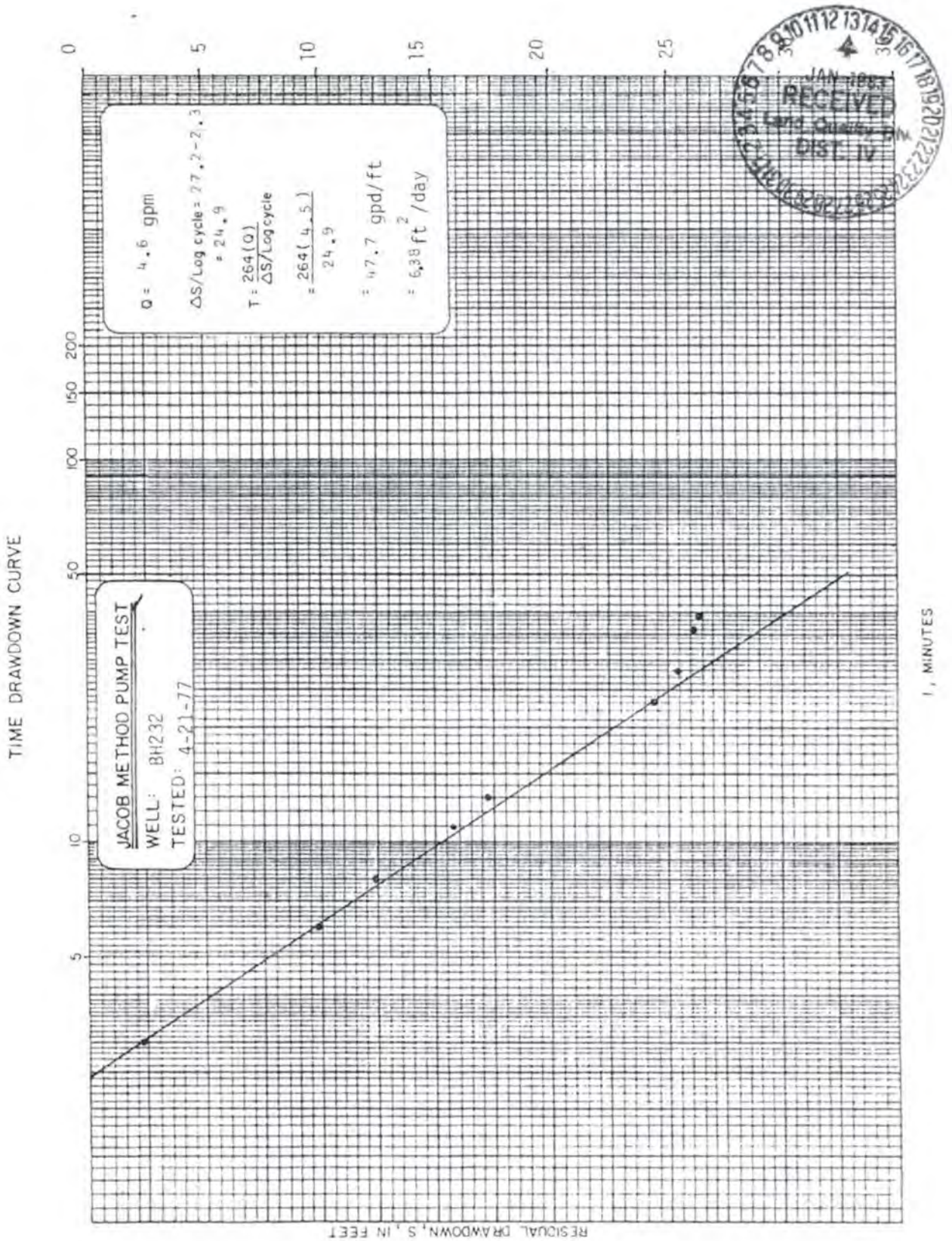
WL from MP Top Casing How measured Galvanometer (Casing 1.95' above grd)

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
4-21-77	1:34	36.53	-	-	-	-
On 1	40		0	-	-	-
1	43	38.75 Q = 3.5	3	-	-	-
1	46	46.30	6	-	-	-
1	48	49.13 Q = 4.6	8	-	-	-
1	51	52.81	11	-	-	-
1	53	56.10	13	-	-	-
2	03	60.80	23	-	-	-
2	08	61.71	28	-	-	-
2	16	62.50	36	-	-	-
2	19	62.70	39	-	-	0
2	20	Pump Off	40	0	0	0
2	21	58.76	41	1	41.0	22.23
2	22	54.98	42	2	21.0	18.45
2	23	51.85	43	3	14.33	15.32
2	24	49.29	44	4	11.0	12.76
2	26	45.14	46	6	7.67	8.61
2	28	42.77	48	8	6.00	6.24
2	30	41.02	50	10	5.00	4.49
2	32	39.79	52	12	4.33	3.26
2	34	39.20	54	14	3.86	2.67
2	38	38.16	58	18	3.22	1.63
2	45	37.70	65	25	2.60	1.17

Specific Capacity = 4.5 gpm/26.17 = .17 gpm/ft.

D6-[illegible]

TFR 6 2/025
RECD 10-25-18



D6-415

TFN 6 2/025

RECD 10-25-18

DEQ Ex. 3-1367

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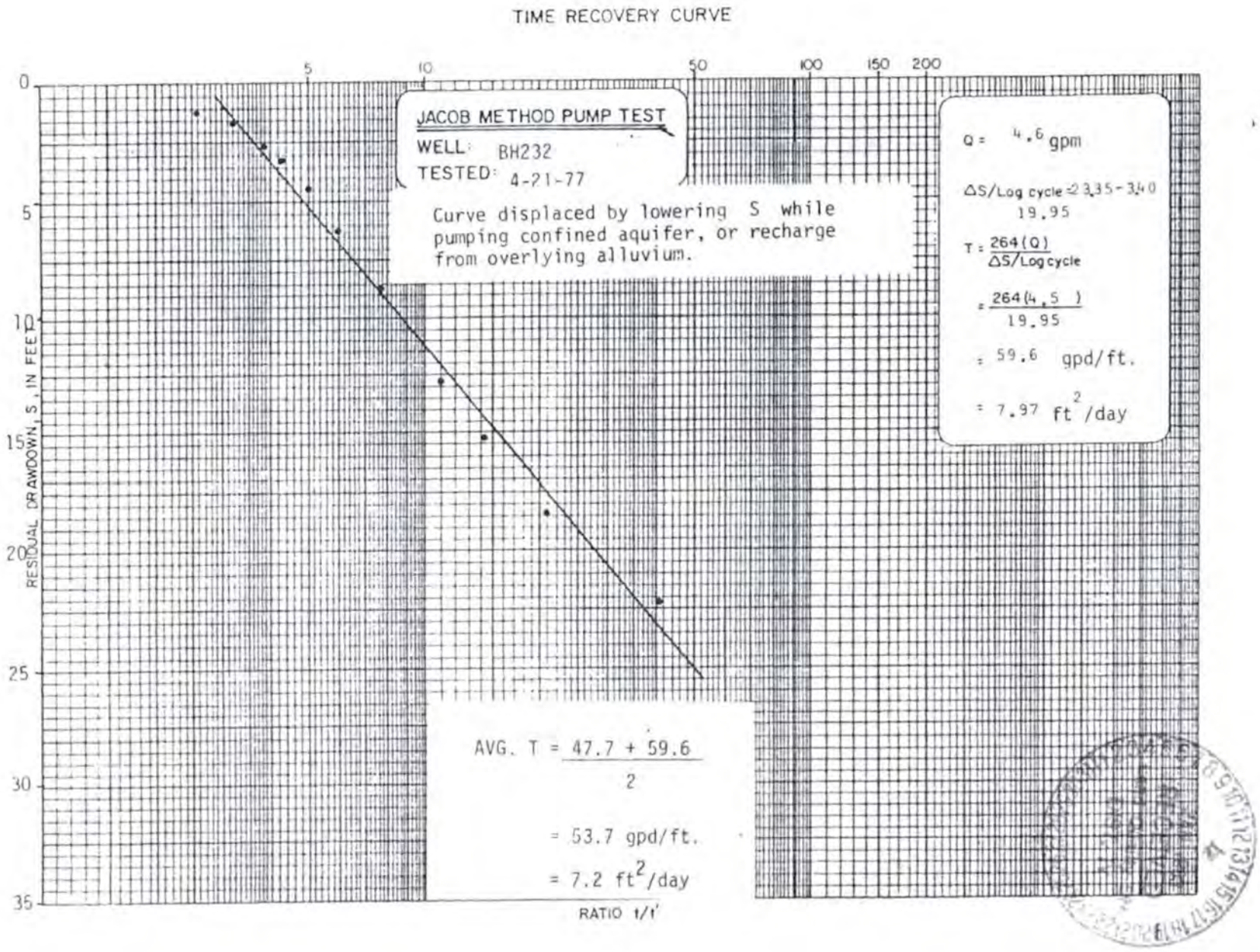

D6-416
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1368

PKS GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO. BH 467

Personnel Araas & Bondar — Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

Owner P.K.S. Address Sheridan, WY

Driller Reed — Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 380 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 343-364 Pump hp. & type 3/4 Teel Pump depth 250 ft.

Aquifer Monarch Aquifer lithology Coal

Altitude of land surface 3619.09 How determined surveyed MP Above Below LSD Altitude MP

SWL from MP 100.00 How measured Galvonometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
2-26-80	10:30	100.00	0			
	10:31	108.37	1			8.37
	10:33	115.97	3			15.97
	10:36	121.30	6			21.30
	10:40	123.75	10			23.75
	10:45	125.23	15			25.23
	10:50	125.92	20			25.92
	11:00	126.45	30			26.45
	11:20	126.50	50			26.50
	11:40	127.60	70			27.60
	12:00	127.92	90			27.92
	12:20	127.72	110			27.72
	12:40	127.60	130			27.60
	13:00	127.72	150			27.72
	13:20	127.82	170			27.82
	13:40	128.00	190			28.00
	14:00	128.11	210			28.11
	14:20	128.16	230			28.16
	14:40	128.43	250			28.43
	15:00	128.30	270			28.30
Off	15:01		271	0	0	
	15:02	116.71	272	1	272	16.71
	15:04	106.19	274	3	91.33	6.19
	15:07	104.73	277	6	46.16	4.73
	15:10	104.00	280	9	31.11	4.00
	15:15	103.33	285	14	20.35	3.33
	15:25	102.76	295	24	12.29	2.76
	15:35	102.43	305	34	8.97	2.43
	15:45	102.15	315	44	7.15	2.15
	16:00	101.90	330	D6-12-400		

JAN 9 2025
RECD 10-25-18

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WATER WELL BH 467

PUMPING RATE DATA

JAN 1983
RECEIVED
Land Quality
DIVISION

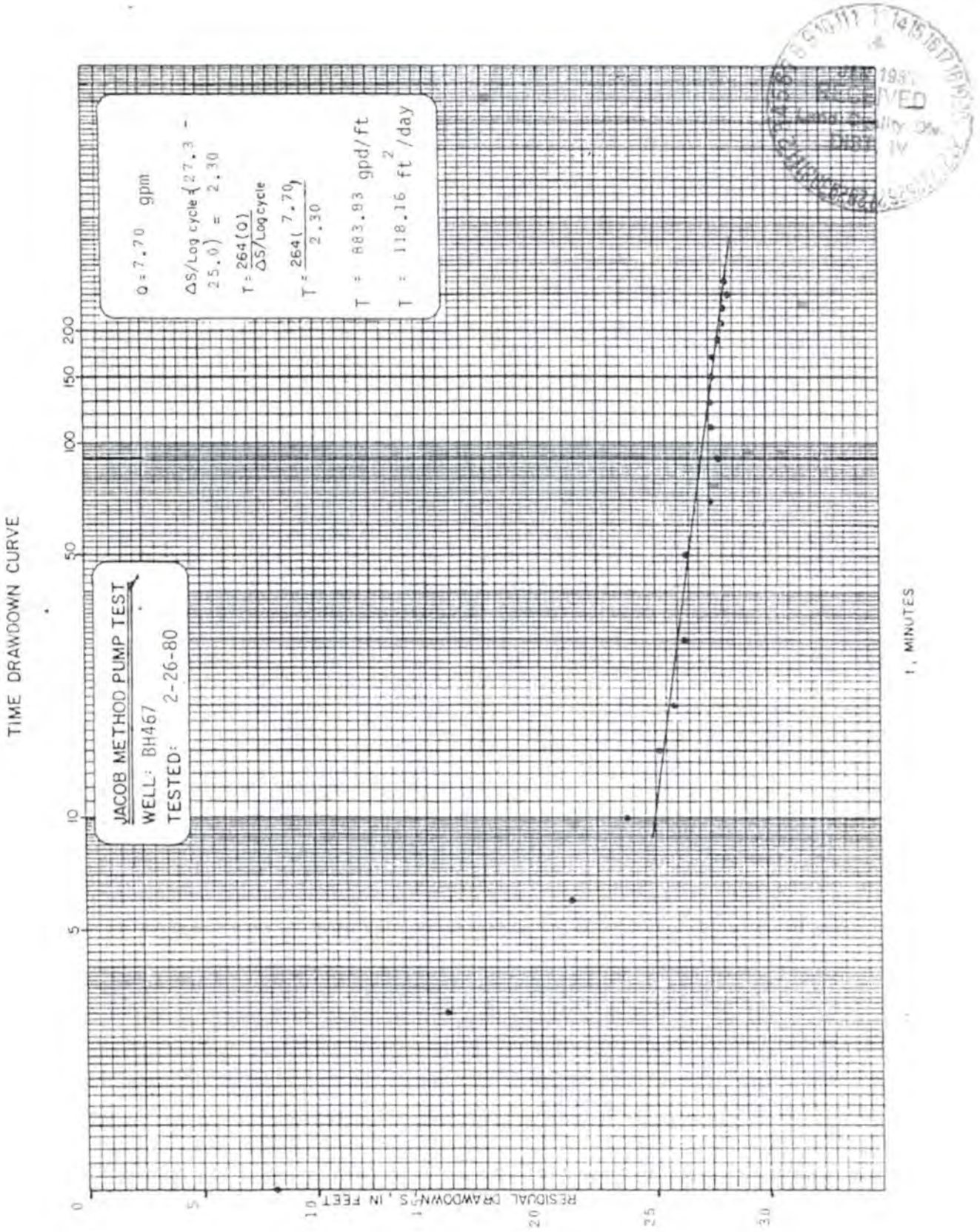
DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED DISCHARGE
2/26/80	1031	28.40	7.24	3.43	1	
	1033	24.70	8.33	3.43	2	16.66
	1036	28.00	7.35	3.43	3	22.05
	1040	27.50	7.48	3.43	4	29.92
	1045	26.10	7.88	3.43	5	39.40
	1050	27.00	7.62	3.43	5	38.10
	1100	26.10	7.88	3.43	10	78.80
	1120	27.00	7.62	3.43	20	152.40
	1140	27.00	7.62	3.43	20	152.40
	1200	26.60	7.73	3.43	20	154.60
	1220	26.80	7.67	3.43	20	153.40
	1240	26.80	7.67	3.43	20	153.40
	1300	27.10	7.59	3.43	20	151.80
	1320	27.20	7.56	3.43	20	151.20
	1340	26.40	7.79	3.43	20	155.80
	1400	26.90	7.65	3.43	20	153.00
	1420	26.50	7.76	3.43	20	155.20
	1440	25.80	7.97	3.43	20	159.40
	1500	26.30	7.82	3.43	20	156.04
					270	2081.17

2081.17/270 = Total Q of 7.70

Specific Capacity = 7.70/28.30 = .27 gpm/ft.

TFN 6 2/025

DEQ-12-25-18



DEQ Ex. 3-1371

TFN 6 2/025
RECD 10-25-18

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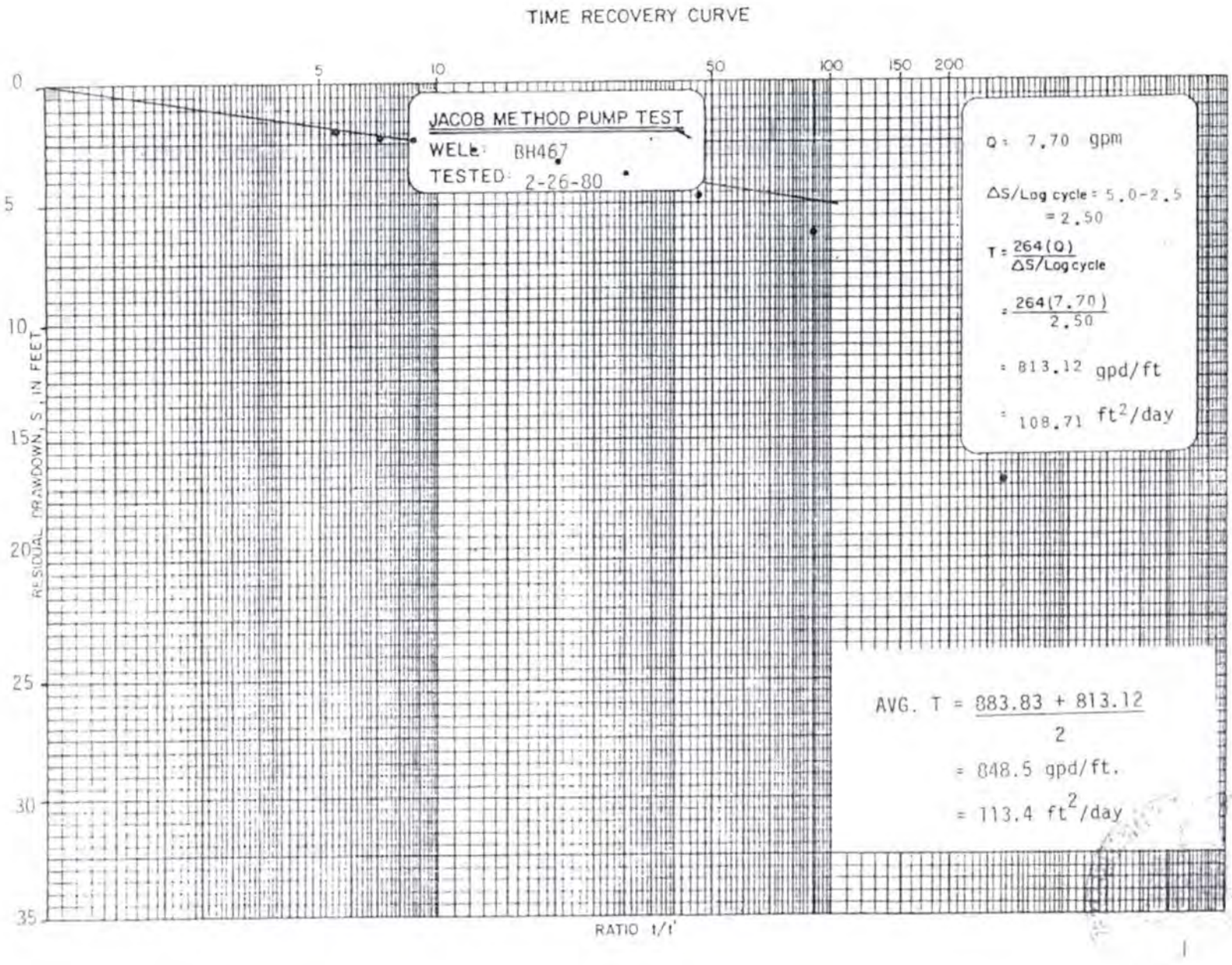

TFN 6 2/025
RECD 10-25-13

DEQ Ex. 3-1372

P.K.S. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S. R. 84 (E) (W) Sec. 14 WELL NO. 496

Personnel Dondar & Araas Test type: (1) Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify)

Well owner P.K.S. Address Sheridan, WY

Tom Kekich Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Well depth 278 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 245' - 270' Pump hp. & type 3/4 Teel Pump depth 250 ft.

Aquifer Lower Monarch Aquifer lithology Coal

Altitude of land surface 3687.6 How determined Surveyed MP Above Below LSD Altitude MP

WL from MP 167.10 How measured Galvonometer

DATE	TIME On	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4-3-80	10:15	167.10	0			0
	10:16	179:54	1			12.44
	10:18	187.18	3			20.08
	10:21	193.46	6			26.36
	10:25	199:88	10			32.78
	10:30	201.34	15			34.24
	10:40	201.35	25			34.25
	10:50	201.24	35			34.14
	11:00	202.82	45			35.72
	11:15	202.72	60			35.62
	11:30	202.94	75			35.84
	11:45	203.45	90			36.35
	12:00	203.50	105			36.40
	12:15	204.76	120			37.66
	12:30	206.68	135			39.58
	12:45	206.75	150			39.65
	14:00	207.12	165			40.02
	14:20	207.24	185			40.14
Off	14:30	207.24	195	0	0	40.14
	14:31	193.63	196	1	196	26.53
	14:36	175.07	201	6	33.50	7.97
	14:40	172.65	205	10	20.50	5.55
	14:45	171.08	210	15	14.00	3.98
	14:50	170.35	215	20	10.75	3.25
	14:55	170.00	220	25	8.80	2.90
	15:00	169.74	225	30	7.50	2.64
	15:10	169.49	235	40	5.87	2.39
	15:30	169.22	255	60	4.25	2.12
	16:00	169.03	285	90	3.17	1.93

TFN 6 2/025

RECD 10-25-18

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JAN 1983
RECEIVED
Land Quality Div.
DIST. IV

WATER WELL 496

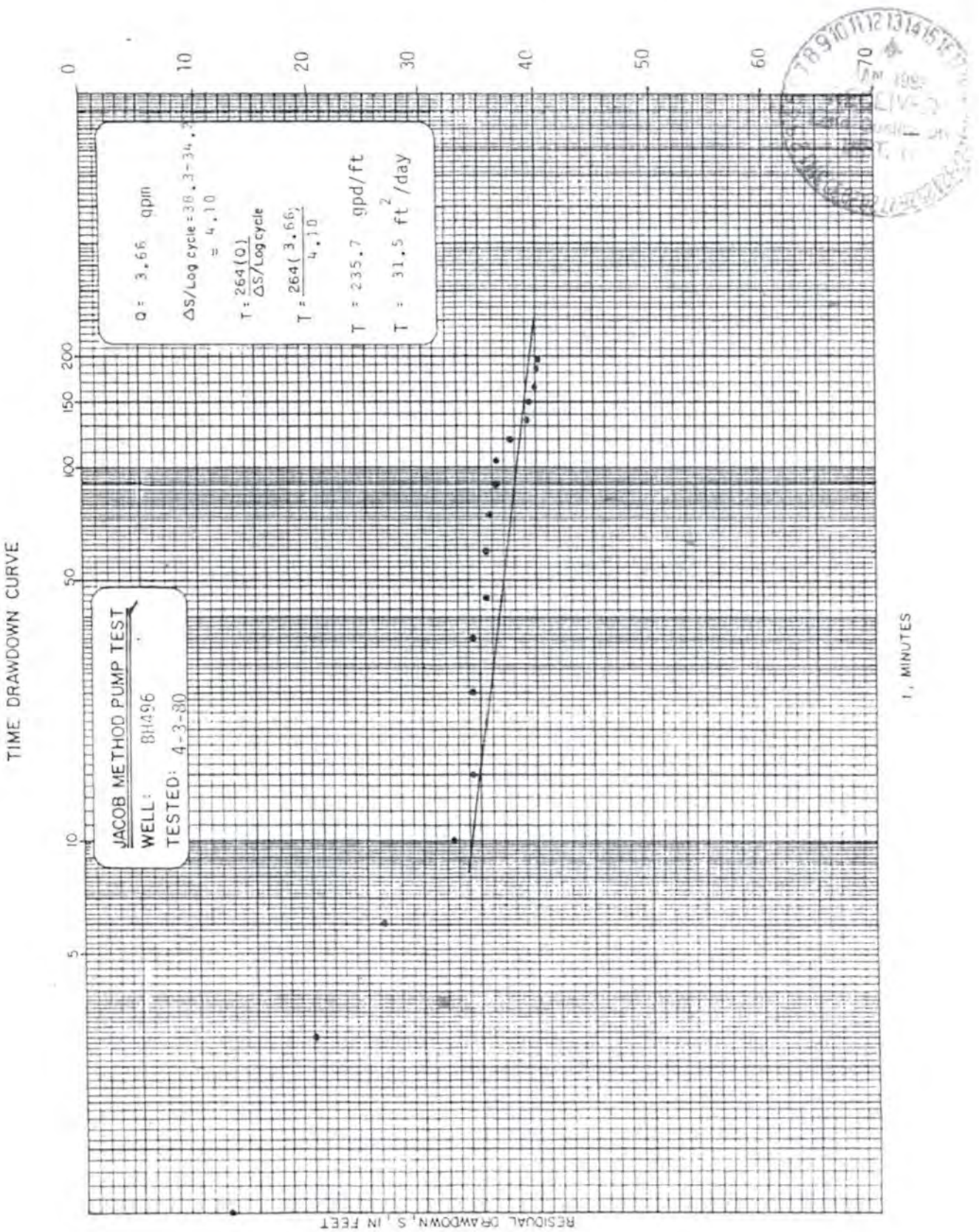
PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
4/3/80	1018	41.00	5.02	3.43	3	15.06
	1021	42.20	4.88	3.43	3	14.64
	1025	43.00	4.79	3.43	4	19.16
	1030	59.20	3.47	3.43	5	17.35
	1040	59.20	3.47	3.43	10	34.70
	1050	60.50	3.40	3.43	10	34.00
	1100	62.00	3.31	3.43	10	33.10
	1115	60.00	3.43	3.43	15	51.45
	1130	60.00	3.43	3.43	15	51.45
	1145	59.00	3.49	3.43	15	52.35
	1200	63.50	3.24	3.43	15	48.60
	1215	55.30	3.72	3.43	15	55.80
	1230	53.80	3.82	3.43	15	57.30
	1345	60.00	3.43	3.43	15	51.45
	1300	62.00	3.31	3.43	15	49.65
	1315	57.30	3.59	3.43	15	53.85
	1330	56.00	3.68	3.43	15	55.20
	1345	55.00	3.74	3.43	15	56.10
	1400	56.00	3.68	3.43	15	55.20
	1420	57.00	3.61	3.43	20	72.20
OFF	1430	57.00	3.61	3.43	10	36.10
					250	914.71

914.71/250 = 3.66, Total Ave. Q = 3.66

Specific Capacity = 3.66/40.14 = .09 gpm/ft.

IFR 9 2/025



DEQ Ex. 3-1375

D6-423

TFN 6 2/025
RECD 10-25-13

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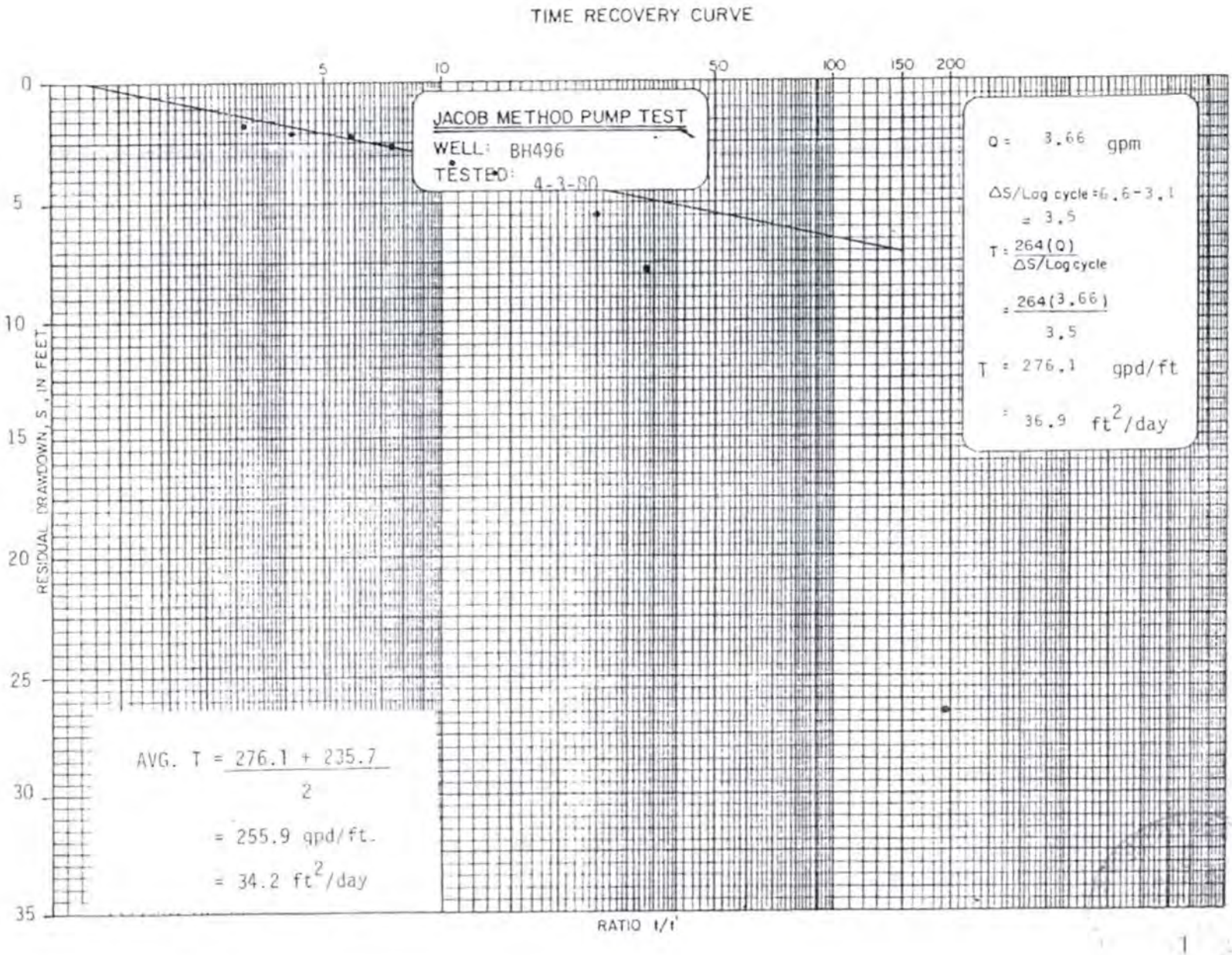

RECD 10-25-18
2025

DEQ Ex. 3-1376

P.K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) R. 84 (W) Sec. 14 WELL NO. 584

Personnel Bondar Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

Owner P.K.S. Address Sheridan, WY

R. Reed Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Well depth 340 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 303' - 327' Pump hp. & type 3/4 Teel (sub.) Pump depth 250 ft.

Aquifer Monarch Aquifer lithology coal

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP 105.95 How measured Galvonometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT RESIDUAL DRAWDOWN
4-9-80	10:30	105.95	0			0
	10:33	124.23	3			18.28
	10:36	139.19	6			33.24
	10:40	141.27	10			35.32
	10:45	145.51	15			39.56
	10:50	147.80	20			41.85
	11:00	149.36	30			43.41
	11:15	150.43	45			44.48
	11:30	150.74	60			44.79
	11:45	151.04	75			45.09
	12:00	151.10	90			45.15
	12:20	151.46	110			45.51
	13:00	151.77	150			45.82
	13:30	152.08	180			46.13
	14:00	152.10	210			46.15
Off	14:35	152.13	245	0	0	46.18
	14:36	136.45	246	1	246.0	30.50
	14:38	120.32	248	3	82.7	14.37
	14:41	113.81	251	6	41.83	7.86
	14:45	110.31	255	10	25.5	4.36
	14:50	108.70	260	15	17.33	2.75
	14:55	108.42	265	20	13.25	2.47
	15:00	108.15	270	25	10.80	2.20
	15:10	107.80	280	35	8.00	1.85
	15:20	107.58	290	45	6.40	1.63
	15:30	107.40	300	55	5.45	1.45
	15:40	107.27	310	65	4.80	1.32
	15:50	107.18	320	75	4.26	1.23
	16:00	107.09	330			

TFN 6 2/025
RECD 10-25-18

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WATER WELL BH 584

PUMPING RATE DATA

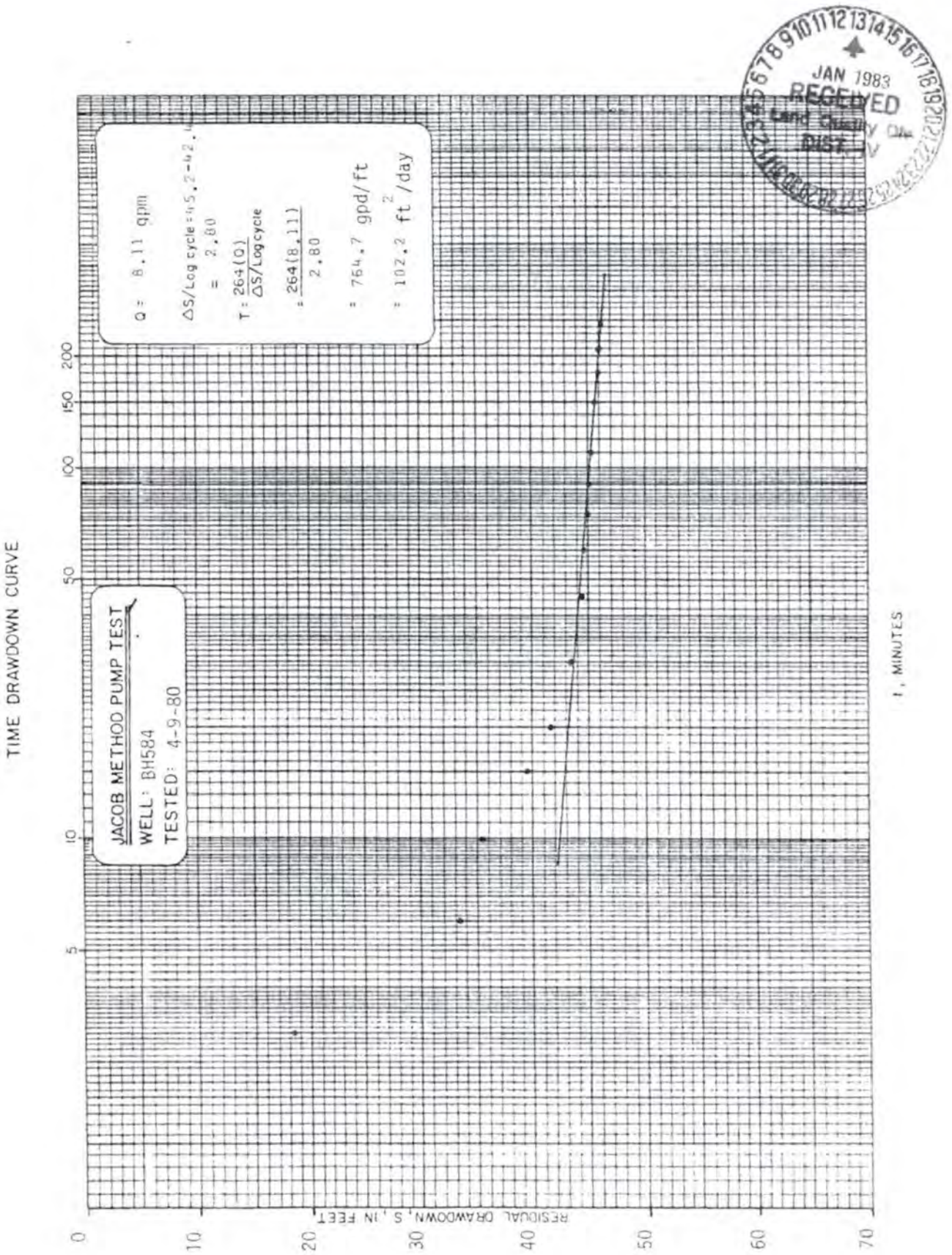
DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
4-9-80	1033	22.50	9.15	3.43	3	27.45
	1040	23.40	8.80	3.43	7	61.60
	1045	24.50	8.40	3.43	5	42.00
	1050	24.30	8.50	3.43	5	42.50
	1100	25.20	8.16	3.43	10	81.60
	1115	25.70	8.00	3.43	15	120.00
	1130	24.00	8.58	3.43	15	128.70
	1145	25.50	8.07	3.43	15	121.05
	1200	26.30	7.83	3.43	15	117.45
	1220	26.00	7.92	3.43	20	158.40
	1300	25.70	8.00	3.43	40	320.00
	1330	25.50	8.07	3.43	30	242.10
	1400	25.50	8.07	3.43	65	524.55
OFF	1435				245	1987.4

1987.4/245 = 8.11, Total Ave. Q = 8.11

Specific Capacity = 8.11/46.18 = .18 gpm/ft.

TFN 6 2/025

R5CP-40-25-18



D6-427

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1379

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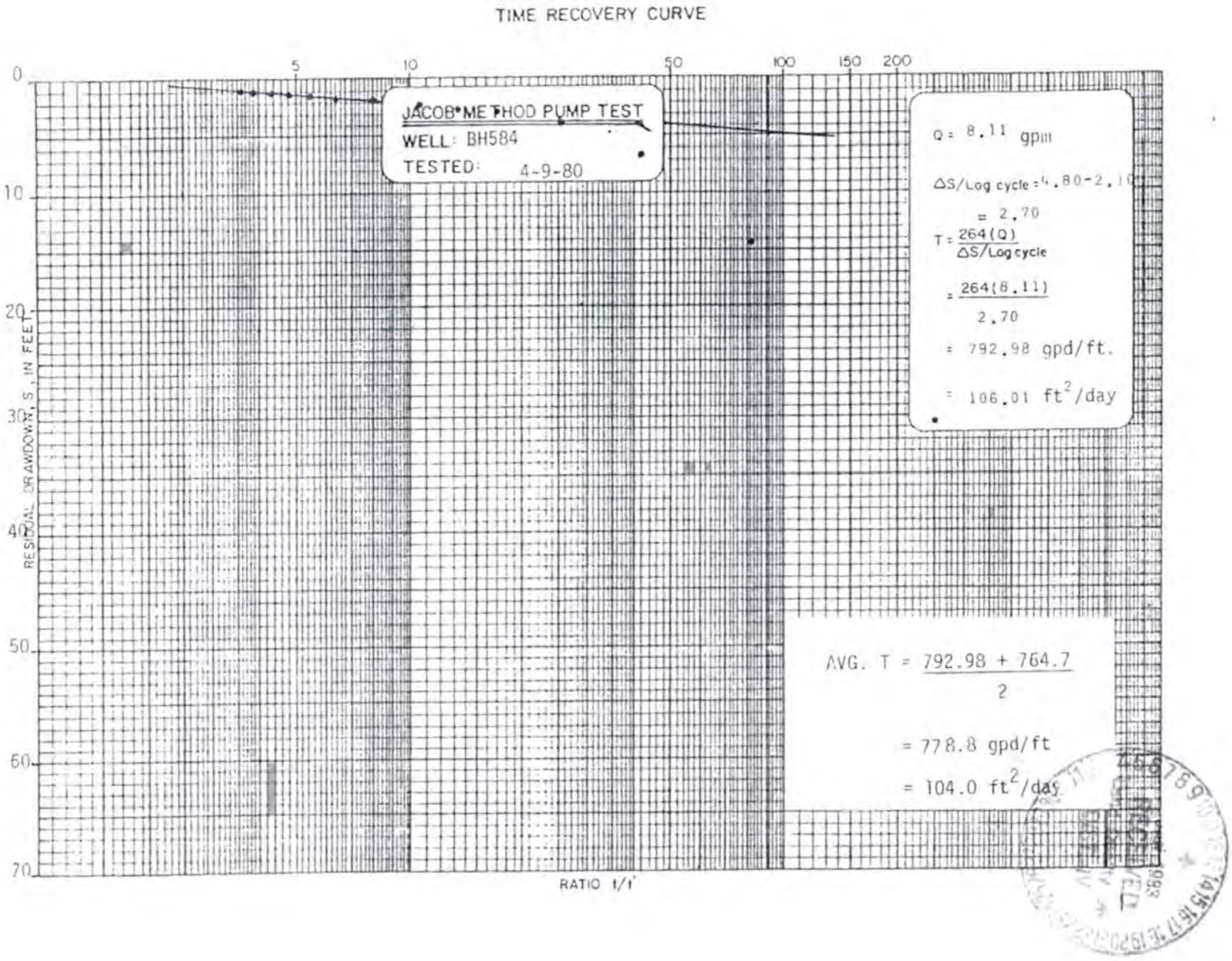

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1380

ADDENDUM D6-5

AQUIFER TEST DATA AND CALCULATIONS

PIT 4

D6-429
TPR 6 2/025
RECD 10-25-13

DEQ Ex. 3-1381

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BAILER TEST

Well # WW390-79

Date: 11/14/79 Personnel: Gerlach, Araas

S.W.: 61.32' Bailer Volume: 2.68 gal.

TIME IN	TIME OUT	BAILER VOLUME (GALS)	ELAPSED TIME t, TO S'(MIN)	t, TO S'(DAY)	REGIONAL DRAWDOWN S'(FT)	VOL(GAL.) / t (DAY)	COMMENTS
13:28	13:29	2.68	114.00	.079		33.85	
13:30	13:31	1.34	112.00	.078		17.23	
13:32	13:33	0	110.00	.076		0	
13:34	13:35	0.67	108.00	.075		8.93	
13:35	13:36	2.68	107.00	.074		36.07	
13:36	13:38	2.68	105.00	.073		36.74	
13:38	13:39	2.68	104.00	.072		36.12	
13:39	13:41	2.68	102.00	.071		37.84	
13:41	13:42½	2.68	100.50	.070		38.40	
13:42½	13:43 3/4	2.68	99.25	.069		38.89	
13:44	13:45¼	2.68	97.75	.068		39.48	
13:45½	13:46 3/4	2.68	96.25	.067		40.09	
13:47	13:48¼	2.68	94.75	.066		40.74	
13:48½	13:49 3/4	2.68	93.25	.065		41.38	
13:50	13:51¼	2.68	91.75	.064		42.05	
13:51½	13:53 3/4	2.68	90.25	.063		42.77	
13:53	13:54¼	2.68	88.75	.062		43.50	
13:54½	13:56	2.68	87.00	.060		44.35	
13:56¼	13:57	2.68	85.50	.059		45.13	
13:573/4	13:59¼	1.34	83.75	.058		23.03	
13:59½	14:01	2.68	82.00	.057		47.06	
14:01¼	14:02 3/4	2.68	80.25	.056		48.08	
14:03	14:04½	2.68	78.50	.055		49.15	
14:043/4	14:06¼	2.68	76.75	.053		50.28	
14:06½	14:08	2.68	75.00	.052		51.46	
14:08¼	14:09 3/4	0.67	73.25	.051		13.17	
						=946.79	
RECOVERY							
14:15			68.00		98.65		
14:32½			50.50		97.81		
14:50½			27.50		97.32		
15:11			12.00		95.62		
15:23			0				

SOLUTION TO WW390 BAILER TEST

$$T = \frac{1}{4\pi(S')}\left(\frac{V_1}{t_1} + \frac{V_2}{t_2} = \frac{V_3}{t_3} + \cdots \frac{V_n}{t_n}\right)$$

Where S'=95.28'-61.32'=33.96' at 115 minutes, so $T = \frac{1}{(12.57)(33.96')}$ (946.79 gal/day)

= 2.22 gpd/ft = 0.3 ft^2/day

D6-439

TFR G 2/025
RECD 10-25-18

BAILER TEST

Well # WW390-79

Date: 11/14/79 Personnel: Gerlach, Araas

S.W.: 61.32' Bailer Volume: 2.68 gal.

PAGE 2

TIME IN	TIME OUT	BAILER VOLUME (GALS)	ELAPSED TIME t, TO S'(MIN)	t, TO S'(DAY)	REGIONAL DRAWDOWN S'(FT)	VOL(GAL.) / t (DAY)	COMMENTS

Ave. Q = $\frac{60.30 \text{ gals}}{41.75 \text{ min.}}$ = 1.44 gpm

Total Residual Drawdown = 98.65'-61.32' = 37.33'

∴ Specific Capacity = $\frac{1.44 \text{ gpm}}{37.33'}$ = 0.04 gpm/ft

D6-421

TFN 6 2/025

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JAN 1983 RECEIVED Land Quality Div. DIST. IV

BAILER TEST

Well # WW391-79

Date: 11/15/79 Personnel: Gerlach, Araas

S.W.: 47.47' Bailer Volume: 2.68 gal.

TIME IN	TIME OUT	BAILER VOLUME (GALS)	ELAPSED TIME t, TO S'(MIN)	t, TO S'(DAY)	REGIONAL DRAWDOWN S'(FT)	VOL(GAL.) / t (DAY)	COMMENTS
12:97	12:08	2.68	162.00	.T13		23.82	
12:08	12:09	2.68	161.00	.111		23.97	
12:09	12:10	2.68	160.00	.111		24.12	
12:10	12.11	2.68	159.00	.110		24.27	
12:11½	12:12½	2.68	157.75	.109		24.46	
12:12½	12:13½	2.68	156.75	.109		24.62	
12:13½	12:14½	2.68	155.75	.108		24.78	
12:14½	12:16	2.68	154.00	.107		25.06	
12:16	12:17	2.68	153.00	.106		25.22	
12:17½	12:18½	2.68	151.75	.105		25.43	
12:18½	12:19½	2.68	150.50	.105		25.64	
12:19	3/412:20	3/4 2.68	149.25	.104		25.86	
12:21	12:22	2.68	148.00	.103		26.08	
12:22	12:23½	2.68	146.75	.102		26.30	
12:23½	12:24½	2.68	145.50	.101		26.52	
12:25	3/412:27½	2.68	142.50	.099		27.08	
12:27	3/412:29	2.68	141.00	.098		27.37	
12:30½	12:31½	2.68	138.50	.096		27.86	
12:31	3/412:32	3/4 2.68	137.25	.095		28.12	
12:33	12:34	2.68	136.00	.094		28.38	
12:34½	12:35½	2.68	134.75	.094		28.64	
12:35½	12:36	3/4 2.68	133.25	.093		28.96	
12:37	12:38½	2.68	131.75	.092		29.29	
12:38½	12:39½	2.68	130.50	.091		29.57	
12:39½	12:40	3/4 2.68	129.25	.090		29.86	
12:42	3/412:44½	2.68	125.75	.087		30.69	
12:44½	12:45	3/4 2.68	124.25	.086		31.06	
12:46	12:47½	2.68	122.75	.085		31.44	
						=754.47	
RECOVERY							
12:49			121.00		79.26		
13:13			97.00		79.06		
13:45			65.00		78.88		
14:50			0		78.64		

SOLUTION TO WW391 BAILER TEST

$$T = \frac{1}{4\pi(S')}\left[\frac{V_1}{t_1} + \frac{V_2}{t_2} + \frac{V_3}{t_3} + \cdots \frac{V_n}{t_n}\right]$$

Where S' = 78.64'-47.47' = 31.17', so T = $\frac{1}{(12.57)(31.17')}$ 754.47 gal/day

= 1.93 gpd/ft = [illegible] ft²/day

TFN 6 2/025

JAN 1982
RECEIVED
Land Quality Div.
DIST. 17

BAILER TEST

Well # WW391-79

Date: 11/15/79 Personnel: Gerlach, Araas

S.W.: 47.47' Bailer Volume: 2.68 gal

PAGE 2

TIME IN	TIME OUT	BAILER VOLUME (GALS)	ELAPSED TIME t, TO S'(MIN)	t, TO S'(DAY)	REGIONAL DRAWDOWN S'(FT)	VOL(GAL.) / t (DAY)	COMMENTS

Ave. Q = $\frac{75.04 \text{ gal}}{40.25 \text{ min.}}$ = 1.86 gpm.

Total Residual Drawdown = 79.26' - 47.47' = 31.79'

∴ Specific Capacity = $\frac{1.86 \text{ gpm}}{31.79'}$ = .06 gpm/ft.

D6-433

TFN 6 2/025

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AQUIFER TEST DATA

State WY County Sheridan T. 57 N. S. R. 84 E. W. Sec. 9 WELL NO. WW 392-79

Personnel Bondar, Araas, Veenstra, Collier Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
2. Single well recovery 4. Recovery with obs. well

Well owner Peter Kiewit Sons' Address P. O. Box 3049, Sheridan, WY 82801
R. Reed (PKS)

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 50.0 ft. Well diameter 7 7/8 in.
Casing diameter 5 in. Casing type PVC
Type of screen or perforation saw slots Interval of screen or perforation 27-50'
Pump hp. & type 1.5 hp Barnes Pump depth 44 ft.
Aquifer Ft. Union Fm. Aquifer lithology Sandy clay and fine grained sandstone

Altitude of land surface 3698.5 How determined surveyed MP Above Below LSD Altitude MP 1.85
WL from MP 20.40 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFT t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
2/26/79						
on	1600	20.40	0.0			0.0
	01	39.78	1.0			19.38
	02	39.70	2.0			19.30
	03	39.78	3.0			19.38
	04	39.77	4.0			19.37
	05	39.80	5.0			19.40
	10	39.73	10.0			19.33
	20	39.80	20.0			19.40
	30	39.74	30.0			19.34
	1700	39.83	60.0			19.43
	30	39.80	90.0			19.40
	1800	39.75	120.0			19.35
	1900	39.62	180.0			19.22
	2000	39.80	240.0			19.40
	2100	39.75	300.0			19.35
	2200	39.47	360.0			19.07
	2300	39.51	420.0			19.11
	2400	39.40	480.0			19.00
2/27/79	0100	39.39	540.0			18.99
	0200	39.50	600.0			19.10
	0300	39.43	660.0			19.03
Pump off						

IFN 6 2/025

P.K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA — 2 OF 3

State WY County Sheridan T. 57 N. S. R. 84 E. W. Sec. 9 WELL NO. WW 392-79

Personnel Bondar, Araas, Veenstra, Collier

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specif
2. Single well recovery (4) Recovery with obs. well

Well owner Peter Kiewit Sons' Address P. O. Box 3049, Sheridan, WY 82801
R. Reed (PKS)

Method drilled: (A) Air-rotary; B. Bored or augered; C. Cable-tool; D. Dug; H. Hyd.-rotary; J. Jetted; P. Air-percussion; R. Rev.-rotary; T. Trenching; V. Driven; W. Drive-wash; Z. Other

Total depth 50.0 ft. Well diameter 7 7/8 in.
Casing diameter 5 saw in. Casing type PVC
Type of screen or perforation slots Interval of screen or perforation 27-50'
Pump hp. & type 1.5 hp Barnes Pump depth 44 ft.
Aquifer Ft. Union Fm. Aquifer lithology Sandy clay and fine grained sandstone
Altitude of land surface 3698.5 How determined surveyed MP Above Below LSD Altitude MP 1.85
WL from MP 20.40 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
2/27/79						
off	0302:00	39.43	662.0	0.0	-----	19.03
	0302:35	26.10	662.58	0.58	1142.38	5.70
	0303:44	21.07	663.73	1.73	383.66	0.67
	0305:13	20.68	665.22	3.22	206.59	0.28
	0307:00	20.57	667.00	5.00	133.40	0.17
	0312:00	20.55	672.00	10.00	67.20	0.15
	0328:00	20.53	688.00	26.00	26.46	0.13
	0411:00	20.48	731.00	69.00	10.59	0.08
	0449:00	20.43	769.00	107.00	7.19	0.03

TFN 6-2/025
RECD 10-25-18

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WATER WELL MW392-79

PUMPING TEST DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
2/26/79	1601	79.2	41.67	55	1	41.67
	1606	81.8	40.34	55	5	201.70
	1621	83.6	39.47	55	15	592.05
	1630	84.0	39.29	55	9	353.61
	1700	84.7	38.96	55	30	1168.80
	1730	85.0	38.82	55	30	1164.60
	1800	84.5	39.05	55	30	1171.50
	1900	85.4	38.64	55	60	2318.40
	2000	84.4	39.10	55	60	2346.00
	2100	84.4	39.10	55	60	2346.00
	2200	88.5	37.29	55	60	2237.40
	2300	85.3	38.69	55	60	2321.40
	2400	86.8	38.02	55	60	2281.20
2/27/79	0100	86.4	38.19	55	60	2291.40
	0200	85.9	38.42	55	60	2305.20
	0300	87.5	37.71	55	60	2262.60
				TOTALS	660	25,403.53

25,403.53 ÷ 660 = 38.49

Total Ave. Q = 38.49 gpm

Specific Capacity = $\frac{38.5 \text{ gpm}}{19.03 \text{ ft.}}$ = 2.02 gpm/ft

D6-436

TFN 6 2/025

DEQ 10-25-18

JAN 1983
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Land Quality Div.
DIST. IV

Results of Aquifer Test Conducted 2/26/79

Pumping Well WW 392-78
Obs. wells WW 393-78 & WW 394-78
Q = 38.5 gpm
r_{393} = 96.7 ft, r_{394} = 174.2 ft.

1. Attempted modified Jacob method Drawdown and Recovery Curve analyses on pumping well 392. For both attempts, the point scatter was very great and the results are inconclusive. May need more data points or there was turbulent flow.

2. Attempted Jacob Time/Drawdown analysis for observation well 393. Plot of points shows great scatter and the results inconclusive.

3. Attempted Theis Time/Drawdown analyses for both observation wells. Well 393 yielded a leaky curve with T = 16,958 gpd/ft. and S = 4.4×10^{-4}. Well 394 yielded a late non-leaky type curve with T = 55,150 gpd/ft. and S = 0.013. Well efficiency calculations for well 393, using the Theis method, calculated to 25% for well 393 and 8% for well 394. The 25% efficiency is very reasonable. Data for well 394 shows insufficient drawdown for any type of test calculation. Therefore, the hydraulic coefficients calculated for well 393 are taken as representative for the aquifer in this area.

IFR 6 2/025

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Pumped Well Efficiency Calculations Using Data From Obs. Wells 393 and 394

Theis Test Pumping Well 392; Obs. Wells 393 and 394: Tested 2/26/79

WW 394

$$u = \frac{1.87\ 1^2\ S}{Tt}$$

r = .21 ft.
S = .013
T = 555150 gpd/ft.
t = .46 day (use max. length of test)

$$u = \frac{(1.87)(.21)^2(.013)}{(55,150)(.46)} = 4.75 \times 15^{9}, \quad w(u) = 18.58$$

S(after 660 min = $\frac{(114.6)(38.5)}{55,150}$ (18.58) = 1.49 ft, but $\frac{1.49}{19.03}$ = .08 = 8% well efficiency, therefore, T value probably too high.

Obs. Well 393

r = .21 ft.
S = 4.4×10^{-4}
T = 16958 gpd/ft
t = use .46 day (length of test)

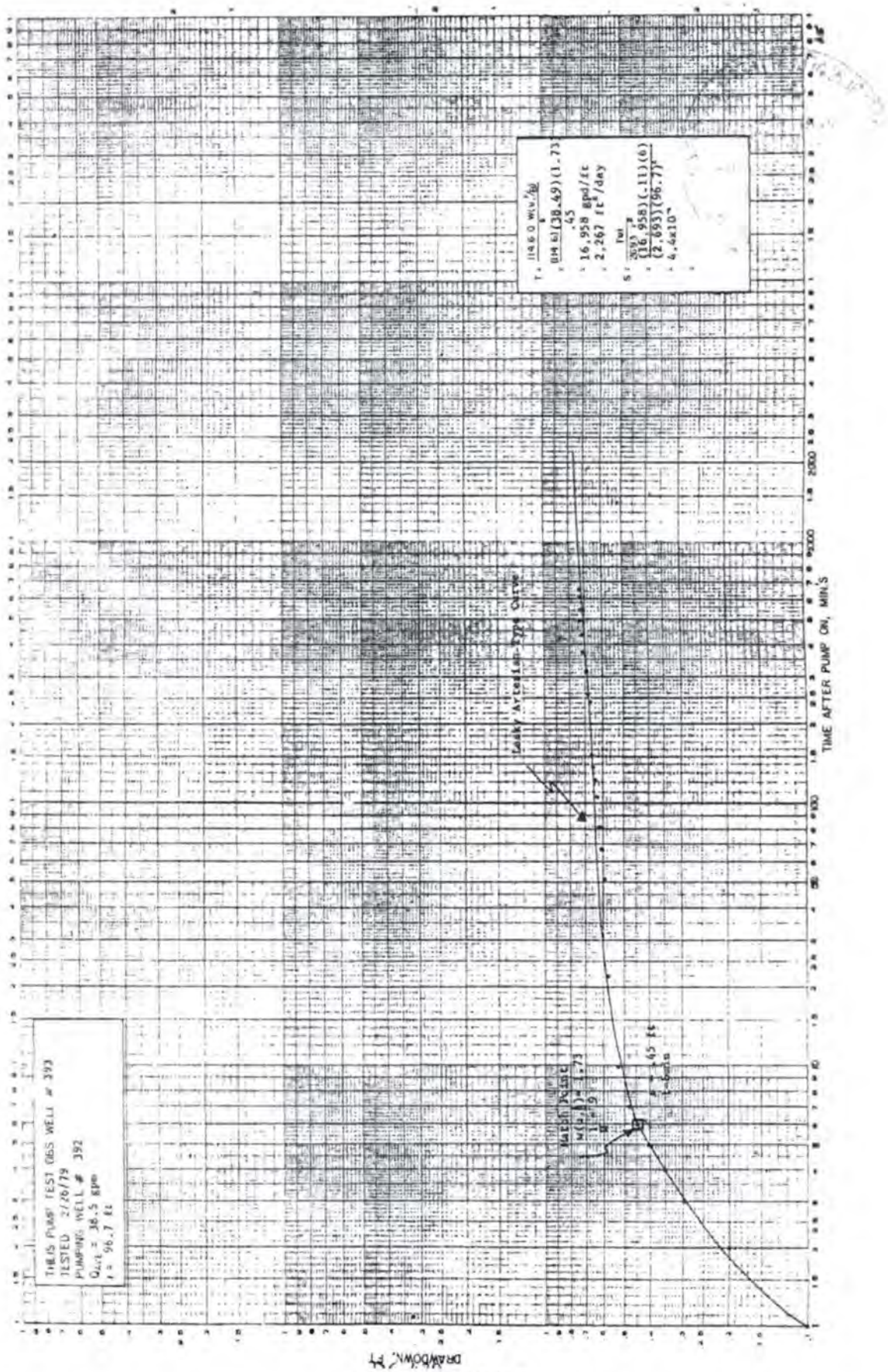
$$u = \frac{(1.87)(.21)^2(4.4\times10^{-4})}{(16,958)(.46)} = 4.65\times10^{-9}, \quad w(u) = 18.61$$

$$\therefore S = \frac{1146Q}{T}\ w(u) = \frac{(114.6)(38.5)(18.61)}{16,958} = 4.84 \text{ ft, but } \frac{4.84}{19.03} = 25\% \text{ well}$$

efficiency - reasonable

D6-428

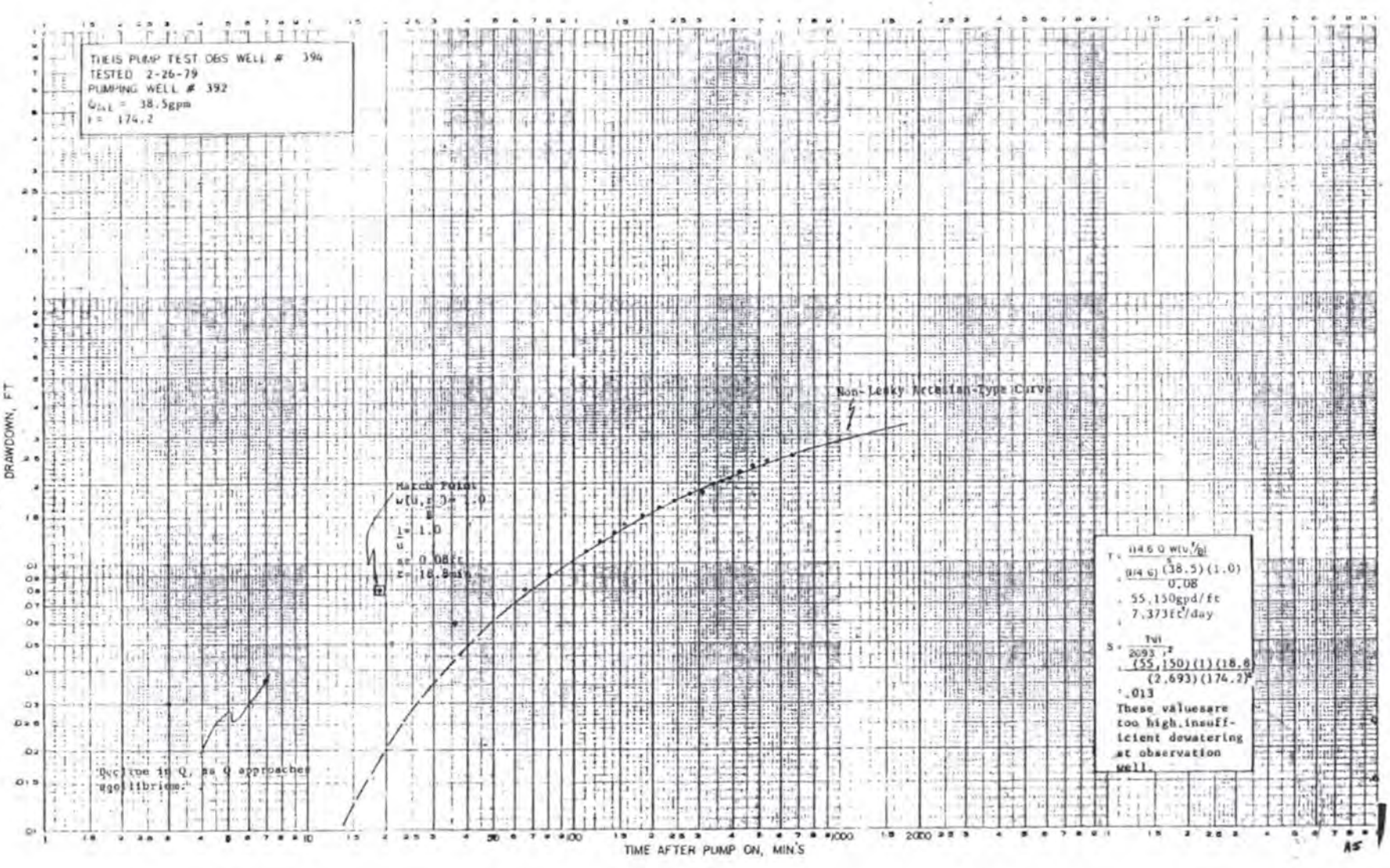
IFN 6 2/025



DEQ Ex. 3-1391

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020



TFN 9 2/025
RECD 10-25-18

DEQ Ex. 3-1392

PKS GEOLOGY AND EXPLORATION — AQUIFER TEST DATA — 1 of 3

State WY — County Sheridan — T. 57 N. S. — R. 84 E. W. — Sec. 15 — WELL NO. WW 395-79

Personnel Rondar, Araas

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specif
2. Single well recovery 4. Recovery with obs. well

Well owner Peter Kiewit Sons' R. Reed (PKS) Address P. O. Box 3049, Sheridan, WY 82801

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 60.0 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 42-60'

Pump hp. & type 1.5 hp Barnes Pump depth 58 ft.

Aquifer Alluvium Aquifer lithology unconsolidated deposits of local origin.

Altitude of land surface 3666.4 How determined surveyed MP Above Below LSD Altitude MP 3666.4

WL from MP 8.25 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
4/20/79						
on	1240	8.25	0			0.0
	41	17.92	1			9.67
	42	28.33	2			20.08
	43	33.70	3			25.45
	44	36.83	4			28.58
	45	38.87	5			30.62
	47	41.11	7			32.86
	50	42.03	10			33.78
	55	42.05	15			33.80
	1300	42.09	20			33.84
	10	41.78	30			33.53
	20	44.65	40			36.40
	30	51.30	50			43.05
	40	52.97	60			44.72
	50	52.12	70			43.87
	1400	53.67	80			45.42
	15	53.92	95			45.67
	40	55.46	120			47.21
	50	55.88	130			47.63
	1500	56.38	140			48.13
	10	56.04	150			47.79
	45	56.08	185			47.86
	55	56.78	195			48.53

TFN 6 2/025

RECD 10-25-18

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R.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA — 2 of 3

tate WY County Sheridan T. 57 N. S. R. 84 E. W. Sec. 15 WELL NO WW 395-79

ersonnel Bondar, Araas, Test type: (1) Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specif

ell owner Peter Kiewit Sons' Address P. O. Box 3049, Sheridan, WY 82801

R. Reed (PKS) Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

o. d depth 60.0 ft. Well diameter 7 7/8 in.
asing diameter 5 in. Casing type PVC
ype of screen or perforation saw slots Interval of screen or perforation 42-60'
Pump hp. & type 1.5 hp Barnes Pump depth 60 ft.
quifer Alluvium Aquifer lithology unconsolidated deposits of local origin.
ltitude of land surface 3666.4 How determined surveyed MP Above Below LSD Altitude MP 3666.82
WL from MP 8.25 How measured galvanometer

RECEIVED
JAN 1993
Land Quality DGR
DIST. IV

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
4/20/79						
off	1600	56.78	200	0	0.0	48.53
	01	40.55	201	1	201	32.30
	02	27.38	202	2	101	19.13
	03	17.98	203	3	67.70	9.73
	04	12.65	204	4	51.00	4.40
	05	10.48	205	5	41.00	2.23
	06	10.00	206	6	34.33	1.75
	07	8.64	207	7	29.58	.39
	08	8.29	208	8	26.00	.04
	09	8.23	209	9	23.22	0.0

TFN 6 2/025

WATER WELL WW 395-79

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
4/20/79	1245	214.60	15.38	55	5	76.90
	1300	214.60	15.38	55	15	230.70
	1320	208.50	15.83	55	20	316.60
	1325	178.8	18.46	55	5	92.30
	1350	201.00	16.42	55	25	410.50
	1430	207.20	15.93	55	40	637.20
	1500	215.80	15.29	55	30	458.70
	1515	212.40	15.54	55	15	233.10
	1530	210.30	15.69	55	15	235.35
	1550	218.30	15.12	55	20	302.40
				TOTALS	190	2993.75

2993.75 gals / 190 min. = 15.76 gpm

Specific Capacity = 15.76 gpm / 48.53 ft. = 0.32 gpm/ft.

D6-442

TFN 6 2/025

DEQ Ex. 3-1395

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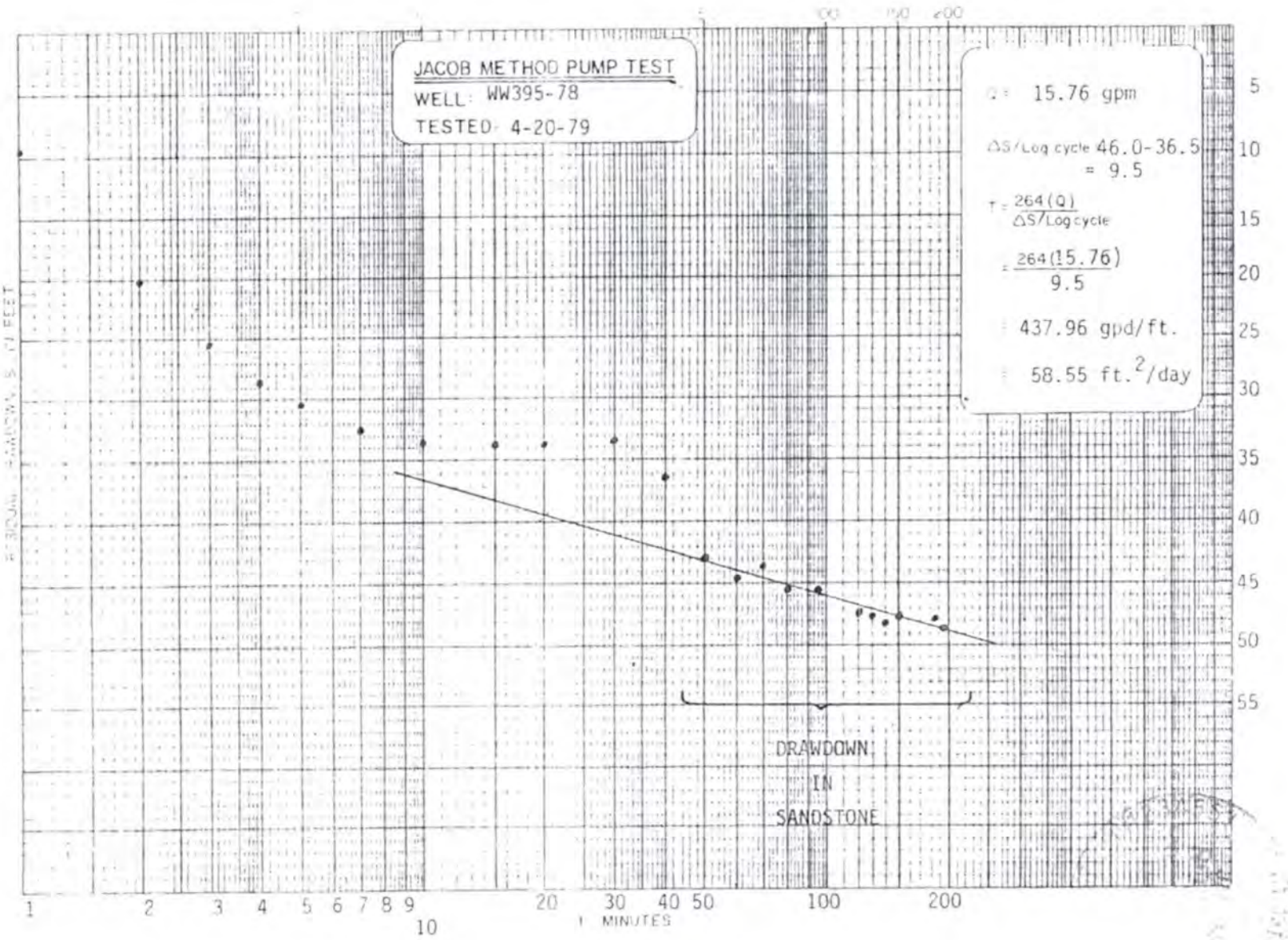
TIME DRAWDOWN CURVE



DEQ
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1396

ADDENDUM D6-6

AQUIFER TEST DATA AND CALCULATIONS

PIT 5

D6-665
TFR 6 2/025
RECD 10-25-13

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BAILER TEST
WELL # WW408-79

Date 12-19-79 Personnel Bondar,Araas,Volk S.W.L. 213.08'
Bailer Volume 2.68 gals.

Time In	Time Out	Bailer Volume (Gals.)	Elapsed Time,t,To S'(Min.)	t, To S'(Day)	Residual Drawdown S' (Ft.)	Vol.(Gal.) t(Day)	Comments
1126:00	1129:20	0.67	241	0.167		4.01	
1129:45	1133:20	2.68	237	0.165		16.24	
1133:35	1137:20	0	233	0.162		--	Bailer valve
1137:45	1141:25	0	229	0.159		--	sticking
1142:45	1146:30	2.01	224	0.156		12.89	
1146:45	1150:25	0	220	0.153		--	"
1150:50	1154:40	2.68	216	0.150		17.87	"
1154:55	1158:30	0	212	0.147		--	"
1159:10	1203:10	0.67	207	0.144		4.65	"
1203:25	1207:15	0	203	0.141		--	"
1207:40	1211:25	2.68	199	0.138		19.42	
1211:55	1215:35	0	195	0.135		--	"
1216:05	1219:50	0	191	0.133		--	"
						75.08	

Recovery			
1230:00	180	219.05	
1330:00	120	218.82	
1430.00	60	218.65	
1530:00	0	218.59	

IFR 6 2/025
RECD 10-25-18

JAN 1983
RECEIVED
Land Quality Div.
DIST. IV

Solution to WW408 Bailer Test

$$T = \frac{1}{4\pi(S')}\left[\frac{V_1}{t_1} + \frac{V_2}{t_2} + \frac{V_3}{t_3} + \ldots \frac{V_n}{t_n}\right]$$

Where S' = 218.59' - 213.08' = 5.51' at 244 mins.

so, $T = \frac{1}{(12.57)(5.51')}\left[75.08 \frac{Gal.}{Day}\right]$

$= 1.08$ gpd/ft. $= 0.14$ ft.^{2}/day

Ave. $Q = \frac{11.39 \text{ gals.}}{53.83 \text{ mins.}} = 0.21$ gpm

Total Residual Drawdown = 219.05' - 213.08'
= 5.97'

∴ specific capacity = 0.21 gpm/5.97' = 0.04 gpm/ft.

D6-447
TFN 6 2/025
DEQ Ex. 3-1399

Scanned, 02/26/2020

BAILER TEST
WELL # WW555-80

Date 3-4-80 Personnel Volk, Bondar S.W.L. 36.10'
Bailer Volume 2.68 gals.

Time In	Time Out	Bailer Volume (Gals.)	Elapsed Time, t, To S'(Min.)	t, To S'(Day)	Residual Drawdown S' (Ft.)	Vol.(Gal.) t(Day)	Comments
1110:00	1112:05	2.68	107.92	0.075		35.73	
1112:30	1114:30	2.68	105.50	0.073		36.71	
1114:45	1116:55	2.68	103.08	0.072		37.22	
1117:15	1119:15	2.68	100.75	0.070		38.29	
1120:00	1122:05	2.68	97.92	0.068		39.41	
1122:30	1124:35	2.68	95.42	0.066		40.61	
1124:55	1127:05	2.68	92.92	0.065		41.23	
1127:20	1129:35	2.68	90.42	0.063		42.54	
1129:50	1132:10	2.68	87.83	0.061		43.93	
1132:25	1134:45	2.68	82.25	0.059		45.42	
						401.09	

Recovery		
1134:45	85.25	44.45
1150:00	70.00	43.05
1210:00	50.00	41.40
1230:00	30.00	40.19
1300:00	0	38.63

RECD 10-25-18
JAN 16 2025

Solution To WW555 Bailer Test

$$T = \frac{1}{4\pi (S')} \left[\frac{V_1}{t_1} + \frac{V_2}{t_2} + \frac{V_3}{t_3} + \ldots \frac{V_n}{t_n} \right]$$

Where S' = 38.63' - 36.10' - 2.53' at 110 mins.

So, $T = \frac{1}{(12.57)(2.53')} \left[401.09 \frac{Gal.}{Day}\right]$

$= 12.61$ gpd/ft. $= 1.69$ ft^2/day

Ave. Q = $\frac{2.68 \text{ gals. x } 10}{24.75 \text{ mins.}} = \frac{26.8 \text{ gals.}}{24.75 \text{ mins.}} = 1.08$ gpm

Total Residual Drawdown = 44.45' - 36.10'
= 8.35'

Specific capacity = 1.08 gpm/8.35' = 0.13 gpm/ft.

Jacob Time Recovery

Time since bailing began, t, (Min.)	Time since bailing ended, t', (Min.)	t/t'	Residual Drawdown, S
24.75	0	--	8.35
40	15.25	2.62	6.95
60	35.25	1.70	5.30
80	55.25	1.45	4.09
110	85.25	1.29	2.53

2/025

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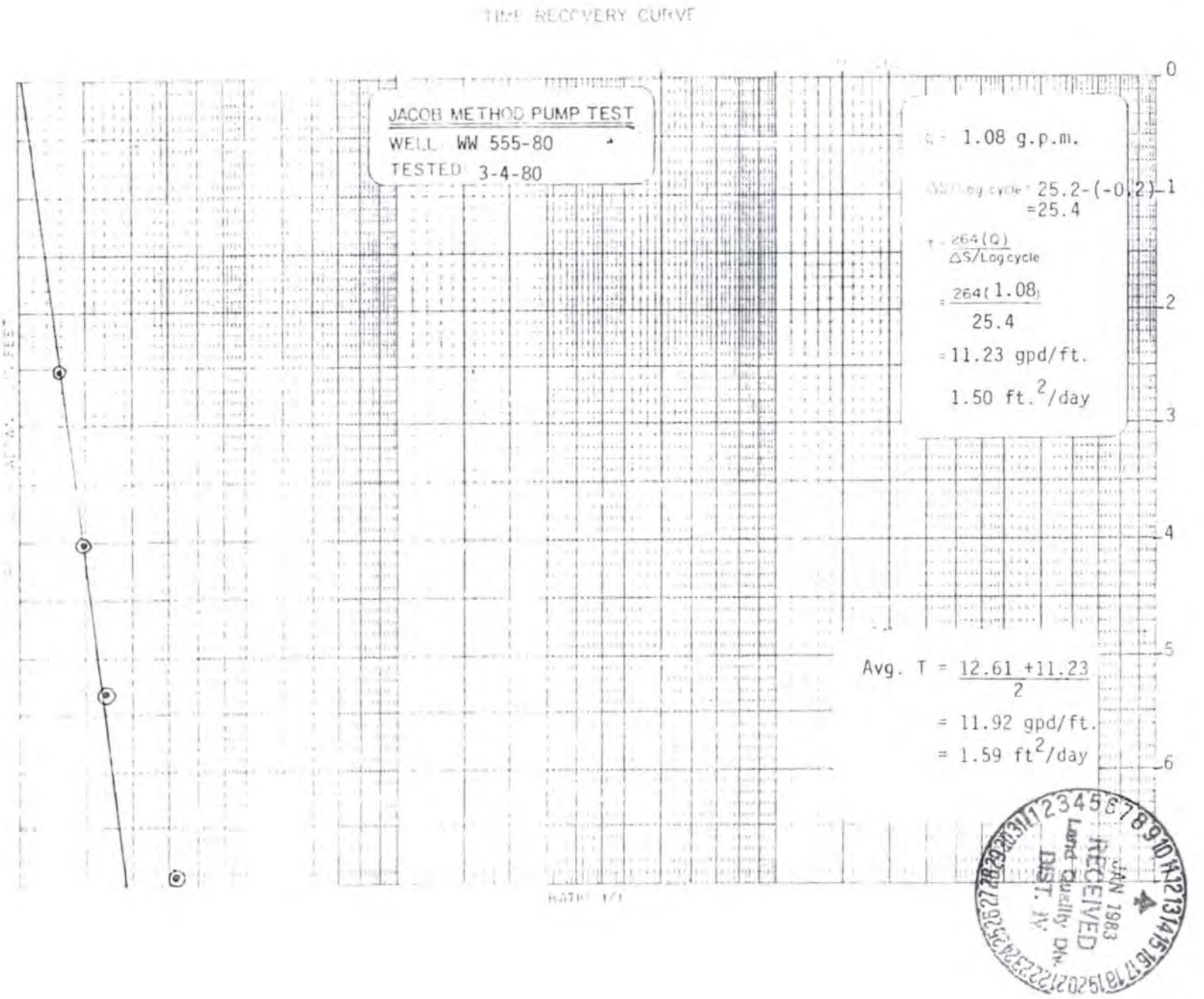

RECD 10-25-18
YFN 6 2/025

DEQ Ex. 3-1402

BAILER TEST
WELL # WW562-80

Date 3-5-80 Personnel Volk, Bondar S.W.L. 97.67'

Bailer Volume 2.68 gals.

Time In	Time Out	Bailer Volume (Gals.)	Elapsed Time, t, To S'(Min.)	t, To S'(Day)	Residual Drawdown S' (Ft.)	Vol.(Gal.) t(Day)	Comments
1112:00	1115:50	2.68	224.17	0.156		17.18	
1116:25	1120:10	0	219.83	0.153		--	
1120:50	1124:00	0	216.00	0.150		--	
1124:15	1127:10	2.68	212.83	0.148		18.11	
1127:25	1130:15	0	209.75	0.146		--	
1130:30	1133:25	2.68	206.58	0.144		18.61	
1134:00	1137:40	2.68	202.33	0.141		19.01	
1138:10	1141:20	2.01	198.67	0.138		14.57	
						87.48	

Recovery

1200:00	180	106.30
1230:00	150	106.17
1330:00	90	106.04
1430:00	30	105.90
1500:00	0	105.85

D6-451

RECD 10-25-18
2/025

Scanned, 02/26/2020

Solution to WW562 Bailer Test

$$T = \frac{1}{4\pi (S')} \left[\frac{V_1}{t_1} + \frac{V_2}{t_2} + \frac{V_3}{t_3} + \cdots \frac{V_n}{t_n} \right]$$

Where $S' = 105.85' - 97.67' = 8.18'$ at 228 mins.

So, $T = \frac{1}{(12.57)(8.18')} \left[87.48 \frac{Gal.}{Day} \right]$

$= \underline{0.85 \text{ gpd/ft}} = 0.11 \text{ ft}^2/\text{day}$

Ave. $Q = \frac{12.73 \text{ gals.}}{29.33 \text{ min.}} = 0.43$ gpm

Total residual drawdown = 106.30' - 97.67'
= 8.63'

∴ Specific capacity = 0.43 gpm/8.63' = 0.05 gpm/ft.

TFN 6 2/025
RECD 10-25-18

ADDENDUM D6-7

GROUNDWATER QUALITY ANALYSES

PIT 5

D6-453
IFN 6 2/025
DEQ 10-25-18

Scanned, 02/26/2020

GROUNDWATER QUALITY
WELL NO. 408 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLER	WEATHER	Lab pH	Turb. (NTN)	TSS	TDS	Lab Cond.	Acidity	Ammonia Nit. as N	Total Phos. as "P"	SAR
10/9/79	1245	Bowlby Veenstra Bondar	Cool	7.4	-	-	2400	2610	-	0.1	0.10	-
5/20/80	1210	Bondar	Cool	7.2	-	-	2560	2780	-	0.61	0.10	-

TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY

WELL NO. 408 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

Total Alkalinity as CaCO3	Bicarbonate As HCO3	Carbonate as CO3	Chloride	Fluoride	NO2+NO3 as "N"	Sulfate	Total Hardness	Calcium	Magnesium	Potassium
460	561	0	12	0.58	8.21	1250	1530	210	244	38
511	626	0	12	0.55	6.4	1310	1620	231	253	29

D6-455

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

GROUNDWATER QUALITY

WELL NO. 408 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

Sodium	Cations-Anions	Al	As	Cd	Cr	Cu	Fe Dissolved	Fe Total	Pb	Mn	Hg	Ni	Se	Ba	Zn	Boron
114	36.49-36.10	0.5	<0.005	<0.005	0.02	0.01	0.14	44.20	<0.02	0.31	<0.001	0.05	<0.005	<0.05	0.45	0.80
108	37.76-38.37	<0.1	<0.005	<0.005	<0.02	0.01	1.03	77.00	<0.02	0.27	<0.001	0.01	<0.005	<0.05	0.31	0.80

TFN 6 2/025
DEC 1 '18
RECD 10-25-18

GROUNDWATER QUALITY
WELL NO. 555 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLER	WEATHER	Lab pH	Turb. (NTN)	TSS	TDS	Lab Cond.	Acidity	Ammonia Nit. as N	Total Phos. as "P"	SAR
3/5/80	1200	Bondar Araas	Cold-snowing	7.0	-	-	984	1200	-	11.5	-	0.51

D6-457
RECD 10-25-18
DEQ 2/025

Scanned, 02/26/2020

GROUNDWATER QUALITY
WELL NO. 555 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

Total Alkalinity as CaCO3	Bicarbonate As HCO3	Carbonate as CO3	Chloride	Fluoride	NO2+NO3 as "N"	Sulfate	Total Hardness	Calcium	Magnesium	Potassium
405	495	0	8	0.59	0.14	404	711	113	105	19

D6-458
TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY

WELL NO. 555 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

Sodium	Cations-Anions	Al	As	Cd	Cr	Cu	Fe Dissolved	Fe Total	Pb	Mn	Hg	Ni	Se	Ba	Zn	Boron
31	16.07-16.74	<0.1	<.005	< .002	<.02	<.01	< .05	-	<.02	0.03	<.001	<.01	<.005	<0.5	0.5	0.5

RECD 10-25-18
FEB 8 2/025

Scanned, 02/26/2020

GROUNDWATER QUALITY
WELL NO. 562 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

DATE	TIME	SAMPLER	WEATHER	Lab pH	Turb. (NTN)	TSS	TDS	Lab Cond.	Acidity	Ammonia Nit. as N	Total Phos. as "P"	SAR
3/6/80	1200	Bondar Araas	Cold	7.2	-	-	720	990	-	1.15	-	3.27

RECEIVED
JAN 1983
Land Quality Div.
DIST. IV

D6-460
TFN 6 2/025
RECD 10-25-18

GROUNDWATER QUALITY

WELL NO. 562 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

Total Aklalinity as CaCO3	Bicarbonate As HCO3	Carbonate as CO3	Chloride	Fluoride	NO2+NO3 as "N"	Sulfate	Total Hardness	Calcium	Magnesium	Potassium
472	576	0	6	1.14	0.15	119	294	55	38	21

RECEIVED
Land Quality Div.
DEQ/AML
TFN 6 2/025
REC'D 10-25-18

Scanned, 02/26/2020

GROUNDWATER QUALITY

WELL NO. 562 FORMATION Monarch Coal AREA Big Horn

PARAMETERS

Sodium	Cations-Anions	Al	As	Cd	Cr	Cu	Fe Dissolved	Fe Total	Pb	Mn	Hg	Ni	Se	Ba	Zn	Boron
129	12.03-12.08	<0.1	<.005	<.002	<.02	<.01	<.05	-	<.02	.06	<.001	<.01	<.005	< Q5	.02	0.2

TFN 6 2/025
RECD 10-25-18

Groundwater Quality Field Parameters

Pit 5 Monarch Coal Wells

Site	Date	Time	Temp. C°	Sp. Cond. Mmhos/cm	pH	How Sampled	Comments
BH408	10-9-79	12:45	14.0	2900	6.82	bailed	lot of drilling mud
BH408	5/20/80	12:10	14.0	3000	6.45	bailed	-
BH555	3/4/80	12:00	10.0	1500	6.92	bailed	-
BH562	3/5/80	12:00	8.0	900	7.16	bailed	-

D6 463

WR 6 2/025

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ADDENDUM D6-8

SURFACE WATER QUALITY ANALYSIS

TFN 6 2/025
DEQ 10-25-18

Sampling Site # TRI

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
8/25/77	---	---	---	---	---	---	---	8.2	8.0	9	298	500
2/07/77	1230	Bowlby	---	0.0	420	12.15	8.1	8.2	5.4	18	350	580
3/28/78	1248	Bowlby	---	9.5	510	9.9	8.15	8.0	210	361	350	520
4/25/78	1015	Bowlby	---	11.0	505	9.6	8.6	8.2	3.0	11	348	510
5/08/78	1315	Bowlby	---	6.5	490	10.8	8.25	7.9	850	1280	226	467
5/22/78	1220	Bowlby Veenstra	---	11.0	390	9.7	---	8.0	80	170	282	366
6/06/78	1105	Bowlby	Sunny,warm	10.0	200	8.6	8.5	8.1	55	152	180	204
6/27/78	1115	Veenstra Ogle	Sunny,warm	12.0	210	---	8.4	8.0	14	56	144	211
7/31/78	1255	Bowlby Veenstra	Part Cloudy 70° - 80°	21.0	450	8.0	---	8.4	3.5	16	174	369
8/03/78	1115	Bowlby Boyle	Part Cloudy 55° - 60°	9.5	445	10.1	8.7	8.4	3.8	5	254	440
9/05/78	1150	Bowlby Araas	---	.2	540	12.8	7.0	8.2	2.4	6	264	400
3/06/79	1300	Collier Bowlby Veenstra Bondar	Part Cloudy 30° - 40°	3.0	480	11.1	7.9	7.9	8.0	19	282	460
5/02/79	1340	Collier Veenstra	Cloudy 30° drizzle, snow	7.5	475	9.65	---	8.5	7.3	19	312	560
5/30/79	1300	Collier Araas	Part Cloudy rained 2 days previous	8.0	225	9.8	7.4	7.8	16	62	142	210
6/14/79	1245	Bondar Araas	Cloudy warm	12.0	200	7.3	7.5	7.7	250	123	136	177
7/10/79	1200	Collier Bowlby	clear 65°	22.0	340	7.3	8.9	8.3	13	30	802	350
7/30/79	1345	Bowlby	Part Cloudy lt.rain 75°	19.5	1010	8.0	6.8	8.1	8.4	220	260	460
9/13/79	1113	Araas Bondar	Part Cloudy rain 60-70°	14.0	450	---	6.4	8.3	3.4	8	310	470
2/11/79	1320	Araas Collier	clear 20°	1.5	505	---	8.75	8.3	1.2	5	340	490

RECEIVED
JAN 1982
DIST. IV

FEB 6 2025
RECD 10-25-13

Scanned, 02/26/2020

Location Big Horn

Sampling Site # TR1

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
3/19/80	1130	Araas Bondar	Cloudy	0.0	795	13.0	9.7	7.9	120	240	328	460
4/29/80	1145	Veenstra Araas	Clear	12.0	300	---	6.0	8.1	28	82	178	300
5/27/80	1405	Veenstra Araas	Warm, Clear	14.0	220	---	6.97	8.1	28	57	194	230
6/16/80	1145	Wollenzien Araas	Warm, Clear	13.0	320	8.2	7.7	8.0	90	358	52	268
7/15/80	1345	Collier Lyden	Warm Cloudy	21.9	370	8.45	8.78	8.5	4.8	14	234	367
8/11/80	1030	Volk Araas	Warm, Clear	20.0	470	7.8	7.71	8.2	5.3	16	310	501
9/02/80	1200	Mazgaj Bowlby	Warm, Clear	16.0	550	8.8	8.1	8.1	7.4	15	270	510
2/09/80	1415	Hill Bondar	Cold, Clear	1.0	580	14.0	7.6	8.1	3.2	7	254	515
3/02/81	1100	Bondar Lyden	Cool, Clear	3.4	600	13.0	7.68	8.2	1.8	2	302	509
4/21/81	1500	Bondar	Rain Cloudy	10.0	240	10.5	7.8	7.8	26	63	132	236
5/12/81	1200	Andersen Veenstra	Rain Cloudy	8.0	450	9.2	7.4	8.2	66	91	218	353
6/02/81	1245	Veenstra Collier	Warm Clear	10.5	220	9.2	6.9	7.7	20	50	102	211
6/22/81	1245	Jones Collier	Warm Cloudy	14.0	270	9.0	8.1	7.5	7.5	21	114	251
8/05/81	1200	Jones Andersen	Warm Clear	22.0	720	8.2	8.6	8.5	45	17	270	409
9/01/81	1230	Jones Andersen	Warm Clear	17.0	500	9.8	7.5	8.3	4.5	2	264	473
2/14/81	1205	Jones Veenstra	Cold Cloudy	0.0	440	13.1	7.4	8.0	1.3	3	306	582
3/29/82	1345	Collier Veenstra	Cloudy 40°F	8.0	660	10.4	7.5	8.2	280	850	316	480
5/3/82	1312	Jones Veenstra	Clear 75°F	11.0	325	8.8	7.7	8.0	44	280	162	278

RECEIVED FEB 18 1981 DIVISION OF RECLAMATION

RECD 10-25-18
TFR 6 2/025

Location BIG RUN

Sampling Site # TR1

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
/24/82	1245	Jones Veenstra	Cloudy 60°F	10.0	240	10.5	6.5	8.2	3.6	31	1520	2040
/15/82	1121	Collier Veenstra	Clear 65°F	11.0	240	10.8	6.9	7.9	66	460	142	218
/27/82	1300	Jones Veenstra	Clear 85°F	21.0	400	8.4	8.1	8.4	2.2	174	176	341
/7/82	1130	Jones Bondar	Clear 80°F	19.0	480	8.6	8.0	8.3	1.2	8.3	254	470

TFN 6 2/025
RECD 10-25-13

Scanned, 02/26/2020

Location Big Horn

Sampling Site # IR1

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	---	---	.04	---	---	260	0	2.0	.3	.1	---	69	8.5
---	.12	.03	.02	.47	216	264	0	2.0	.2	.19	---	81	---
---	.1	.3	---	---	148	181	0	3.0	.35	.72	---	109	---
---	58.2	.03	---	---	184	224	0	1.0	.16	.05	---	78	---
---	.6	.92	---	---	116	141	0	3.0	.18	.35	---	112	---
---	.1	.17	---	---	138	169	0	2.0	.12	.28	---	59	---
---	.54	.18	---	---	86	105	0	1.0	.10	.55	---	19	---
---	.49	.07	---	---	96	117	0	1.0	.09	.02	---	15	---
<1	.32	.03	<.01	.33	156	186	2.0	1.0	.21	.01	---	35	---
---	.18	.01	---	---	181	217	2.0	1.0	.18	<.01	---	59	---
---	.02	.24	---	---	169	207	0	<1.0	.19	.18	---	74	---
---	.75	.02	---	---	163	199	0	4.0	.23	.26	---	75	---
---	.46	.02	---	---	172	190	10.0	3.0	.18	.01	---	101	---
---	.52	.17	---	---	83	102	0	1.0	.09	.06	---	26	---
---	.15	.24	---	---	80	97	0	2.0	.08	.01	---	12	---
---	<.01	.05	---	---	142	173	0	---	.17	.01	---	41	---
---	.60	.09	---	---	171	209	0	3.0	.16	.01	---	60	---
---	<.01	.03	---	---	195	238	0	1.0	.20	.03	---	68	---
---	.04	.03	---	---	200	245	0	4.0	.15	.09	---	81	---
---	.21	.42	---	---	166	203	0	2.0	.15	.20	---	91	---
---	<.05	.23	---	---	128	156	0	1.0	.11	.02	---	36	---
---	.09	.03	---	---	96	117	0	<1.0	.10	.02	---	23	---
---	.07	.01	---	---	104	127	0	1.0	.14	.05	---	35	---
---	.63	.02	---	---	160	163	16.0	.2	.17	<.01	---	41	---

RAMACO

Brook Mine

October 2018

Addendum D6-12-451

RECD 10-25-18

TEN 6 2/025

DEQ Ex. 3-1420

Location Big Horn

2/

Sampling Site # TR1

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	.09	<.01	---	---	206	251	0	<1.0	.20	.02	---	72	---
---	.06	.02	---	---	213	260	0	2.0	<.01	.01	---	71	---
---	<.05	.10	---	---	213	260	0	2.0	.18	.08	---	77	---
---	.11	.05	---	---	194	237	0	2.0	.16	<.01	---	85	---
---	.13	.03	---	---	101	123	0	2.0	.13	.04	---	19	---
---	.73	.01	---	---	134	164	0	2.0	.21	.06	---	51	---
---	<.05	.03	---	---	85	104	0	2.0	.14	.05	---	19	---
---	.17	.02	---	---	108	132	0	<1.0	.12	.06	---	19	---
---	<.01	---	---	---	176	215	0	2.0	.16	.10	---	49	---
---	.23	---	---	---	194	237	0	1.0	.19	.28	---	61	---
---	.13	---	---	---	204	249	0	2.0	.26	.22	---	71	---
<1	.05	.19	---	.72	174	212	0	3.9	.20	.16	---	91	---
<1	.12	.09	—	.20	107	131	0	1.0	.10	<.01	—	22	—
<1	1.61	.01	—	3.95	367	448	0	11.0	.50	2.40	—	830	—
—	.04	.13	—	.28	82	100	0	1.4	.11	.12	—	25	
<1	.12	.03	—	.35	146	174	2.3	1.0	.13	.16	—	37	—
<1	.04	.26	—	.40	191	234	0	1.4	.21	<.01	—	56	—

RAMACO

Brook Mine

October 2018

TFN 6 2/025

RECD 10-25-18

Addendum D6-12-452

DEQ Ex. 3-1421

Scanned, 02/26/2020

Location: Big North

Sampling Site # TR1

3/

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
260	58	27	1.5	17	---	5.89 - 5.71	---	---	<.1	---	<.01
263	59	28	2.0	17	---	6.06 - 6.08	---	---	.1	---	<.02
203	43	23	4.0	27	---	5.31 - 5.38	<.5	---	<.1	---	<.005
229	54	23	2.0	18	---	5.39 - 5.35	---	---	<.1	---	<.005
172	35	20	7.0	28	---	4.85 - 4.76	---	---	.2	---	<.005
172	38	19	3.0	14	---	4.13 - 4.07	---	---	<.1	---	<.005
92	25	8	1.0	6	---	2.13 - 2.16	---	---	<.1	---	<.005
104	28	8	1.0	5	---	2.30 - 2.26	---	---	.1	---	<.005
171	42	17	1.0	10	---	3.89 - 3.87	<5.0	.5	<.1	---	<.005
216	49	23	1.0	12	---	- .02	---	---	<.1	---	<.005
218	47	24	1.0	15	---	.09	<5.0	---	<.1	---	<.005
212	48	22	2.0	16	---	.02	---	---	<.1	---	<.005
228	49	26	2.0	21	---	5.55 - 5.62	---	---	<.1	---	<.005
98	23	10	1.0	7	---	2.28 - 2.23	---	---	<.1	---	<.005
85	23	7	1.0	4	---	1.91 - 1.90	---	---	<.1	---	<.005
164	38	17	1.0	10	---	3.75 - 3.70	---	---	<.1	---	<.005
205	47	22	2.0	15	---	4.78 - 4.76	---	---	.1	---	<.005
224	52	23	2.0	18	---	5.30 - 5.34	---	---	<.1	---	<.005
249	57	26	2.0	17	---	- .05	---	---	<.1	---	<.005

RAMACO

Brook Mine

October 2018

Addendum D6-12-453

TFN 6 2/025

RECD 10-25-13

Location Big North

Sampling Site # TR1

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
213	46	24	5	21	---	5.31 - 5.30	---	---	.1	---	<.005
144	36	13	1	7	---	3.22 - 3.35	---	---	<.1	---	<.005
107	26	10	1	6	---	2.43 - 2.43	---	---	<.1	---	<.005
122	28	13	2	8	---	2.86 - 2.83	---	---	<.1	---	<.005
176	41	18	1	10	---	3.98 - 4.05	---	---	<.1	---	<.005
237	50	27	2	23	---	5.79 - 5.65	---	---	<.1	---	<.005
259	51	32	2	17	---	6.00 - 5.80	---	---	<.1	---	<.005
277	62	29	<1	13	---	6.11 - 5.92	---	---	<.1	---	<.005
241	54	26	2	17	---	5.60 - 5.71	---	---	<.1	---	<.005
110	27	10	3	5	---	2.51 - 2.45	---	---	<.1	---	<.005
154	35	16	2	13	---	3.69 - 3.84	---	---	<.1	---	<.005
96	26	8	1	5	---	2.14 - 2.17	---	---	<.1	---	<.005
123	30	11	1	6	---	2.72 - 2.59	---	---	<.1	---	<.005
205	48	21	2	11	---	4.63 - 4.59	---	---	.2	---	<.005
218	49	23	2	16	---	5.10 - 5.23	---	---	<.1	---	<.005
97	56	24	2	17	---	5.61 - 5.64	---	---	.2	---	<.005
219	44	27	2.4	25	---	5.52 - 5.47	<5	---	1.0	---	<.005
118	32	9.4	1.6	5.1	---	2.63 - 2.62	---	---	<.1	---	<.005
688	103	105	20	238	---	24.66 -24.92	---	---	<.1	---	<.005
93	25	7.5	1.6	6.1	---	2.17 - 2.20	---	---	<.1	---	<.005
165	38	17	1.1	10	---	3.78 - 3.72	---	---	<.1	---	<.005
221	53	22	1.7	14	---	5.06 - 5.03	---	---	<.1	---	<.005

RECD 10-25-18

Scanned, 02/26/2020

Location Big North

Sampling Site # TR1

4/

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.01	---	<.1	---	<.01	.73	.27	---	<.1	---	---	---	<.02
---	<.005	---	<.02	---	<.01	---	.25	---	<.01	---	<.02	---	.02
---	<.005	---	<.02	---	<.01	5.58	.23	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	.38	.13	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	23.8	.19	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	4.73	<.05	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	3.91	.08	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	.02	1.28	.06	---	<.02	---	---	---	<.02
<.005	<.005	<.02	<.02	.02	.02	.48	.06	<.02	<.02	---	<.02	.03	<.02
---	<.005	---	<.02	---	<.01	.38	.07	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	.74	.08	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	.51	<.05	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	.02	---	.08	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	---	.07	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	---	.06	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	---	.07	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	.01	.41	.08	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	.30	.05	---	.03	---	---	---	.03
---	<.005	---	<.02	---	<.01	<.05	<.05	---	<.02	---	---	---	<.02

D6-477
TFN 6 2/025
RECD 10-25-1 3

Sampling Site # TR1

4/

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	<.01	4.28	.05	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	.20	.05	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	<.01	1.20	.07	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	3.79	<.05	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	<.01	.30	.06	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	<.01	.39	<.05	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	.02	.29	<.05	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	.02	.24	<.05	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	.02	.22	<.05	---	<.02	---	<.02	---	.02
---	<.002	---	<.02	---	<.01	1.79	.09	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	1.68	.06	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.10	1.38	.14	---	<.02	---	<.02	---	.02
---	<.002	---	<.02	---	<.01	.57	<.05	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	.04	.28	.08	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	.02	.33	<.05	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	<.05	<.05	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	6.46	.12	---	<.02	---	<.02	---	.02
—	<.002	—	<.02	—	<.01	5.25	<.05	—	<.02	—	<.02	—	<.02
—	<.002	—	<.02	—	<.01	.15	.13	—	<.02	—	<.02	—	<.02
—	<.002	—	<.02	—	<.01	5.25	.19	—	<.02	—	<.02	—	.02
—	<.002	—	<.02	—	<.01	.33	<.05	—	<.02	—	<.02	—	<.02
—	<.002	—	<.02	—	<.01	.22	<.05	—	<.02	—	<.02	—	<.02

RECD 10-25-18 TFN 6 2/025

Scanned, 02/26/2020

Location Big Horn

Sampling Site # TR1

5/

PARAMETERS

Mercury Total	Mercury Dissol.	Nickel Total	Nickel Dissol.	Selenium Total	Selenium Dissol.	Vanadium Total	Vanadium Dissol.	Zinc Total	Zinc Dissol.	Barium	Boron	Total Kje. Nitrogen
---	---	---	<.1	---	<.005	---	---	---	<.02	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	<.5	---	<.01	---	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.02	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
<.001	<.001	---	<.01	<.005	<.005	<.1	<.01	.02	.02	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.0002	---	.02	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.03	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.03	<.5	.5	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.02	<.5	.3	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.001	---	<.01	---	<.01	---	<.5	---	<.01	---	---	---
---	<.001	---	.05	---	<.005	---	<.5	---	.02	---	---	---
---	<.001	---	<.01	---	<.005	---	<.5	---	<.01	---	---	---

D6-476

TFN 6 2/025

RECD 10-25-13

October 2018 Addendum D6-12-457 RAMACO Brook Mine

DEQ Ex. 3-1426

Location Big Horn

Sampling Site # TR1

5/

PARAMETERS

Mercury Total	Mercury Dissol.	Nickel Total	Nickel Dissol.	Selenium Total	Selenium Dissol.	Vanadium Total	Vanadium Dissol.	Zinc Total	Zinc Dissol.	Barium	Boron	Total Kje. Nitrogen
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	.01	---	<.005	---	---	---	.10	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	<1	---	.05	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.04	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.05	<.5	<.1	---
---	<.001	---	.01	---	<.005	---	---	---	.02	.5	<.1	---
---	<.001	---	.02	---	<.005	---	---	---	.03	<.5	<.1	---
---	<.001	---	.02	---	<.005	---	---	---	.01	<.5	<.1	---
---	<.002	---	<.01	---	<.005	---	---	---	.02	<.5	<.1	---
---	<.002	---	<.01	---	<.005	---	---	---	.02	<.5	<.1	---
---	<.002	---	<.01	---	<.005	---	---	---	.24	<.5	<.1	---
---	<.002	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.0002	---	.03	---	<.005	---	---	---	.08	<.5	<.1	---
---	<.0002	---	<.02	---	<.005	---	---	---	.30	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.09	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	.07	---
—	<.0002	—	<.01	—	<.005	—	—	—	<.01	<.5	.08	—
—	.0003	—	<.01	—	<.005	—	—	—	<.01	<.5	.12	—
—	.0006	—	<.01	—	<.005	—	—	—	<.01	<.5	.32	—
—	.0006	—	<.01	—	<.005	—	—	—	<.01	<.5	.05	—
—	<.0004	—	<.01	—	<.005	—	—	—	<.01	<.5	.1	—

RECEIVED JAN 1983 DEQ Lane County DEQ DIST. IV

TFN 6 2/025
RECD 10-25-1 3

Scanned, 02/26/2020

Location: Dry Fork

Sampling Site # TR2B

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
12/9/80	1015	Hill Bondar	Clear Cold	0.0	700	12.0	7.9	8.1	2.4	3	364	657
3/2/81	1415	Lyden Bondar	Clear 55°F	6.3	710	14.8	8.3	8.5	.8	4	366	644
4/22/81	1220	Bondar	Cldy-Rain	12.0	400	10.4	8.0	7.8	15	47	248	397
5/12/81	0845	Andersen Veenstra	Rain 45°F	7.0	490	9.5	6.8	8.2	13	22	258	432
6/2/81	0915	Veenstra Collier	Clear Warm	9.0	220	9.2	7.0	7.7	26	72	94	209
7/22/81	0845	Jones Collier	Ptly Cldy Warm	14.0	280	8.8	7.4	7.5	14	32	134	268
8/5/81	0805	Jones Andersen	Clear 85°F	20.0	600	6.3	8.5	8.5	100	31	404	539
9/1/81	0830	Jones Andersen	Clear 80°F	14.5	675	8.1	7.35	8.2	2.2	13	364	634
2/14/81	1000	Jones Veenstra	Ptly Cldy 25°F	0.0	725	12.9	6.7	8.1	1.7	3	424	754
3/29/82	0950	Collier Veenstra	Cloudy 40°F	7.0	720	11.0	6.9	8.3	26	142	414	610
5/ 3/82	0930	Jones Veenstra	Clear 75°F	14.0	420	-	7.00	8.00	50	328	246	420
5/24/82	1000	Jones Veenstra	Cloudy 60°F	10.0	270	11.6	5.90	7.80	3.20	26	1210	1780
6/15/82	0830	Collier Veenstra	Clear 70°F	12.0	300	8.4	6.40	7.90	120	580	162	278

D6-476
TFN 6 2/025
RECD 10-25-18

Sampling Site # TR2B

1a/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
7/27/82	0955	Jones Veenstra	Clear 85°F	20.0	500	9.0	8.20	8.40	3.60	12	240	402
9/ 7/82	0850	Jones Bondar	Clear 80°F	17.0	625	6.8	7.95	8.20	1.40	12	336	556

DEQ/MFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Location Big Horn 2/

Sampling Site # TR2B

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	.06	.15	---	---	247	302	0	4	.25	.20	---	129	---
---	.19	.11	---	---	223	250	11	4	.21	.12	---	135	---
---	.13	.18	---	---	133	162	0	2	.14	.16	---	62	---
---	1.26	.10	---	---	146	178	0	4	.70	.45	---	75	---
---	.10	.03	---	---	78	95	0	2	.13	.11	---	25	---
---	.26	.04	---	---	103	126	0	1	.13	.17	---	31	---
---	.06	---	---	---	202	246	0	3	.19	.20	---	96	---
---	.20	---	---	---	202	247	0	4	.17	.23	---	118	---
---	.44	---	---	---	245	299	0	4	.33	.96	---	124	---
---	.12	.16	---	.78	211	258	0	3.7	.23	.14	---	132	---
<1	.17	.19	---	.38	143	174	0	2.1	.13	.08	---	53	---
<1	3.04	.02	---	5.79	536	654	0	12	.58	3.06	---	478	---
---	.07	.19	---	.40	98	119	0	1.9	.19	.07	---	41	---
---	.06	.09	---	.49	167	198	2.6	2.6	.17	.08	---	66	---
---	.08	.68	---	.58	220	268	0	4.4	.26	<.01	---	97	---

RAMACO

Brook Mine

October 2018

Addendum D6-12-461

TFN 6 2/325

RECD 10-25-18

DEQ Ex. 3-1430

Sampling Site # TR2B

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
321	73	34	2	29	---	7.74 - 7.76	---	---	<.1	---	<.005
305	54	41	3	27	---	7.34 - 7.40	---	---	.1	---	<.005
162	35	18	3	15	---	3.97 - 4.00	---	---	<.1	---	<.005
190	41	21	2	16	---	4.55 - 4.66	---	---	<.1	---	<.005
91	21	9	1	6	---	2.10 - 2.14	---	---	<.1	---	<.005
128	28	14	1	7	---	2.89 - 2.75	---	---	<.1	---	<.005
267	56	31	2	20	---	6.27 - 6.16	---	---	<.1	---	<.005
266	51	34	3	26	---	6.52 - 6.64	---	---	<.1	---	<.005
311	64	37	3	27	---	7.49 - 7.68	---	---	.1	---	<.005
290	59	35	3	30	---	7.20 - 7.08	<5	---	<.1	---	<.005
175	41	18	1.8	12	---	4.07 - 4.03	---	---	<.1	---	<.005
418	128	24	18	272	---	20.65 -21.02	---	---	<.1	---	<.005
118	28	11	2.2	9.9	---	2.84 - 2.86	---	---	<.1	---	<.005
207	44	24	1.1	16	---	4.87 - 4.79	---	---	<.1	---	<.005
275	55	33	2.3	22	---	6.53 - 6.52	---	---	<.1	---	<.005

D6-479 2/025
RECD 10-25-18

Scanned, 02/26/2020

Sampling Site # TR2B

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	<.03	.16	<.05	---	<.02	---	<.02	---	.03
---	<.005	---	<.02	---	<.02	.10	<.05	---	<.02	---	<.02	---	.04
---	<.002	---	<.02	---	<.01	1.10	.08	---	<.02	---	<.02	---	.04
---	<.002	---	<.02	---	<.01	.75	<.05	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	1.77	.11	---	<.02	---	<.02	---	.03
---	<.002	---	<.02	---	.01	.99	.06	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	.01	<.05	<.05	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	.02	.11	<.05	---	<.02	---	<.02	---	.02
---	<.002	---	<.02	---	<.01	.05	<.05	---	<.02	---	<.02	---	.05
---	<.002	---	<.02	---	<.01	1.50	.13	---	<.02	---	<.02	---	.04
---	<.002	---	<.02	---	<.01	5.48	<.05	---	<.02	---	<.02	---	.04
---	<.002	---	<.02	---	<.01	.2	<.05	---	<.02	---	<.02	---	.16
---	<.002	---	<.02	---	<.01	7.53	.18	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	.46	<.05	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	.33	<.05	---	<.02	---	<.02	---	<.02

RECEIVED JAN 1983 Land Quality Div. DIST. IV

RAMACO

Brook Mine

October 2018

TFN 6 2/025

RECD 10-25-13 Addendum D6-12-463

Location Big Horn

5/

Sampling Site # TR2B

PARAMETERS

Mercury		Nickel		Selenium		Vanadium		Zinc		Barium	Boron	Total Kje. Nitrogen
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.			
---	<.001	---	.02	---	<.005	---	---	---	.05	<.5	<.1	---
---	<.0002	---	.01	---	<.005	---	---	---	.01	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.02	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.17	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.19	<.5	<.1	---
---	<.0002	---	.01	---	<.005	---	---	---	.03	<.5	<.1	---
---	.0003	---	<.01	---	<.005	---	---	---	.18	<.5	<.1	---
---	<.0002	---	.01	---	<.005	---	---	---	.04	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	.09	---
---	<.0002	---	<.01	---	<.005	---	---	---	.01	<.5	.10	---
---	<.0002	---	.02	---	<.005	---	---	---	< .01	<.5	.08	---
---	.0003	---	<.01	---	<.005	---	---	---	< .01	<.5	.28	---
---	.0009	---	<.01	---	<.005	---	---	---	.01	<.5	.03	---
---	.0014	---	<.01	---	<.005	---	---	---	.01	<.5	.14	---

RECD 10-25-18

DEQ Ex. 3-1433

Scanned, 02/26/2020

Sampling Site # GCO

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
0/03/78	1130	Bowlby Boyle	Ptly. Cldy. 57°F	10.0	510	10.0	8.3	8.4	5.2	10	314	520
2/05/78	0940	Bowlby Araas	Cool	2.0	750	----	8.2	8.2	3.4	78	416	570
3/06/79	1340	Bondar Veenstra	Ptly. Cldy. 35°F	2.0	650	9.2	8.2	7.7	10.0	30	480	750
5/02/79	1500	Collier Veenstra	Snow 30°F	8.2	533	10.95	---	8.5	16.0	53	344	580
5/30/79	1345	Collier Araas	Ptly. Cldy. 55°F	8.8	250	10.0	7.2	7.7	54.0	174	172	290
6/14/79	1320	Bondar Araas	Cldy. 60°F	16.0	180	8.7	7.6	7.8	34.0	162	192	177
7/10/79	1220	Collier Bowlby	Clear 65°F	23.5	590	8.3	9.0	8.3	8.6	26	376	610
7/30/79	1425	Bowlby	Ptly. Cldy. 75°F	20.0	1230	8.4	6.5	8.2	4.6	22	576	840
8/13/79	1025	Araas Bondar	Ptly. Cldy. 65°F	14.0	1030	----	5.8	8.2	5.5	15	396	790
2/11/79	1425	Araas Collier	Clear 20°F	1.0	597	----	8.9	8.2	1.8	10	516	740
3/19/80	1035	Araas Bondar	Ptly. Cldy. 35°F	3.0	960	12.2	7.3	8.1	12.0	27	564	790
4/29/80	1230	Araas Veenstra	Warm 81°F	15.0	400	----	5.6	8.1	25.0	95	234	380
5/27/80	1330	Hill Collier	Ptly. Cldy. 70°F	14.0	550	----	6.5	8.1	50.0	116	184	280
6/16/80	1300	Wollenzien Araas	Ptly. Cldy. 75°F	15.0	349	9.0	7.9	8.1	50.0	145	52	293
7/15/80	1420	Collier Lyden	Ptly. Cldy. 70°F	23.5	920	14.0	9.0	8.7	3.0	8	632	890
8/11/80	1045	Volk Araas	Clear 75°F	19.5	1000	11.4	8.2	8.4	7.3	27	700	1000
9/02/80	1100	Mazgaj Bowlby	Clear 85°F	18.0	920	8.2	8.0	8.4	8.4	26	570	880
2/09/80	1515	Hill Bondar	Clear Cold	0.0	800	12.6	7.6	7.8	4.2	8	428	745
3/02/81	1000	Lyden Bondar	Ptly. Cldy. 55°F	3.0	925	10.8	7.6	8.1	2.2	15	484	780
4/21/81	1040	Bondar	Cldy. Rain Cool	12.0	560	9.0	7.6	7.7	18.0	39	364	594

D6-R2
TFN 6 2/025
RECD 10-25-18

Sampling Site # GCO

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
		Andersen	Rain									
/12/81	1245	Veenstra	Cold	10.0	1025	9.0	7.1	8.2	8.0	20	574	852
		Veenstra	Clear									
/02/81	1315	Collier	Warm	10.0	200	8.7	7.0	7.4	4.0	85	76	196
		Jones	Cldy.									
/22/81	1345	Collier	Warm	16.0	320	8.4	7.8	7.5	19.0	39	144	302
		Jones	Clear									
/05/81	1245	Andersen	85° F	23.0	1000	10.0	8.5	8.4	85.0	29	564	789
		Jones	Clear									
/01/81	1250	Andersen	85° F	18.0	980	11.8	7.8	8.3	3.8	10	602	935
		Jones	Cldy.									
/14/81	1313	Veenstra	Cold	0.0	925	13.2	7.1	8.0	1.6	4	516	891
		Collier	Clear									
/29/82	1415	Veenstra	Cool	9.0	950	13.3	7.9	8.6	1.5	6.5	536	770
/3/82	1340	Jones	Clear	16.0	550	8.6	7.3	8.0	22	187	332	555
		Veenstra	75°F									
/24/82	1300	Jones	Cloudy	10.0	380	9.4	6.5	7.9	180	195	218	388
		Veenstra	65°F									
/15/82	1320	Collier	Clear	15.0	400	9.2	6.8	7.9	140	800	210	379
		Veenstra	70°F									
/27/82	1330	Jones	Clear	23.0	700	12.2	8.2	8.5	3.0	22	394	633
		Veenstra	85°F									
/7/82	1200	Jones	Clear	19.0	800	11.8	8.0	8.3	1.4	11	480	740
		Bondar	80°F									

IFN 6 2/025
RECD 10-25-13

Scanned, 02/26/2020

Location Big Horn

Sampling Site # GCO

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	.10	.07	---	---	185	221	3	3	.29	.06	---	92	---
---	.32	.17	---	---	178	217	0	3	.36	.62	---	147	---
---	2.15	.17	---	---	249	303	0	6	.35	.55	---	161	---
---	1.0	.10	---	---	169	187	10	5	.22	.07	---	119	---
---	.56	.36	---	---	75	92	0	1	.12	.12	---	49	---
---	.13	.32	---	---	62	76	0	2	.09	.07	---	26	---
---	<.01	.11	---	---	192	235	0	4	.31	.09	---	118	---
---	.62	.41	---	---	249	303	0	7	.30	.59	---	201	---
---	<.01	.27	---	---	272	331	0	6	.41	.32	---	165	---
---	.54	.13	---	---	258	315	0	6	.24	.27	---	154	---
---	.45	.36	---	---	254	309	0	6	.26	.33	---	187	---
---	.10	.35	---	---	130	159	0	2	.15	.08	---	68	---
---	.31	.03	---	---	85	104	0	1	.12	.13	---	46	---
---	.14	.02	---	---	100	121	0	1	.17	.10	---	45	---
---	.03	.21	---	---	276	305	15	10	.33	.84	---	226	---
---	.16	.38	---	---	314	378	2	11	.33	.69	---	249	---
---	.06	.23	---	---	292	346	5	8	.01	.68	---	209	---
---	.05	.22	---	---	283	345	0	5	.30	.34	---	153	---

RAMACO

Brook Mine

October 2018

TFN 6 2/025

RECD 10-25-13

Addendum D6-12-467

Location Big Horn

Sampling Site # GCO

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	.74	.37	---	---	262	320	0	6	.24	.18	---	173	---
---	.72	.26	---	---	189	231	0	6	.22	.58	---	127	---
---	.09	.47	---	---	259	317	0	9	.27	1.32	---	220	---
---	.18	.05	---	---	64	78	0	1	.16	.14	---	31	---
---	.26	.13	---	---	100	123	0	2	.18	.27	---	47	---
---	.10	---	---	---	266	325	0	6	.30	.67	---	221	---
---	.26	---	---	---	229	364	0	9	.25	.62	---	234	---
---	.68	---	---	---	268	327	0	5	.39	1.10	---	165	---
<1	.19	.27	---	.82	262	295	0	8	.32	.27	---	189	---
<1	.28	.37	---	.57	172	210	0	3.1	.20	.18	---	99	---
<1	.17	.21	---	.48	125	152	0	2.1	.16	.14	---	59	---
---	.05	.17	---	.49	116	141	0	2.4	.15	.07	---	59	---
---	.16	.22	---	.65	224	263	5.4	4.6	.28	.32	---	126	---
---	.06	.91	---	.80	256	313	0	7.9	.37	.99	---	159	---

RAMACO Brook Mine

October 2018 Addendum D6-12-468

TFN 6 2/025

RECD 10-25-18

DEQ Ex. 3-1437

Scanned, 02/26/2020

Sampling Site # GCO

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
248	48	31	2	17	---	.03	---	---	<.1	---	<.005
276	51	36	2	28	---	.05	<5	---	<.1	---	<.005
362	59	52	3	28	---	.02	---	---	<.1	---	<.005
250	50	31	2	19	---	5.87 - 5.99	---	---	<.1	---	<.005
105	22	12	2	10	---	2.54 - 2.55	---	---	<.1	---	<.005
77	18	8	1	8	---	1.90 - 1.85	---	---	<.1	---	<.005
273	52	35	3	22	---	6.46 - 6.41	---	---	<.1	---	<.005
390	72	51	4	38	---	9.57 - 9.40	---	---	<.1	---	<.005
386	72	50	4	34	---	9.30 - 9.05	---	---	.1	---	<.005
359	73	43	3	30	---	.01	---	---	<.1	---	<.005
383	71	50	4	32	---	9.15 - 9.16	---	---	<.1	---	<.005
171	36	20	2	12	---	4.02 - 4.11	---	---	<.1	---	<.005
114	25	13	1	9	---	2.71 - 2.70	---	---	<.1	---	<.005
124	25	15	2	9	---	2.93 - 2.96	---	---	<.1	---	<.005
422	78	55	4	41	---	10.36 - 10.57	---	---	<.1	---	<.005
468	80	65	5	49	---	11.64 - 11.82	---	---	<.1	---	<.005
437	76	60	4	40	---	10.58 - 10.48	---	---	<.1	---	<.005
402	78	51	<1	24	---	9.09 - 8.99	---	---	<.1	---	<.005

JAN 1983 RECEIVED Land Quality Div. DIST. IV

RAMACO Brook Mine

October 2018 Addendum D6-12-469

TFR 6 2/025
RECD 10-25-13

Sampling Site # GCO

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
373	69	49	3	31	---	8.87 - 9.04	---	---	<.1	---	<.005
268	51	34	3	26	---	6.57 - 6.64	---	---	<.1	---	<.005
409	78	52	4	39	---	9.97 - 10.15	---	---	<.1	---	<.005
79	16	9	1	6	---	1.89 - 1.97	---	---	.1	---	<.005
139	27	17	2	9	---	3.22 - 3.07	---	---	<.1	---	<.005
405	75	53	4	34	---	9.67 - 9.42	---	---	.1	---	<.005
446	78	61	5	44	---	10.96 - 11.13	---	---	<.1	---	<.005
378	66	52	3	30	---	8.93 - 9.05	---	---	.1	---	<.005
386	68	52	3.2	37	---	9.41 - 9.41	<5	---	.2	---	<.005
235	48	28	2.1	20	—	5.62 - 5.59	—	—	<.1	—	<.005
160	35	18	1.7	14	—	3.84 - 3.79	—	—	<.1	—	<.005
144	32	16	2.6	14	—	3.55 - 3.62	—	—	<.1	—	<.005
307	102	13	3.1	26	—	7.36 - 7.25	—	—	<.1	—	<.005
357	64	48	3.4	35	—	8.74 - 8.65	---	---	<.1	—	<.005

D6-487

TFN 6 2/025
RECD 10-25-13

October 2018

Addendum D6-12-470

DEQ Ex. 3-1439

Scanned, 02/26/2020

Sampling Site # GCO

4/

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	<.01	.49	.15	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	.02	.58	.09	---	<.02	---	---	---	.05
---	<.005	---	<.02	---	<.01	.80	.12	---	<.02	---	---	---	.12
---	<.005	---	<.02	---	.01	---	.10	---	<.02	---	---	---	.06
---	<.005	---	<.02	---	<.01	---	.15	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	---	.12	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	---	.07	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	.36	.10	---	<.02	---	---	---	.07
---	<.005	---	<.02	---	<.01	.63	.10	---	<.02	---	---	---	.08
---	<.005	---	<.02	---	<.01	.36	<.05	---	<.02	---	---	---	.07
---	<.005	---	<.02	---	<.01	.93	<.05	---	<.02	---	---	---	.10
---	<.005	---	<.02	---	<.01	.24	.06	---	<.02	---	<.02	---	.03
---	<.005	---	<.02	---	<.01	3.73	.11	---	<.02	---	<.02	---	.03
---	<.005	---	<.02	---	<.01	3.12	.05	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	<.01	.23	<.05	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	<.01	.66	.10	---	<.02	---	<.02	---	.18
---	<.005	---	<.02	---	.01	.48	.07	---	<.02	---	<.02	---	.10
---	<.005	---	<.02	---	.02	.31	<.05	---	<.02	---	<.02	---	.05

D6-488
TFR 6 2/025
RECD 10-25-18

October 2018

Addendum D6-12-471

RAMACO

Brook Mine

DEQ Ex. 3-1440

Sampling Site # GCO

4/

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	.02	.26	.08	---	<.02	---	<.02	---	.10
---	<.002	---	<.02	---	<.01	1.30	.11	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	.86	.07	---	<.02	---	<.02	---	.11
---	<.002	---	<.02	---	<.01	2.38	.30	---	<.02	---	<.02	---	.09
---	<.002	---	<.02	---	<.01	1.46	<.05	---	.04	---	<.02	---	.02
---	<.002	---	<.02	---	.01	<.05	<.05	---	<.02	---	<.02	---	.09
---	<.002	---	<.02	---	.02	.28	.07	---	<.02	---	<.02	---	.06
---	<.002	---	<.02	---	<.01	.11	.09	---	<.02	---	<.02	---	.08
---	<.002	---	<.02	---	<.01	.29	<.05	---	<.02	---	<.02	---	.06
---	<.002	---	<.02	---	<.01	3.87	<.05	---	<.02	---	<.02	---	.09
---	<.002	---	<.02	---	<.01	2.78	.13	---	<.02	---	<.02	---	.04
---	<.002	---	<.02	---	<.01	7.29	.13	---	<.02	---	<.02	---	.03
---	<.002	---	<.02	---	<.01	.55	<.05	---	<.02	---	<.02	---	.04
---	<.002	---	<.02	---	<.01	.33	<.05	---	<.02	---	<.02	---	<.02

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Location Big Horn

Sampling Site # GCO

5/

PARAMETERS

Mercury Total	Mercury Dissol.	Nickel Total	Nickel Dissol.	Selenium Total	Selenium Dissol.	Vanadium Total	Vanadium Dissol.	Zinc Total	Zinc Dissol.	Barium	Boron	Total Kje. Nitrogen
---	<.001	---	<.01	---	<.005	---	---	---	.01	---	---	---
---	<.002	---	.01	---	<.005	---	---	---	.01	<.5	.1	---
---	<.002	---	<.01	---	<.005	---	---	---	.05	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	---	---	.12	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.001	---	.01	---	<.005	---	---	---	.02	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.2	---
---	<.001	---	<.01	---	<.01	---	---	---	<.01	<.5	.2	---
---	<.001	---	.01	---	<.005	---	---	---	.03	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.01	<.5	<.1	---
---	<.001	---	.03	---	<.005	---	---	---	.22	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.05	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.07	<.5	.2	---
---	<.001	---	.02	---	<.005	---	---	---	.01	<.5	.2	---
---	<.001	---	.02	---	<.005	---	---	---	.03	<.5	<.1	---

RAMACO

Brook Mine

October 2018

Addendum D6-12-473

RECD 10-25-18
TFN 6 2/025
D6-490

Location Big Horn

Sampling Site # GCO

5/

PARAMETERS

Mercury Total	Mercury Dissol.	Nickel Total	Nickel Dissol.	Selenium Total	Selenium Dissol.	Vanadium Total	Vanadium Dissol.	Zinc Total	Zinc Dissol.	Barium	Boron	Total Kje. Nitrogen	
---	<.0002	---	.02	---	<.005	---	---	---	.02	<.5	<.1	---	
---	<.0002	---	<.01	---	<.005	---	---	---	.03	<.5	<.1	---	
---	<.0002	---	<.01	---	<.005	---	---	---	.02	<.5	.1	---	
---	<.0002	---	<.01	---	<.005	---	---	---	.04	<.5	<.1	---	
---	<.0002	---	<.01	---	<.005	---	---	---	.13	<.5	<.1	---	
---	<.0002	---	.03	---	<.005	---	---	---	.13	<.5	<.1	---	
---	<.0002	---	<.01	---	<.005	---	---	---	.32	<.5	.2	---	
---	<.0002	---	<.01	---	<.005	---	---	---	.35	<.5	.1	---	
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	.12	---	
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	.12	---	
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	<.01	---	
---	.0004	---	<.01	---	<.005	---	---	---	<.01	<.5	.14	---	
---	.0007	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---	
---	.0006	---	<.01	---	<.005	---	---	---	<.01	<.5	.17	---	

D6-491

TFN 6 2/025

REC'D 10-25-18

RECEIVED JAN 1993 Land Quality DIV DIST. IV

RAMACO

Brook Mine

October 2018

Addendum D6-12-474

DEQ Ex. 3-1443

Scanned, 02/26/2020

Sampling Site # GC2

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
5/08/78	1100	Bowlby	---	5.2	640	11.3	8.5	7.9	290	568	308	596
5/22/78	1135	Veenstra	---	15.0	375	8.2	---	7.6	110	190	258	385
6/06/78	1025	Bowlby	Clear Warm	13.0	220	8.8	9.2	8.1	45	126	192	219
6/27/78	1100	Veenstra	Ogle Clear Warm	13.0	150	---	8.6	7.9	13	37	118	142
7/31/78	1245	Veenstra	Bowlby Partly Cloudy 75°	24.0	625	7.5	---	8.4	8	27	396	675
2/05/78	1120	Araas	Bowlby ---	0.2	840	12.7	7.82	8.0	9.4	22	505	620
3/06/79	1125	Veenstra	Bondar Partly Cloudy 35°	1.0	800	10.8	---	8.0	4.0	14	525	800
5/02/79	1410	Collier	Veenstra Rain 35°F	9.7	554.6	10.0	---	8.6	6.6	19	376	610
5/30/79	1200	Araas	Collier Partly Cloudy 50°	8.0	223	8.5	7.5	7.6	48.0	120	156	210
6/14/79	1115	Araas	Bondar Cloudy Warm	15.0	222	8.4	7.3	7.8	220	23	144	214
7/10/79	1140	Bowlby	Collier Clear 65°F	24.0	530	9.5	8.8	8.3	11	21	346	550
7/30/79	1330	Bowlby	Rain 75°F	22.0	1150	9.2	8.1	8.4	8.4	30	582	830
9/13/79	1133	Bondar	Araas Rain 60°F	15.0	900	---	6.7	8.3	4.3	14	488	760
2/11/79	1255	Collier	Araas Clear 20°F	2.0	790	---	8.5	8.3	1.1	5	498	750
3/19/80	1215	Hill	Bondar Partly Cloudy 40°	4.0	905	9.0	9.1	8.1	9.2	12	546	770
4/29/80	1115	Araas	Veenstra Clear 65°F	15.0	370	---	6.21	8.1	8.9	21	218	360
5/27/80	1330	Veenstra	Araas Partly Cloudy 70°	14.0	300	---	6.33	7.9	55.0	114	208	230
6/16/80	1105	Araas	Wollenzien Clear 70°F	14.0	310	10.5	7.66	8.0	29.0	56	48	272
7/15/80	1250	Collier	Lyden Partly Cloudy 70°	24.3	840	11.7	8.86	8.5	8.4	22	592	857
8/11/80	1000	Volk	Araas Clear 70°	21.0	755	9.4	8.0	8.3	5.5	21	702	1000

RECD 10-25-18 TFN 5 2/025

Sampling Site # GC2

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
9/02/80	1135	Bowlby Mazgaj	Clear 85°F	17.0	1250	8.4	8.1	8.4	7.6	16	616	930
2/09/80	1330	Hill Bondar	Clear Cold	0.0	820	14.20	7.3	8.1	2.4	4	450	756
3/02/81	1130	Lyden Bondar	Clear 55°F	4.8	875	---	8.4	8.3	1.2	7	472	763
4/21/81	1300	Bondar	Cloudy Rain	14.0	620	9.2	8.0	7.9	6.4	20	390	606
5/12/81	1142	Andersen Veenstra	Rain 35°F	12.0	950	9.2	7.2	8.1	6.2	22	574	841
5/02/81	1215	Veenstra Collier	Clear Warm	10.0	205	8.3	7.2	7.5	26	60	68	197
5/22/81	1140	Jones Collier	Partly Cldy. Warm	17.0	280	7.3	7.8	7.4	15	29	132	279
1/05/81	1045	Jones Andersen	Clear 85°F	19.0	1030	10.4	8.7	8.5	75	38	514	767
1/01/81	1200	Jones Andersen	Clear 80°F	20.0	980	12.4	8.1	8.3	14	18	594	912
2/14/81	1140	Jones Veenstra	Partly Cldy. 30°F	0.0	850	13.6	7.4	8.1	2.4	4	470	825
8/29/82	1314	Collier Veenstra	Clear 45°F	9.0	1000	13.2	8.1	8.5	1.6	13	534	760
/3/82	1200	Jones Veenstra	Clear 75°F	12.0	800	10.4	7.7	8.2	3.4	42	390	606
/24/82	1125	Jones Veenstra	Cloudy 60°F	14.0	425	7.8	6.9	8.0	12.0	133	160	275
/15/82	1041	Collier Veenstra	Clear 70°F	15.0	460	8.1	7.0	7.8	76.0	350	248	446
/27/82	1135	Jones Veenstra	Clear 85°F	23.0	730	9.2	8.0	8.4	3.4	9	392	633
/7/82	1105	Jones Bondar	Clear 80°F	20.0	800	13.10	8.5	8.4	2.2	20	476	710

TFN 8 2/025
RECD 10-25-18

Scanned, 02/26/2020

Location Big Horn

Sampling Site # GC2

2/

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	.7	.61	---	---	161	196	0	4	.26	.48	---	155	---
---	.2	.24	---	---	125	153	0	3	.13	.44	---	74	---
---	.49	.17	---	---	74	90	0	1	.09	.15	---	35	---
---	.86	.06	---	---	49	60	0	1	.04	.07	---	21	---
<1.0	.42	.10	.10	.73	202	242	2	5	.25	.23	---	142	---
---	.28	.35	---	---	267	325	0	4	.38	1.15	---	160	---
---	2.19	.14	---	---	257	314	0	7	.38	.62	---	173	---
---	1.22	.11	---	---	195	203	17	5	.24	.08	---	131	---
---	.58	.33	---	---	67	82	0	1	.11	.12	---	38	---
---	.54	.18	---	---	73	90	0	2	.10	.07	---	34	---
---	<.01	.21	---	---	178	217	0	3	.28	.19	---	109	---
---	.65	.32	---	---	256	310	1	6	.30	.23	---	198	---
---	<.01	.23	---	---	255	310	0	5	.39	.26	---	158	---
---	.57	.13	---	---	247	301	0	5	.23	.29	---	149	---
---	.55	.28	---	---	252	307	0	6	.25	.29	---	184	---
---	.26	.27	---	---	122	149	0	2	.14	.23	---	64	---
---	.16	.02	---	---	77	93	0	1	.11	.11	---	43	---
---	.13	.02	---	---	93	114	0	<1	.17	.12	---	41	---
---	.40	.12	---	---	263	303	9	8	.30	.20	---	216	---
---	.06	.24	---	---	316	386	0	11	.32	.07	---	253	---

RAMACO

Brook Mine

October 2018

Addendum D6-12-477

D6-494
TFN 6 2/025
RECD 10-25-13

Location Big Horn

Sampling Site # GC2

2/

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	.06	.16	---	---	309	368	4	8	.01	.49	---	223	---
---	.20	.26	---	---	273	333	0	6	.30	.36	---	164	---
---	.46	.22	---	---	255	311	0	6	.24	.21	---	172	---
---	.54	.21	---	---	198	242	0	6	.23	.60	---	132	---
---	.28	.36	---	---	247	302	0	10	.28	1.35	---	216	---
---	.18	.03	---	---	65	80	0	1	.15	.12	---	30	---
---	.21	.08	---	---	97	118	0	2	.16	.22	---	42	---
---	.17	---	---	---	260	318	0	7	.28	.60	---	177	---
---	.33	---	---	---	281	343	0	9	.24	.28	---	227	---
---	.56	---	---	---	259	315	0	5	.36	1.00	---	148	---
<1	.32	.29	---	.82	256	300	5.9	4.2	.29	.27	---	191	---
<1	.21	.31	---	.64	199	242	0	4.6	.22	.33	---	121	---
<1	.06	.10	---	.30	104	127	0	1.9	.09	.07	---	34	---
---	.14	.09	---	.54	129	157	0	2.8	.19	.34	---	74	---
---	.23	.23	---	.68	213	251	0	4.8	.27	.37	---	133	---
---	.07	2.35	---	.75	266	315	0	6.8	.38	.56	---	155	---

D6-495
YER 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Sampling Site # GC2

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
271	53	34	5	24	---	6.61 - 6.59	---	---	<.1	---	<.005
183	37	22	3	12	---	4.24 - 4.16	---	---	.1	---	<.005
94	22	10	1	8	---	2.25 - 2.26	---	---	<.1	---	<.005
62	14	7	1	5	---	1.50 - 1.48	---	---	<.1	---	<.005
297	58	37	3	29	---	7.26 - 7.14	<5	---	<.1	---	<.005
382	74	48	3	30	---	.15	---	---	<.1	---	<.005
381	55	60	3	31	---	.04	---	---	<.1	---	<.005
287	54	37	2	20	---	6.69 - 6.78	---	---	<.1	---	<.005
90	19	10	1	8	---	2.18 - 2.18	---	---	<.1	---	<.005
95	21	10	1	8	---	2.27 - 2.23	---	---	<.1	---	<.005
249	48	31	2	20	---	5.90 - 5.91	---	---	<.1	---	<.005
396	76	50	4	37	---	9.62 - 9.44	---	---	<.1	---	<.005
368	69	48	4	31	---	8.77 - 8.55	---	---	<.1	---	<.005
344	66	43	3	29	---	-.01	---	---	<.1	---	<.005
377	70	49	5	32	---	9.03 - 9.06	---	---	<.1	---	<.005
162	34	19	2	13	---	3.83 - 3.85	---	---	<.1	---	<.005
101	22	11	1	8	---	2.41 - 2.45	---	---	<.1	---	<.005
118	24	14	1	9	---	2.80 - 2.75	---	---	<.1	---	<.005
403	73	53	4	39	---	9.84 - 10.00	---	---	<.1	---	<.005
470	82	65	5	48	---	11.64 - 11.88	---	---	<.1	---	<.005

RECEIVED
Land Quality Div.
JAN 2019
DIST. IV

RAMACO

Brook Mine

October 2018

Addendum D6-12-479

TFN 6 2/025
REC'D 10-25-18

Sampling Site # GC2

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
463	79	64	4	43	---	11.24 - 11.09	---	---	<.1	---	<.005
407	78	52	<1	27	---	9.33 - 9.08	---	---	<.1	---	<.005
368	69	48	3	31	---	8.78 - 8.89	---	---	<.1	---	<.005
281	54	36	5	25	---	6.83 - 6.93	---	---	<.1	---	<.005
404	77	52	4	39	---	9.87 - 9.83	---	---	.2	---	<.005
79	16	9	1	6	---	1.88 - 1.97	---	---	.2	---	<.005
128	25	16	2	9	---	3.00 - 2.86	---	---	<.1	---	<.005
400	75	52	4	26	---	9.24 - 9.14	---	---	<.1	---	<.005
424	73	59	5	43	---	10.49 - 10.63	---	---	<.1	---	<.005
355	71	43	3	28	---	8.36 - 8.50	---	---	.1	---	<.005
385	72	50	3.3	37	---	9.23 - 9.39	<5	---	<.1	---	<.005
277	54	35	2.4	25	---	6.68 - 6.63	---	---	<.1	---	<.005
124	30	12	1.4	7.7	---	2.85 - 2.84	---	---	<.1	---	<.005
169	33	21	3.8	16	---	4.19 - 4.19	---	---	<.1	---	<.005
300	57	38	3.2	27	---	7.25 - 7.17	---	---	<.1	---	<.005
364	64	50	3.4	33	---	8.80 - 8.74	---	---	<.1	---	<.005

RECD 10-25-18

RECEIVED
Water Quality Div.
DEQ, WV

Scanned, 02/26/2020

Sampling Site # GC2

4/

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	<.01	17.3	.10	---	---	---	---	---	.02
---	<.005	---	<.02	---	<.01	8.18	.09	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	.02	3.05	.09	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	.02	1.48	.12	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	.81	.06	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	<.01	.92	.07	---	<.02	---	---	---	.05
---	<.005	---	<.02	---	<.01	.45	.06	---	<.02	---	---	---	.10
---	<.005	---	<.02	---	.01	---	.09	---	<.02	---	---	---	.06
---	<.005	---	<.02	---	<.01	---	.13	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	.01	---	.15	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	---	.08	---	<.02	---	---	---	<.02
---	<.005	---	<.02	---	<.01	.48	.06	---	<.02	---	---	---	.02
---	<.005	---	<.02	---	<.01	.67	.30	---	<.02	---	---	---	.09
---	<.005	---	<.02	---	<.01	<.05	<.05	---	<.02	---	---	---	.05
---	<.005	---	<.02	---	<.01	.57	<.05	---	<.02	---	---	---	.11
---	<.005	---	<.02	---	<.01	.95	.06	---	<.02	---	<.02	---	.03
---	<.005	---	<.02	---	<.01	4.03	.12	---	<.02	---	<.02	---	.02
---	<.005	---	<.02	---	<.01	1.74	.06	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	<.01	.46	<.05	---	<.02	---	<.02	---	<.02
---	<.005	---	<.02	---	<.01	.39	.06	---	<.02	---	<.02	---	.08

RAMACO

Brook Mine

October 2018

Addendum D6-12-481

RECD 10-25-18

TFN 6 2/325

D6-498

DEQ Ex. 3-1450

Location _____

Sampling Site # GC2

4/

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	.02	<.05	<.05	---	<.02	---	<.02	---	.02
---	<.005	---	<.02	---	.02	.25	<.05	---	<.02	---	<.02	---	.06
---	<.005	---	<.02	---	.02	.49	.07	---	<.02	---	<.02	---	.09
---	<.002	---	<.02	---	<.01	.72	.09	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	.79	.06	---	<.02	---	<.02	---	.03
---	<.002	---	<.02	---	<.01	2.02	.24	---	<.02	---	<.02	---	.07
---	<.002	---	<.02	---	<.01	.90	.05	---	<.02	---	<.02	---	.02
---	<.002	---	<.02	---	.01	<.05	<.05	---	<.02	---	<.02	---	.07
---	<.002	---	<.02	---	.02	.49	<.05	---	<.02	---	<.02	---	.05
---	<.002	---	<.02	---	<.01	.14	.05	---	<.02	---	<.02	---	<.02
---	<.002	---	<.02	---	<.01	.31	<.05	---	<.02	---	<.02	---	.10
---	<.002	---	<.02	---	<.01	1.05	<.05	---	<.02	---	<.02	---	.07
---	.002	---	<.02	---	<.01	2.10	.16	---	<.02	---	<.02	---	.02
---	<.002	---	<.02	---	<.01	5.84	.10	---	<.02	---	<.02	---	.02
---	<.002	---	.02	---	<.01	.76	<.05	---	<.02	---	<.02	---	.03
---	<.002	---	<.02	---	<.01	.53	<.05	---	<.02	---	<.02	---	<.02

D6-499
TFN 6 2/025
RECD 10-25-13

October 2018 Addendum D6-12-482 RAMACO Brook Mine

Scanned, 02/26/2020

Location Big Horn

Sampling Site # GC2

5/

PARAMETERS

Mercury		Nickel		Selenium		Vanadium		Zinc				Total Kje.
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Barium	Boron	Nitrogen
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.06	<.5	.3	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	<.01	---	.02	<.5	<.1	---
---	<.002	---	<.03	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.08	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.02	<.5	.3	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.2	---
---	<.001	---	.01	---	<.005	---	---	---	.03	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.02	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.05	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.03	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.05	<.5	.2	---

RAMACO

Brook Mine

October 2018

Addendum D6-12-483

D6-500

TFR 6 2/025

RECD 10-25-18

DEQ Ex. 3-1452

Location Big Horn

Sampling Site # GC2

5/

PARAMETERS

Mercury Total	Mercury Dissol.	Nickel Total	Nickel Dissol.	Selenium Total	Selenium Dissol.	Vanadium Total	Vanadium Dissol.	Zinc Total	Zinc Dissol.	Barium	Boron	Total Kje. Nitrogen
---	<.001	---	.01	---	<.005	---	---	---	.02	<.5	.1	---
---	<.001	---	.02	---	<.005	---	---	---	.03	<.5	.1	---
---	<.0002	---	.02	---	<.005	---	---	---	.02	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.06	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.17	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.0002	---	.03	---	<.005	---	---	---	.02	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.41	<.5	.2	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	.11	---
—	<.0002	—	<.01	—	<.005	—	—	—	<.01	<.5	.13	—
—	.0002	—	<.01	—	<.005	—	—	—	<.01	<.5	<.01	—
—	.0005	—	.01	—	<.005	—	—	—	<.01	<.5	.1	—
—	.0008	—	<.01	—	<.005	—	—	—	<.01	<.5	.08	—
—	.0007	—	<.01	—	<.005	—	—	—	<.01	<.5	.16	—

D6-501
TFR 6 2/025
RECD 10-25-13

RECEIVED
JAN 1988
Land Quality Div.
DIST. IV

Scanned, 02/26/2020

Location Big Horn

Sampling Site # BH-003

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
/20/79	1015	Bondar Araas	Cloudy warm	17.0	1680	7.6	6.8	7.8	8.0	67	1250	1720
/10/79	1100	Collier Bowlby	Clear 65° F	19.0	1850	6.1	8.1	7.8	28.0	42	1340	1860
/31/79	0945	Bowlby	Rain 75°F	18.0	1530	7.8	5.7	8.0	14.0	28	1440	1930
/13/79	1210	Bondar Araas	Rain 60°F	17.0	1800	---	6.75	7.9	5.1	17	1140	1800
2/11/79	1150	Araas Collier	Clear 20°F	6.0	1780	---	8.2	7.8	6.8	18	1500	2130
/19/80	1300	Hill Bondar	Clear 30°F	7.0	2000	10.8	8.9	8.1	8.8	13	1390	1970
4/29/80	1050	Araas Veenstra	Clear 65°F	17.0	2000	---	6.44	8.2	7.2	22	1210	1790
5/27/80	1300	Hill Collier	Ptly. Cldy 70°F	17.0	1800	---	7.32	8.3	27.0	32	1070	1540
/16/80	1030	Wollenzien Araas	Clear 65°F	19.0	1790	7.3	7.9	8.2	20.0	36	976	1640
/15/80	1130	Collier Lyden	Ptly. Cldy 70°F	22.0	1830	10.28	8.2	8.3	31.0	43	1100	1670
/2/80	1100	Mazgaj Bowlby	Clear 85°F	17.0	2000	7.9	7.8	8.2	13.0	17	1210	1870
/9/80	1300	Hill Bondar	Clear Cold	3.0	2000	11.4	7.65	8.1	6.3	8	1110	1730
/2/81	1230	Lyden Bondar	Ptly Cldy 55° F	8.6	1600	10.7	8.05	8.2	6.0	12	968	1490
/12/81	1045	Andersen Veenstra	Rain 32°F	11.0	2000	8.2	7.4	8.0	23.0	46	1160	1790
/2/81	1100	Veenstra Collier	Clear Warm	15.0	1350	8.6	7.3	7.6	8.2	16	1080	1700

TFN 6 2/025
RECD 10-25-18

Location Big Horn

Sampling Site # BH-003 (Con.

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
6/22/81	1030	Jones Collier	Ptly Cldy Warm	17.5	1625	7.7	7.9	7.6	7.4	8	974	1600
8/5/81	1015	Jones Andersen	Clear 85°F	24.0	1980	6.3	8.2	8.2	200.0	60	1124	1690
9/1/81	1020	Jones Andersen	Clear 80°F	17.0	1600	8.7	7.25	8.0	11.0	25	966	1490
12/14/81	1115	Jones Veenstra	Ptly Cldy 20°F	4.0	2400	8.9	6.9	7.7	3.8	14	1320	2140
3/29/82	1145	Collier Veenstra	Clear 50°F	10.0	2300	9.9	7.2	7.9	5.4	60.5	1370	1966
5/3/82	1130	Jones Veenstra	Clear 75°F	14.0	1650	9.2	7.5	7.8	3.2	8.5	1040	1490
5/24/82	1110	Jones Veenstra	Cloudy 60°F	13.0	2000	8.0	6.9	7.9	8.4	123	156	264
6/15/82	1005	Collier Veenstra	Clear 70°F	15.0	1800	5.3	7.0	7.6	2.9	25	1090	1680
7/27/82	1050	Jones Veenstra	Clear 85°F	20.0	2000	5.2	7.1	7.6	14.0	35	1280	1840
9/7/82	1030	Jones Bondar	Not flowing this sampling period									

RECD 10-25-13

Scanned, 02/26/2020

Location Big Horn

Sampling Site # BH-003

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	9.42	.22	---	---	427	521	0	9	.48	2.56	---	549	---
---	.26	.08	---	---	437	534	0	9	.66	1.97	---	607	---
---	3.23	.07	---	---	487	594	0	10	.56	1.35	---	642	---
---	<.01	.05	---	---	489	597	0	2	.67	1.17	---	612	---
---	4.15	.03	---	---	533	651	0	13	.50	.96	---	663	---
---	2.66	.02	---	---	538	656	0	5	.60	1.36	---	572	---
---	4.21	.17	---	---	552	673	0	11	.76	2.98	---	464	---
---	3.18	.07	---	---	483	589	0	9	.69	1.71	---	407	---
---	3.07	.04	---	---	483	590	0	9	.85	2.28	---	399	---
---	3.42	.04	---	---	440	498	19	9	.82	3.62	---	422	---
---	4.00	.02	---	---	551	672	0	12	.06	2.57	---	481	---
---	4.35	.09	---	---	545	666	0	11	.83	1.12	---	440	---
---	2.24	.02	---	---	409	499	0	13	.72	1.23	---	401	---
---	.21	.02	---	---	435	530	0	13	.73	22.20	---	420	---
---	8.19	<.01	---	---	423	516	0	12	.78	18.03	---	410	---
---	7.04	.03	---	---	436	533	0	8	.69	14.00	---	358	---
---	.25	---	---	---	515	628	0	8	.68	3.65	---	444	---
---	2.91	---	---	---	405	495	0	7	.59	6.67	---	344	---
---	7.88	---	---	---	586	715	0	12	.91	7.82	---	516	---
---	3.78	.02	---	6.52	627	765	0	14	.85	.96	---	494	---
< 1	4.57	.02	—	4.54	471	575	0	9.8	.59	1.07	—	372	—
< 1	.08	.08	—	.30	102	125	0	1.7	.09	.06	—	32	—
—	4.64	.02	—	4.87	488	595	0	9.6	.49	2.24	—	436	—
—	5.81	.05	—	4.69	402	490	0	9.1	.65	2.84	—	625	—

RAMACO

Brook Mine

October 2018

Addendum D6-12-487

RECD 10-25-13

TFN 6 2/025

Sampling Site # BH-003

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
561	105	73	13	200	---	20.26 - 20.42	---	---	<.1	---	<.005
581	107	76	15	223	---	21.69 - 21.79	---	---	<.1	---	<.005
609	114	79	16	242	---	23.14 - 23.48	---	---	<.1	---	<.005
639	112	88	18	208	---	22.30 - 22.67	---	---	.1	---	<.005
631	119	81	17	277	---	-----	---	---	<.1	---	<.005
542	104	69	15	261	---	22.61 - 22.92	---	---	<.1	---	<.005
419	70	59	14	279	---	20.84 - 21.23	---	---	.1	---	<.005
399	64	58	12	236	---	18.54 - 18.53	---	---	<.1	---	<.005
400	72	54	13	224	---	18.10 - 18.42	---	---	<.1	---	<.005
344	59	48	15	255	---	18.36 - 18.11	---	---	<.1	---	<.005
427	67	63	17	289	---	21.51 - 21.55	---	---	<.1	---	<.005
360	66	48	7	301	---	20.50 - 20.48	---	---	<.1	---	<.005
339	63	45	12	226	---	16.91 - 17.04	---	---	<.1	---	<.005
416	89	47	17	237	---	19.04 - 19.45	---	---	<.1	---	<.005
417	89	47	16	224	---	18.50 - 18.67	---	---	<.1	---	<.005
350	69	43	16	224	---	17.16 - 17.47	---	---	<.1	---	<.005
360	82	38	14	277	---	20.49 - 20.07	---	---	<.1	---	<.005
276	53	35	13	225	---	15.65 - 15.99	---	---	.2	---	<.005
502	81	73	20	306	---	23.87 - 23.43	---	---	<.1	---	<.005
454	93	54	17	320	---	23.44 - 23.22	<5	---	.2	---	<.005
399	72	54	13	209	---	17.40 - 17.44	---	---	<.1	---	<.005
119	31	10	1.3	7.5	---	2.73 - 2.77	---	---	<.1	---	<.005
427	40	80	16	231	---	19.02 - 19.11	---	---	<.1	---	<.005
522	108	62	19	247	---	21.67 - 21.32	---	---	<.1	---	<.005

October 2018 Addendum D6-12-488
TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Sampling Site # BH-003

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	.01	.10	<.05	---	<.02	---	---	---	.32
---	<.005	---	<.02	---	<.01	8.94	.06	---	<.02	---	---	---	.39
---	<.005	---	<.02	---	<.01	.53	.05	---	<.02	---	---	---	.44
---	<.005	---	<.02	---	<.01	.46	.10	---	<.02	---	---	---	.20
---	<.005	---	<.02	---	<.01	<.05	<.05	---	<.02	---	---	---	.43
---	<.005	---	<.02	---	<.01	.26	<.05	---	<.02	---	---	---	.33
---	<.005	---	<.02	---	<.01	.11	<.05	---	<.02	---	<.02	---	.21
---	<.005	---	<.02	---	<.01	.29	<.05	---	<.02	---	<.02	---	.22
---	<.005	---	<.02	---	<.01	.23	<.05	---	<.02	---	<.02	---	.15
---	<.005	---	<.02	---	<.01	.34	<.05	---	<.02	---	<.02	---	.06
---	<.005	---	<.02	---	.02	<.05	<.05	---	<.02	---	<.02	---	.16
---	<.005	---	<.02	---	.02	.16	<.05	---	<.02	---	<.02	---	.30
---	<.005	---	<.02	---	.02	.18	<.05	---	<.02	---	<.02	---	.22
---	<.002	---	<.02	---	<.01	.57	<.05	---	<.02	---	<.02	---	.36
---	<.002	---	<.02	---	<.01	.28	.18	---	<.02	---	<.02	---	.47
---	<.002	---	<.02	---	<.01	.11	<.05	---	<.02	---	<.02	---	.21
---	<.002	---	.04	---	.03	.06	.06	---	<.02	---	<.02	---	.30
---	<.002	---	<.02	---	.02	.24	.09	---	<.02	---	<.02	---	.15
---	<.002	---	<.02	---	<.01	.22	.09	---	<.02	---	<.02	---	.55
---	<.002	---	<.02	---	<.01	.39	.07	---	<.02	---	<.02	---	.25
—	<.002	—	<.02	—	<.01	.35	<.05	—	<.02	—	<.02	—	.15
—	<.002	—	<.02	—	<.01	2.23	.13	—	<.02	—	.02	—	.02
—	<.002	—	<.02	—	<.01	.38	<.05	—	<.02	—	.02	—	.28
—	<.002	—	<.02	—	<.01	.70	<.05	—	<.02	—	.02	—	.27

JAN 1988 RECEIVED Land Quality Div. DIST. 1

October 2018 RAMACO Brook Mine

TFN 6 2/025

RECD 10-25-13 Addendum D6-12-489

Location Big Horn

Sampling Site # BH-003

5/

PARAMETERS

Mercury		Nickel		Selenium		Vanadium		Zinc		Barium	Boron	Total Kje. Nitrogen
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.			
---	<.001	---	.03	---	<.005	---	---	---	.05	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.02	<.5	.2	---
---	<.001	---	.04	---	<.005	---	---	---	.02	<.5	.2	---
---	<.001	---	.05	---	<.005	---	---	---	.04	<.5	.1	---
---	<.001	---	.01	---	<.005	---	---	---	.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.001	---	.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.05	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.04	<.5	.1	---
---	<.001	---	.04	---	<.005	---	---	---	.04	<.5	.5	---
---	<.001	---	.03	---	<.005	---	---	---	.04	<.5	.1	---
---	<.0002	---	.02	---	<.005	---	---	---	.02	<.5	.1	---
---	<.0002	---	.03	---	<.005	---	---	---	.02	<.5	.1	---
---	<.0002	---	.02	---	<.005	---	---	---	.20	<.5	<.1	---
---	<.0002	---	.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.0002	---	.06	---	<.005	---	---	---	.05	<.5	<.1	---
---	<.0002	---	.02	---	<.005	---	---	---	.24	<.5	.2	---
---	<.0002	---	.01	---	<.005	---	---	---	.54	<.5	.2	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	.16	---
—	<.0002	—	<.01	—	<.005	—	—	—	<.01	<.5	.17	—
—	.0004	—	<.01	—	<.005	—	—	—	<.01	<.5	<.01	—
—	<.0002	—	.02	—	<.005	—	—	—	<.01	<.5	.23	—
—	.0003	—	.03	—	<.005	—	—	—	<.01	<.5	.11	—

RECD 10-25-18
TFN 6 2/025

Scanned, 02/26/2020

Sampling Site # TR5B

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
0/03/78	1010	Boyle Bowlby	Ptly. Cldy. 55°	13.5	1150	6.8	7.39	8.2	22	16	840	1130
2/05/78	1050	Araas Bowlby	Clear Cold	4.5	1900	11.2	7.4	8.1	12	27	1350	1550
3/06/79	1035	Veenstra Bondar	Ptly. Cldy. 35°	6.0	1500	11.5	7.09	7.9	36	63	1030	1410
5/02/79	1200	Collier Veenstra	Rain 35° F	9.8	1276	9.7	----	8.4	20	64	1060	1410
5/30/79	1115	Araas Collier	Ptly. Cldy. 50°	14.0	1100	8.7	7.9	8.1	29	79	1070	1340
6/14/79	1030	Araas Bondar	Cldy. Warm	21.0	1420	8.4	7.8	8.2	230	54	1150	1463
7/10/79	1045	Bowlby Collier	Clear 65° F	21.0	1450	7.7	8.0	8.1	87	15	1140	1540
8/30/79	1305	Bowlby	Rain 75°F	22.0	1800	7.2	7.7	8.0	11	28	1260	1610
9/13/79	1229	Araas Bondar	Rain 60°F	15.0	520	---	7.8	8.3	4.9	11	362	560
2/11/79	1110	Araas Collier	Clear 20° F	4.0	2600	---	8.41	8.0	19	38	2270	2690
3/19/80	1320	Hill Bondar	Snowing 30° F	6.0	2480	10.0	9.0	8.1	40	50	1810	2150
4/29/80	1030	Araas Veenstra	Clear 60° F	17.0	2500	---	7.34	8.2	6.9	17	1890	2390
5/27/80	1230	Hill Collier	Ptly. Cldy. 70°	19.0	2100	---	7.60	8.4	15.0	20	1660	1980
6/16/80	1000	Wollenzien Araas	Clear 65° F	20.0	2400	7.3	8.10	8.2	4.5	10	1440	2130
7/15/80	1100	Collier Lyden	Ptly. Cldy. 70°	22.0	1800	7.3	8.18	8.2	7.2	16	1740	2170
8/11/80	0930	Volk Araas	Clear 65° F	20.0	1320	7.8	7.52	8.2	4.5	12	1690	2110

DEQ-208
TFN 6 2/025
RECD 10-25-18

Sampling Site # TR5B

1/

PARAMETERS

DATE	Time	Samplers	Weather	Temp. C°	Field Cond. Mmhos/cm	Dissol. Oxygen ppm	Field pH	Lab pH	Turb. (NTU)	TSS	TDS	Lab Cond. Mmhos/cm
9/02/80	1015	Bowlby Mazgaj	Clear 85° F	17.0	2300	8.2	7.44	8.3	3.6	5	1520	2110
2/09/80	1015	Hill Bondar	Clear Cold	3.0	2450	13.7	7.40	8.1	5.0	5	1540	2080
3/02/81	1300	Lyden Bondar	Clear 55° F	8.5	2500	10.8	8.35	7.8	23	99	1470	2200
4/22/81	0930	Bondar	Rain, Cool	14.0	2020	9.10	7.70	7.9	18	44	1426	2170
5/12/81	1015	Andersen Veenstra	Ptly. Cldy. 45°	12.0	2400	8.8	7.0	8.1	34	70	1520	2190
5/02/81	1030	Veenstra Collier	Clear Warm	12.0	2450	7.6	7.5	8.0	60	95	1340	2040
6/22/81	1000	Jones Collier	Ptly. Cldy. Warm	17.0	1700	7.8	8.1	7.7	19	21	1180	1790
7/05/81	0950	Jones Andersen	Clear 85° F	20.0	1875	7.9	8.2	8.5	22	23	1054	1600
9/01/81	1000	Jones Andersen	Clear 80° F	17.0	1800	8.1	7.15	8.2	2.5	2	1120	1720
2/14/81	1055	Jones Veenstra	Ptly. Cldy. 20°	3.0	1850	12.0	7.2	8.1	5	6	1040	1660
3/29/82	1100	Collier Veenstra	Clear 50° F	9.0	1800	10.6	7.5	8.1	6.5	25	1160	1620
5/3/82	1050	Jones Veenstra	Clear 70°F	18.0	1800	8.2	7.9	8.3	2.8	11.5	1230	1870
5/24/82	1030	Jones Veenstra	Ptly. Cldy.65°F	10.0	2300	9.6	7.4	8.0	6.6	96	122	225
5/15/82	0922	Collier Veenstra	Clear 70°F	18.0	2300	8.2	7.1	8.2	1.2	16	1800	2510
7/27/82	1020	Jones Veenstra	Clear 85°F	23.0	2400	8.6	8.0	8.2	2.6	6	1640	2170
9/7/82	1000	Bondar Jones	Clear 80°F	20.0	2000	8.2	8.0	8.2	1.8	11	1500	2030

October 2018 Addendum D6-12-492

D6-492

RECD 10-25-18

IRN 6 2/025

DEQ Ex. 3-1461

Scanned, 02/26/2020

Location Big Horn 2/

Sampling Site # TR5B

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	.15	.02	---	---	263	321	0	6	.40	.52	---	360	---
---	.76	.02	---	---	214	261	0	7	.39	.56	---	765	---
---	4.79	.04	---	---	311	380	0	8	.57	.44	---	510	---
---	1.82	.05	---	---	280	310	16	14	.49	.42	---	512	---
---	2.32	.15	---	---	310	378	0	6	.44	.53	---	501	---
---	1.37	.12	---	---	313	382	0	7	.37	.42	---	545	---
---	.20	.07	---	---	324	395	0	7	.51	2.01	---	572	---
---	1.34	.07	---	---	296	361	0	7	.37	.79	---	600	---
---	<.01	.11	---	---	211	258	0	3	.26	.05	---	95	---
---	8.14	.03	---	---	424	517	0	17	.42	3.10	---	1160	---
---	4.77	.16	---	---	351	428	0	14	.50	3.47	---	856	---
---	4.00	.13	---	---	307	375	0	13	.52	2.50	---	996	---
---	2.93	.09	---	---	303	368	<1	10	.48	2.26	---	854	---
---	7.14	.04	---	---	298	364	0	11	.56	4.46	---	822	---
---	6.79	.02	---	---	284	326	10	13	.53	11.91	---	885	---
---	6.68	<.01	---	---	287	350	0	12	.49	11.28	---	830	---
---	5.68	.01	---	---	363	443	0	13	.04	4.76	---	814	---
---	4.24	.09	---	---	405	494	0	11	.58	2.25	---	834	---

RAMACO

Brook Mine

October 2018

Addendum D6-12-493

TFN 6 2/025

RECD 10-25-18

Location Big Horn

2/

Sampling Site # TR5B

PARAMETERS

Acidity	Ammonia Nitrogen	Total Phos.	Ortho-Phos.	SAR	Total Alkal.	Bicarb. Alkal.	Carb.	Chloride	Fluoride	NO_3+NO_2	NO_3	Sulfate	Silica
---	4.43	.03	---	---	418	510	0	14	.58	2.11	---	739	---
---	4.03	.03	---	---	446	545	0	13	.66	1.52	---	644	---
---	4.59	<.01	---	---	467	569	0	16	.35	1.69	---	718	---
---	3.90	.02	---	---	382	466	0	13	.72	1.97	---	691	---
---	.11	.02	---	---	403	492	0	9	.59	3.76	---	565	---
---	2.53	---	---	---	404	493	0	9	.49	2.68	---	500	---
---	5.69	---	---	---	382	467	0	4	.40	9.55	---	509	---
---	6.22	---	---	---	324	396	0	8	.50	4.84	---	485	---
---	5.14	.04	---	3.49	339	413	0	5.4	.44	2.01	---	579	---
<1	4.78	.02	—	3.74	345	416	2.4	8.5	.45	2.05	—	607	—
<1	.06	.05	—	.17	88	108	0	.70	.08	.02	—	16	—
—	2.24	.01	—	4.19	367	448	0	11	.44	2.79	—	994	—
—	.72	.03	—	3.74	343	419	0	11	.58	2.87	—	881	—
—	.31	.14	—	3.59	365	445	0	12	.62	2.14	—	811	—

RECEIVED JAN 1986 Land Quality Div. DIST. #1

RAMACO Brook Mine
October 2018 2/025 10-25-18 Addendum D6-12-494

Scanned, 02/26/2020

Sampling Site # TR5B

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
477	99	56	10	74	---	.03	---	---	<.1	---	<.005
800	146	104	14	91	---	.08	---	---	.1	---	<.005
610	116	78	10	104	---	<.05	---	---	<.1	---	<.005
633	111	87	12	92	---	16.98 - 16.72	---	---	<.1	---	<.005
617	98	91	12	93	---	16.69 - 16.84	---	---	<.1	---	<.005
678	114	96	13	91	---	17.86 - 17.86	---	---	<.1	---	<.005
679	117	94	13	104	---	18.45 - 18.73	---	---	<.1	---	<.005
714	141	88	14	99	---	18.94 - 18.67	---	---	.1	---	<.005
276	57	33	2	20	---	6.44 - 6.28	---	---	<.1	---	<.005
1100	182	156	25	254	---	.15	---	---	.1	---	<.005
822	145	112	18	198	---	25.49 - 25.48	---	---	<.1	---	<.005
823	132	120	24	234	---	27.25 - 27.43	---	---	<.1	---	<.005
748	116	111	18	193	---	23.84 - 24.30	---	---	<.1	---	<.005
553	98	75	20	284	---	23.91 - 24.38	---	---	<.1	---	<.005
712	118	101	20	235	---	24.98 - 25.32	---	---	<.1	---	<.005
703	116	101	22	216	---	24.03 - 24.18	---	---	<.1	---	<.005
652	99	98	21	268	---	25.23 - 24.93	---	---	<.1	---	<.005
736	122	105	13	250	---	25.93 - 25.95	---	---	<.1	---	<.005

DEQ-512
TFN 6 2/025
RECD 10-25-18

Sampling Site # TR5B

3/

PARAMETERS

Total Hardness	Calcium	Magnesium	Potassium	Sodium	% Sodium	Cations-Anions	Oil & Grease	Aluminum Total	Aluminum Dissol.	Arsenic Total	Arsenic Dissol.
522	81	78	22	299	---	23.99 - 24.32	---	---	.1	---	<.005
440	65	68	20	312	---	22.86 - 22.86	---	---	<.1	---	<.005
511	84	73	22	320	---	24.69 - 24.88	---	---	<.1	---	<.005
509	92	68	19	283	---	22.95 - 22.57	---	---	<.1	---	<.005
478	81	67	18	231	---	20.03 - 20.41	---	---	<.1	---	<.005
509	109	58	17	200	---	19.33 - 18.98	---	---	.1	---	<.005
504	100	62	32	179	---	18.69 - 19.07	---	---	<.1	---	<.005
534	99	69	16	134	---	16.92 - 17.18	---	---	.1	---	<.005
530	97	70	15	185	---	19.00 - 18.99	5	---	<.1	---	<.005
521	76	81	17	196	---	19.41 - 19.79	---	---	<.1	---	<.005
95	4.4	21	1	4	---	2.11 - 2.11	---	---	<.1	---	<.005
786	102	129	23	270	---	28.04 - 28.37	---	---	<.1	---	<.005
752	102	121	22	236	---	25.85 - 25.52	---	---	<.1	---	<.005
707	96	114	22	220	---	24.27 - 24.51	---	---	<.1	---	<.005

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

Sampling Site # TR5B

4/

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	<.01	.49	<.05	---	<.02	---	---	---	.16
---	<.005	---	<.02	---	<.01	1.57	.05	---	<.02	---	---	---	.22
---	<.005	---	<.02	---	<.01	1.22	<.05	---	<.02	---	---	---	.19
---	<.005	---	<.02	---	.01	---	.06	---	<.02	---	---	---	.34
---	<.005	---	<.02	---	<.01	---	<.05	---	<.02	---	---	---	.21
---	<.005	---	<.02	---	<.01	---	<.05	---	<.02	---	---	---	.06
---	<.005	---	<.02	---	<.01	---	.05	---	<.02	---	---	---	.10
---	<.005	---	<.02	---	.02	.22	.05	---	<.02	---	---	---	.12
---	<.005	---	<.02	---	<.01	.50	.08	---	<.02	---	---	---	.03
---	<.005	---	<.02	---	<.01	<.05	<.05	---	<.02	---	---	---	.12
---	<.005	---	<.02	---	<.01	.97	<.05	---	<.02	---	---	---	.11
---	<.005	---	<.02	---	<.01	.11	<.05	---	<.02	---	<.02	---	.04
---	<.005	---	<.02	---	<.01	.14	<.05	---	<.02	---	<.02	---	.07
---	<.005	---	<.02	---	<.01	.08	<.05	---	<.02	---	<.02	---	.03
---	<.005	---	<.02	---	<.01	1.41	<.05	---	<.02	---	<.02	---	.03
---	<.005	---	<.02	---	<.01	.16	<.05	---	<.02	---	<.02	---	.05
---	<.005	---	<.02	---	.04	.05	<.05	---	<.02	---	<.02	---	.03
---	<.005	---	<.02	---	.02	.14	<.05	---	<.02	---	<.02	---	<.02

TFN 6 2/025
RECD 10-25-18

Sampling Site # TR5B

4/

PARAMETERS

Cadmium		Chromium		Copper		Iron		Lead		Molyb.		Manganese	
Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.	Total	Dissol.
---	<.005	---	<.02	---	.02	.39	<.05	---	<.02	---	<.02	---	.16
---	<.002	---	<.02	---	<.01	.14	<.05	---	<.02	---	<.02	---	.10
---	<.002	---	<.02	---	<.01	.24	<.05	---	<.02	---	<.02	---	.07
---	<.002	---	<.02	---	<.01	.54	<.05	---	<.02	---	<.02	---	.12
---	<.002	---	<.02	---	<.01	.20	<.05	---	<.02	---	<.02	---	.08
---	<.002	---	<.02	---	<.01	<.05	<.05	---	<.02	---	<.02	---	.09
---	<.002	---	<.02	---	.02	<.05	<.05	---	<.02	---	<.02	---	.05
---	<.002	---	<.02	---	<.01	.17	.05	---	<.02	---	<.02	---	.08
---	<.002	---	<.02	---	<.01	.47	<.05	---	<.02	---	<.02	---	.04
—	<.002	—	<.02	—	<.01	.23	<.05	—	<.02	—	<.02	—	<.02
—	<.002	—	<.02	—	<.01	1.86	<.05	—	<.02	—	<.02	—	.16
—	<.002	—	<.02	—	<.01	.27	<.05	—	<.02	—	<.02	—	<.02
—	<.002	—	<.02	—	.01	.09	<.05	—	<.02	—	<.02	—	<.02
—	<.002	—	<.02	—	<.01	.20	<.05	—	<.02	—	<.02	—	<.02

RECD 10-25-18 Addendum D6-12-498 October 2018

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Location Big North

Sampling Site # TR5B

5/

PARAMETERS

Mercury Total	Mercury Dissol.	Nickel Total	Nickel Dissol.	Selenium Total	Selenium Dissol.	Vanadium Total	Vanadium Dissol.	Zinc Total	Zinc Dissol.	Barium	Boron	Total Kje. Nitrogen
---	<.001	---	<.01	---	<.005	---	---	---	.01	<.5	.2	---
---	<.0002	---	.02	---	<.005	---	---	---	.02	<.5	.3	---
---	<.0002	---	.02	---	<.005	---	---	---	.02	<.5	.2	---
---	<.001	---	.01	---	<.005	---	---	---	.02	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.2	---
---	<.001	---	.03	---	<.005	---	---	---	.01	<.5	.3	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	.3	---
---	<.001	---	<.01	---	<.01	---	---	---	<.01	<.5	.2	---
---	<.001	---	<.01	---	<.005	---	---	---	.02	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.01	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	<.01	<.5	<.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.01	<.5	.1	---
---	<.001	---	.01	---	<.005	---	---	---	<.01	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.05	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.04	<.5	.1	---
---	<.001	---	<.01	---	<.005	---	---	---	.05	<.5	.2	---
---	<.001	---	.04	---	<.005	---	---	---	.04	<.5	.1	---
---	<.001	---	.03	---	<.005	---	---	---	.09	<.5	.2	---

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TFN 6 2/025
RECD 10-25-18

Sampling Site # TR5B

PARAMETERS

Mercury Total	Mercury Dissol.	Nickel Total	Nickel Dissol.	Selenium Total	Selenium Dissol.	Vanadium Total	Vanadium Dissol.	Zinc Total	Zinc Dissol.	Barium	Boron	Total Kje. Nitrogen
---	<.0002	---	.02	---	<.005	---	---	---	.02	<.5	.1	---
---	<.0002	---	.01	---	<.005	---	---	---	.02	<.5	.2	---
---	<.0002	---	<.01	---	<.005	---	---	---	.01	<.5	.2	---
---	<.0002	---	<.01	---	<.005	---	---	---	.12	<.5	.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.01	<.5	.1	---
---	<.0002	---	.02	---	<.005	---	---	---	.31	<.5	< .1	---
---	<.0002	---	<.01	---	<.005	---	---	---	.32	<.5	.2	---
---	<.0002	---	<.01	---	<.005	---	---	---	1.09	<.5	.1	---
---	<.0002	---	<.01	---	<.005	---	---	---	<.01	<.5	.16	---
—	<.0002	—	<.01	—	<.005	—	—	—	<.01	<.5	.18	—
—	<.0002	—	.02	—	<.005	—	—	—	<.01	<.5	<.01	—
—	<.0002	—	.03	—	<.005	—	—	—	<.01	<.5	.26	—
—	.0007	—	<.01	—	<.005	—	—	—	<.01	<.5	.22	—
—	.0005	—	<.01	—	<.005	—	—	—	<.01	<.5	.27	—

D6-517
TFN 6 2/025
RECD 10-25-18

RECEIVED JAN 1989 Land Quality DIST. III

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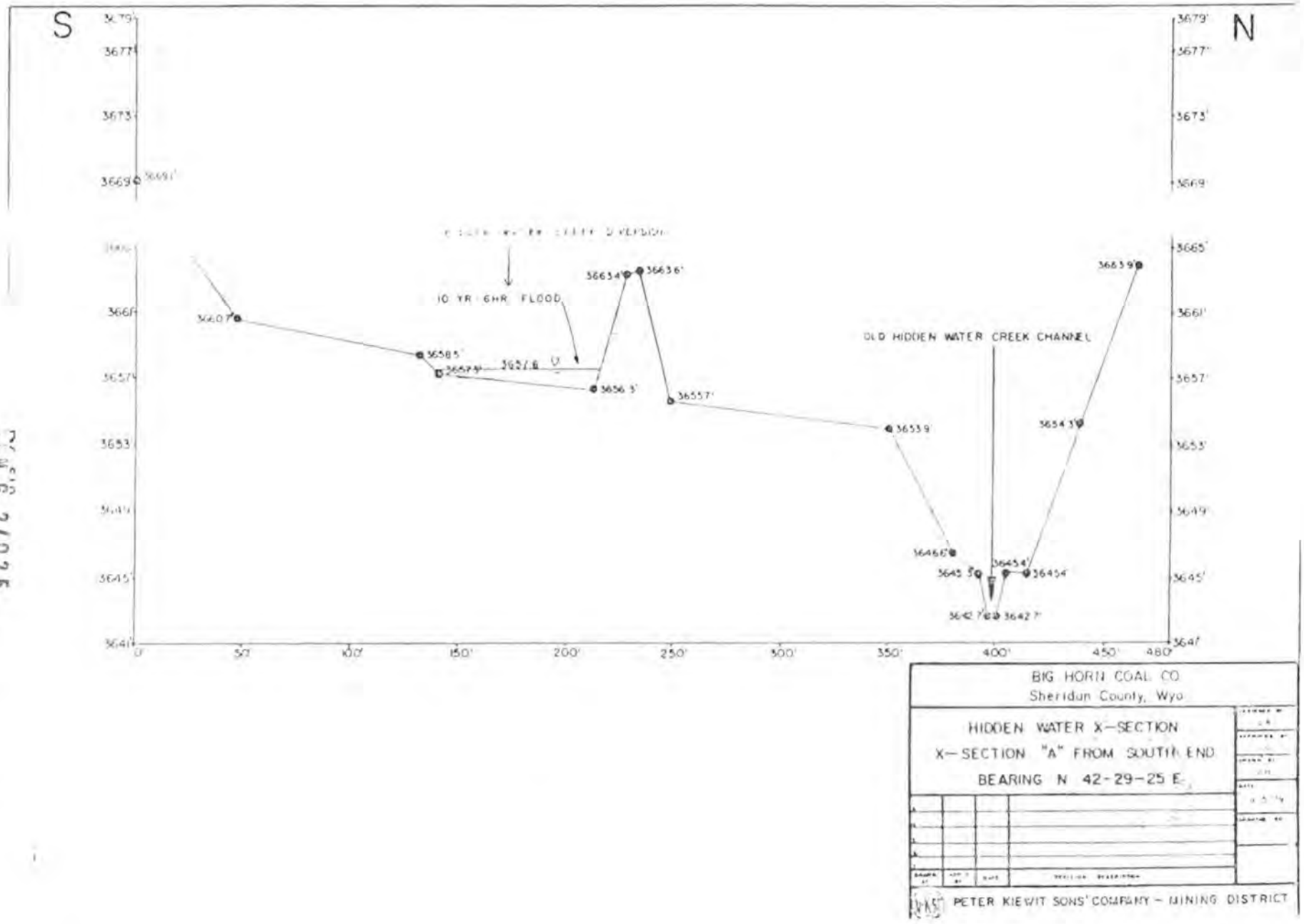
ADDENDUM D6-9

HIDDEN WATER CREEK CROSS SECTIONS

WITH TEN YEAR SIX HOUR FLOOD EVALUATIONS

D6-518
TFN 6 2/025
10-25-13



BIG HORN COAL CO.
Sheridan County, Wyo.

HIDDEN WATER X-SECTION
X-SECTION "A" FROM SOUTH END
BEARING N 42-29-25 E.

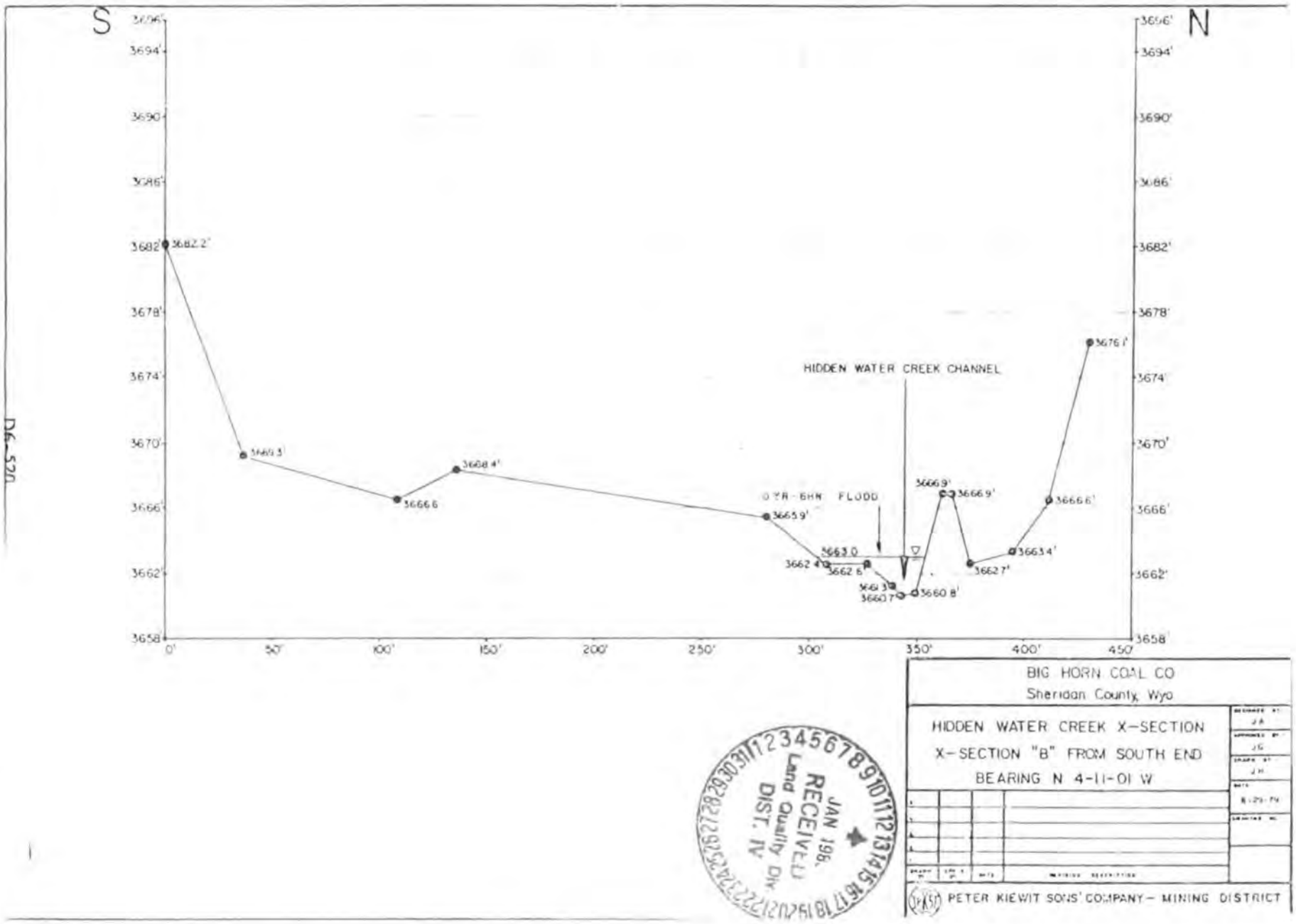
PETER KIEWIT SONS' COMPANY - MINING DISTRICT

RECD 2/025
EFF 6
RECD 10-25-18

DEQ Ex. 3-1471

Scanned, 02/26/2020

RAMACO



BIG HORN COAL CO
Sheridan County, Wyo

HIDDEN WATER CREEK X-SECTION
X-SECTION "B" FROM SOUTH END
BEARING N 4-11-01 W

PETER KIEWIT SONS' COMPANY – MINING DISTRICT

JAN 1998
RECEIVED
Land Quality Div
DIST. IV

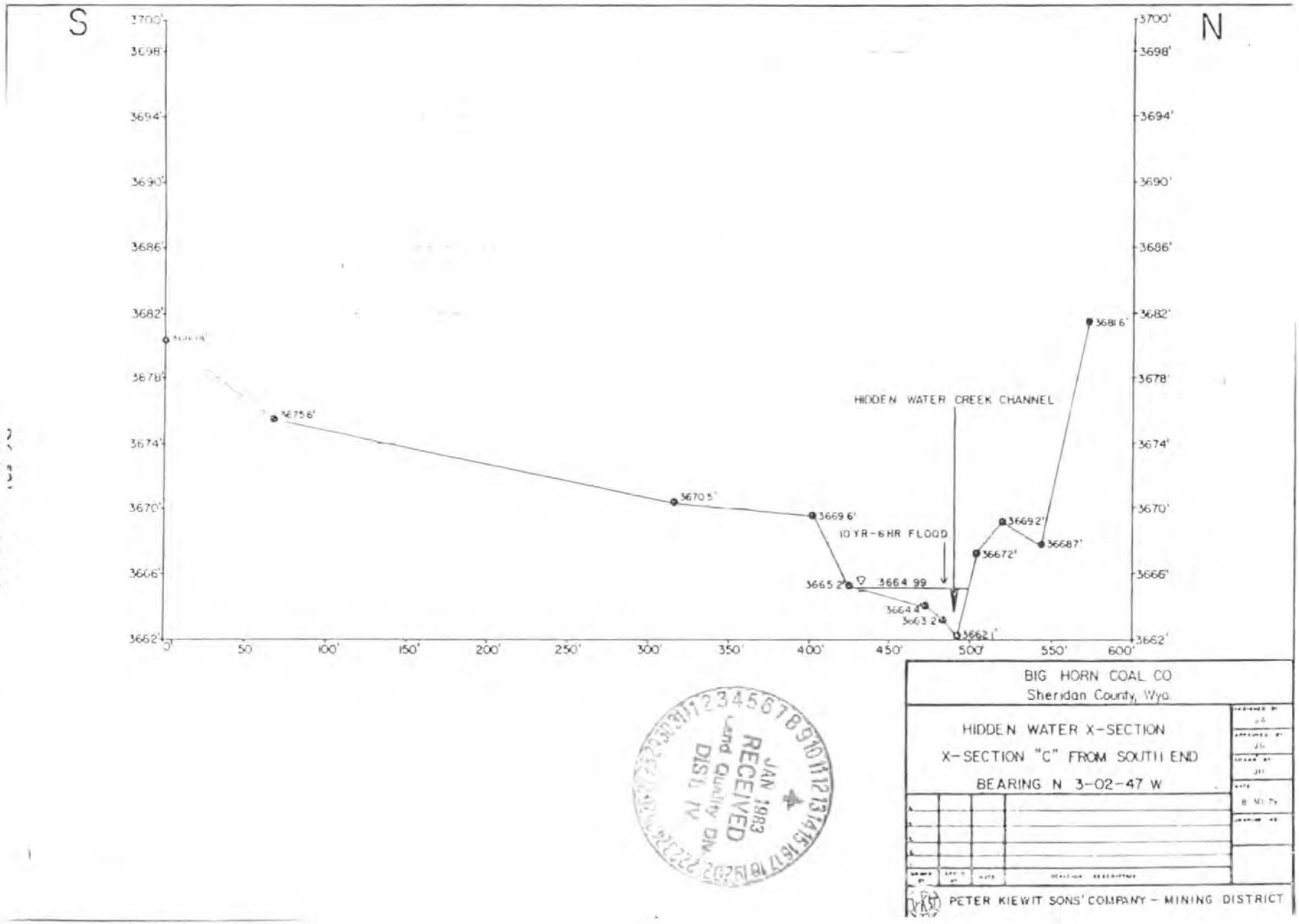
October 2018

TFN 6 2/025
REED 10-25-18

Addendum D6-12-503

Brook Mine

DEQ Ex. 3-1472

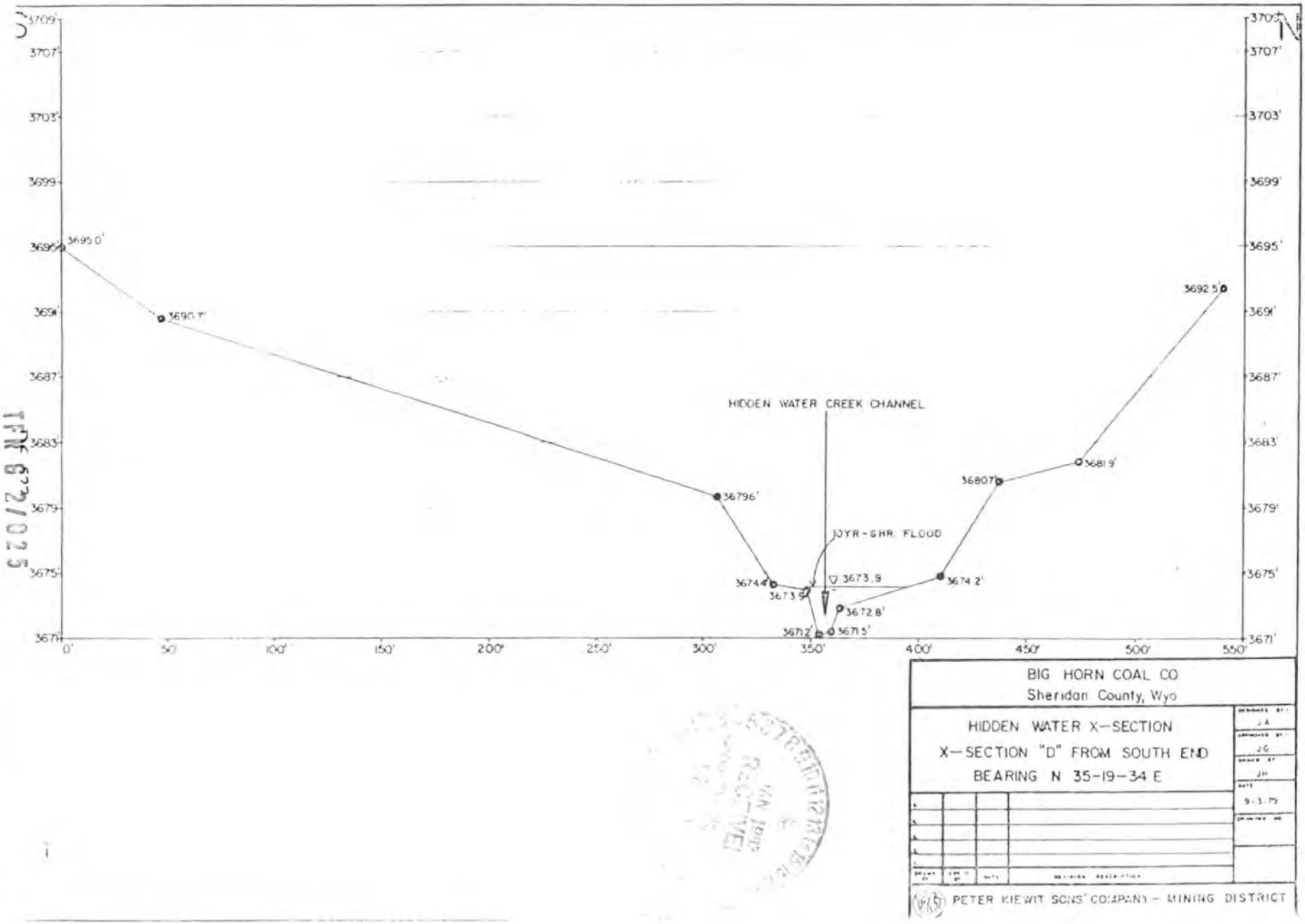


JAN 1983
RECEIVED
Land Quality Div.
DIST IV

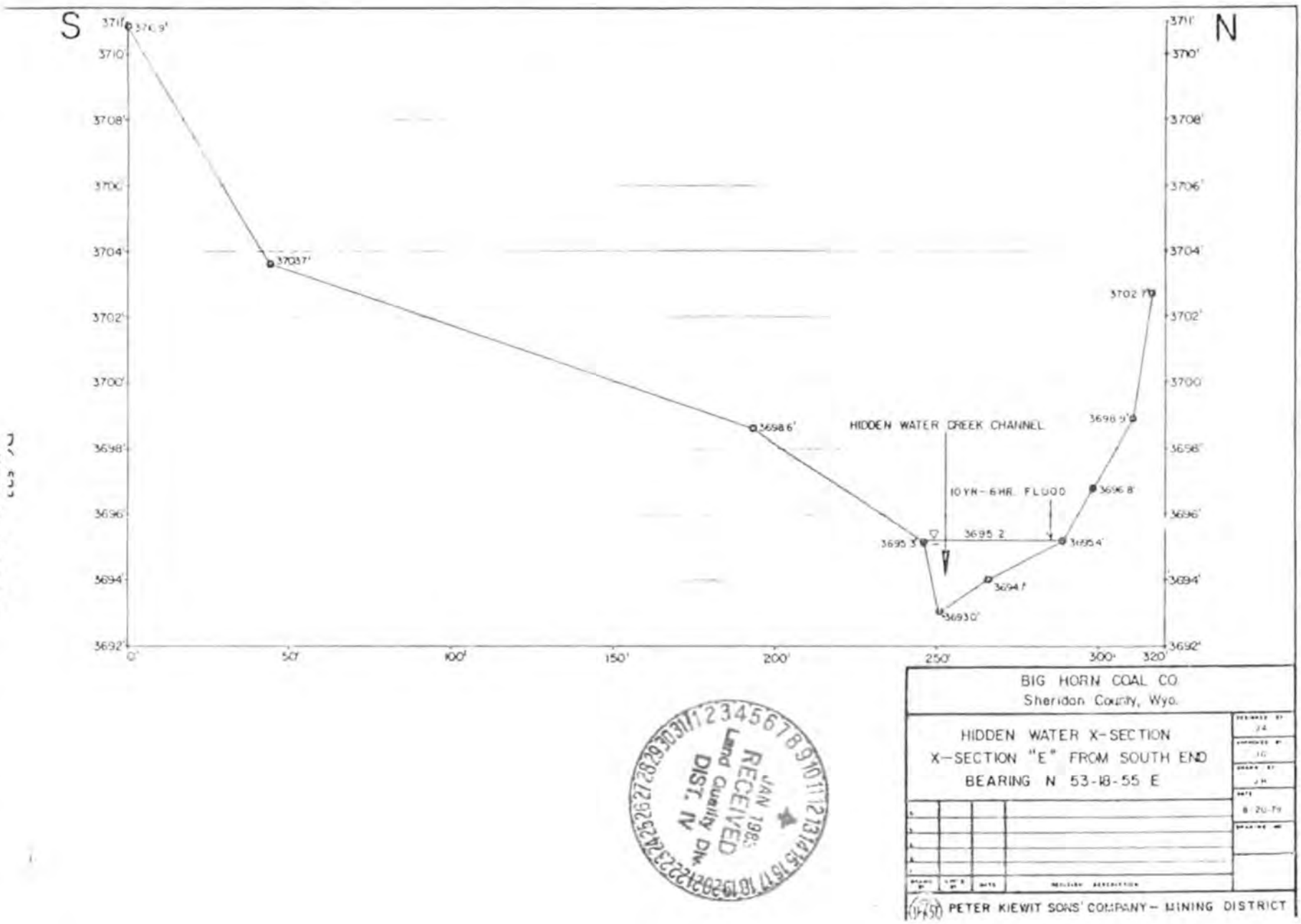
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1473

Scanned, 02/26/2020



TFR 6/22/023
RECD 10-25-13



RECEIVED
JAN 1980
Land Quality Div.
DIST. IV

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1475

Scanned, 02/26/2020

JAN 1983
RECEIVED
Quality Div.
DIST. IV.

ADDENDUM D6-10

HIDDEN WATER CREEK

BACKHOE PIT STUDY

TFN 6 2/025
RECD 10/25-18

Pit Number BH1

DATE: 6/25/79

TIME: 1:20 MDT

HYDROLOGIC SOIL TYPE: Alluvial

ROOTING DEPTH: 8.5

Can Number	Depth	Soil Moisture %	Comments
			did not reach water table, no evidence
			of subirrigation, bagged samples.

STRATIGRAPHY	COMMENTS
0-1.8	very fine sand, few 1-5 mm scoria chips.
1.8-2.0	1-20 mm diameter subangular scoria and medium sand.
2.0-2.2	fine sand.
2.2-2.6	Subangular-rounded scoria and sandstone 1-50 mm diameter.
2.6-3.3	Very fine sand with 1-5 mm coal and scoria chips.
3.3-4.0	Subangular-rounded scoria and sandstone (1-100 mm) with medium sand.
4.0-4.9	Subangular scoria (5-30 mm diameter), few coal chips 5 mm diameter.
4.9-8.5	Subangular scoria -1-200 mm diameter, coal chips and sandy clay.
8.5-9.5	Sandy clay with subangular 5-200 mm scoria chips.
9.5-12.5	Subangular scoria 1-100 mm (primarily 5-10 mm), some subangular
	sandstone, (same size).

TFN 6 2/025
WEBB 10-25-18

Scanned, 02/26/2020

Pit Number BH2

DATE: 6/25/79

TIME: 12 MDT

HYDROLOGIC SOIL TYPE: Alluvial

ROOTING DEPTH: 6.0

Can Number	Depth	Soil Moisture %	Comments
			Second highest terrace.
			Samples taken from intervals as below.
			No water encountered.
			No apparent subirrigation.
			Total root depth approx. 6 feet.
			Orientation horizontal with stream.

STRATIGRAPHY	COMMENTS
0-1.4	Silt with mix of scoria chips.
1.4-1.5	Subrounded to rounded scoria (1-10 mm).
1.5-1.8	Silt with scoria chips.
1.8-1.9	Subrounded to rounded scoria (1-10 mm).
1.9-2.0	Med to coarse sand, few coal chips.
2.0-4.1	Fine to med. sand with 2 mm diameter coal and scoria chips.
4.1-4.6	Very coarse scoria chips.
4.6-5.3	1-20 mm scoria and sandstone chips (subangular to rounded).
5.3-6.1	Very coarse sand w/ 1-100 mm, subangular to rounded sandstone and scoria chips (larger sandstone pieces).
6.1-8.8	Very fine sand w/1-15 mm angular to subrounded scoria chips and 10-120 mm sandstone.
8.8-15	Stratified angular to subrounded scoria (1-20 mm) and baked sandstone (1-100 mm) coal & scoria 1-2 mm, and quartz. No distinct clay lenses present.

TFN 6 2/025
DEQ Ex. 3-1478
RECD 10-25-13

Pit Number BH 3

DATE: 6/24/79

TIME: 1:00 MDT

HYDROLOGIC SOIL TYPE: Alluvial

ROOTING DEPTH: total 6.5'

Can Number	Depth	Soil Moisture %	Comments
			No water encountered.
			No apparent subirrigation.
			Samples taken at interval above.
			Highest terrace.
			Orientation horizontal with stream.

JAN 1983 RECEIVED Land Quality Div. DIST. IV

STRATIGRAPHY	COMMENTS
0-2.0	silt 1-5 mm scoria chips throughout.
2.0-2.5	very fine sand chips throughout
2.5-3.0	silt (buried B horizon).
3.0-4.6	Very fine sand.
4.6-4.8	Subangular to rounded 1-50 mm scoria, w/weathered coal chips.
4.8-5.7	Very fine sand with coal and scoria chips throughout.
5.7-6.5	Silty clay.
6.5-6.6	Fine sand.
6.6-7.8	Sandy clay.
7.8-8.0	Fine to med. sand.
8.0-9.7	Sandy clay
9.7-10.4	Silt w/few 1 mm scoria.
10.4-12.4	Very fine sand to silt.
12.4-13.0	Scoria 1 to 100 mm, rounded to angular.

TFN 6 2/025
ACCR 10-25-18

Scanned, 02/26/2020

Pit Number BH 4

DATE: 6/25/79

TIME: 2:30 MDT

HYDROLOGIC SOIL TYPE: Residual-Colluvial

ROOTING DEPTH: 3.0'

Can Number	Depth	Soil Moisture %	Comments
			No water.
			No subirrigation.
			Samples taken 8.6' to top.

	STRATIGRAPHY	COMMENTS
	0-1.2	Silt w/angular 1-10 mm scoria (B Horizon).
	1.2-2.4	Silt w/angular-subrounded sandstone & scoria (C Horizon).
slight orientation	2.4-2.7	Fine sand w/1-5 mm scoria & burn chips.
	2.7-4.0	Fine to med. sand w/angular to subrounded sandstone and scoria (1-50 mm).
	4.0-4.7	Fine to medium sand w/angular to subrounded sandstone & scoria (1-150 mm).
	4.7-4.9	Weathered coal.
	4.9-6.2	Silty clay, angular 1-25 mm scoria w/some sandstone.
	6.2-8.6	Colluvial mix angular to subrounded (5 mm-300 mm) sandstone mudstone, shale, scoria.
	8.6-10.9	Soft weathered gray shale bedrock.
	10.9-11.5	Sandstone and mudstone-weathered.

TFN 6 2/025

RECD 10-25-18

Pit Number BH 5

DATE: 6/25/79

TIME: 3:30 MDT

HYDROLOGIC SOIL TYPE: Colluvial

ROOTING DEPTH: 6.3'

Can Number	Depth	Soil Moisture %	Comments
			Did not reach water table, no evidence
			of subirrigation, coal dry.

STRATIGRAPHY	COMMENTS
0-2.3	Chocolate brown, fine sand with 0-50 mm diameter multicolored
	mudstone.
2.3-4.0	Gray sandy shale with 0-50 mm diameter multicolored mudstone.
4.0-4.8	Sandy clay, brown (mostly clay).
4.8-5.2	Dark brown carbonaceous shale.
5.2-5.3	White powdery silt sized particles.
5.3-11 TD	Black coal-poor quality, weathered.

D6-529

TFN 6 2/025

RECD 10-25-18

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Pit Number BH 6

DATE: 6/26/79

TIME: 9:00 MDT

HYDROLOGIC SOIL TYPE: Alluvial

ROOTING DEPTH: approx. 4.5'

Can Number	Depth	Soil Moisture %	Comments
			Reached the water table at 10.85'.
			Horizontal orientation.

STRATIGRAPHY	COMMENTS
0-1.3	Silt to very fine sand w/1-5 mm coal and scoria.
1.3-1.55	1-20 mm sandstone and scoria, subrounded to rounded.
1.55-1.7	Very fine sand.
1.7-3.1	1-30 mm sandstone, and scoria, and friable coal chips, (rounded)
	mostly 5-10 mm.
3.1-4.7	1-100 mm sandstone, scoria and friable coal chips, (rounded) mostly
	5-10 mm.
4.7-6.4	Silty clay mixed w/1-50 mm subrounded to rounded sandstone and
	scoria, some mudstone.
6.4-7.0	Same w/less clay (1-100 mm).
7.0-7.7	Well sorted subrounded to rounded scoria and sandstone 1-15 mm.
7.7-8.6	Well sorted subrounded to rounded scoria and sandstone 1-150 mm.
8.6-10.85	Coarse sand mixed w/clay, subrounded to rounded sandstone and
	scoria chips

TFN 6 2/025

RAMACO

Pit Number BH 7

Brook Mine

DATE: 6/26/79

TIME: 10:00 MDT

HYDROLOGIC SOIL TYPE: Alluvial

ROOTING DEPTH: 7.0'

JAN 198: RECEIVED Land Quality DIV. DIST. IV

Can Number	Depth	Soil Moisture %	Comments
			Hit water table at 12.6'
			. All strata have horizontal
			orientation.

STRATIGRAPHY	COMMENTS
0.0-2.0	Fine sand with intermixed 1-5 mm subangular scoria chips
2.0-2.1	1-10 mm subangular scoria chips.
2.1-2.4	Fine sand.
2.4-2.5	Medium sand with intermixed 1-3 mm subangular scoria chips.
2.5-3.6	Fine sand with intermixed 1-10 mm subangular chips.
	(large material near stream).
3.6-8.4	Scoria and sandstone, subangular - rounded 1-100 mm with inter-
	mixed fine sand and clay. Very few coal chips.
8.4-12.6	Subangular rounded sandstone and scoria. 1-30 mm diameter with sand
	and clay.

TFN 6 2/025
RECD 10-25-1 8

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Page 2 of 2 Pit Number BH 8

DATE: _____

TIME: _____

HYDROLOGIC SOIL TYPE: _____

ROOTING DEPTH: _____

Can Number	Depth	Soil Moisture %	Comments

STRATIGRAPHY	COMMENTS
11.2 - 11.4	Subangular to rounded, sandstone and scoria chips. Pinches out away from stream.
11.4 - 11.9	Fine sand with some clay.
11.9 - 13.0	Subangular to rounded coal, sandstone, scoria (5-75mm).

TFN 6 2/025
DEQ Ex. 3-1484
RECD 10-25-13

Page 1 of 2

Pit Number BH 8

DATE: 6/26/79

TIME: 11:00 MDT

HYDROLOGIC SOIL TYPE: alluvial

ROOTING DEPTH: aporox. 3.8 '

Can Number	Deoth	Soil Moisture %	Comments
			Horizontal orientation in all strata.
			No subirrigation. No samples.
			Did not reach water table.

STRATIGRAPHY	COMMENTS
0.0-0.5	Silt.
0.5-1.2	Fine to very fine sand.
1.2-3.6	Silt w/intermixed 1-5 mm mudstone, scoria, sandstone chips.
3.6-4.3	Angular-rounded sandstone & scoria chips (5-50 mm).
4.3-6.4	Fine sand, subrounded to rounded 1-5 mm scoria chips.
6.4-6.5	Subrounded to rounded 5-20 mm scoria and sandstone chips
	and few coal chips.
6.5-6.8	Fine sand.
6.8-7.3	Subangular to rounded scoria and sandstone chips (5-30 mm).
7.3-7.9	Fine sand w/intermixed coal chips.
7.9-8.1	Subangular to rounded scoria and sandstone, coal chips (5-25 mm diameter
8.1-9.6	Fine to medium sand w/few coal chips.
9.6-9.7	Subangular to rounded (2-10 mm) sandstone, scoria and coal chips.
9.7-11.2	Fine to medium sand. Moist at 10.0'

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Pit Number BH 9

DATE: 6/26/79

TIME: 12:30 MDT

HYDROLOGIC SOIL TYPE: Alluvium

ROOTING DEPTH: at least 1.93'

Can Number	Depth	Soil Moisture %	Comments
			Water at 1.93'

STRATIGRAPHY	COMMENTS
0-.95	Mottled clay, very fine sandy clay, and chips.
.95-1.45	Well sorted, very coarse sand, 4-5 mm coal, scoria rounded.
1.45-1.5	Silty clay, coal chips.
1.5-1.9	Very coarse sand, 1-5 mm rounded coal, sandstone, scoria chips
	w/larger to (50mm) coal chips.
1.9-2.5	1-5 mm rounded coal, sandstone, scoria chips w/few subangular to
	rounded 5-50 sandstone, coal, scoria.
	Stream channel moist but no flow. Perched water in channel
	between pits 6 and 9.

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Pit Number BH 10

DATE: 6/26/79

TIME: 11:00 MDT

HYDROLOGIC SOIL TYPE: alluvium

ROOTING DEPTH: approx. 7.0'

RECEIVED JAN 198 Land Quality DIST. IV

Can Number	Depth	Soil Moisture %	Comments
			did not reach the water table.

STRATIGRAPHY	COMMENTS
0-1.5	Silt w/intermixed angular-subrounded scoria, sandstone, coal
	and mudstone (5-50 mm).
1.5-2.7	Same as above, only 1-10 mm.
2.7-3.5	Very fine sand w/coal and mudstone chips.
3.5-3.7	Very fine sand w/rounded coal and scoria 1-5 mm.
3.7-4.9	Very fine sand w/coal chips.
4.9-5.5	Very fine to fine sand w/5-50 mm rounded sandstone, scoria,
	and coal chips.
5.5-5.9	Fine sand w/coal chips (1-2 mm).
5.9-5.95	Subrounded to rounded sandstone (1-20 mm).
5.95-6.4	Well sorted (1-5 mm) scoria, sandstone, coal chips.
6.4-8.8	Subrounded - rounded (1-10 mm) sandstone, scoria chips w/few
	large chips to 100 mm.
8.8-9.5	Fine sand w/10-100 mm sandstone, scoria (rounded) w/1-5 mm coal
	chips.

D6-535

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Pit Number BH 10

DATE: _____

TIME: _____

HYDROLOGIC SOIL TYPE: _____

ROOTING DEPTH: _____

RECEIVED

Can Number	Depth	Soil Moisture %	Comments

STRATIGRAPHY	COMMENTS
9.5-10.0	Clay, grey.
10.0-11.55	Fine Sand w/10-100 mm sandstone, scoria (rounded) w/1-5 mm coal chips.

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DEBD 10-25-13

ADDENDUM D6-11

HIDDEN WATER CREEK

SOIL MOISTURE AND INFILTRATION TESTS

D6-537
IFR 6 2/025
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Infiltrometer Forms

Area Pit 4 Site No. BH8 Sampler JB & DK

Date 5/15/79 Time 1000 N. 1550094 E. 589195

Elevation 3664.35 Hydrologic Soil Type Alluvial

Actual Soil Classification Ft. Collins Loam

Vegetation Type Mixed silver & big sagebrush, grass and alfalfa

Approx. Rooting Depth 0-0.5;M;F
0.5-1.0;C;F
1.0-2.0;F;C

Can No.	Depth	Soil Moisture%	Comments
45	.1	16.0	
49	.5	14.5	
53	1.0	14.9	
57	2.0	14.3	5-20mm subangular scoria chips at 4.0'
61	4.0	16.3	Could not penetrate easily
56	4.5	15.0	At 5.0' another scoria stratified layer
			TDD 5.0
			Soil moisture tube installed. TD of tube
			is 4.5'. Did not reach water table.

Amt. of Drop Measured (in)	Time Filled	Time Emptied	Time (hrs) To Drwdn.	Infilt. Rate Inches/Hr.	Comments
.05	2:45	2:51:45	.1125	.44	Double ring was
.05	2:54:15	2:59	.0792	.63	prewetted for approx.
.05	3:00	3:07	.1167	.43	15 minutes. Sampler
.05	3:07:30	3:14:30	.1167	.43	JA. Test performed
.05	3:15:30	3:22	.1083	.46	5/14/79.
.05	3:22:30	3:29	.1083	.46	
.05	3:30	3:36:30	.1083	.46	
.05	3:37:30	3:45	.1250	.40	
.05	3:46	3:53:30	.1250	.40	
.05	3:54:30	4:02	.1250	.40	
.05	4:03	4:10:30	.1250	.40	
.05	4:11	4:19:30	.1417	.35	
.05	4:20	4:28:30	.1417	.35	
.05	4:29:30	4:37:30	.1333	.38	
.05	4:38:30	4:46:30	.1333	.38	
.05	4:47	4:55	.1333	.38	
				Mean = .42	

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DEQ Ex. 3-1490-25-1 3

Soil Moisture and Double Ring
Infiltrometer Forms

Area Pit 4 Site No. BH9 Sampler JB

Date 5/15/79 Time 1215 N. 1549922 E. 589013

Elevation 3673.24 Hydrologic Soil Type Alluvial

Actual Soil Classification Ft. Collins Loam

Vegetation Type Perennial grass Approx.Rooting Depth 0-.5; M;VF

0.5-4.0;F;VF

Can No.	Depth	Soil Moisture%	Comments
35	.1	32.2	
36	.5	15.8	
34	1.0	15.7	
39	2.0	15.4	Subangular scoria
40	4.0	13.6	(alluvial gravel)at 10.5-11.4'
33	6.0	15.2	
38	8.0	20.8	Could not penetrate beyond 11.4'
42	10.0	21.9	TDD 11.4'
47	11.0	21.0	Did not reach water table. Installed soil
			moisture tube.

Amt. of Drop Measured (in)	Time Filled	Time Emptied	Time (hrs) To Drwdn.	Infilt.Rate Inches/Hr.	Comments
.05	11:14	11:50	.60	.08	Double ring was
.05	11:51	12:34	.72	.07	prewetting for
.05	12:35	1:21	.77	.06	approx. 15 minutes.
				Mean =.07	Sampler MB. Analysis
					performed 5/15/79.

D6-520

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DEQ 10-25-18

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Soil Moisture and Double Ring
Infiltrometer Forms

Area Pit 4 Site No. BH10 Sampler JB & DK

Date 5/16/79 Time 1100 N. 1549777 E. 588248

Elevation 3700.19 Hydrologic Soil Type Residual/Colluvial

Actual Soil Classification Zigweid loam

Vegetation Type Big sagebrush,grass Approx.Rooting Depth 0-.5;C;F&VF;
0.5-4.0;F:F-M (sagebrush 0->4.0;
VF;C&VC)

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Can No.	Depth	Soil Moisture%	Comments
123	.1	11.4	Did not reach water table,soil moisture
124	.5	16.2	tube installed
126	1.0	17.2	
127	2.0	16.7	Scoria and sandstone colluvial and/or
128	4.0	16.3	bedrock at 3.0'
			Subangular & subrounded scoria and
			sandstone at 4.0' (bedrock and/or colluvium)

Amt. of Drop Measured (in)	Time Filled	Time Emptied	Time (hrs) To Drwdn.	Infilt.Rate Inches/Hr.	Comments
.05	10:25	10:37	.27	.19	Double ring was
.05	10:37	11:04	.45	.11	prewetted for approx.
.05	11:05	11:30	.42	.12	10 minutes.
.05	11:31	11:53:45	.38	.13	Sampler JA test
.05	11:51	12:15:30	.34	.15	performed 5/15/79
.05	12:16	1:36	.33	.15	
.05					
.05				Mean =.14	

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Soil Moisture and Double Ring
Infiltrometer Forms

Area Pit 4 Site No. BH11 Sampler Bowlby, Araas, Bondar

Date 5/14/79 Time 1411 N. 1550106 E. 589479

Elevation 3662.89 Hydrologic Soil Type Alluvial (lowest terrace)

Actual Soil Classification Ustic torrifluvent - fine loamy

Vegetation Type Silver & big sagebrush, perennial grass, and alfalfa Approx. Rooting Depth

Can No.	Depth	Soil Moisture%	Comments
			No soil moisture samples taken.

Amt. of Drop Measured (in)	Time Filled	Time Emptied	Time (hrs) To Drwdn.	Infilt. Rate Inches/Hr.	Comments
.05	2:15	2:33:20	.3055	.16	Double ring was
.05	2:36:30	2:58	.3583	.14	prewetted for approx.
.05	3:00	3:26:30	.4417	.11	15 minutes
.05	3:27	3:49	.3667	.14	
.05	3:50	4:22	.5333	.09	
.05	4:24	4:53	.4833	.10	
				Means=.12	

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Infiltrometer Forms

Area Pit 4 Site No. BH12 Sampler JB & DK

Date 5/16/79 Time 1200 N.1549566 E.590512

Elevation 3650.29 Hydrologic Soil Type Alluvial (lowest terrace)

Actual Soil Classification Ft. Collins Loam

Vegetation Type Grass, silver sagebrush and alfalfa

Approx.Rooting Depth 0-.5;M;VF
.5-1.0;C;VF;M
1.0 - 4.0;F,M

Can No.	Depth	Soil Moisture%	Comments
99	.1	9.5	Did not reach water table.
100	.5	13.8	Soil moisture tube installed.
98	1.0	9.8	5.5
103	2.0	8.8	5.5- 6.5 very fine sand,well
109	4.0	12.1	sorted
107	6.0	9.1	Hit alluvium/colluvium at 7.0'
104	7.0	TDD 14.5	(5-10 mm in diameter, angular and sub-angular scoria, sandstone and coal chips)

Amt. of Drop Measured (in)	Time Filled	Time Emptied	Time (hrs) To Drwdn.	Infilt.Rate Inches/Hr.	Comments
.05	2:28	2:36	.13	.38	Double ring was
.05	2:36:30	2:57	.34	.15	prewetted for approx.
.05	2:58	3:19	.35	.14	15 minutes. Sampler
.05	3:20	3:43	.38	.13	JA test performed
.05	3:44	4:01	.28	.18	5/15/79
.05	4:02	4:21:30	.33	.15	
				Mean =.19	
				Mean excluding =.15	
				1st reading	

IFN 6 2/025

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Soil Moisture and Double Ring
Infiltrometer Forms

Area Pit 4 Site No. BH39 Sampler JB & DK

Date 5/15/79 Time 1345 N. 1549880 E. 589116

Elevation 3671.60 Hydrologic Soil Type Alluvial(highest terrace)

Actual Soil Classification Ft. Collins loam

Vegetation Type Perennial grass Approx.Rooting Depth 0-.5;M;VF

0.5-4.0;F;VF

Can No.	Depth	Soil Moisture%	Comments
46	.1	23.2	
37	.5	17.9	
41	1.0	16.5	Subangular scoria chips (5-20mm diameter)
43	2.0	9.0	from 7.0-8.8'
44	4.0	21.1	Subangular scoria chips (20mm diameter)
50	6.0	19.0	reached at 8.8' which could not be
51	8.0	11.8	penetrated
52	8.8	12.5	8.8 TDD
			Did not reach water table. Installed
			soil moisture tube.

Amt. of Drop Measured (in)	Time Filled	Time Emptied	Time (hrs) To Drwdn.	Infilt.Rate Inches/Hr.	Comments

D6-743

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Soil Moisture and Double Ring
Infiltrometer Forms

Area Pit 4 Site No. BH40 Sampler JB & DK

Date 5/15/79 Time 1510 N. 1550054 E. 588749

Elevation 3676.09 Hydrologic Soil Type Alluvial(highest terrace)

Actual Soil Classification Stoneham Loam

Vegetation Type grass,big sagebrush Approx.Rooting Depth 0-.5;M:M-VF

0.5-5.0; F;C,M&F

Can No.	Depth	Soil Moisture%	Comments
55	.1	13.1	
54	.5	14.9	
58	1.0	10.6	
59	2.0	10.0	
48	4.0	14.7	Hit subangular scoria and subrounded
64	6.0	16.5	gravel at 11.0' (moist)
62	8.0	13.3	TDD 11.0'
63	10.0	21.8	
60	11.0	14.2	Installed soil moisture tube.

Amt. of Drop Measured (in)	Time Filled	Time Emptied	Time (hrs) To Drwdn.	Infilt.Rate Inches/Hr.	Comments

D6-544

TFN 6 2/025

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Soil Moisture and Double Ring
Infiltrometer Forms

Area Pit 4 Site No. BH41 Sampler JB & DK

Date 5/16/79 Time 1300 N. 1549380 E. 590440

Elevation 3652.26 Hydrologic Soil Type Alluvial(highest terrace)

Actual Soil Classification Bibman Loam

Vegetation Type Predominately alfalfa Approx.Rooting Depth 0-.5; M;F&VF
with silver and big sagebrush,grasses .5-2.0; C VF&M

2.0-4.0;F;M

Can No.	Depth	Soil Moisture%	Comments
125	.1	20.6	
121	.5	17.6	Clay layer 1.0-2.0'
120	1.0	15.5	
119	2.0	15.1	
118	4.0	17.4	Hit subangular-subrounded sandstone and
116	6.0	20.8	scoria,1-5mm in diameter at 12.1'
115	8.0	13.9	TDD 13.0'
112	10.0	15.9	Did not reach water table.
117	12.0	11.5	Soil moisture tube installed.

Amt. of Drop Measured (in)	Time Filled	Time Emptied	Time (hrs) To Drwdn.	Infilt.Rate Inches/Hr.	Comments

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ADDENDUM D6-12

HIDDEN WATER CREEK

FLOOD IRRIGATION ASSESSMENT

TFN 6 2/025
RECD 10-25-13

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

October 4, 1979

J. Bowlby
Log No. 1747

JAN 1983
RECEIVED
Land Quality Div.
DIST. IV

Jim Bowlby, Hydrologist
Peter Kiewit Sons, Co.
Sheridan, Wyoming 82801

Dear Jim,

The Area Soil Scientist and myself recently visited an area adjacent to Hidden Water Creek encompasing approximately seven acres. We were asked to make recommendations as to whether it would be feasible to flood irrigate or spread water on the area to increase production.

The drainage area above the proposed site exceeds two thousand acres with a moderate slope of three to eight percent and a curve number of seventy-five. This would call for minimum of a fifty-five foot emergency spillway or a seventy-eight inch conduit to carry a twenty-four hour storm with a storm frequency of twenty-five years. Cubic second feet would exceed 250. Cost of a diversion of this type with control gates would be in excess of $15,000. A structure would also be required to return the water to the channel of Hidden Water Creek to eliminate back cutting and this structure would cost between $10,000 and $12,000.

The area proposed to be irrigated has a slope of four percent. We do not recommend spreading water on land with a slope exceeding 2-3 percent so the area was not addressed for this type of supplemental irrigation.

The seven acres could be flood irrigated, but in looking at the stream flow charts on Hidden Water Creek, the reliance of water during the critical growing season of plants for late June, July and August is almost non-existant.

Considering the cost of an estimated $3700 per acre for structures to irrigate and the unreliability of water for plant growth, I would not recommend that this area be further studied for any type of irrigation.

Sincerely,

F. S. Smith
District Conservationist
Soil Conservation Service
Sheridan, Wyoming 82801

D6-547
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ADDENDUM D6-13

Big Horn Coal Mine
Groundwater Restoration Demonstration

TFR 6 2/025
RCVD 10-25-18

Filed: 5/17/2017 11:26:19 AM WEQC

C1-Objection Exhibit F

BIG HORN COAL COMPANY

BIG HORN MINE

GROUNDWATER RESTORATION DEMONSTRATION

EXHIBIT
tabbies
BHC 15

Big Horn Coal Company
Groundwater Restoration Demonstration

Feb. 2002

BHC15-001

01 BHC GW RESTORATION DEMONSTRATION NARRATIVE AND TABLES.PDF

YFN 6 2/025
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FOREWORD

The Administrator of the Wyoming Department of Environmental Quality, Land Quality Division, has declared that requests for final incremental bond release at coal mines must be preceded by: 1) a demonstration that the postmining groundwater conditions support the postmining land use as per Coal Rules and Regulations Chapter 4, Section 2.(h)(i) and Chapter 4, Section 2.(i)(i) and; 2) verification of the accuracy of the Probable Hydrologic Consequences (PHC) predictions for groundwater as per Coal Rules and Regulations Chapter 4, Section 2.(i). One of the principal objectives in Big Horn Coal's reclamation has been to restore the quantity of groundwater in the mine backfill and adjacent areas to a level suitable for livestock use and meeting the livestock use water quality standards set forth under the Wyoming Department of Environmental Quality, Water Quality Division's Rules and Regulations, Chapter VIII. Section 5, Table 1. Groundwater quality data are presented in this report demonstrating how these standards have been met at Big Horn Mine. In terms of restoring groundwater quantity characteristics, Big Horn's specific objectives have been to re-establish infiltration and recharge capacities, aquifer storage and groundwater flow, and aquifer saturated thicknesses.

This report is intended to fulfill the requirements for demonstrating postmining groundwater conditions at Big Horn Mine and more specifically to verify that the quantity and quality of groundwater has been restored throughout the majority of all reclaimed mine lands and throughout all adjacent areas to conditions suitable for livestock watering. Data and analyses are provided for reclaimed mine spoil sites not yet fully meeting livestock watering criteria showing trends in groundwater recovery which allow forecasts to be made of meeting the restoration goals. Groundwater conditions now existing within and contiguous to Big Horn Mine are compared to predictions made in the PHC assessments of the mine permit document.

This report is inclusive of all of Big Horn Mine and has been prepared intentionally well in advance of any request for Final Incremental Bond release because, as demonstrated in this report, coal bed methane gathering activities have begun to significantly impact groundwater conditions in areas adjacent to the mine. This submittal does not request any changes in Big Horn Mine's currently approved groundwater monitoring program nor does it request any release from liability for postmining groundwater conditions.

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I POSTMINING GROUNDWATER QUANTITY

Groundwater conditions within and adjacent to Big Horn Mine were influenced by nearly 100 years of surface and underground coal mining activities. This chapter begins with an overview of the historic mining developments that are inferred to have or are known to have affected groundwater conditions within and proximate to Big Horn Mine.

1903 to 1963 - According to records compiled by Dunrud and Osterwald (1980), coal mining near Big Horn Mine began at the underground Dietz No. 5 Mine in 1903 immediately south of present-day Big Horn Mine. From 1904 to 1940, underground coal mines including the Dietz No. 8 Mine, the Hotchkiss Nos. 1 and 2 Mines, the Model Mine, the Carney Mine and the Acme and Acme No. 2 Mines were developed over large areas within and contiguous to Big Horn Mine. The Plachek strip coal mine on Goose Creek (the Plachek Pit reservoir of Section 22) operated from 1957 to 1963 and the B and W strip coal mine operated from 1948 to 1953 within a portion of what ultimately became Big Horn's Pit 3. In essence, Big Horn Coal Company, which consolidated Big Horn Mine in 1963, was restricted in its mining to "islands" of coal separating the historic mines.

1965 – Large-scale stripping operations are underway along the east side of Goose Creek east of the former Plachek Pit within Big Horn's Pit 1.

1973 - Tongue River immediately below the mouth of Goose Creek is diverted 500 feet north into the old B and W Mine coal pits to allow mining in Pit 2.

Summer 1978 – Tongue River is routed into its permanent postmining channel after the final backfilling and grading of Pit 2. Mining begins in the Pit 3 area.

Early 1980's – Mining in Pit 3 intercepts alluvium of Tongue River causing local drawdown of the alluvial water table.

1984 – Pit 1 was extensively backfilled, leaving open only the "Southeast Triangle" groundwater sump.

1985 – Pit 3 advancement ceases and most exposed coal faces are covered. This reduces the groundwater inflow rate to Pit 3.

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December 1996 – Backfilling of the Pit 1 "Southeast Triangle", which began in 1994, is completed and the groundwater sump is closed. Pit pumpage of groundwater from the Dietz 2, Dietz 3 and Monarch coal aquifers ceases.

1999 – Coal bed methane gathering activities begin pumping groundwater from the Dietz 3, Monarch and Carney coal seams in areas south and southeast of Big Horn Mine.

2000 – Backfilling and grading of Pit 3 is completed late in the year and Pit 3 Reservoir begins filling.

In Section 6.1.5 of the Reclamation Plan, alluvial groundwater from Tongue River and Goose Creek valleys is predicted to be a significant recharge source to the postmining coal aquifers in areas adjacent to the mine reclamation and to the mine backfill (spoils) as well via, in part, groundwater recharge from resaturated spoils along the downgradient coal/spoils contacts (see Exhibits RP-14, RP-15 and RP-16 of the Reclamation Plan). The mined edges of the Dietz 2 coal, Dietz 3 coal and, particularly, Monarch coal seams contact reclaimed spoils which in turn contact Goose Creek and/or Tongue River channels or the native alluvium underlying the stream valleys over broad lengths along the perimeters of reclaimed Pits 1, 2 and 3. Streamflow infiltration from Goose Creek and from Tongue River together with subsurface flow from the alluvium of these valleys has recharged the mine backfill, which has in turn recharged the native coal aquifers at the coal/spoils contacts. Groundwater in the alluvium of Tongue River valley south of Pit 3 Reservoir and streamflow in Tongue River north of the reservoir were also identified as the principal recharge sources to Pit 3 Reservoir via the South French Drain and North French Drain, respectively (see Sections 7.3.1.1 and 7.3.1.4 of the Reclamation Plan). Very little, if any, groundwater resaturation was predicted at Pits 4 and 5 because the coals mined in these areas naturally existed as remnants isolated from recharge sources of the Tongue River and Goose Creek valley floors. No groundwater aquifers were identified before or during mining in Pits 4 and 5 and none has been projected to develop after mining in either area (see Section 6.1.5, Reclamation Plan).

Chapter 4, Section 2.(h)(i) of the Wyoming Department of Environmental Quality, Land Quality Division Rules and Regulations states that "the recharge capacity of reclaimed

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lands shall be restored to a condition which supports the approved postmining land use". Big Horn Coal's objective to restore the mine backfill and adjacent aquifers to a condition suitable for livestock watering would be greatly compromised were the spoils sufficiently impermeable so as to not readily transmit water horizontally as groundwater movement, or vertically as infiltration of surface water, inclusive of rainfall, snowmelt and streamflow. The infiltration rate of a soil or of strata where soil is absent is defined as the rate at which water infiltration takes place, expressed in depth of water per unit of time, usually in inches per hour. The following section of this text explores the approximate, effective infiltration rate of the mine backfill where the effective infiltration rate is broadly defined as the rate at which the backfill resaturated as a result of water infiltration from all sources including stream channel and other surface water infiltration combined with lateral groundwater inflow from unmined aquifers.

I.A Groundwater Recovery In Backfill Aquifer In Pits 1, 2, 3, 4 And 5

I.A.1 Infiltration Rates

No direct measurements have been made of infiltration rates on reclaimed lands at Big Horn Coal beyond those presented in the 1993-1994 Annual Report (Table 16). No attempt has been made to convert the infiltration rates of the 1993-1994 Annual Report into groundwater recharge or spoil resaturation rates. Instead, effective infiltration rates, as defined in the previous section, have been estimated for portions of Pits 1 and 2 corresponding to four topsoil request areas formerly approved by LQD before topsoil was applied on the regraded spoils. These areas, shown on Exhibit 1 accompanying this document, were selected for effective infiltration rate calculations because the timing and sources of groundwater recharge within Pits 1 and 2 can be estimated with some accuracy. The resaturation of spoils within these areas is credited almost exclusively to the infiltration of streamflow in Tongue River and Goose Creek and lateral groundwater flow from the alluvium of these valleys. Lateral groundwater flow to spoils from the Dietz 3 and Monarch coal seams and the infiltration of precipitation and snowmelt over the spoils probably constituted a very small fraction of the total spoil resaturation.

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Pits 1 and 2

As of October 2001, groundwater in the backfill at Big Horn Mine had recovered to the potentiometric elevations shown on Exhibit 1. This exhibit also shows potentiometric elevations in Monarch coal adjacent to the mine and in Tongue River alluvium between Pits 2 and 3 near the South French Drain as of October 2001. The first step in estimating effective infiltration rates was to convert the potentiometric elevations shown within the topsoil request areas into volumes of saturated spoils. This was accomplished by first preparing a digital map of structure contours on the top of the Monarch coal from Exhibit D5-12 (Appendix D5) and then subtracting from this surface a unit amount of 22 feet representative of the average thickness of the coal (see Exhibit D5-11, Appendix D5) to derive structural contours on the bottom of Monarch coal. Using surface modeling software, this intermediate product was then subtracted from the potentiometric contour elevations (Exhibit 1) to derive approximate volumes of saturated spoils above the original Monarch floor (assumed pit floors) within each topsoil request area.

Having estimated the volumes of saturated spoils within the topsoil request areas of Pits 1 and 2, the final elements needed for computing approximate effective infiltration rates were an estimate of the effective porosity of the spoils and estimates of the time elapsed between when the spoils began resaturating and ending with the October 2001 groundwater level measurement date. Although the backfill of Pits 1 and 2 was undoubtedly constantly subject to some resaturation in the form of seepage from Goose Creek and Tongue River even as mining continued in the area, the date resaturation began was assumed to be equivalent to the date Tongue River was turned into its final channel, July 1978. Under this assumption, the time elapsed between July 1978 and October 2001 was constant for the four topsoil request blocks of Exhibit 1 at 23.2 years. The effective porosity of the spoils was assumed to be 20 percent in the effective infiltration rate calculations. A porosity of 23 percent was found for the spoils at the Plachek Pit through multiple well testing but all other multiple well tests at Big Horn Mine returned storage coefficients that were much lower (see Table RP-12, Reclamation Plan). The low storage coefficients were thought to be indicative of coarse-grained spoils being overlain by fine-grained materials (see Section

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6.1.2, Reclamation Plan). While this hydraulic differentiation can be expected after the spoils are fully or nearly fully saturated, an effective porosity of approximately 20 percent is probably more indicative of the spoils in their dry, loose state.

Effective infiltration rates computed per the above procedure are presented on Table 1. The rates range from 5.9 to 13.9 inches per year, which is very high relative to what would be expected for the vertical infiltration of rainfall and snowmelt alone. As an example, Davis and Zabolotney (1996) found through groundwater flow modeling that the premining infiltration rate from surface water sources (precipitation, snowmelt, overland runoff, etc.) to shallow overburden aquifers at Belle Ayr coal mine was about 0.16 inches per year. Reclaimed lands at the mine were found to have an infiltration rate of about 2 inches per year. The authors concluded that the postmining infiltration rates will likely diminish over time as the spoils settle and as evapotranspiration losses increase with increasing vegetal growth. Big Horn Mine reported infiltration rates ranging from 0.10 inches per hour to 3.00 inches per hour from eight, double ring infiltration tests conducted on backfill in Pits 1, 3 and 4 (see Table 16, 1993-1994 Annual Report). The average infiltration rate from these tests was 0.82 inches per hour.

The reader is again advised that the effective infiltration rates of Table 1 are not true soil infiltration rates but are inclusive instead of groundwater recharge from all sources. The rates may also be biased somewhat high by the assumption that the total recharge period for Pits 1 and 2 was only 23.2 years prior to October 2001 when in fact the backfill of both pits was subject to some constant recharge that was probably not entirely captured by pit pumpage before July 1978, the assumed starting date for recharge. Conversely, resaturation in the Pit 1/Pit 2 area has not been limited to the topsoil application areas alone but has also occurred contiguous to these areas in pre-law portions of the mine. This could tend to bias the estimated effective infiltration rates low. Regardless of the analytical technique's limitations, the resultant infiltration rate values (recharge values) clearly indicate that the backfill of Pits 1 and 2 has resaturated very quickly and there are no apparent properties of the spoils that retard water infiltration or movement in either the vertical or horizontal planes.

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Pit 3

As shown more fully in Section I.A.2. below, all indications are that the Pit 3 spoils have resaturated very rapidly, virtually in phase with the filling of Pit Three Reservoir. Effective infiltration rates were not computed for the Pit 3 spoils because the topsoil application dates (hence, the approximate backfilling dates) ranged over 16 years (1985 through 2000), but a large portion of the recharge was probably supplied by Pit 3 Reservoir as it began filling beginning in late 2000. Because of the diversity of recharge sources and the temporal duration of backfilling activities at Pit 3, it would be very difficult to establish a starting date for recharge with any accuracy.

I.A.2 Subsurface Flows

I.A.2.a Water Level Recovery Within Mine Backfill And Adjacent Affected Aquifers

Figures A-1 through A-28 in Addendum A are hydrographs of groundwater elevations versus time for wells monitoring the backfill aquifer and Carney coal, and wells monitoring all aquifers affected by mining, including the alluvium of Tongue River and Goose Creek valleys, and the Dietz 2, Dietz 3 and Monarch coal seams. Although some of the non-backfill wells were removed from the monitoring program in March 2001 (Change No. 6 to Permit 213-T5; partially approved April 20, 2001), groundwater elevations were measured in most wells as recently as October 2001. Groundwater saturation, as portrayed by hydrographs, is considered fundamental to understanding subsurface flow because the groundwater elevation in a well is a product of both horizontal and vertical water movement.

The text of the following sections identifies evidence of potentiometric declines in the coal aquifers caused by coal bed methane (CBM) gathering activities that began near Big Horn Mine in 1999. This is particularly true for the Monarch and Carney coals. Gas and groundwater production records of the Wyoming Oil and Gas Commission were interrogated via internet link on April 29, 2002 to obtain information relating to CBM activities for selected areas adjacent to Big Horn Mine. These areas include Sections 13 and 22 through 27 south and southeast of the mine (sections of land shown on Exhibit 1). The

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search revealed the existence of 120 CBM wells in various stages of permitting and development (expired, cancelled or abandoned permits not included), although groundwater production data were recorded for only 20 wells; one in section 13 and the other 19 in section 26. All 20 wells are developed in either the Monarch or Carney coal seams. Many of the other wells not having groundwater production records also have no indication of the coal completion interval in the records reviewed for this search. The groundwater production data of the 20 wells are temporally variable, suggesting that the wells have been intermittently operated. What can be stated is that, in the period 1999 through early 2002, the cumulative groundwater production of the 20 wells was 799 acre-feet (AF); 50 AF from the one well in Section 13 and 749 AF from the 19 wells in Section 26. The well in Section 13 is in Carney coal and had an average groundwater production rate of 25 gpm from May 1999 through August 2000. The two wells with the largest cumulative water production in Section 26 (both in Carney coal) had average water production rates of 30 to 31 gpm from May 1999 through August 2000. The two wells with the lowest cumulative water production in Section 26 (both in Carney coal) produced at rates between 4 and 5 gpm. CBM development activities remain brisk around Big Horn Mine and the volumes of groundwater produced will almost certainly increase in the near future.

Hydrographs of alluvial wells

Hydrographs for the alluvial aquifers are presented as Figures A-1, A-2, A-3, A-9 and A-13. Those for wells 206-76 and 397-78 (Figures A-1 and A-2), located near the South French Drain (Exhibit 1), suggest water table recovery of about one to two feet from 1989 to present (fall 2001), probably as the result of the final backfilling of Pits 1 and 2. The water table elevation fluctuations within these two wells over the past several years appear to be within the ranges seen in 1979 and 1980. The hydrographs for the remaining three alluvial wells, Nos. 403-78, 508-79 and 644-80 (Figures A-3, A-9 and A-13, respectively), show no apparent influence of mining upstream of the mine on Goose Creek and Tongue River (wells Nos. 508-79 and 403-78, respectively) and downstream of the mine on Tongue River (No. 644-80; see Exhibit 1). Underflow in the alluvium of the stream valleys, as evidenced by the groundwater elevation trends of the five wells, appears

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to have fully or nearly fully re-established, as predicted in the Reclamation Plan (Sections 6.1.5 and 6.2.2).

The Reclamation Plan concludes that the only drawdown observed in alluvium historically monitored by Big Horn Mine occurred in the immediate vicinity of South French Drain (Section 6.2.2), and this drawdown will be permanent as a result of the high water line of the reservoir always remaining below the base of alluvium intercepted by the drain. Permanent, postmining water table elevations predicted for the alluvium contiguous to South French Drain are shown on Exhibit RP-16. Water table elevations in alluvium of the same area as recorded in October 2001 are also shown on Exhibit 1 accompanying this text. The water table elevations of the two drawings are very similar and the inferred flow patterns vary only slightly with Exhibit 1 showing a somewhat smaller area of the valley floor underflow being affected by Pit 3 Reservoir drainage. Based on Exhibit 1 and Exhibit RP-16, it is concluded that the alluvial underflow conditions have been restored and the affects of Pit 3 Reservoir on alluvial water table elevations and flow patterns are as predicted.

Hydrographs of Dietz 2 coal wells

Groundwater elevations in Dietz 2 coal were predicted to return to premining conditions quickly after mining because saturated Dietz 2 coal was mined only in Pit 1 and the alluvial subcrop recharge zones of the aquifer were not disturbed by mining (see Section 6.1.5, Reclamation Plan). Groundwater hydrographs through October 2001 are presented in Addendum A for Dietz 2 coal wells Nos. 469-79, 596-80, 686-81, 687-81 and 828-84 as Figures A-8, A-12, A-18, A-19 and A-26, respectively. The wells are located on Exhibit 1. The hydrographs show that the potentiometric surfaces in wells Nos. 469-79, 686-81 and 687-81, located south and southeast of Pits 1 and 2, have recovered significantly since about 1994 to elevations equivalent or greater to those of the early 1980's. The mechanisms of aquifer recharge and subsurface flow in the Dietz 2 coal are clearly fully re-established south and southeast of Big Horn Mine. Groundwater elevations in wells Nos. 596-80 and 828-84 remain about four feet and two feet, respectively, below peak elevations observed in the early to mid-1980's. Water levels in these wells fluctuate from about one to two feet

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between readings, indicating variable recharge and subsurface flow rates that are probably associated with cyclical precipitation changes and seasonal changes in Tongue River flow rates/stages. This is considered evidence of the aquifer flow functioning normally in response to natural changes in recharge volumes and rates. The differences in water elevations in wells 596-80 and 828-84 over what they were 15 to 20 years ago are small relative to the potentiometric heads existing above the top of the coal.

Hydrographs of Dietz 3 coal wells

Like the Dietz 2 coal, groundwater flow and potentiometric elevations in the Dietz 3 coal were projected to recover from drawdown quickly after reclamation at Big Horn Mine because none of the coal's alluvial recharge subcrop zones were disturbed by mining (see Section 6.1.5 Reclamation Plan). Groundwater hydrographs are presented in Addendum A for five Dietz 3 monitor wells: Nos. 462-79, 468-79, 576-80, 660-81 and 827-84 corresponding to Figures A-4, A-7, A-10, A-17 and A-25, respectively. The wells are located on Exhibit 1. In all cases, notes on the hydrographs indicate that the wells have become affected by CBM gas gathering activities beginning at various times from 1999 to October 2001. CBM wells have been withdrawing groundwater and gas from the Dietz 3, Monarch and Carney coal seams in areas immediately south and southeast of Big Horn Mine since approximately 1999. With the exception of well 576-80, all the Dietz 3 wells show water level recovery to potentiometric elevations slightly less than to significantly greater than what was observed in the early 1980's. By 1998, potentiometric elevations at well 576-80 had recovered to within less than four feet of peak elevations observed in 1986, but beginning in late 1999 the well has experienced renewed drawdown presumably as a result of CBM activities. The recovery of mining-related drawdown and reduction of flow in the Dietz 3 aquifer appears to have been substantially complete by 1998 or 1999 but since that time there has been significant renewed drawdown associated with CBM gathering activities. These activities are projected to locally escalate in the future and drawdown in the Dietz 3 will undoubtedly increase in areas within and adjacent to Big Horn Mine.

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Hydrographs of Monarch coal wells

Mining at Big Horn Coal removed the Monarch coal's alluvial recharge subcrop zones and replaced them with spoils. The coal's postmining groundwater recharge is primarily via the spoils which in turn are recharged by underflow in the alluvium of Tongue River and Goose Creek, by seepage from Tongue River along its reconstructed length between Pits 2 and 3, and by seepage from Pit 3 Reservoir. Because the spoil recharge sources are areally extensive and supported by perennial water bodies, the recovery of potentiometric elevations and groundwater flow in the Monarch aquifer was projected to be relatively rapid after final reclamation (see Section 6.1.5, Reclamation Plan).

Addendum A contains groundwater hydrographs for three Monarch wells: Nos. 467-79, 584-80 and 825-84 corresponding to Figures A-6, A-11 and A-24, respectively. The hydrographs of all three wells show significant groundwater level recovery beginning in 1996 that was likely a result of substantially closing the Pit 1 final opening, but the recovery periods were relatively short lived until potentiometric declines began again in 1999 or 2000. Beginning in year 2000, the potentiometric trends in wells 467-79 and 584-80 reversed and the water levels rose abruptly to elevations unmatched in the history of the wells. This phenomenon is almost certainly indicative of gas buoyancy reducing the specific weight of the groundwater and causing the water levels in the wells to rise. This has not been observed to date in well 825-84 where the groundwater surface has steadily declined since late 1999. The potentiometric declines that began in the Monarch in late 1999 or 2000 are ascribed to local CBM gathering activities as is the apparent gas buoyancy found in wells 467-79 and 584-80. Although potentiometric elevations and groundwater flow in the coal had significantly recovered as the mine pits were backfilled, the recovery was not entirely complete by the time CBM activity-related drawdown began in 1999 and 2000. Ignoring the effects of gas buoyancy, up to about 10 feet of additional recovery to historic peak groundwater elevations remained at well 584-80, some 8 feet remained at well 825-84 and about 5 feet remained at well 467-79.

The potentiometric surface shown for the Monarch coal on Exhibit 1 adjacent to the reclaimed spoils is very similar in pattern and value to the projected postmining potentiometric surface of the coal shown on Exhibit RP-16 of the Reclamation Plan. The

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drawings differ slightly in that the potentiometric contours of Exhibit 1, drawn with October 2001 water level measurements, are shifted slightly upgradient from those of Exhibit RP-16. This is due to the stage in Pit 3 Reservoir still being some six feet below its projected average elevation. As the reservoir fills, groundwater elevations in the spoils and adjacent Monarch coal will rise, causing the potentiometric contours of Exhibit 1 to shift downgradient in better agreement with the same contours of Exhibit RP-16.

Hydrograph of Carney coal well

The Carney coal seam was not physically or hydraulically affected by mining at Big Horn since it lies some 100 feet below the Monarch coal (see Section 6.2.2, Reclamation Plan). A hydrograph is presented for one Carney well in Addendum A - well 465-79 corresponding to Figure A-5. The hydrograph clearly shows no effect from mining, although potentiometric elevations in the well declined over 100 feet from 1999 through year 2000 as a result of local CBM gathering activities. The pattern and timing of the drawdown in well 465-79 is similar to that seen in wells Nos. 462-79, 468-79 and 660-81, developed in Dietz 3 coal, and to Monarch coal well 467-79.

Hydrographs of mine backfill wells

As previously mentioned, saturation of the mine backfill and establishment of groundwater flow through the backfill were also projected to be relatively rapid after mine reclamation because of the large, perennial recharge sources provided by Goose Creek, Tongue River and the Pit 3 Reservoir. Groundwater hydrographs illustrating recharge trends are provided for nine spoil wells in Addendum A. These include wells Nos. 655-81, 656-81, 657-81, 745-82, 816-83, 819-84, 823-84, 906-90 and 907-90 corresponding to Figures A-14 through A-16, A-20 through A-23, A-27 and A-28, respectively. A tenth spoil well, labeled "C-2001" on Exhibit 1, was constructed in late August 2001 near the north shore of Pit 3 Reservoir. No hydrograph has yet been prepared for this well because of the well's short period of record. The reader is also advised that well 816-83 in Pit 4 spoils and wells 906-90 and 907-90 in Pit 5 spoils are recording only minor groundwater saturation in keeping with the prediction set forth in Section 6.1.5 of the Reclamation Plan that there would be very little, if any, resaturation of the spoils in either of these two pits.

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As predicted, all of the Pit 1, 2 and 3 spoil wells show relatively rapid and, in most cases, generally consistent groundwater recovery beginning up to 20 years ago in the early 1980's. Well 745-82, located north of Tongue River in Pit 3 spoils, and well 819-84, located east of Goose Creek in Pit 2 spoils, are showing pronounced seasonal water elevation fluctuations that are ascribed to changes in stream stages and alluvial water table elevations of the respective valleys. This phenomenon, also apparent to a lesser degree in wells 657-81 and 823-84, is demonstrative of the spoils' ability to rapidly transmit water from vertical and horizontal recharge sources (ie. high infiltration and horizontal groundwater movement rates). Groundwater recovery rates in Pits 1 through 3 spoils began diminishing between late 1997 to 2000, indicating that the potentiometric surface was approaching hydrostatic equilibrium with recharge and discharge sources. Groundwater elevations in the Pit 3 spoils contiguous to Pit 3 Reservoir will likely continue to ascend slightly, perhaps another two to four feet, as the stage in the reservoir ascends the final six feet above the approximate elevation observed October 2001 to its average operating elevation of 3560.5 feet.

Well 816-83 in Pit 4 spoils is 50 feet deep and with a groundwater elevation of 3634.0 (Oct. 2001) there is only some 5.5 feet of water in the well. This is insufficient for any practical use; therefore and as predicted, the Pit 4 spoils are not identified as an aquifer. Wells 906-90 and 907-90 developed in Pit 5 spoils are 75 and 160 feet deep, respectively. The groundwater elevations shown on Exhibit 1 for October 2001 translate to water column heights of 6.9 feet and 5.2 feet for wells 906-90 and 907-90, respectively. Again, these small water columns are insufficient for any practical well development and the Pit 5 spoils are not identified as an aquifer. The hydrographs for the Pits 4 and 5 wells do not suggest that the water levels may rise significantly. Instead, the groundwater elevations appear to be in dynamic equilibrium with local recharge and discharge sources. Further evidence that the Pit 4 and Pit 5 backfill does not/will not constitute an aquifer was seen in October 2001 when wells 816-83 and 906-90 were sampled for water quality analyses. Each well was bailed dry after yielding less than 10 gallons of groundwater.

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I.A.2.b Potentiometric Surface In Backfill Aquifer

Exhibit 1 illustrates the potentiometric surface in backfill and adjacent Monarch coal at Big Horn Mine as of October 2001. The drawing also shows water table elevations in Tongue River alluvium adjacent to the South French Drain, as discussed above under the title *Hydrographs of alluvial wells*. Exhibit 1 shows that the groundwater gradient in Pit 1 is from west to east, from recharge provided by Goose Creek. In Pit 2 and between Pits 2 and 3, the Tongue River has a profound effect on the water table configuration. This is particularly evident with the 3580-foot water table contour traversing nearly parallel to the river between Pits 2 and 3, indicating flow directly from the river into the spoils and thence into Pit 3 Reservoir. The 3580-foot contour in the spoils of Pits 1 and 3 join the same water table contour in Tongue River alluvium south of South French Drain. Overall, the salient feature of Exhibit 1 is that the spoils of Pits 1, 2 and 3 are in direct hydraulic continuity with the alluvium of Goose Creek and Tongue River.

The potentiometric surfaces of the backfill, Monarch coal and Tongue River alluvium near the South French Drain on Exhibit 1 agree in form and value with the potentiometric surfaces projected for the same aquifers on Exhibit RP-16 of the Reclamation Plan. Potentiometric elevations shown on Exhibit 1 for the spoils are up to about 10 feet lower than those projected on Exhibit RP-16, especially through the northwestern portion of Pit 3 adjacent to Pit 3 Reservoir. The difference is due in part to the fact that the stage in the reservoir was still some six feet below it normal projected stage when Exhibit 1 was prepared (October 2001), and due in part to the fact that Exhibit 1 was drawn using additional backfill groundwater control points not available when Exhibit RP-16 was created. Overall, the potentiometric configurations of Exhibit 1 agree remarkably well with those of Exhibit RP-16, allowing the conclusion that the goal of restoring groundwater quantity has been met.

Exhibit 1 illustrates one groundwater feature in the spoils that is not shown on Exhibit RP-16. It is that Reservoir 14 contains a permanent pool supplied by groundwater in Pit 2 spoils. Although the pool depth is only some two to three feet, the reservoir did not go dry in year 2001 despite the occurrence of a severe drought that began in year 2000.

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The 3580-foot groundwater contour encircling Reservoir 14 on Exhibit 1 indicates that the reservoir's evaporative losses locally suppress the spoils' potentiometric surface.

I.A.2.c Groundwater Production Rates In Backfill

No conventional aquifer tests have been completed in Big Horn Mine spoils beyond those that are reported in Section 6.1.2 of the Reclamation Plan; however, eight test holes and one monitor well (well C-2001) were drilled in Pits 1 and 3 in August 2001 and from this work additional data are available on approximate groundwater production rates in the spoils. The results of the tests described in the Reclamation Plan show a wide diversity in spoil hydraulics with transmissivities ranging from about 5 gallons per day per foot (gpd/ft) to over 22,000 gpd/ft. Production rates in those tests ranged from less than one gpm to 37 gpm. Overall, the transmissivity (a measure of an aquifer's total yield available to a well) of the spoils was projected to be at least as great as the undisturbed coals.

The eight test holes that were drilled in the spoils, together with monitor well C-2001, are located on Exhibit 1 and geologic logs for the sites are presented in Addendum A. The test holes were drilled in repeated attempts to construct five additional monitoring wells that would be used for assessing postmining groundwater elevations, water quality and aquifer hydraulic characteristics. The test holes could not be completed as monitoring wells because the spoils consistently caved into the boreholes at such large volumes and rates so as to preclude successful insertion of well casing. While sloughing of mine backfill in boreholes is not unique, the problem at Big Horn was obviously exacerbated in some cases by the boreholes producing large groundwater flows that washed out the unconsolidated materials. Groundwater yields estimated by experienced personnel during airlifting of the open boreholes are noted on the logs of three of the sites in Addendum A. Holes A-A and A-A1 produced approximately 20 to 25 gpm while hole B-A2 was noted as producing some 25 to 30 gpm, all from airlifting near the base of the spoils. Well C-2001 was noted as yielding 10 gpm during final airlift development. While the permeability and transmissivity of the spoils will probably diminish as the materials settle and compact, all evidence now indicates that groundwater yields in Pits 1 through 3 are more than sufficient to supply livestock watering wells.

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I.A.3 Backfill Storage Characteristics

I.A.3.a Backfill Storage Characteristics Reported In Mine Permit Document

The groundwater storage characteristics of the backfill at Big Horn Mine are quantitatively and qualitatively assessed in the Reclamation Plan. Table RP-12 quantifies storage coefficients in spoils from four multiple-well pumping tests. The results range from a high of 0.23 for spoils of the Plachek Pit to a low of 0.0002 for a test completed in Pit 3 spoils. The high value is indicative of unconsolidated strata under water table conditions while the low value and others found like at the mine are indicative of groundwater under confined to semi-confined conditions. Similar storage coefficient values characterized the native coal and overburden strata of Big Horn Mine, with the largest storage found in the alluvium of Goose Creek and Tongue River valleys and the smallest values found in the deeper coal seams. By reference to studies conducted at strip coal mines in southeastern Montana (Van Voast et al., 1978), the Reclamation Plan cites low spoil storage coefficients indicative of rubble-strewn pit floors and cites further the conclusion that the premining and postmining occurrence and flow of groundwater are not expected to be dissimilar (Section 6.1.2, Reclamation Plan).

I.A.3.b Current Status Of Groundwater Storage In Mine Backfill

There have been no direct measurements of backfill storage coefficients at Big Horn Mine beyond those referenced above in the previous text section. However, indirect evidence of groundwater storage in the spoils exists in the findings and products presented above including the groundwater hydrographs of wells in the backfill (Addendum A), the potentiometric surface map of the spoils (Exhibit 1) and the logs of the test holes drilled in the spoils (Addendum A).

The hydrographs of the spoil wells in Pits 1 through 3 together with the potentiometric surface map of the spoils show groundwater recovery to predicted elevations over nearly all portions of the backfill. Below the phreatic surface of the spoils, groundwater is held in storage, as is true for any aquifer. Both the effective porosity

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(unconfined storage) and confined storage properties of the spoils probably vary considerably over the mine as a result of the spoils' textural diversity, but overall, the effective porosity appears to be large as evidence by the geologic logs of the spoils test holes (Addendum A) describing loose, caving materials with noticeable voids. The large porosity of the spoils described in the test holes is also demonstrative of materials exhibiting large permeabilities, and hence, large groundwater yields, which indeed was the case for the several test holes where yields were estimated. Groundwater also readily moves into and out of storage in the spoils, as evidence by the seasonal water elevation fluctuations that are very apparent in the hydrographs of several of the spoil wells, most notably wells Nos. 745-82 and 819-84. These seasonal fluctuations are caused by the water table in the spoils rapidly responding to changes in recharge (river stage) and discharge (evapotranspiration losses), which in turn is indicative of an aquifer having large porosity and permeability.

Finally, groundwater storage releases and flow through the spoils have been sufficient to maintain a permanent pool in Reservoir No. 14 within Pit 2 through over a year of drought (2000-2001) when recharge from precipitation and runoff was very small and evaporative losses were high.

I.A.4 Recharge Capacity Of Mine Backfill

The data and findings presented in the previous sections of this text fully demonstrate the recharge capacity of the reclaimed lands within Big Horn Coal Mine.

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II POSTMINING GROUNDWATER QUALITY

As defined in Section I, the intended post mining use of groundwater at the Big Horn Mine will be for livestock consumption. The Wyoming Department of Environmental Quality defines groundwater quality standards for this use (Class III) and others in Chapter VIII of Wyoming Water Quality Rules and Regulations (March 1993). Chapter VIII constituent and concentration suitability criteria for domestic (Class I), agricultural (Class II) and livestock uses are presented in Table 4. Based upon the intended use of groundwater from Big Horn Coal's restored and adjacent aquifer systems, the following evaluation is restricted to the assessment of groundwater for Class III laboratory analytical constituents and concentration limits. By mutual agreement with the WDEQ, Big Horn Coal Company also includes the analytical results and assessment for ammonia nitrogen.

Big Horn Coal Company commits to Class III groundwater quality restoration objectives for Big Horn Coal Company's Pits 1, 2, and 3 disturbance areas and adjacent aquifers. Premining assessments in the Pit 4 and Pit 5 areas conclusively demonstrated the lack of groundwater in the mine-affected geologic units of both areas. It was anticipated there would never be usable quantities of groundwater within either of these areas when fully reclaimed. This prediction has been confirmed, as discussed above under Section I.

A relevant water quality assessment which included backfill wells from several northern Powder River Basin (Gillette, Wyoming) coal mines has been compiled by the WDEQ (Ogle, 2002). Wells represented in this assessment were monitored for upwards of 15 years and demonstrated steady but only relatively slow recharge rates. Only one of the referenced wells had recharged to the premining level. Typically dissolution of sodium, calcium, magnesium, and sulfate during initial saturation resulted in an elevated TDS in sampled groundwater from these sources. Elevated sulfate and TDS routinely exceeded Class III limits during initial saturation. In general, elevated TDS and sulfate concentrations in the backfill aquifers declined as the aquifers continued to be recharged and flushed. In summary, with sufficient time, TDS and sulfate concentrations are expected to meet Class III limits.

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The WDEQ's assessment also references generalized historic backfill water quality research from southeastern Montana as summarized by Van Voast et al (1976). The research indicated that backfill groundwater tends to contain increased concentrations of minerals and chemically resemble that of the associated inorganic aquifers rather than that of coal aquifers. Additionally, TDS concentrations generally range from 1,500 to 3,500 mg/L but were found to occur as high as 6,000 mg/L. The research also concluded that notable percentages of available salts were dissolved during initial backfill saturation and the concentrations of salts declined with exposure to subsequent pore volumes. Research indicates that, although trace metals might occur in undisturbed groundwater locally, they generally are more common in backfill area groundwater. The distribution and concentrations of dissolved trace metals in backfill groundwater was, however, determined to be of no great significance.

As discussed in Section 6.2.2 of the Reclamation Plan, there has historically been no mine-attributed change of water quality in the affected (Dietz 2, Dietz 3 and Monarch) coal aquifers, or in the two alluvial aquifer systems. The Carney coal aquifer, underlying the Monarch coal, was not physically or hydraulically affected by mining.

Big Horn Coal Company's groundwater monitoring database indicates that several different laboratories provided groundwater analytical services to the mine over the years. Northern Testing Laboratory of Billings, Montana, and Inter-Mountain Laboratories of Sheridan, Wyoming, provided much of the groundwater quality analytical services from 1980 through 1983. Records indicate virtually all of the groundwater analyses from about 1983 through most of 1990 were conducted by the Peter Kiewit & Sons' corporate laboratory, historically located in Sheridan, Wyoming. Inter-Mountain Laboratories resumed contract groundwater analytical services in late 1990 and continues to provide these services. Other than small differences in the reported quantifiable limits for lead, chromium, arsenic and selenium, there does not appear to be significant analytical variability resulting from changes in the laboratories used, or changes in the regulatory and industry-accepted laboratory practices that would have occurred within Big Horn's period of record.

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II.A Constituents For Class III Water Quality Assessment

In consultation with the WDEQ/LQD, fourteen analytical water quality constituents of Class III criteria were selected for evaluating postmining groundwater quality characteristics at Big Horn Mine. These include: pH, total dissolved solids (TDS), the combined nitrate and nitrite compounds (reported as nitrogen), chloride, and sulfate along with dissolved concentrations of aluminum, arsenic, cadmium, cadmium, copper, lead, selenium, and zinc. With exception to the analysis of pH, which is a unitless measurement, all analytical results are reported in milligram per liter (mg/L) concentrations. Regulatory-defined maximum concentration limits or allowable ranges of each constituent are presented with the analytical result summary tables in Addendum B.

II.A.1 Monitoring Results For Class III Water Quality Criteria

Laboratory analytical data are compiled from 15 monitoring wells that are sampled annually during the current monitoring regime. The monitoring well sample locations are shown on Exhibit 1. The number of samples obtained from these wells varies, based upon well installation dates and historic monitoring frequencies. Analytical result summaries are presented in tabular format numerically by aquifer and include life of well minimum, maximum and arithmetic mean concentrations for each of the targeted constituents (Addendum B, Tables B-1 through B-15). Figures B-1 through B-6 illustrate graphic constituent concentrations for those wells that have exceeded one or more Wyoming Class III quality criteria. Big Horn Coal Company did not analyze combined nitrogen compounds as nitrate plus nitrite from approximately 1982 to 1996; however there are sufficient data to assess this constituent.

II.A.1.a Groundwater Quality In Mine Spoils

The analytical results of historic groundwater sampling from nine well locations within the reclaimed spoils of Big Horn Coal Company's five pit disturbances are presented in well identification numeric sequence in Tables B-1 through B-8.

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Pits 1 and 2 spoils

Analytical results obtained from monitoring wells 656-81, 819-84, and 823-84 are used to assess backfill water quality of Pits 1 and 2. Results of the analytical assessment for these wells are presented respectively as Tables B-1, B-5, and B-6.

The water quality at wells 656-81and 819-84 reflects the major influence to the backfill materials from the high quality waters of Goose Creek and its alluvium. With exception of a single occurrence of chromium (0.08 mg/L in 1986 at 819-84), targeted Class III constituent concentrations from both wells have not been exceeded. Four individual analytical results from 656-81 are considered anomalous and are not utilized in the assessment. Out of 37 samples from 819-84, two analytical results are considered outliers. Concentrations of dissolved solids at both wells are typically on the order of 1000 mg/L. Concentrations of all of the Class III constituents from these wells are considered stable.

The analyses presented in Table B-6 from reclaimed spoils well 823-84 confirm overall very high quality backfill recharge. Readily dissolved ions were apparently flushed from the newly saturated backfill at this location by approximately 1986. Since 1987, dissolved solids have ranged from 42 to 710 mg/L. Although primary recharge to the aquifer at this is location is from the Tongue River, the unusually low concentrations of dissolved solids at this location likely result from the influence of nearby Reservoir 14. Sulfate concentrations continue to fluctuate somewhat, but average less than 150 mg/L. Since 1987, of the eight-trace metals targeted, zinc was detected twice at 0.02 and 0.05 mg/L, and copper was detected once at 0.02 mg/L. Records indicate that, from 1987 through 1991, pH laboratory analyses of samples from this well consistently were above the Class III limit of 8.5, with a maximum pH measurement of 10 occurring in October 1990. Since 1992, three pH measurements have exceeded 8.5 while the life of well average pH from 37 samples is 7.6. These occurrences of elevated pH indicate not only the presence of soluble carbonate in the backfill matrix, but more importantly, these occurrences further confirm the nearly pristine backfill groundwater's initial lack of buffering capacity resulting from low concentrations of dissolved cations. Figure B-2 graphically illustrates the historical pH values of well 823-84.

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Pit 3 spoils

Three additional backfill wells are situated in Pit 3 reclaimed spoils on the north side of the Tongue River. These include 745-82, 657-81 and the recently installed C-2001. Analytical results of Class III constituents for these three wells correspond respectively with Tables B-3, B-2, and B-8.

Analytical results from 745-82 have never exceeded any of the Class III constituent limits. Historically, TDS concentrations demonstrate a conclusive downward trend from 3760 mg/L in 1982 to approximately 1100 mg/L in recent years. The peak sulfate concentration has declined from 2230 to less than 600 mg/L since 1999. With exception to copper and zinc occurring near the detection limit on isolated occasions, Class III trace metals are generally no longer detected in well 745-82.

The analytical results presented in Table B-2 for spoils well 657-81 are atypical of those obtained from other wells in Big Horn Coal Company's Pits 1, 2, and 3 backfill. Several factors contribute to the delayed stabilization of groundwater quality at 657-81. These factors include localized low aquifer transmissivity and probable infiltration of low quality groundwater resulting from exposure to numerous active underground coal fires burning in the partially saturated areas of the adjacent Monarch coal seam to the northwest. The underground coal fires are located outside of Big Horn Coal's Pit 3 disturbance in areas of historical underground mine workings and are currently observed approximately 1,000 feet northwest of 657-81. Water temperature measurements during sampling of 657-81 have historically fluctuated and have exceeded 20° Celsius on several occasions. Elevated groundwater TDS concentrations potentially attributable to underground combustion of local coal aquifers is found in the results of baseline monitoring presented in Appendix D6 of the Welch No.1-North Mine's Permit 497-T3 (1999). The Welch Mine is located north and adjacent to Big Horn Mine property. There are documented, active burns in dry or partially saturated zones of the Dietz 2, Dietz 3, and Monarch seams within and adjacent to the Welch Mine that are believed to be associated with the abandoned Acme underground coal mine. One of the historic Welch Mine Dietz 3 monitoring wells (D3-M1), located within one half mile downdip (and hydraulically downgradient) from a documented active burn,

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consistently yielded elevated TDS concentrations of approximately 5800 mg/L in the early and mid-1980's, prior to the well's abandonment. Other Dietz 3 monitoring wells closer to the burn were dry, however, down hole temperature measurements at these locations exceeded 70° C. Additionally, several Monarch coal wells located less than one mile downgradient from the burn contained elevated baseline TDS concentrations on the order of 2500 mg/L, over two times the concentration observed in Big Horn Mine's 825-84 Monarch monitoring well.

Since sampling commenced at 657-81, peak TDS concentrations (6440 mg/L in 1984) have declined to less than 6000 mg/L in recent years, but typically remain above target Class III limits. Several times throughout monitoring, concentrations of dissolved solids have shown dramatic fluctuations, apparently from subtle temporary shifts in the principal source of recharge or infiltration paths. In 1991, TDS concentrations abruptly fell to 546 mg/L with another significant temporary reduction in TDS occurring in 1999. Maximum sulfate concentrations of 3280 mg/L have fallen and continued to remain below Class III limits since 1996. Although chromium concentrations intermittently exceeded 0.05 mg/L from 1982 to 1989, since 1990 this element has not been detected at 657-81. Analytical results for pH, TDS, sulfate and chromium are provided in graphical format as Figures B-3 through B-5.

A single water sample (Table B-8) has been collected from the recently installed Pit 3 spoils monitoring well (C-2001) that was completed in the northern area of the backfill. Initial water quality testing confirmed all constituents to be below the targeted livestock criteria limits. Currently, sulfate concentrations are at 2100 mg/L and the TDS results are reported to be 3960 mg/L. With exception to zinc, which was found to be present at 0.02 mg/L, there were no detectable concentrations of the Class III trace metals present. Water quality in the adjacent spoils is expected to continue to improve quickly as a result of further influence from the new Pit 3 Reservoir.

Pit 4 spoils

Although there is insufficient quantity of water to develop for livestock use in the reclaimed Pit 4 backfill, sufficient volume is available to sample. Because of very limited

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infiltration, the water quality at the single monitoring well (816-83, Table B-4) has been slow to stabilize. Water quality at the well has, however, shown significant improvement. Historically, the pH has fallen below the targeted range of 6.5 to 8.5 and TDS, sulfate and chromium have exceeded the targeted Class III limits. These constituent concentrations are presented in graphical format as Figures B-6 through B-8. Additionally, at one time or another, all of the other seven Class III trace metals have been detected. As of the most recent three samples collected since 1997, only TDS has exceeded target Class III limits from a single sample.

Pit 5 spoils

Due to the lack of groundwater in the Pit 5 area prior to mining, as anticipated, the backfill contains insufficient quantity of groundwater to develop for livestock use. Sufficient water is available to sample well 906-90 by purging slowly with a hand bailer. The well produced less than 10 gallons during the most recent sampling event. Analytical results for this well are summarized in Table B-7 and with some exceptions mentioned below, are generally within Class III limits. A single sample collected in April 1998 contained TDS concentrations above 5000 mg/L. Also, there have been three radical single sample spikes in nitrate and nitrite concentrations at the well occurring in 1998, 1999, and 2001 that have ranged from 113 to 338 mg/l. Figures B-9 and B-10 graphically show concentrations of TDS and nitrate and nitrite compounds from 1992 through the present. Ammonia concentrations show simultaneous spikes ranging from approximately 62 to 133 mg/L. Very low concentrations of aluminum, copper, selenium and zinc have been present on occasion in samples from well 906-90; however these trace metals are typically not detected. With exception to the occurrences of the three nutrient concentration spikes mentioned earlier, backfill water quality at Pit 5 appears relatively stable and the groundwater has otherwise consistently met livestock use limits.

Livestock grazing probably has not contributed to the intermittently elevated nitrogen compounds observed at 906-90, based upon the limited amount of seasonal unconfined grazing conducted within and above the reclaimed Pit 5 area. Although there is the potential for isolated remnants of nitrogen based blasting agents to occur within surface coal

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mine backfill, in this case the source for the elevated concentrations of nitrogen compounds is more likely attributed to backfill recharge water that is exposed to the underground coal fires known to exist in the adjacent, abandoned underground Acme Mine workings. Baseline ammonia concentrations at the Welch No.1 Mine's historic D3-M1 monitoring well (discussed earlier in this section), intermittently exceeded 15 mg/L. During the same period of baseline groundwater monitoring, several other Welch Mine Dietz 3 and Monarch monitoring wells located within one mile downgradient from areas of the Acme Mine underground burn also demonstrated erratic low-level fluctuations in ammonia and combined nitrate and nitrite concentrations.

Tongue River alluvium

Groundwater quality of the Tongue River alluvium aquifer is monitored at a single downgradient well location from the Big Horn Mine (644-80, Table B-9). Groundwater quality of the alluvium at this location has been and continues to be of excellent livestock quality. With exception to a single anomalous occurrence of lead, Class III limits have not been exceeded in over twenty years of routine monitoring. For this assessment, one analytical result for nitrate and nitrite (1.22 mg/L) and one lead result (0.24 mg/L) are considered anomalies and were not included for the statistical assessment.

Dietz 2 coal

The analyses from two recent Dietz 2 coal aquifer water samples obtained downgradient from the Big Horn Mine at well 828-84 (Table B-10) confirm excellent livestock water quality. Sulfate is not a detectable constituent at this location and TDS averages 1250 mg/L. Trace metal concentration averages are below detectable levels.

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Dietz 3 coal

Analytical results from wells 468-79 and 827-84 are assessed in Tables B-11 and B-12. These results characterize the water quality downgradient from the Big Horn Mine in the adjacent Dietz 3 coal aquifer. The data from both wells confirm excellent water quality for livestock use and indicate no degradation of water quality in approximately two decades of monitoring.

Monarch coal

Two downgradient Monarch coal aquifer wells (467-79 and 825-84) are located to the east and northeast of the Big Horn Mine. The analytical results obtained from over 15 years of monitoring both wells are presented in Tables B-13 and B-14. As with the water quality from the overlying Dietz 2 and Dietz 3 coal aquifers, groundwater quality from the Monarch coal continues to meet livestock use criteria. Class III constituents have never exceeded target limits to date, and there have been no apparent changes in constituent concentrations resulting from Big Horn Mine's operations.

Carney coal

The analytical results obtained from 35 samples collected since 1979 from monitoring well 465-79 are presented in Table B-15. The data represents historic water quality monitored from the Carney coal aquifer. As stated previously, Big Horn Coal did not physically or hydraulically impact the Carney coal. Water quality of the Carney aquifer has and continues to be suitable for livestock use.

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III VERIFICATION OF POSTMINING PROBABLE HYDROLOGIC CONSEQUENCES

III.A Review Of Predicted Probable Hydrologic Consequences

As stated in Section 6.2.2 of the Reclamation Plan, the coal seams mined at Big Horn Coal, in descending order the Dietz 2, Dietz 3 and Monarch coals, together with the alluvium of Goose Creek and Tongue River valleys, were identified as the only strata physically mined that is capable of yielding enough groundwater to be classified as aquifers. The Carney coal seam, another aquifer found about 100 feet beneath the Monarch, was not physically or hydrologically affected by mining. Prior to mining, the Dietz and Monarch coal seams were locally recharged primarily by groundwater where the coals subcropped in saturated alluvium of Goose Creek and Tongue River valleys. Mining within Pits 1, 2 and 3 variously affected groundwater elevations in the coal seams depending upon the positions of the pits relative to the coals' alluvial subcrop zones. Potentiometric declines of 10 feet and more were recorded in the Dietz 2 and Dietz 3 seams up to about one mile downdip (southeast and east) of mining and up to about 1.5 miles downdip of the mine in Monarch coal (Section 6.2.2, Reclamation Plan). The coal seams were dry in Pits 4 and 5 and no aquifers were intercepted in these areas. The southern boundary of Pit 3 intercepted saturated alluvium of Tongue River along a length of about 2,000 feet. This caused the water table in the alluvium to decline over a portion of the valley floor between the river and the mine pit. Mining did not cause water table declines in alluvial wells monitored by the mine other than those proximate to the southern boundary of Pit 3 (Section 6.2.2, Reclamation Plan). No unnatural groundwater quality changes were observed in either the affected coal seam aquifers or in the alluvium of the stream valleys (Section 6.2.2, Reclamation Plan). The channel and alluvial deposits of Goose Creek were also mined in the 1950's and 1960's but hydrologic impacts were not predicted for this mining because it was pre-law.

With the creation of Pit 3 Reservoir, the postmining hydrology of Big Horn Mine will be significantly different than premining. Beyond the existence of the reservoir where none existed prior to mining, the changes will be rather limited with regard to postmining groundwater quantity and quality. The reservoir will be supplied primarily by the North

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French Drain, which connects the reservoir to channel flows in Tongue River, and by the South French Drain, which connects the reservoir to saturated alluvium of Tongue River upstream of the North French Drain. Other, projected water supplies to Pit 3 Reservoir include groundwater sources from reclaimed saturated spoils and the Dietz 3 and Monarch coal seams but these sources will be minor relative to what will be provided by the two French drains (Section 7, Reclamation Plan). The average pool elevation of the reservoir will be below the floor of Tongue River alluvium where the alluvium connects to the South French Drain, meaning that the water table in the alluvium proximate to the drain will be permanently lower than premining. Permanent drawdown of the alluvial water table is projected to occur only proximate to the South French Drain where is will extend slightly less than half-way across Tongue River valley south from Pit 3 Reservoir to the river channel (see Exhibit RP-25 and Section 7.3.1.1.1, Reclamation Plan). The mined edges of the Dietz 3 and Monarch coal seams will be below the normal operating level of the reservoir and, although the edges of both seams were covered with backfill, the reservoir should act as a constant head recharge source to the coals similar to the natural subcrops of the coals in saturated alluvium of both Tongue River and Goose Creek (see Exhibits RP-15 and RP-16, Reclamation Plan).

III.A.1 Groundwater Elevations, Recharge And Infiltration Rates, Water Quality And Aquifer Yields

Groundwater elevations

Groundwater elevations in the affected coal seam aquifers and in the reclaimed spoils are projected to recover relatively rapidly to equilibrium conditions after final backfilling of the mine pits and after Pit 3 Reservoir fills (Section 6.2.2, Reclamation Plan). Groundwater elevations will recover quickly in the aquifers because of significant recharge in the form of seepage from perennial channel flows in Tongue River and Goose Creek, as well as by groundwater flow from the saturated alluvium of these valleys where the alluvium contacts the spoils and where the alluvium contacts remaining coal subcrops. Groundwater elevations in Dietz 2 coal are projected to fully recover within two years after final backfilling of Pit 1 (by year 1999). Groundwater elevations in the Dietz 3 and Monarch seams are predicted to fully recover within two to three years after filling of Pit 3 Reservoir. Postmining

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groundwater elevations in the coal seam aquifers are expected to be similar to premining groundwater elevations. Groundwater elevations and gradients in the reclaimed spoils of Pits 1 through 3 were projected to be approximately the same as the premining Monarch coal. Attainment of hydrostatic equilibrium within the spoils is projected to occur within five years of final Pit 3 reclamation (Section 6.2.2, Reclamation Plan). Pit 3 Reservoir began filling in late 2000, and as of January 2002, it appears that the reservoir will reach its normal pool elevation (3560.5 feet) before the end of the first quarter 2002.

Infiltration and recharge rates

Section 6.1.5 of the Reclamation Plan describes how the reclaimed backfill will be recharged simultaneously with and by the same mechanisms as the coal aquifers since the backfill is physically connected to the same alluvial recharge sources and to the reconstructed Tongue River channel adjacent to Pit 2. Recharge to all affected aquifers and to the backfill of Pits 1 through 3 is projected to be relatively rapid, as described above. A backfill aquifer will not be restored in Pits 4 and 5 because these areas lie stratigraphically and topographically above the Tongue River valley where lateral groundwater recharge is inadequate to sustain significant groundwater saturation (Section 6.2.2, Reclamation Plan). Recharge to the Pits 4 and 5 spoils is predicted to be restricted to precipitation infiltration as opposed to the significant lateral groundwater recharge provided by the alluvium of Tongue River and Goose Creek valleys.

Postmining infiltration rates are qualitatively discussed in Section 6.2.2 of the Reclamation Plan in the context of referencing groundwater elevation recovery rates observed in coal monitoring wells. Postmining water table elevations in the backfill of Pits 1 through 3 are predicted to be hydraulically connected to the Monarch coal and to the saturated alluvium of Goose Creek and Tongue River. Based on these observations and conclusions, groundwater resaturation rates (groundwater infiltration rates) are projected to be relatively rapid for the affected coal and Tongue River alluvial aquifers as well as for the backfill itself.

Groundwater quality

The groundwater quality of the postmining spoils is predicted to be diverse but total dissolved solids concentrations are projected to decline over time as saturation levels and

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groundwater flow patterns stabilize. Ultimately, the groundwater quality of the spoils is predicted to be suitable for the same uses that the coal aquifers had prior to mining (Section 6.2.2, Reclamation Plan).

Aquifer yields

Section 6.1.5 of the Reclamation Plan concludes that premining groundwater flow directions and gradients will be restored in the coal aquifers proximate to the reclaimed spoils of Pits 1 through 3; hence it can be inferred that the groundwater yields, transmissivities and storage characteristics of these aquifers will be restored. Section 6.2.2 of the Reclamation Plan concludes that the transmissivities of the resaturated spoils in Pits 1 through 3 appear to be at least that of the undisturbed coal aquifers; therefore it can be inferred that these spoils will yield sufficient groundwater for livestock watering as did the premining coal aquifers.

III.A.2 Projected Surface Water/Groundwater Interactions

In Section 6.2.3 of the Reclamation Plan, the most significant source of postmining coal recharge is stated to be Tongue River and its alluvium. The coal seams, particularly the Monarch, are projected to be the principal source of groundwater recharge to the backfill of Pits 1 through 3. Streamflow depletion in Tongue River associated with aquifer drawdown is described as minute, if any, and projected to cease after reclamation is complete and groundwater elevations in the coals and spoils aquifers have recovered. Section 7 of the Reclamation Plan describes the functions of the French drains on Pit 3 Reservoir to permanently connect the reservoir to the channel flow and alluvial groundwater flow of Tongue River. The South French Drain will permanently lower the water table in the alluvium of the river proximate to the drain. These projections taken together, it is clear that the Tongue River fluvial system is projected to remain a critical component in the surface and groundwater functions of Big Horn Mine.

III.B Demonstration Of Groundwater Restoration

This document has shown that the quantity of groundwater in the affected aquifers and backfill at Big Horn Mine has been essentially fully restored. Lateral groundwater flow from

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the alluvium of Tongue River and Goose Creek valleys together with direct infiltration of streamflow in Tongue River over its reconstructed reach have been predominate recharge sources restoring subsurface flow and water storage in the backfill of Pits 1 through 3 and the affected coal aquifers. Resaturation (effective infiltration) rates in Pits 1 through 3 have been high while the backfill of Pits 4 and 5 remain essentially dry, as predicted. As of October 2001 or before, groundwater elevations and patterns of groundwater movement in the backfill and in the affected coal seams proximate to the backfill closely matched those predicted for equilibrium conditions in the Reclamation Plan. The storage characteristics of the coal seam aquifers have been restored with the recovery of the aquifers' potentiometric elevations. The backfill rapidly transmits water from surface sources as evidenced by groundwater elevations in the backfill changing seasonally in response to changes in stream stages and changes in alluvial water table elevations in Tongue River and Goose Creek valleys. Groundwater moving in to and out of storage in the backfill has been sufficient to provide a perennial pool in Reservoir 14 of Pit 1. Evidence obtained from test holes and most monitor wells indicates moderate to high rates of groundwater movement and storage in the spoils. Groundwater yields recorded from test holes and monitor wells completed in Pits 1 through 3 spoils are generally more than adequate to supply conventional livestock watering wells.

Water table elevations in the alluvium of Tongue River valley adjacent to the South French Drain on the Pit 3 Reservoir show permanent drawdown, as predicted. The alluvial groundwater will remain a principal supply source for the reservoir. Groundwater elevations and flow patterns now found within the alluvium near South French Drain agree with predictions made in the Reclamation Plan and appear to be in equilibrium with recharge provided by the Tongue River fluvial system.

With the exception of well 657-81 in Pit 3, groundwater quality data for Pits 1 through 3 spoils overwhelmingly indicate that the water is acceptable for livestock use per standards set forth by the WDEQ/WQD (Rules and Regulations, Chapter VIII, Section 5, Table 1). Solute concentrations exceeding the livestock use standards have been relatively rare in the backfill groundwater with the exception of well 657-81 in Pit 3 and well 823-84 in Pit 1. Over the past 20 years, total dissolved solids and sulfate concentrations in the groundwater of well 657 have frequently exceeded the livestock use standards, although the concentrations have diminished somewhat over time. High solute concentrations in well 657-81 are probably

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due to the fact that the transmissivity (groundwater flow rate) of the spoils is known to be very small there. The elevated sulfate and TDS concentrations at well 657-81 will very likely continue to diminish over time as the spoils continue to be recharged and flushed, as has been observed at mines in the northern Powder River Basin (see Section II). The groundwater quality in well No. 823-84 in Pit 1 is uniquely different from all other spoil aquifer wells in that the solute concentrations there are very low but pH values frequently exceeded the livestock use standard prior to 1992. The high pH values in this well have diminished over time as the carbonate buffering capacity of the water increased with increasing solute concentrations. With the exception of the high pH values, the quality of the water at well 823-84 has otherwise frequently been excellent, meeting even the domestic use criteria of the Wyoming Department of Environmental Quality, Water Quality Division (R&R, Chapter VIII, 1993). The groundwater quality at both wells 657-81 and 823-84, while continuing to improve over time, is not indicative of Big Horn Mine's spoils aquifer as a whole having water quality suitable for livestock consumption.

Groundwater elevations in the backfill will continue to rise some two to four feet in areas proximate to Pit 3 Reservoir as the reservoir fills to its normal operating elevation. The patterns of groundwater flow will remain the same as shown in this document and water table elevations in the backfill and in the spoils proximate to the backfill will continue to fluctuate together in phase with seasonal changes in the stages of Tongue River and Goose Creek. Solute concentrations in groundwater of the Pit 1 through 3 spoils will continue to diminish and become more areally consistent as soluble mineral constituents are flushed out of the spoils.

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IV REFERENCES

Davis, A.D. and G.A. Zabolotney, 1996, Ground-Water Simulations For The Determination of Postmining Recharge Rates At The Belle Ayr Mine: Journal of Mining Engineering, Nov. 1996.

Dunrud, Richard and Frank W. Osterwald, 1980, Effects Of Coal Mine Subsidence In The Sheridan, Wyoming, Area: U.S. Geological Survey Professional Paper 1164, U.S. Gov't. Printing Office, Washington, D.C.

Ogle, Kathy M., Jan. 2002, Backfill Areas And Backfill Monitor Wells, Coal Mines Northern Powder River Basin, Wyoming: Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne, WY (draft).

Pittsburg & Midway Coal Company, Welch No. 1 North Mine Permit 497-T3, Appendix D6, May 1999.

Van Voast, W.A., Hedges, R.B., and J.J. McDermott, 1978, Strip Coal Mining And Mine-Land Reclamation In The Hydrologic System, Southeastern Montana: Old West Regional Commission proj. compl. rpt., OWRC Grant No. 10570165, 122 p. (NTIS Rpt. No. PB301253/AS).

---, 1976, Hydrologic Aspects Of Strip Mining The Sub-bituminous Coal Fields Of Montana, *in* the Fourth Symposium on Surface Mining and Reclamation, NCA/BCR Coal Conference and Expo III, October 19-21, 1976, Louisville, KY, pp. 160-172.

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REPORT TABLES

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TABLE 1 DOUBLE RING INFILTRATION TEST RESULTS

SITE NO.		MINE AREA	LOCATION COORDINATES NORTHING	LOCATION COORDINATES EASTING	SOIL TYPE	DATE TESTED	INFILTRATION RATE (INCHES/HOUR)
BH1	*	PIT 1	1544320	595950	NATIVE RESIDUAL	10/31/1978	1.85
BH3		PIT 3	1548550	594850	NATIVE ALLUVIAL/COLLUVIAL	05/22/1979	1.42
BH4		PIT 3	1548590	594510	NATIVE ALLUVIAL	05/22/1979	0.95
BH5		PIT 3	1549720	594940	NATIVE ALUVIAL/COLLUVIAL	05/22/1979	0.77
BH6		PIT 3	1550550	594980	NATIVE COLLUVIAL	05/23/1979	1.74
BH8	*	PIT 4	1550094	589195	NATIVE COLLUVIAL		0.42
BH9	*	PIT 4	1549922	589013	NATIVE COLLUVIAL	05/15/1979	0.07
BH10	*	PIT 4	1549777	590248	NATIVE COLLUVIAL	05/15/1979	0.14
BH11	*	PIT 4	1550106	589479	NATIVE COLLUVIAL	05/15/1979	0.12
BH12	*	PIT 4	1549566	590512	NATIVE COLLUVIAL	05/15/1979	0.15
BH13	*	PIT 4	1549508	590702	NATIVE COLLUVIAL	05/15/1979	0.32
BH14		TONGUE RIVER	1545981	586156	NATIVE COLLUVIAL	05/15/1979	0.62
BH15		TONGUE RIVER	1546581	585818	NATIVE COLLUVIAL	06/04/1979	8.58
BH16		TONGUE RIVER	1545921	586765	NATIVE COLLUVIAL	06/05/1979	0.96
BH17		TONGUE RIVER	1545527	585226	NATIVE COLLUVIAL	06/05/1979	0.39
BH18		TONGUE RIVER	1545515	585819	NATIVE COLLUVIAL	06/05/1979	1.09
BH23		TONGUE RIVER	1547182	594578	NATIVE COLLUVIAL	06/04/1979	1.22
BH24		TONGUE RIVER	1547160	595008	NATIVE COLLUVIAL	05/23/1979	3.06
BH25		TONGUE RIVER	1547164	595229	NATIVE COLLUVIAL	05/23/1979	1.92
BH27		PIT 3	1548584	594249	NATIVE COLLUVIAL	05/22/2007	3.67
BH32		PIT 3	1551117	594412	NATIVE COLLUVIAL	05/23/1979	1.54
BH34		PIT 3	1547606	592807	RECLAIMED	06/01/1979	0.28
BH35		PIT 1	1545466	593034	NATIVE RESIDUAL	06/05/1979	7.25
BH36		GOOSE CREEK	1541865	590222	NATIVE ALLUVIAL	06/01/1979	3.74
BH37		GOOSE CREEK	1541806	590370	NATIVE ALLUVIAL	06/01/1979	8.24
BH48	*	PIT 1	1543157	592479	RECLAIMED	09/15/1981	0.10
BH49	*	PIT 1	1544349	592109	RECLAIMED	09/15/1981	0.65
BH50	*	PIT 3	1549126	593083	RECLAIMED	09/16/1981	0.46
BH51	*	PIT 3	1549902	593295	RECLAIMED	09/16/1981	0.54
BH52	*	PIT 3	1542090	591965	RECLAIMED	09/17/1981	1.15
BH53	*	PIT 3	1541715	592150	RECLAIMED	09/16/1981	0.39
BH54	*	PIT 3	1544985	597378	NATIVE RESIDUAL	08/21/1987	4.35
BH55	*	PIT 4	1549520	590015	RECLAIMED	08/21/1987	3.00
BH56	*	PIT 4	1549950	588045	NATIVE RESIDUAL	08/20/1987	1.41

* INDICATES THE TEST DATA/RESULTS ARE NOT INCLUDED IN APPENDICES D6 AND D11 OF PERMIT 213-T3.

This is reprinted Table 16 from Big Horn Coal Company's 1993-1994 Annual Report.

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Table 2 Spoil aquifer hydraulic properties - Big Horn Coal Area

Aquifer	Spoils	Spoils	Spoils	Spoils		Spoils	Spoils	Spoils	Spoils	Spoils
Well #	Plachek Pit Wells	655	656	657		658	745 746	819	823	818
Date of Test	15-Jul-75	21-Jul-81	14-Jul-81	10-Aug-82	06-Oct-81	06-Oct-81	09-Jul-82	20-Mar-84	21-Mar-84	
Source	Rahn	KM&E	KM&E	KM&E		KM&E	KM&E	KM&E	KM&E	
TYPE OF TEST	Time-Drawdown; leaky type curves	Jacob Time - Drawdown Time-Calc. Recovery Theis Nonequilibrium	Jacob Time-Recovery	Jacob Time Drawdown/ Recovery	Slug Method	Slug Method	Jacob Time Drawdown/ Recovery; Theis Time-Calc Recovery	Jacob Time Drawdown/ Recovery	Jacob Time Drawdown/ Recovery; Theis Non-Leaky	
Length of Test (HRS)	46.30	26.00	5.83	3.25	1.58	1.92	6.32	4.08	22.20	
Discharge (GPM)	6.50	37.00	1.29	0.65	----	----	1.67	0.55	1.73	
Final Drawdown (FT)	19.12	0.82	25.78	5.28	10.35	12.82	2.72	51.97	100.90	
Specific Capacity (GPM / FT)	0.30	----	0.10	0.12	----	----	0.60	0.00	0.20	
Hydraulic Conductivity (GPD/FT2)	4.00	1182?	0.85?	58?	7?	14.25?	930?	1.2?	10.1?	481.7? 509.0?
Transmissivity (GPD/FT)	172	22466	11	58	26	57	17662	5	191	9153 9671
Storage Coefficient	0.23	6.0x10-3	----	----	----	----	2.0x10-4	----	----	1.4x10-2 1.2x10-2
COMMENTS	From Rahn report (Gerlach Thesis)	Pumped well 654. Unable to measure its water level; all aquifer coefficients derived from observation well 655. Saturated thickness questionable	Saturated thickness is questionable	Two tests ran; Base of spoils not exactly known		Saturated thickness is questionable; base of spoils questionable	745 pumped well; 746 observation. Saturated thickness is questionable	Base of spoils questionable; good test	Pumped well, well efficiency poor; base of spoils questionable	Observation well; base of spoils questionable

This is reprinted Table RP-12 from Big Horn Coal Company's Reclamation Plan (Permit 213-T5).

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Table 3 Effective Infiltration Rates In Backfill For Selected Areas Of Pits One And Two At Big Horn Mine[1]

Topsoil Application Area 1-1	
Sampled	May-85
Approved	02/20/1998
Area (ft^2)	1,370,094
Saturated Spoils Volume (ft^3)	77,544,000
Water Volume (ft^3)	15,508,800
Recharge Time (years)	23.2
Groundwater Movement (ac-ft/day)	0.04
Effective Infiltration Rate (in/yr)	5.9
Topsoil Application Area 1-2	
Sampled	Jun-87
Approved	07/14/1987
Area (ft^2)	2,031,313
Saturated Spoils Volume (ft^3)	117,126,000
Water Volume (ft^3)	23,425,200
Recharge Time (years)	23.2
Groundwater Movement (ac-ft/day)	0.06
Effective Infiltration Rate (in/yr)	6.0
Topsoil Application Area 1-3	
Sampled	Apr-96
Approved	10/24/1996
Area (ft^2)	1,438,327
Saturated Spoils Volume (ft^3)	193,077,000
Water Volume (ft^3)	38,615,400
Recharge Time (years)	23.2
Groundwater Movement (ac-ft/day)	0.10
Effective Infiltration Rate (in/yr)	13.9
Topsoil Application Area 1-4	
Sampled	3rd Qtr. 97
Approved	06/16/1998
Area (ft^2)	5,523,236
Saturated Spoils Volume (ft^3)	493,506,000
Water Volume (ft^3)	98,701,200
Recharge Time (years)	23.2
Groundwater Movement (ac-ft/day)	0.27
Effective Infiltration Rate (in/yr)	9.3

Coal Thickness (ft)	22
Porosity	20%
Last Groundwater Sample	Oct-01
Recharge Starting Date	Jul-78

1. As used in this analysis, the effective infiltration rate is the rate at which the spoils resaturated from all surface water and groundwater sources expressed as inches per year of water applied over each respective topsoil application unit.

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TABLE 4 UNDERGROUND WATER CLASS USE SUITABILITY

Constituent or Parameter	I Domestic Concentration*	II Agriculture Concent.*	III Livestock Concent.*
Aluminum (Al)	---	5.0	5.0
Ammonia (NH_3-N)	0.5[8]	---	---
Arsenic (AS)	0.05	0.1	0.2
Barium (Ba)	1.0	---	---
Beryllium (Be)	---	0.1	---
Boron (B)	0.75	0.75	5.0
Cadmium (Cd)	0.01	0.01	0.05
Chloride (Cl)	250.0	100.0	2000.0
Chromium (Cr)	0.05	0.1	0.05
Cobalt (Co)	---	0.05	1.0
Copper (Cu)	1.0	0.2	0.5
Cyanide (CN)	0.2	---	---
Fluoride (F)	1.4-2.4[7]	---	---
Hydrogen Sulfide($H_2$5)	0.05	---	---
Iron (Fe)	0.3	5.0	---
Lead (Pb)	0.05	5.0	0.1
Lithium (Li)	---	2.5	---
Manganese (Mn)	0.05	0.2	
Mercury (Hg)	0.002	---	0.00005
Nickel (Ni)	---	0.2	---
Nitrate (NO_3-N)	10.0	---	---
Nitrite (NO_2-N)	1.0	---	10.0
(NO_3+NO_2)-N	---	---	100.0
Oil & Grease	Virtually Free	10.0	10.0
Phenol	0.001	---	---
Selenium (Se)	0.01	0.02	0.05
Silver (Ag)	0.05	---	---
Sulfate (SO_4)	250.0	200.0	3000.0
Total Dissolved Solids (TDS)	500.0	2000.0	5000.0
Uranium (U)	5.0	5.0	5.0
Vanadium (V)	---	0.1	0.1
Zinc (Zn)	5.0	2.0	25.0
pH	6.5-9.0s.u.	4.5-9.0s.u.	6.5-8.5s.u
SAR	---	8	---
RSC	---	1.25 meq/l	---
Combined Total Radium 226 and Radium 228[9]	5pCi/l	5pCi/l	5pCi/l
Total Strontium 90	8pCi/l	8pCi/l	8pCi/l
Gross alpha particle radioactivity (including Radium 226 but excluding Radon and Uranium)[9]	15pCi/l	15pCi/l	15pCi/l

*mg/l, unless other wise indicated

This is reprinted from Table 1, Chapter VIII, Wyoming Water Quality Rules And Regulations, March 1993.

TFN 6 2/025
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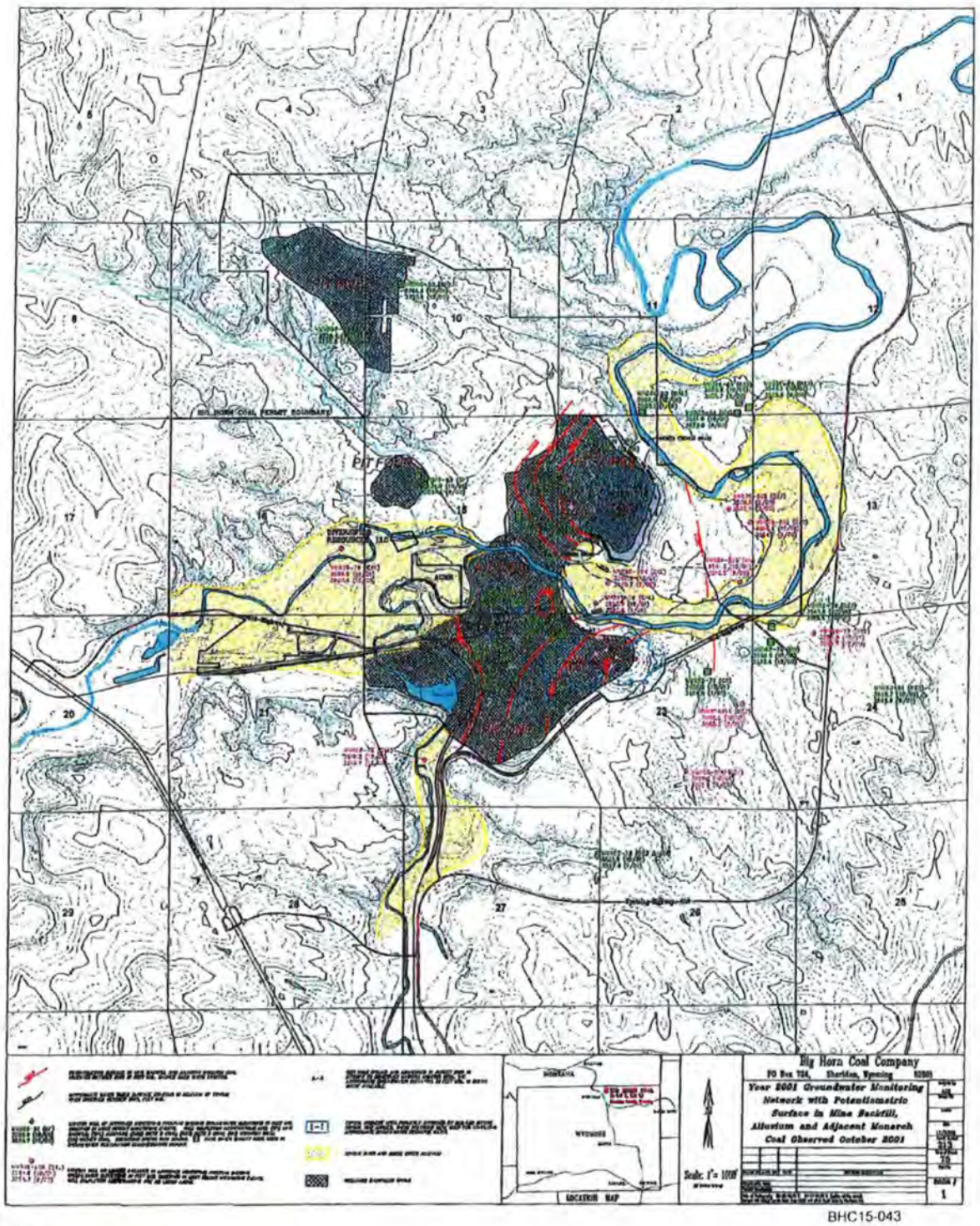

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ADDENDUM D6-14

Big Horn Coal Mine
Aquifer Test Data

TFN 6 2/025
DEQR 10-25-18

MICRO FILMED SEP 21 '84

ADDENDUM D6-4

DATA LOG SHEETS OF AQUIFER PUMP TESTS WITH RESPECTIVE GRAPHS OF DATA POINTS AND AQUIFER COEFFICIENT CALCULATIONS

9/8/84-213.T4

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TFN 1 5/293 PERMIT

D6-313 7/31/89-213.T3

TFN 6 2/025

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DIETZ - 1

COAL WELLS

8/30/99 213 T6
9/2/94-213.T6
LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT 213-T2
7/3 '89-213-T3
D6-314
TFN 6 2/025
DEQB 10-25-18

GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

e Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 25 WELL NO. 463

onnel Bondar - Gentry Test type: 1. Single well drawdown (3.) Drawdown with obs. well 5. Other (specify)
2. Single well recovery (4.) Recovery with obs. well

PKS Address Box 3049 Sheridan, WY

ler D. Fudge Method drilled: (A.) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

al well depth 243 ft. Well diameter 7 7/8 in.

rg diameter 5 in. Casing type PVC

e of screen or perforation slots Interval of screen or perforation 160'-165', 185'-200' Pump hp. & type 3/4 Teel Pump depth 190 ft.

ifer Dietz 1AB Aquifer lithology coal

itude of land surface 3698.5' How determined surveyed MP Above Below LSD Altitude MP

t. from MP 87.44' How measured Galvanometer

MICRO FILMED SEP 21 '84

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
6-9-80	0910	87.44	0			0
	11	99.45	1			12.01
	13	111.74	3			24.30
	16	125.15	6			37.71
	20	140.00	10			52.56
	25	151.36	15			63.92
	30	155.27	20			67.83
	40	160.22	30			72.78
	50	162.90	40			75.46
	1000	164.55	50			77.11
	15	166.17	65			78.73
	30	167.68	80			80.24
	45	169.03	95			81.59
	1100	170.11	110			82.67
	15	171.62	125			84.18
	30	173.06	140			85.62
	50	174.15	160			86.71
	1210	174.76	180			87.32
	1230	175.30	200			87.86
	1250	175.54	220			88.10
	1310	175.76	240			88.32
	1330	176.20	260			88.76
	1359	176.58	289			89.14
OFF	1400	176.58	290	0	0	89.14
	1401	167.33	291	1	291	79.89
	1403	151.96	293	3	97.67	74.52
	1406	156.58	296	6	49.33	69.14
	1412	147.50	302	12	25.17	60.06
	1420	136.63	310	20	15.50	49.19

8/30/99-213 T3

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7/31/89-213 T3

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Brook Mine

GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 25 WELL NO. 463 (cont)

el Bondar - Gentry — Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify)
2. Single well recovery (4) Recovery with obs. well

ner PKS Address Box 3049 Sheridan, WY

Fudge Method drilled: (A) Air-rotary; B. Bored or augered; C. Cable-tool; D. Dug; H. Hyd.-rotary; J. Jetted; P. Air-percussion; R. Rev.-rotary; T. Trenching; V. Driven; W. Drive-wash; Z. Other

ell , in 243 ft. Well diameter 7 7/8 in.

diameter 5 in. Casing type PVC

f screen erforation slots Interval of screen or perforation 160'-165', 185'-200' Pump hp. & type 3/4 Teel Pump depth 190 ft.

Dietz 1AB Aquifer lithology coal

e of land ace 3698.5' How determined surveyed MP Above Below LSD Altitude MP

om MP How measured Galvanometer

TE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
-9-80	35	121.04	325	35	9.28	33.60
	45	113.39	335	45	7.44	25.95
	1500	105.48	350	60	5.83	18.04
	15	100.25	365	75	4.87	12.81
	30	96.82	380	90	4.22	9.38
	45	94.90	395	105	3.76	7.46

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89-213 T3

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TFN 6 2/025

WATER WELL 463

PUMPING RATE DATA

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DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
6-9-80	0913	35.20	5.11	3.00	3	15.33
	16	36.80	4.89	3.00	3	14.67
	20	39.00	4.62	3.00	4	18.48
	25	52.30	3.44	3.00	5	17.20
	30	67.00	2.69	3.00	5	13.45
	40	68.30	2.64	3.00	10	26.40
	50	73.20	2.46	3.00	10	24.60
	1000	75.00	2.40	3.00	10	24.00
	15	75.30	2.39	3.00	15	35.85
	30	75.80	2.37	3.00	15	35.55
	45	75.20	2.39	3.00	15	35.85
	1100	75.50	2.38	3.00	15	35.70
	15	77.40	2.33	3.00	15	34.95
	30	76.80	2.34	3.00	15	35.10
	50	78.40	2.30	3.00	20	46.00
	1210	78.50	2.29	3.00	20	45.80
	30	76.70	2.35	3.00	20	47.00
	50	77.50	2.32	3.00	20	46.40
	1310	78.00	2.31	3.00	20	46.20
	30	79.20	2.27	3.00	20	45.40
	1400	80.50	2.24	3.00	30	67.20
					290	711.13

Average Q = 711.13 gal = 2.45 gpm
290 min

specific capacity = 2.45 gpm / 89.14 ft = 0.03 gpm / ft.

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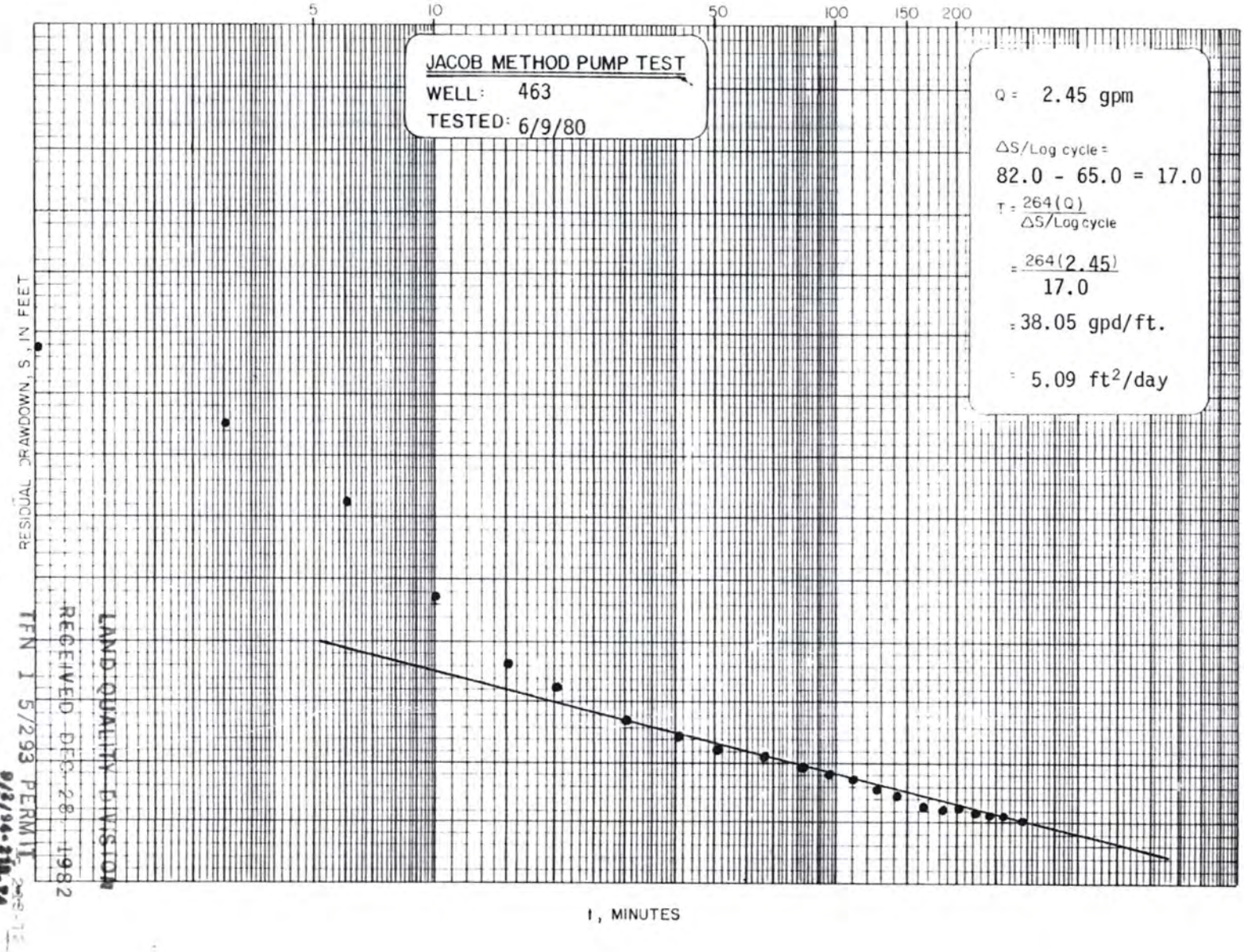

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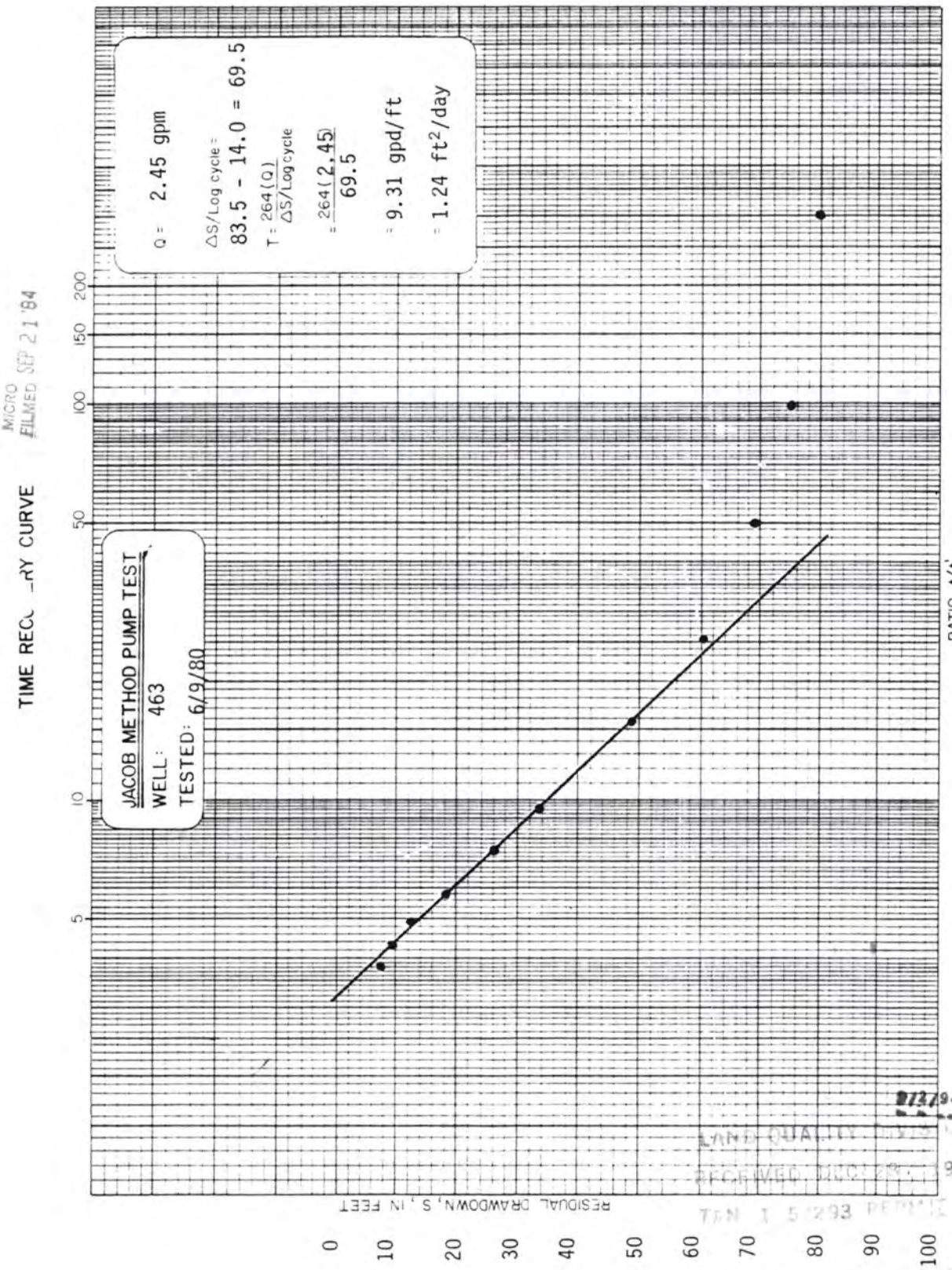

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D6-319
TFN 6 2/025
RECD 10-25-18

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RAMACO

Brook Mine

; GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 25 WELL NO. obs. 463A

nnel Bondar, Gentry

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
2. Single well recovery 4. Recovery with obs. well

PKS Address Box 3049 Sheridan, WY

D. Fudge Method drilled: (A.) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

l well depth 210 ft. Well diameter 7 7/8 in.

g diameter 5 in. Casing type PVC

of screen

r perforation saw slots Interval of screen or perforation 158-170', 185-203' Pump hp. & type Pump depth ft.

MICRO FILMED SEP 21 '89

ifer Dietz 1AB Aquifer lithology coal

ude of land urface 3701.7' How determined surveyed MP Above Below LSD Altitude MP

. from MP 79.70' How measured Galvanometer - continuous recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
6-9-80	0910	79.70	0			0
	0925	80.02	15			0.32
	0940	80.51	30			0.81
	0955	81.22	45			1.52
	1010	81.91	60			2.21
	1025	82.52	75			2.82
	1040	83.17	90			3.47
	1055	83.74	105			4.04
	1110	84.27	120			4.57
	1125	84.72	135			5.02
	1140	85.18	150			5.48
	1155	85.55	165			5.85
	1210	85.95	180			6.25
	1225	86.26	195			6.56
	1240	86.54	210			6.84
	1255	86.84	225			7.14
	1310	87.10	240			7.40
	1325	87.31	255			7.61
	1340	87.50	270			7.80
	1355	87.71	285			8.01
OFF	1400	87.77	290	0		8.07
	1410	87.85	300	10	30	8.15
	1425	87.87	315	25	12.60	8.17
	1440	87.71	330	40	8.25	8.01
	1455	87.41	345	55	6.27	7.71
	1510	87.07	360	70	5.14	7.37
	1525	86.67	375	85	4.41	6.97
	1540	86.24	390	100	3.90	6.54
	1555	85.80	405	115	3.52	6.10
	1610	85.39	420	130	3.23	5.69

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9/2/94-213.98

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TFN 6 2/025

8/31/89-213 TS

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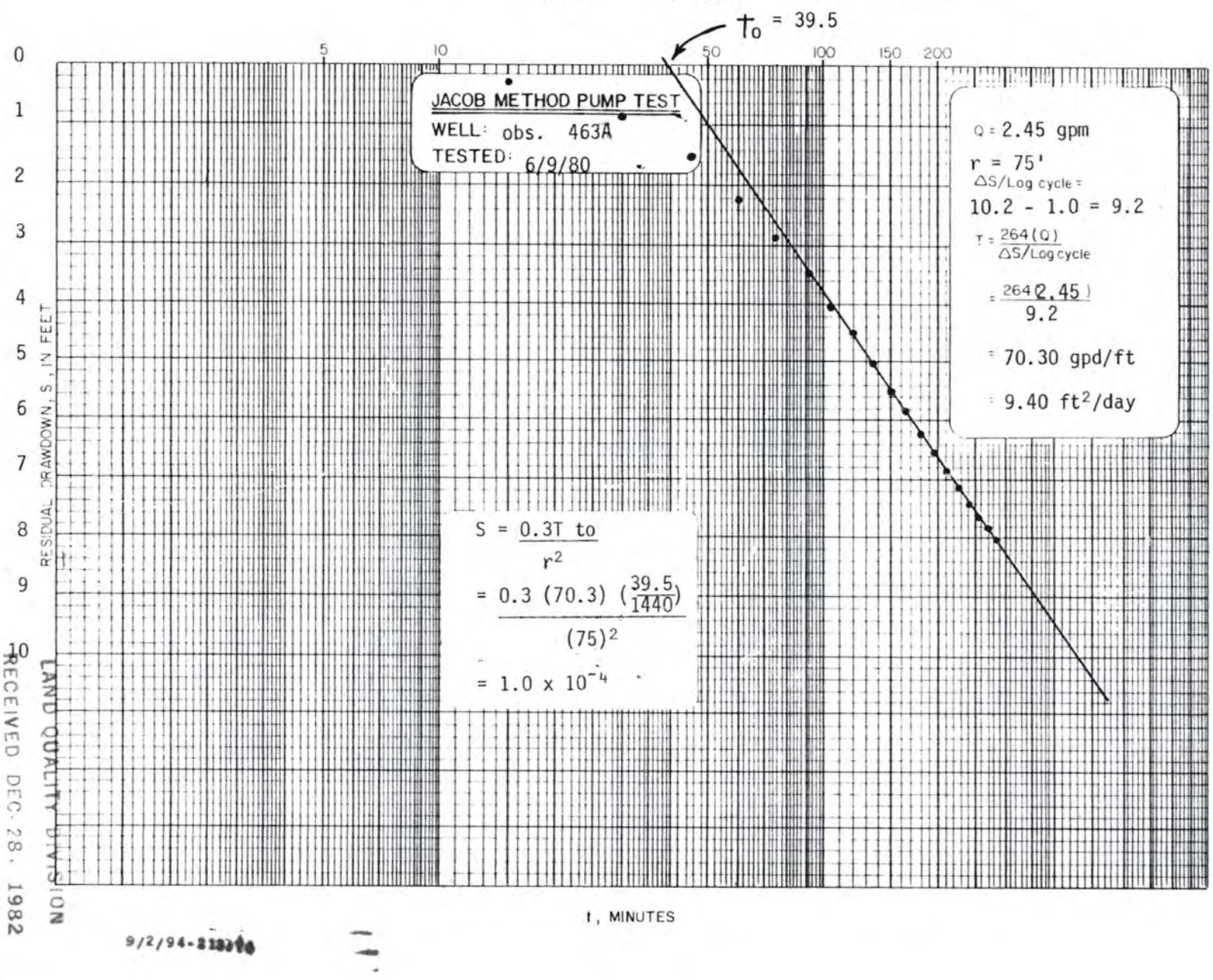
TIME DRA /N CURVE



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TFN 6 2/025
TFN 1 5/293 PERMIT 213-T2
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LAND QUALITY DIVISION
9/2/94-213-T6
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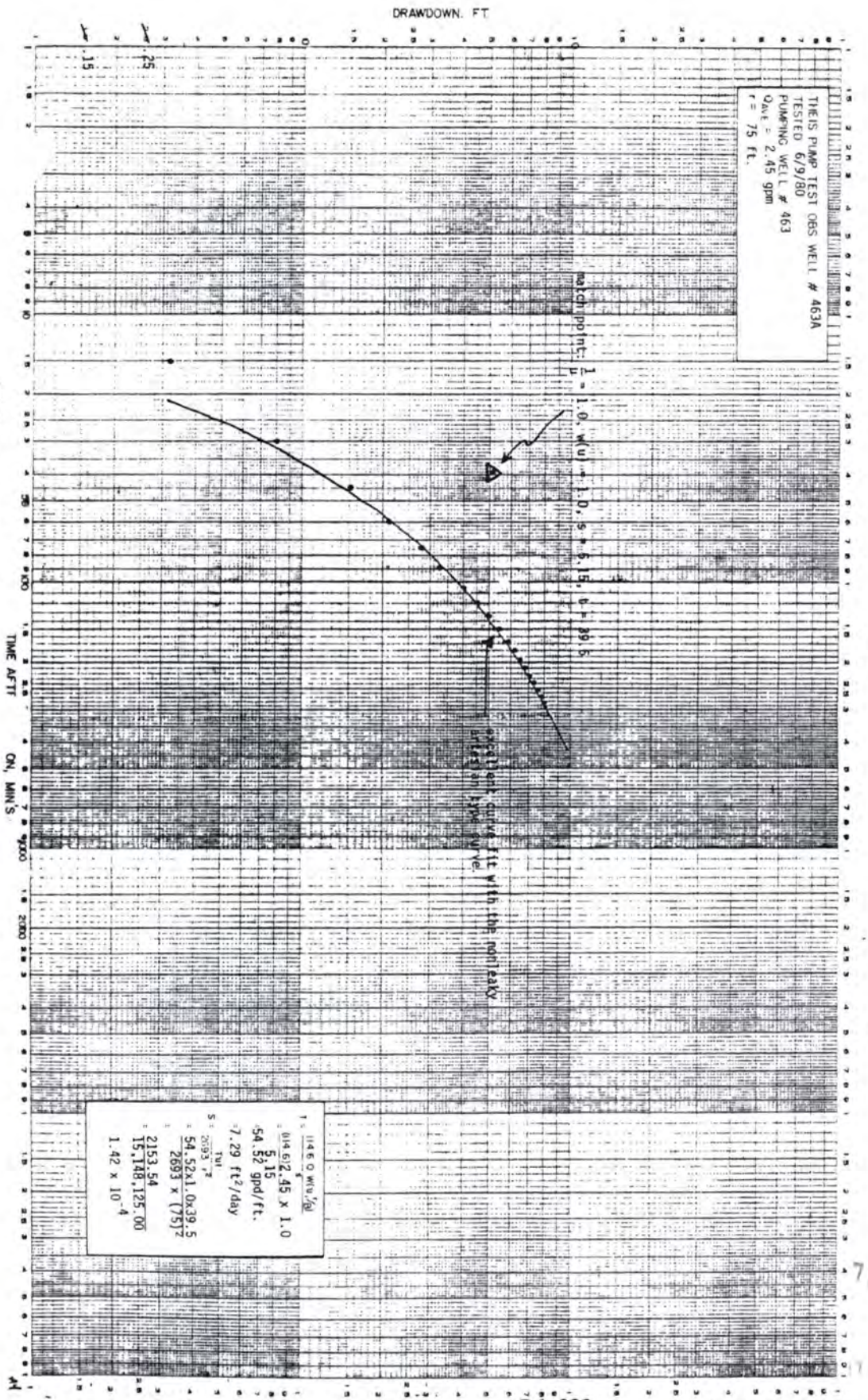

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7/31/89-213 T3

TFN 6 2/025

RECD 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N), R. 84 (W), Sec. 26 WELL NO. 464

Personnel Bondar - Gentry

Test Type: (1) Single well drawdown (2) Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner PKS

Address Sheridan, WY Box 3049 Driller R. Reed

Method drilled: (A) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slots Interval of screen or perforation 163' - 180'

Pump hp & type 3/4 Teel Pump depth 210 ft. Aquifer Dietz 1B

Aquifer lithology coal Altitude of land surface 3781.9

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 107.12 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
6-11-80	0900	107.12	0			0
	02	122.15	2			15.00
	05	137.25	5			30.13
	15	164.09	15			56.97
	25	169.60	25			62.48
	35	174.13	35			67.01
	45	175.88	45			68.76
	1000	175.58	60			68.46
	15	182.00	75			74.88
	30	181.82	90			74.70
	45	183.06	105			75.94
	1100	183.36	120			76.24
	20	183.62	140			76.50
	40	183.54	160			76.42
	1200	186.12	180			79.00
	20	190.95	200			83.83
	40	188.40	220			81.32
	1300	188.05	240			80.93
	20	189.00	260			81.88
	40	190.32	280			83.20
OFF	50	190.87	290	0		83.75

LAND QUALITY DIVISION
RECEIVED DEC. 28. 1982

D6-323

TFN D 2/025

Scanned, 02/26/2020

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 26 WELL NO. 464

nnel Bondar - Gentry Test type: (1) Single well drawdown 2) Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specif)

owner PKS Address Box 3049 Sheridan, WY

r R. Reed Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

w h 220 ft. Well diameter 7 7/8 in.

g diameter 5 in. Casing type PVC

of screen t perforation slots Interval of screen or perforation 163'-180' Pump hp. & type 3/4 Teel Pump depth 210 ft.

fer Dietz 1B Aquifer lithology Coal

ude of land urface 3781.9 How determined surveyed MP Above Below LSD Altitude MP

from MP 107.12 How measured Galvanometer

MICRO FILMED SEP 21 '84

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
	51	184.91	291	1	291	77.79
	53	176.99	293	3	97.66	69.87
	56	173.39	296	6	49.33	66.27
	1400	171.38	300	10	30.00	64.26
	05	169.03	305	15	20.33	61.91
	15	165.00	315	25	12.60	57.88
	30	159.70	330	40	8.25	52.58

9/3/96-213.T4

LAND QUALITY DIVISION

RECEIVED DEC 28 1992

TFN 2 8/22

213-T2

213-T3

D6-324

TFN 6 2/025

REED 10-25-18

WATER WELL 464

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

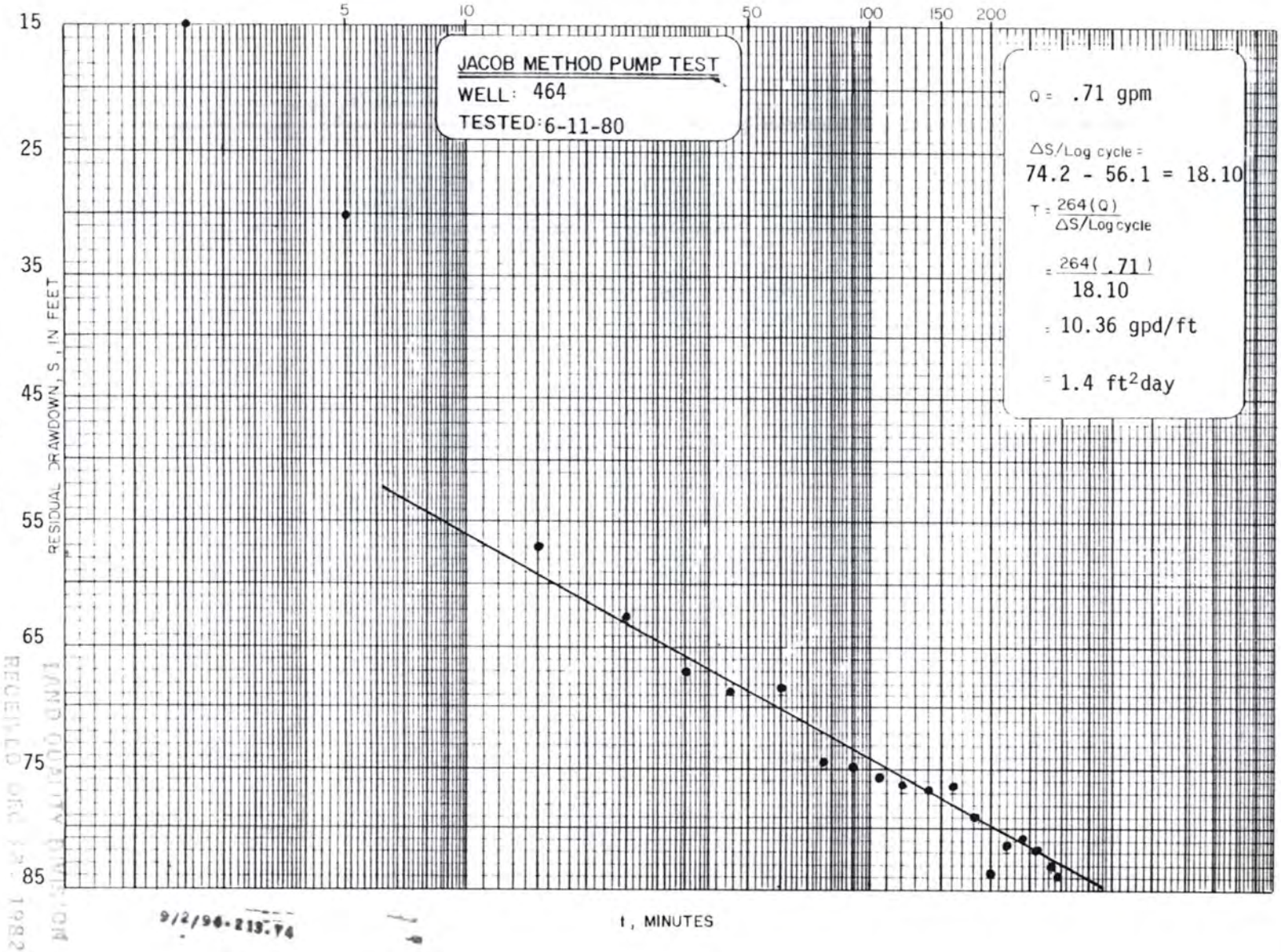
DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
6-11-80						
	05	49.00	3.67	3.00	5	18.35
	15	155.00	1.16	3.00	10	11.60
	35	190.00	.95	3.00	20	19.00
	45	358.00	.50	3.00	10	5.00
	1000	358.00	.50	3.00	15	7.50
	15	137.00	1.31	3.00	15	19.65
	30	350.00	.51	3.00	15	7.65
	45	312.00	.58	3.00	15	8.70
	1120	335.00	.54	3.00	35	18.90
	40	335.00	.54	3.00	20	10.80
	1200	230.00	.78	3.00	20	15.60
	20	230.00	.78	3.00	20	15.60
	40	460.00	.39	3.00	20	7.80
	1300	325.00	.55	3.00	20	11.00
	20	330.00	.55	3.00	20	11.00
	40	325.00	.55	3.00	30	16.50
				TOTALS	290.00	204.65
	Average	Q = 204.65 gal. .71 gpm				
		290.00 min.				
						9/2/94-213.74
		specific	capacity = .71 gpm	= .01 gpm/ft		
			83.75ft.			

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT
8/30 89-213 T3
TFN 8 2/025
DEC 10-25-18

Scanned, 02/26/2020

TIME DRA WN CURVE

MICRO FILMED SEP 21 '84



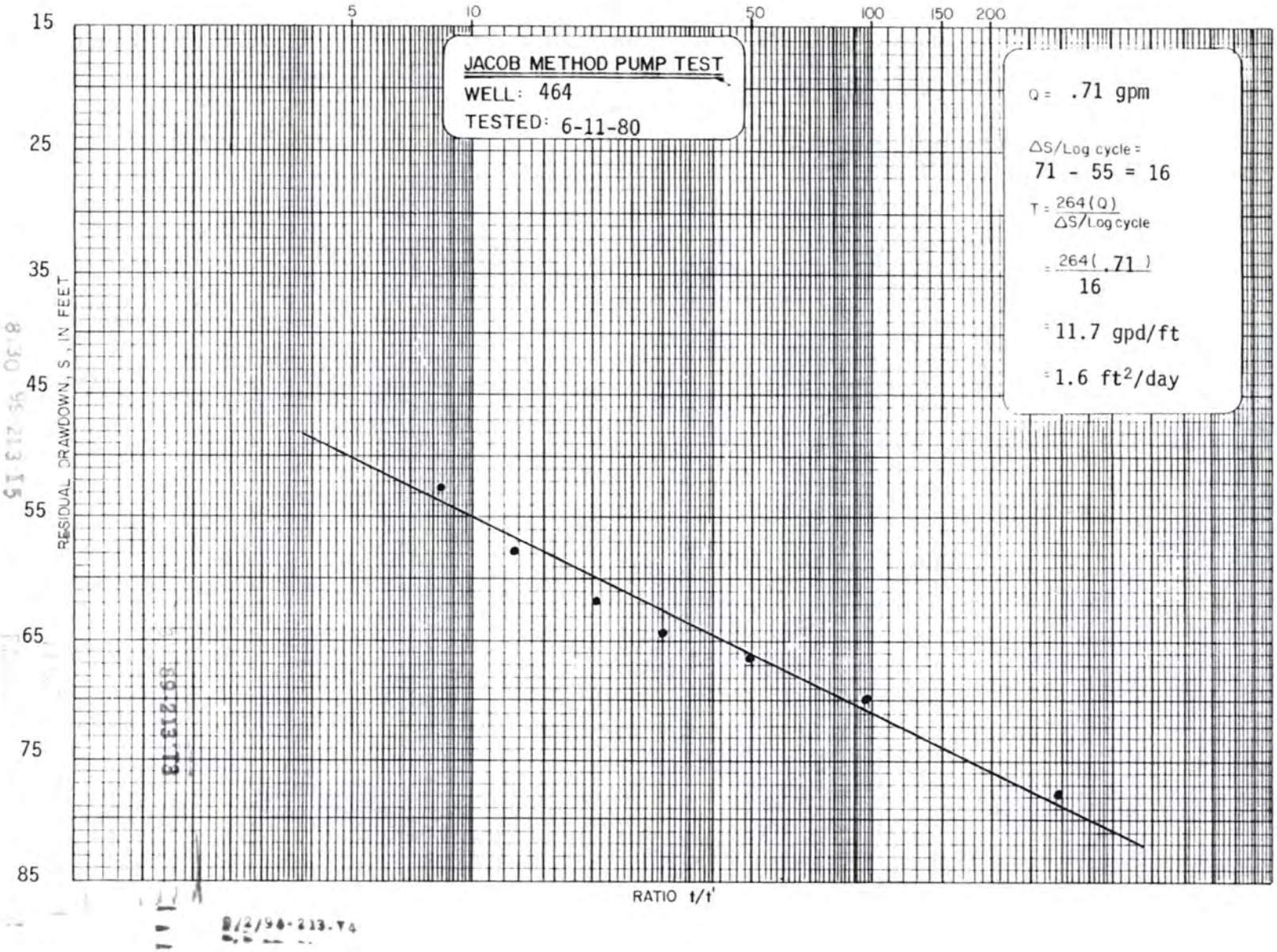
9/2/96-213.74

8430 99-113.5
TFN 6 2/025
RECD 10-25-18
TFN 1 5/293 PERMIT
RECEIVED OCT 25 1982

DEQ Ex. 3-1558

MICRO FILMED SEP 2 1 '84

TIME RECOVE. . CURVE



RECD 10-25-18

DEQ Ex. 3-1559

Scanned, 02/26/2020

AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 24 WELL NO. BH 688

Personnel Collier

Test Type: (1) Single well drawdown (2) Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

11 Owner PKS

ddress Sheridan, Wyoming Driller D. Fudge

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

MICRO FILMED SEP 21 '84

Total well depth 280 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 245' - 265'

Pump hp & type ½ red jacket Pump depth 250 ft. Aquifer Dietz 1B

Aquifer lithology coal Altitude of land surface 3719'

How determined surveyed MP Above Below LSD Altitude MP 3720.3'

WL from MP 119.59 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
11-13-81						
PUMP ON	0920	119.59	0			0
	0921	126.95	1			7.36
	0924	139.51	4			19.92
	0926	145.82	6			26.23
	0930	150.01	10			30.42
	0933	152.74	13			33.15
	0941	154.30	21			34.71
	0950	156.48	30			36.89
	1000	158.17	40			38.58
	1015	159.00	55			39.41
	1031	161.40	71			41.81
	1050	162.23	90			42.64
	1115	163.21	115			43.62
	1145	164.25	145			44.66
PUMP OFF	1230	165.33	190	0		45.74
	1231	158.20	191	1	191	38.61
	1232	153.02	192	2	96	33.43
	1233	148.77	193	3	64.33	29.18
	1234	145.55	194	4	48.50	25.96
	1235	143.00	195	5	39.00	23.41

8:30 LAND QUALITY DIVISION RECEIVED DEC 28 1982 TFN I 5/293 PERMIT 213-T2 89-213 T3 TFN 6 2/025

D6-328

AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 24 WELL NO. BH 688

Personnel Collier

Test Type: (1) Single well drawdown (2) Single well recover
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner PKS

ss Sheridan, Wyoming

Driller D. Fudge

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

MICRO FILMED SEP 21 '84

Total well depth 280 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 245' - 265'

Pump hp & type ½ red jacket Pump depth 250 ft. Aquifer Dietz 1B

Aquifer lithology Coal Altitude of land surface 3719'

How determined Surveyed MP Above Below LSD Altitude MP 3720.3'

WL from MP 119.59 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
11-13-81	1240	134.40	200	10	20.00	14.81
	1245	131.05	205	15	13.67	11.46
	1255	128.13	215	25	8.60	8.54
	1310	126.50	230	40	5.75	6.91
	1330	125.40	250	60	4.17	5.81
	1453	123.87	333	143	2.33	4.28

D/2/84-213-T4

LAND QUALITY DIVISION

RECEIVED OCT 29 1992

TFN 2 5/293 PERMIT 213-T2

2/31/89-213 T3

8/30 99-213 T5

TFN 6 2/025

RECD 10-25-18

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WATER WELL BH 688

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
11-13-81	0921	42	7.14	5	1	7.14
	0924	44	6.82	5	3	20.46
	0933	45	6.67	5	9	60.03
	0941	46	6.52	5	8	52.16
	0950	46	6.52	5	9	58.68
	1015	45	6.67	5	25	166.75
	1050	46.5	6.45	5	35	225.75
	1115	46.5	6.45	5	25	161.25
	1145	48	6.25	5	30	187.50
	1230	48	6.25	5	45	281.25
				TOTALS =	190	1220.97

Average Q = 1220.97 / 190 = 6.43 gpm

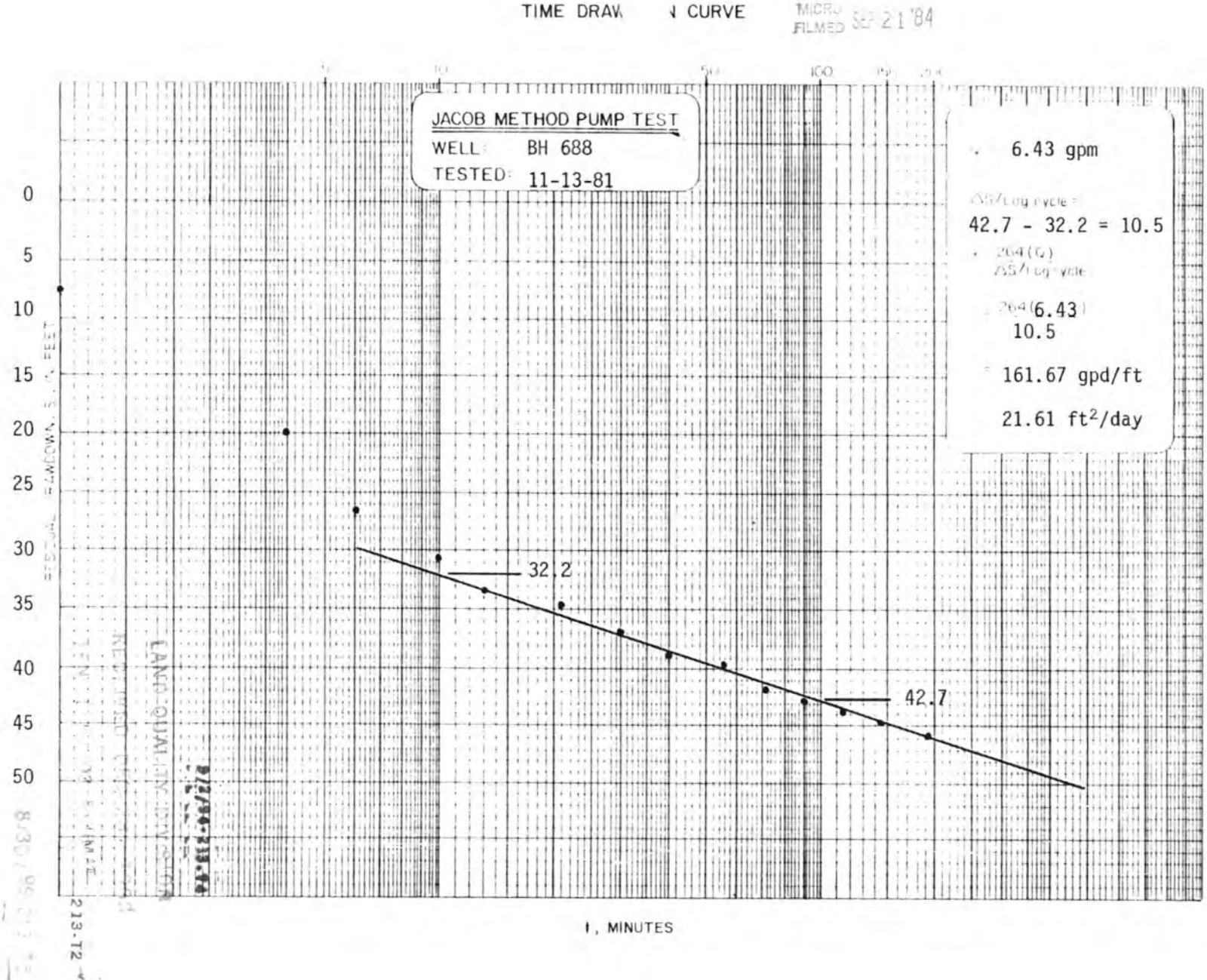
Specific Capacity = 6.43 gpm / 45.74 ft = .14 gpm/ft

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT
89-213-T8
TFN 6 2/025
DEC 10-25-18

RECD 10-25-18

TFN 6 2/025

MICRO FILMED SEP 21 '84



LAND QUALITY DIVISION

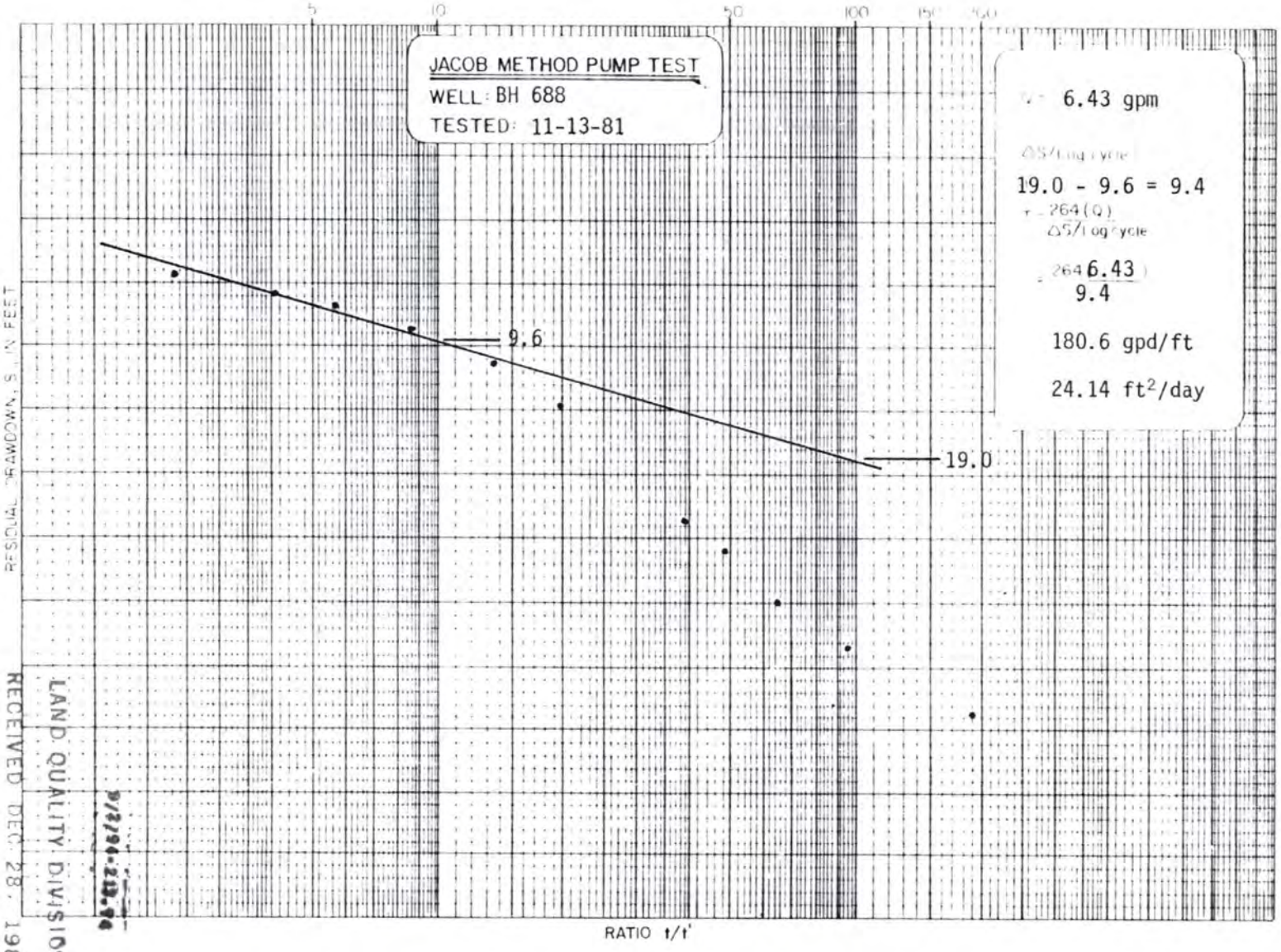
0-213-T3

DEQ Ex. 3-1563

Scanned, 02/26/2020

MICRO FILMED SEP 21 '84

TIME RECO. .Y CURVE



RECEIVED DEC 28, 1982
LAND QUALITY DIVISION
TFN 6 2/025
RECD 10-25-18
TFNJ 5/293 PERMIT

DEQ Ex. 3-1564

MICRO FILMED SEP 21 '84

DIETZ - 2

COAL WELLS

8/30-89-213-T5
9/2/94-213.T4
LAND QUALITY DIVISION
RECEIVED
TFN 1 5/253 PERMIT
7/31/89-213-T3
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1565

Scanned, 02/26/2020

K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

te Wyoming County Sheridan T. 57 (N) S. R. 84 (E.) W. Sec. 24 WELL NO. 469

sonnel Bondar

Test type: (1.) Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify)

ll c PKS Address Box 3049 Sheridan, WY

iller R. Reed Method drilled: (A.) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

tal well depth 253 ft. Well diameter 7 7/8 in.

sing diameter 5 in. Casing type PVC

pe of screen or perforation slots Interval of screen or perforation 227 - 244' Pump hp. & type 3/4 Teel Pump depth 200 ft.

MICRO FILMED SEP 21 '84

uifer Dietz 2BC Aquifer lithology Coal

titude of land surface 3614.9 How determined Surveyed MP Above Below LSD Altitude MP

/L from MP 33.78 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
7-3-80	0840	33.78	0			0
	41	44.18	1			10.40
	43	54.65	3			20.87
	46	66.46	6			32.68
	50	76.15	10			42.37
	55	81.84	15			48.06
	0900	84.35	20			50.57
	10	86.76	30			52.98
	20	87.58	40			53.80
	30	88.17	50			54.39
	45	89.13	65			55.35
	1000	89.74	80			55.96
	15	90.53	95			56.75
	30	91.23	110			57.45
Pump Off	48		128	0		
	49	79.25	129	1	129	45.47
	51	74.23	131	3	43.66	40.45
	54	68.32	135	6	22.50	34.54
	1100	58.86	141	12	11.75	25.08
	10	47.60	151	22	6.86	13.82
	20	41.44	161	32	5.03	7.66
	30	38.19	171	42	4.07	4.41
	40	36.55	181	52	3.48	2.77
	55	35.56	196	67	2.92	1.78
	1210	35.10	211	92	2.29	1.32
	25	34.90	226	107	2.11	1.12
	45	34.69	246	127	1.93	.91
	1305	34.55	266	147	1.80	.77
	30	34.43	291	172	1.70	.65
	[illegible]	34.36	321	202	1.59	.58

8/30/84-213.75

9/2/84-213.74

9/4/84-213.73

D6-384

TFN 6 2/023

RECD 10-25-18

WATER WELL 469

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7-3-80	0800					
	0843	30.00	6.00	3.00	3	18.00
	50	46.50	3.90	3.00	7	27.30
	0900	56.40	3.20	3.00	10	32.00
	10	60.50	3.00	3.00	10	30.00
	20	61.00	3.00	3.00	10	30.00
	30	66.40	2.71	3.00	10	27.10
	45	60.00	3.00	3.00	15	45.00
	1000	61.40	2.93	3.00	15	43.95
	15	65.00	2.77	3.00	15	41.55
	30	63.60	2.83	3.00	15	42.45
				TOTALS	110	337.55

Total average Q = 337.55 gals = 3.38 gpm
110 min.

specific capacity = 3.38 gpm = 0.059 gpm/ft
57.45ft

8/30/99-213 T3

9/2/94-213.T4

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT 213-T2

89-213 T3

D6-335

TFN 6 2/025

DEQ Ex. 3-1567 10-25-18

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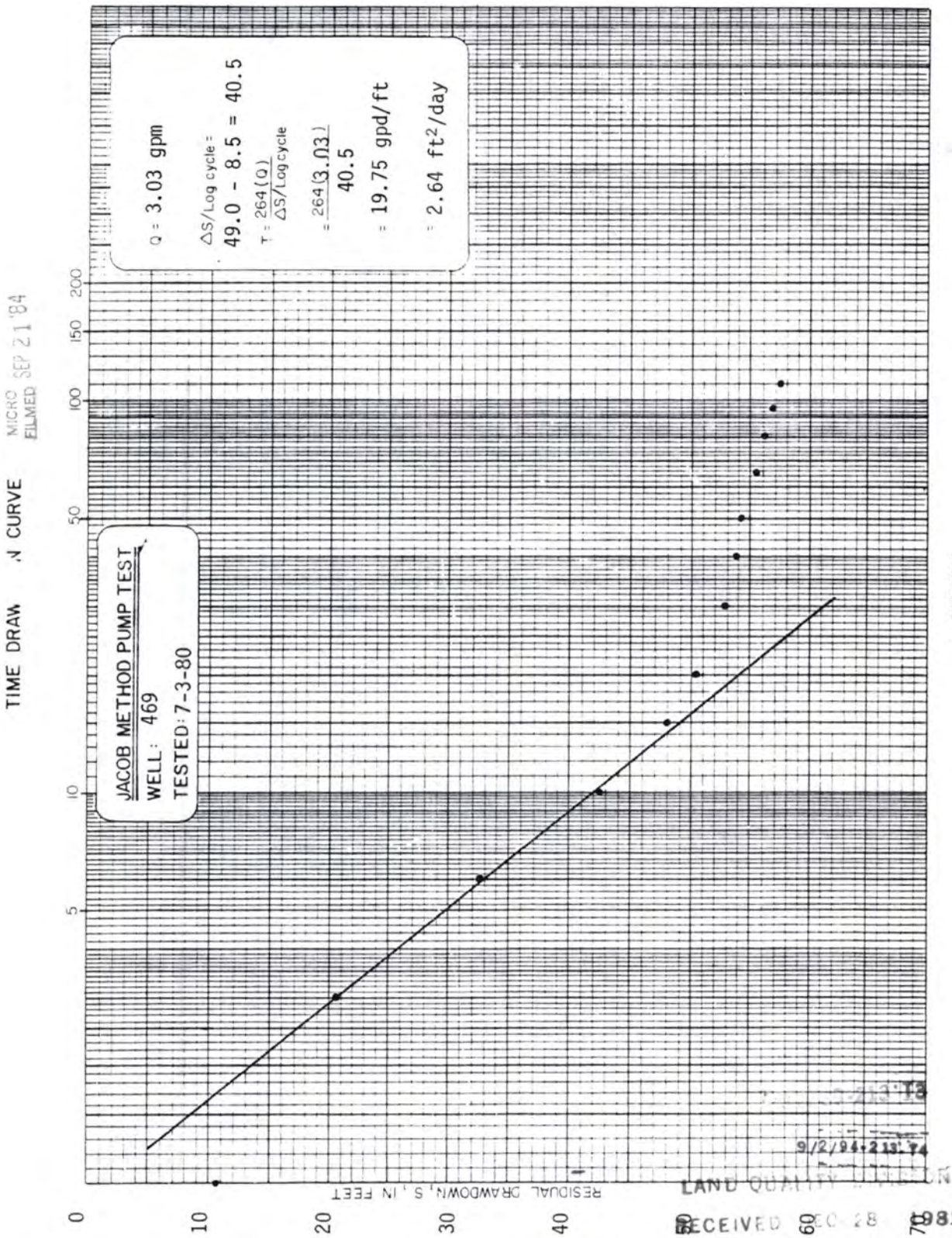
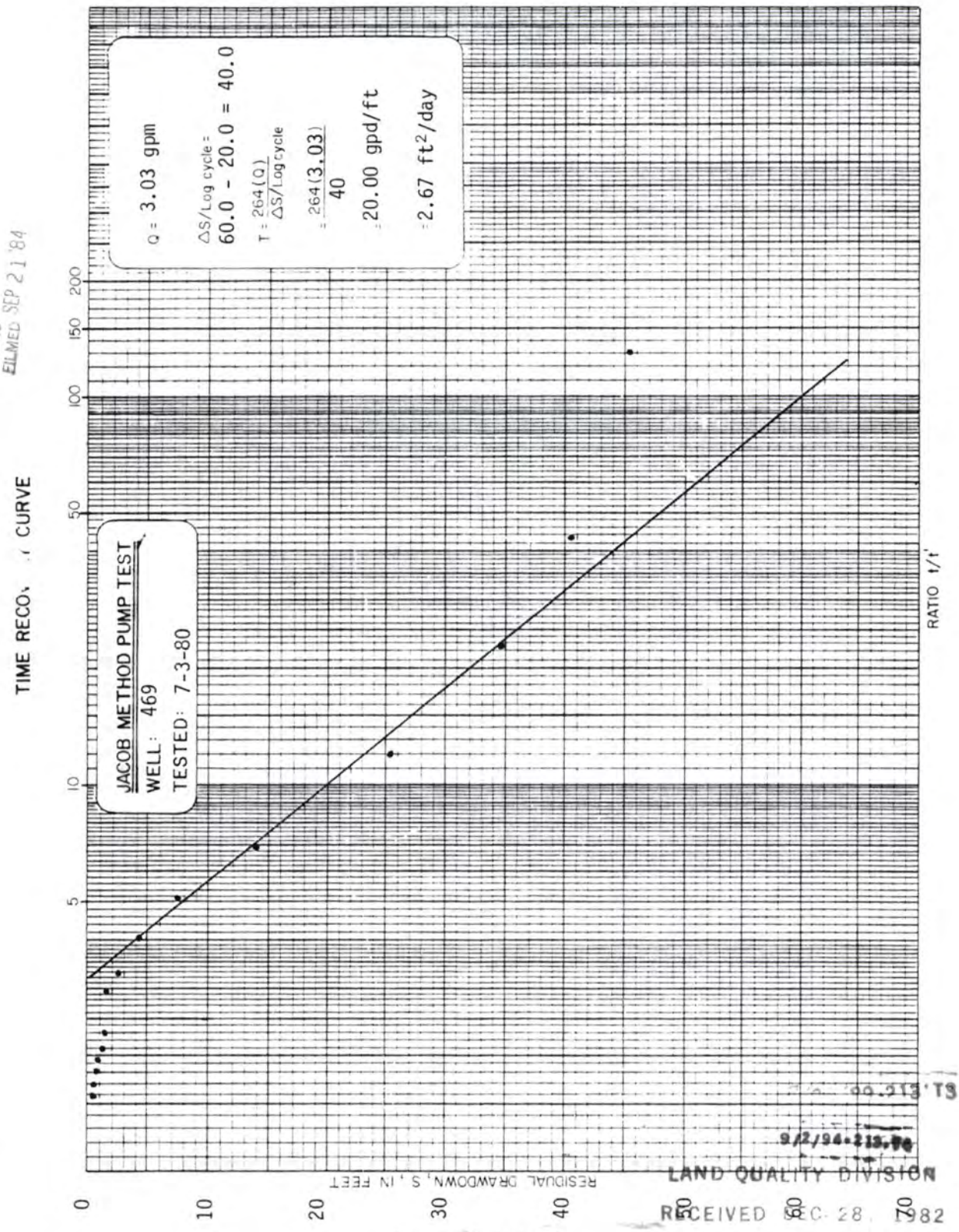


9/2/94 2:13:14
LAND QUALITY
RECEIVED DEC 28 1982
8/30 95 2:13:15
TFN 1 5/293 PERMIT
D6-336
TFR 6 27 0 2 5
RECD 10-25-18

DEQ Ex. 3-1568



MICRO FILMED SEP 21 '84

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT

D6-337
TFR 6 2/025
RECD 10-25-18

DEQ Ex. 3-1569

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K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

te Wyoming County Sheridan T. 57 (N.) S. R. 84 E. W. Sec. 14 WELL NO. 596

rsonnel Bondar, Halcolm

Test type: (1.) Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
(2.) Single well recovery 4. Recovery with obs. well

ll r PKS Address Box 3049 Sheridan, WY

ille R. Reed Method drilled: (A.) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

tal well depth 120 ft. Well diameter 7 7/8 in.

sing diameter 5 in. Casing type PVC

pe of screen or perforation slots Interval of screen or perforation 96 - 109'

Pump hp. & type 3/4 Teel Pump depth 115 ft.

quifer Dietz 2BC Aquifer lithology coal

titude of land surface 3590' How determined surveyed MP Above Below LSD Altitude MP

VL from MP 23.91' How measured Galvanometer

MICRO FILMED SEP 21 '84

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
6-19-81	0935	23.91	0			0
	36	39.06	1			15.15
	38	52.25	3			28.34
	41	56.67	6			32.76
	45	60.23	10			36.32
	50	64.21	15			40.30
	1000	67.84	25			43.93
	15	70.60	40			46.69
	30	72.08	55			48.17
	45	74.55	70			50.64
	1100	76.43	85			52.52
	20	77.80	105			53.89
	40	79.07	125			55.16
	1200	80.25	145			56.34
	20	81.68	165			57.77
	40	82.54	185			58.63
Pump Off	1300	83.39	205	0		59.48
	01	69.37	206	1	206	45.46
	03	53.85	208	3	69.33	29.94
	06	44.47	211	6	35.17	20.56
	10	39.80	215	10	21.50	15.89
	15	37.00	220	15	14.67	13.09
	20	35.40	225	20	11.25	11.49
	30	33.33	235	30	7.83	9.42
	45	31.62	250	45	5.56	7.71
	1400	30.54	265	60	4.42	6.63
	20	29.63	285	80	3.56	5.72
	40	29.05	305	100	3.05	5.14
	1500	28.55	325	120	2.71	4.64

9/2/94 218-84
LAND QUALITY DIVISION
D6-398
TFN 6 2/025
PERMIT 213-T2

WATER WELL 596

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
6-19-81	0936	16.10	19.75	5.30	1	19.75
	0938	17.10	18.60	5.30	2	37.20
	0941	19.70	16.14	5.30	3	48.42
	0945	18.60	17.10	5.30	4	68.40
	0950	18.10	17.57	5.30	5	87.85
	1000	18.20	17.47	5.30	10	174.70
	1015	18.60	17.10	5.30	15	256.50
	1030	20.10	15.82	5.30	15	237.30
	1045	19.60	16.22	5.30	15	243.30
	1100	18.60	17.17	5.30	15	257.77
	1120	19.48	16.32	5.30	20	326.40
	1140	20.21	15.73	5.30	20	314.60
	1200	20.16	15.77	5.30	20	315.40
	1220	20.05	15.86	5.30	20	317.20
	1240	20.85	15.25	5.30	20	305.00
	1300	20.24	15.71	5.30	20	314.20
				TOTALS	205	3323.99
			Total Average Q =	3323.99 gal / 205 min = 16.21	gpm	
			Specific capacity	= 16.21 gpm / 59.48 ft = 0.27	gpm/ft	

9/2/94-213 T6
3/1/89-213 T3
TPR 6 2/025
DEQ 10-25-18

Scanned, 02/26/2020

MICRO FILMED SEP 21 '84

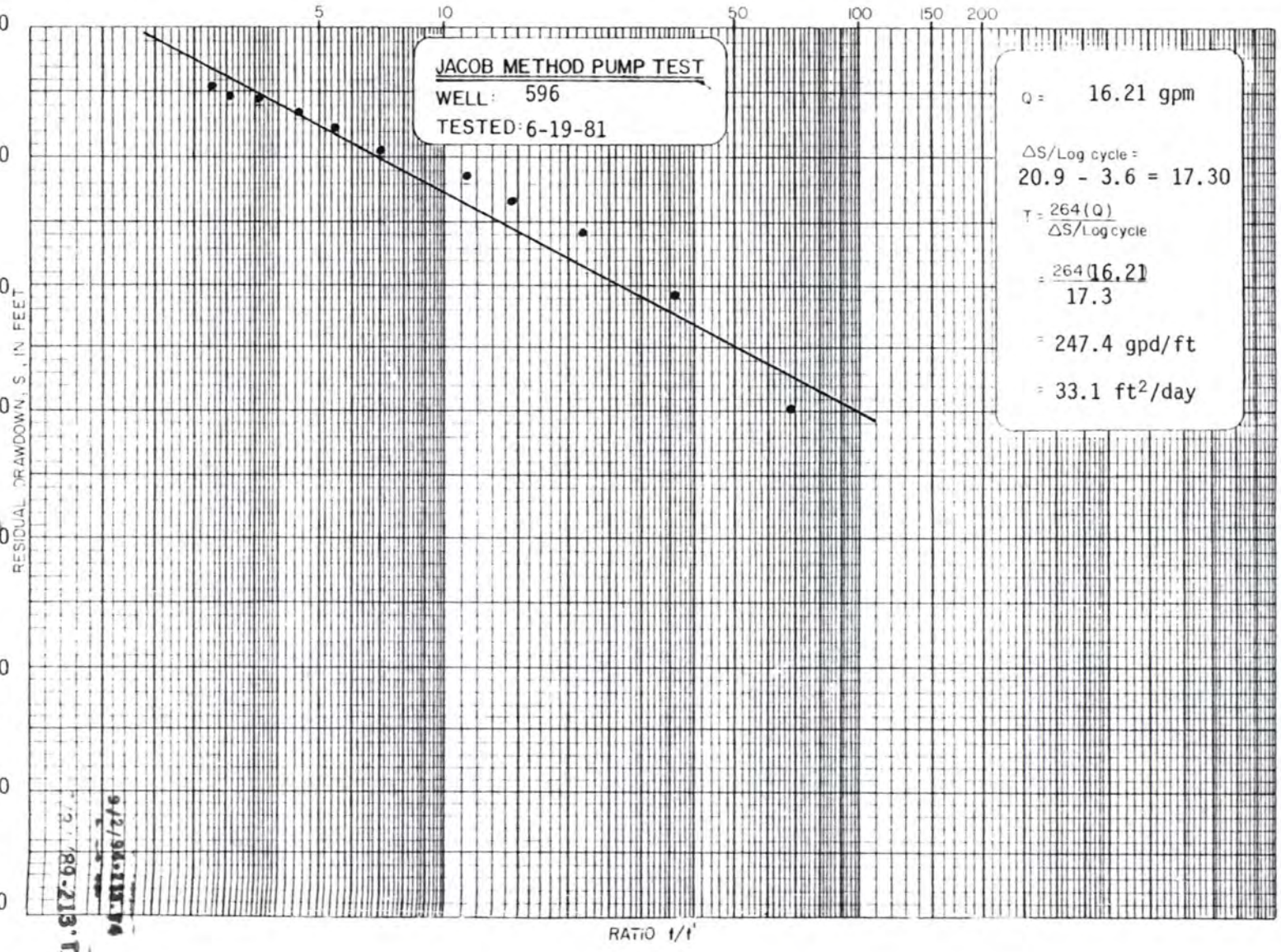
TIME DRAW N CURVE

D6-340
TFR 6 2/025
RECD 10-25-18
LAND QUALITY DIVISION
RECEIVED DEC 28, 1982
JUN 15/293 PERMIT
7/31/89-213 T3

DEQ Ex. 3-1572

TIME RECOVERY CURVE

FILMED SEP 21 '84



D6-341
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT

TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

RAMACO

Brook Mine

GEOLOGY AND EXPLORATION

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO. BH647

anel Bondar - Volk

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify)
2. Single well recovery 4. Recovery with obs. well

wner PKS Address Box 3049 Sheridan, WY

Reed R. Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

w n 341 ft. Well diameter 7 7/8 in.

diameter 5 in. Casing type PVC

of screen perforation slots Interval of screen or perforation 314 - 334' Pump hp. & type 3/4 Teel Pump depth 150 ft.

er Dietz 2BC Aquifer lithology Coal

de of land rface 3673' How determined surveyed MP Above Below LSD Altitude MP

from MP 77.20 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
-2-81	1035	77.20	0			0
	1036	81.22	1			4.02
	38	Galv.	3			---
	41	Malfunct.	6			---
	45		10			---
	50		15			---
	55	95.00	20			17.8
	1100	96.36	25			19.16
	05	96.90	30			19.70
	10	98.98	35			21.78
	20	100.56	45			23.36
	30	104.03	55			26.83
	45	105.56	70			28.36
	1200	105.90	85			28.70
	20	106.65	105			29.45
	40	106.74	125			29.54
	1300	105.37	145			28.17
	20	112.50	165			35.30
	40	112.84	185			35.64
	1400	112.30	205			35.10
	20	111.38	225			34.18
	40	113.95	245			36.75
	1500	115.55	265			38.35
	20	115.77	285			38.57
	30	115.53	295			38.33
ump (at) OFF	45	117.13	310			39.93

8/30 WS-213.T5
7/31/89-213 TS
9/12/94-213.T4

LAND QUALITY DIVISION
RECEIVED [illegible] 1982
JAN 1 5/293 PERMIT 213.T2

D6-342

JAN 6 2/025

RECD 10-25-18

GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO. BH647

nel Bondar - Volk

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
2. Single well recovery (4) Recovery with obs. well

wner PKS Address Box 3049 Sheridan, WY

R. Reed Method drilled: (A) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 84

wel 341 ft. Well diameter 7 7/8 in.

diameter 5 in. Casing type PVC

of screen perforation slots Interval of screen or perforation 314 - 334' Pump hp. & type 3/4 Teel Pump depth 150 ft.

r Dietz 2BC Aquifer lithology Coal

de of land face 3673' How determined surveyed MP Above Below LSD Altitude MP

rom MP 77.20 How measured Galvanometer

ATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
-2-81	1545	117.13	310	0		39.93
	46	112.29	311	1	311	35.09
	48	103.58	313	3	104.3	26.38
	51	94.43	316	6	52.7	17.23
	55	87.62	320	10	32	10.42
	1600	84.47	325	15	21.7	7.27
	10	82.39	335	25	13.4	5.19
	20	81.72	345	35	9.9	4.52
	30	81.22	355	45	7.9	4.02
	1700	80.63	385	75	5.1	3.43
	1730	80.11	415	105	4.0	2.91
	1800	79.82	445	135	3.3	2.62
	1830	79.59	475	165	2.9	2.32
	1900	79.42	505	195	2.6	2.22
	1930	79.25	535	225	2.4	2.05

8-30-89-213 T3

8-30-89-213 T5

TFN 6 2/025

REC'D 10-25-18

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WATER WELL BH647

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
1-2-81	1035	138 (ice in hose - do not use 1035 data)				
	1055	65	2.70	2.92	5	13.50
	1100	63.5	2.76	2.92	5	13.8
	1105	64	2.74	2.92	5	13.7
	1110	57.4	3.05	2.92	10	30.5
	1120	57.7	3.04	2.92	10	30.4
	1130	49	3.58	2.92	15	53.7
	1145	49.5	3.54	2.92	15	53.10
	1200	51.3	3.42	2.92	20	68.4
	1220	48.5	3.61	2.92	20	72.2
	1240	54	3.24	2.92	20	64.8
	1300	42	4.17	2.92	20	83.4
	1320	43.3	4.05	2.92	20	81.0
	1340	44	3.98	2.92	20	79.6
	1400	45.5	3.85	2.92	20	77.0
	1420	46	3.81	2.92	20	76.2
	1440	42	4.17	2.92	10	41.7
	1450	45	3.89	2.92	10	38.9
	1500	42.5	4.12	2.92	20	82.4
	1520	42	4.17	2.92	25	104.25
				TOTAL =	290	1,078.55
				$\bar{Q} = \frac{1078.55}{290} = 3.72$ gpm		
				spec. cap. $= \frac{3.72}{39.93ft} = 0.1$ gpm/ft.		

RECEIVED DEC 28 1982

D6-344 TFN 1 5/293 PERMIT

TFN 6 2/025

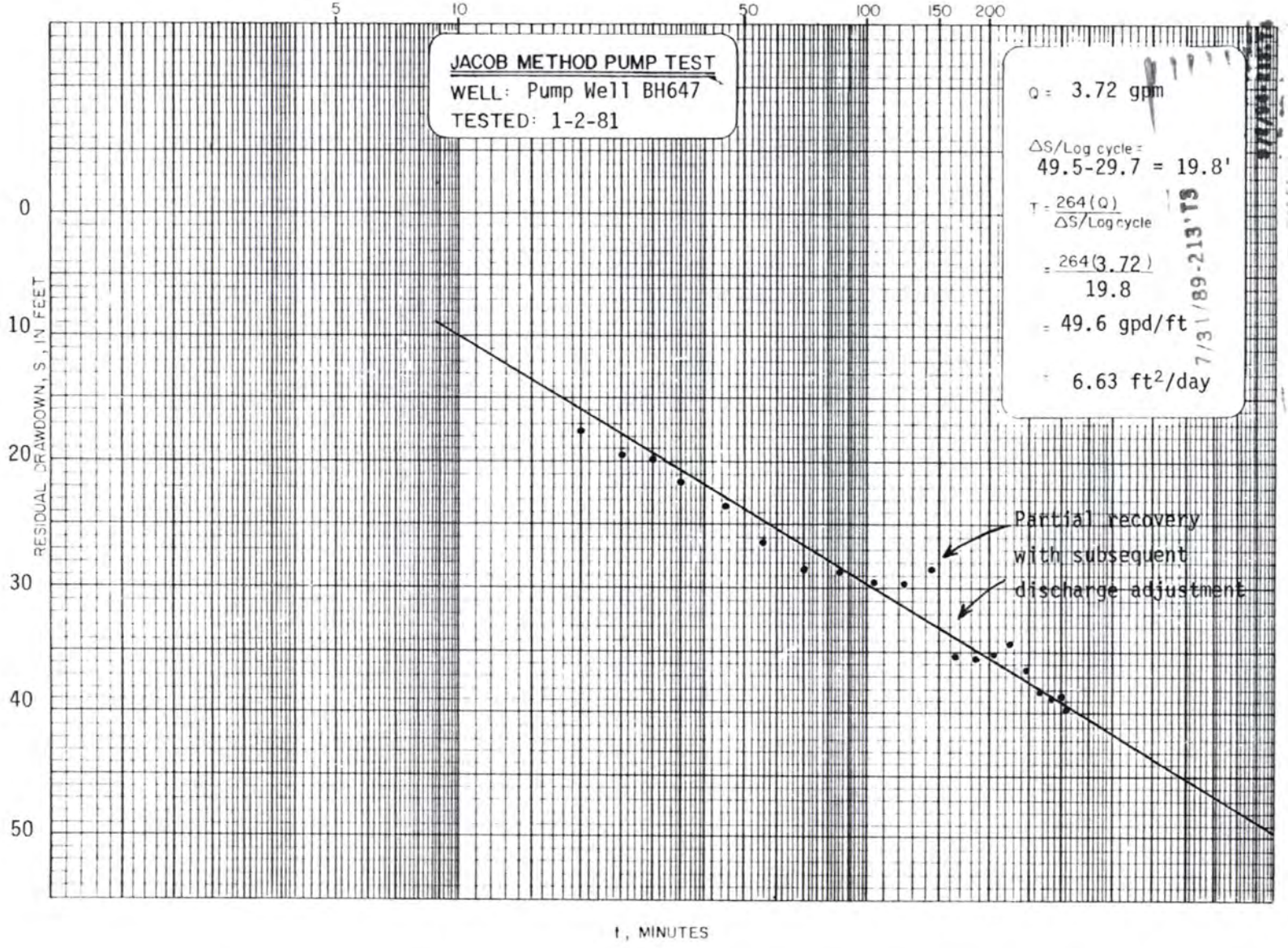
DEQ 10-25-18

Brook Mine

RAMACO

MICRO FILMED SEP 2 1 '34

TIME DRAWDOWN CURVE



7/31/89-213 T3
213-T2
D6-345
TFN 6 2/025
RECD 10-25-18
8/30 99 213 T5

Addendum D6-14-34

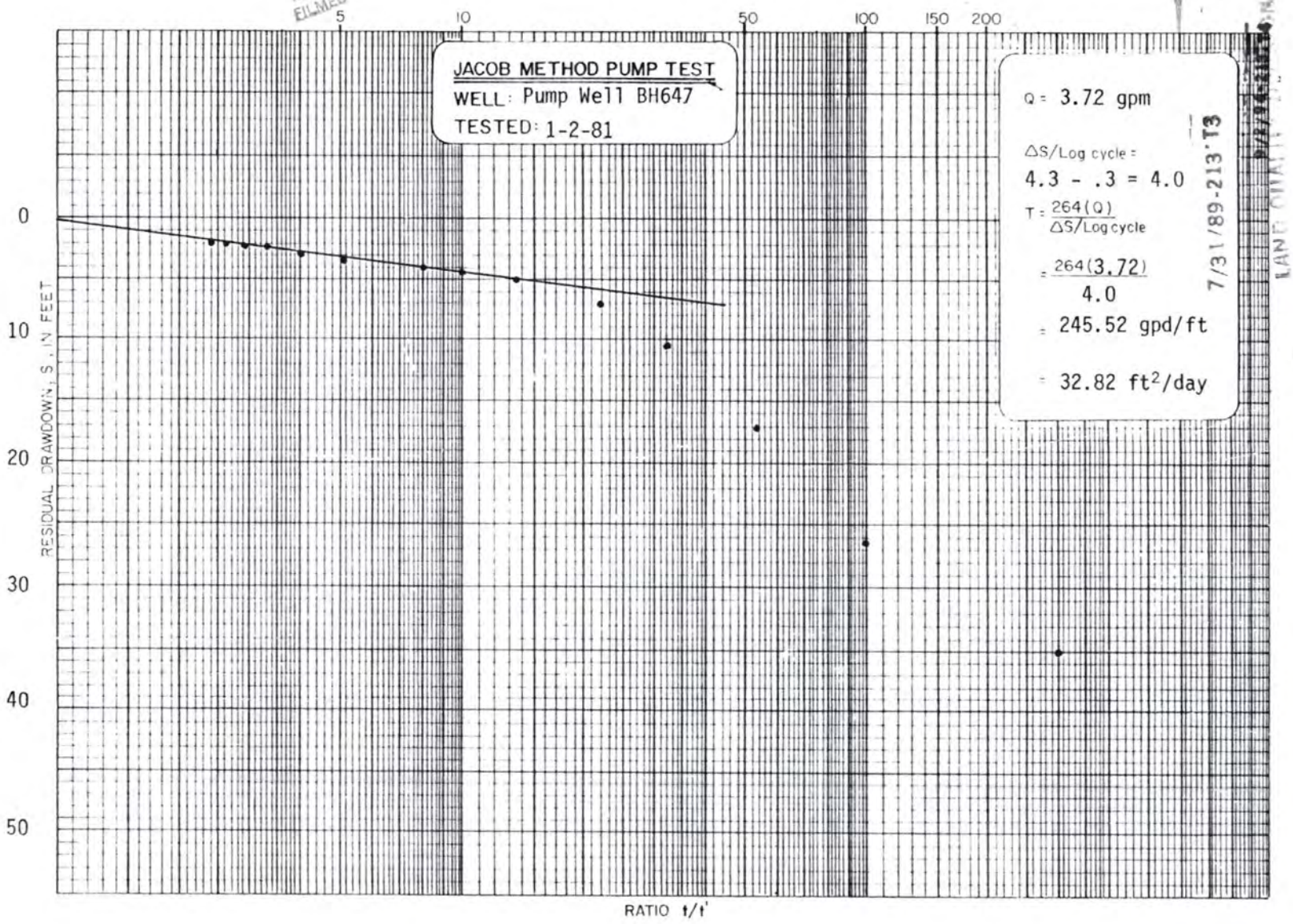
October 2018

DEQ Ex. 3-1577

Brook Mine

MICRO FILMED SEP 21 '84

TIME RECOVERY CURVE



D6-346
APR 8 2025
RECD 10-25-18

Addendum D6-14-35

October 2018

RAMACO

DEQ Ex. 3-1578

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GEOLOGY AND EXPLORATION

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO obs BH466

nel Bondar - Volk

Test type: 1. Single well drawdown 3. Drawdown with obs. well (5) Other (specify) 2. Single well recovery 4. Recovery with obs. well

vner PKS Address Box 3049 Sheridan, WY obs-Well Drawdown

R. Reed Method drilled: (A) Air-rotary D. Dug P. Air-percussion V. Driven B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash C. Cable-tool J. Jetted T. Trenching Z. Other

vel. 320 ft. Well diameter 7 7/8 in.

diameter 5 in. Casing type PVC

f screen perforation slots Interval of screen or perforation 289 - 304' Pump hp. & type N/A Pump depth ft.

MICRO FILMED SEP 21 '84

r Dietz 2BC Aquifer lithology coal

le of land face 3660.5' How determined surveyed MP Above Below LSD Altitude MP

rom MP 68.0 How measured Steven's Recorder & Galvanometer

ATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
-2-81	1035	68.0	0			0
	50	68.01	15			.01
	1105	68.08	30			.08
	1120	68.17	45			.17
	35	68.28	60			.28
	1205	68.56	90			.56
	1235	68.82	120			.82
	1305	69.06	150			1.06
	1335	69.27	180			1.27
	1405	69.49	210			1.49
	1505	69.85	270			1.85
	1535	70.02	300			2.02
mp off	1545	70.04	310			2.04

R130 99-213.T5

7/3 ~~99-213.T3~~

~~9/2/94-213.T4~~

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TFN 1 5/293 PERMIT

D6-347

TFN 6 2/025

REVD 10-25-18

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RAMACO

Brook Mine

GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO. Obs BH466

nel Bondar - Volk

Test type: 1. Single well drawdown 3. Drawdown with obs. well (5.) Other (specify)
2. Single well recovery 4. Recovery with obs. well

wner PKS Address Box 3049 Sheridan, WY Obs Well Recovery

Peed Method drilled: (A) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

we. 320 ft. Well diameter 7 7/8 in.

diameter 5 in. Casing type PVC

MICRO FILMED SEP 21 '84

of screen perforation slots Interval of screen or perforation 289 - 304' Pump hp. & type N/A Pump depth ____ ft.

er Dietz 2BC Aquifer lithology coal

de of land face 3660.5' How determined surveyed MP Above Below LSD ____ Altitude MP ____

rom MP 68.0 How measured Steven's Recorder & Galvanometer

ATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
-2-81	1545	70.04	310	0	0	2.04
	1550	70.09	315	5	63	2.09
	1558	70.12	323	13	24.85	2.12
	1612	70.12	337	27	12.48	2.12
	1620	70.10	345	35	9.86	2.10
	1635	70.02	360	50	7.20	2.02
	1705	69.83	390	80	4.88	1.83
	1805	69.50	450	140	3.21	1.50
	1905	69.26	510	200	2.55	1.26
	2005	69.10	570	260	2.19	1.10
	2105	68.98	630	320	1.97	.98
	2205	68.87	690	380	1.82	.87
	2305	68.79	750	440	1.70	.79
1-3-81	2405	68.72	810	500	1.62	.72
	105	68.65	870	560	1.55	.65
	205	68.59	930	620	1.50	.59
	305	68.54	990	680	1.46	.54
	405	68.50	1050	740	1.42	.50
	505	68.46	1110	800	1.39	.46
	605	68.42	1170	860	1.36	.42
	705	68.39	1230	920	1.34	.39
	740	68.36	1290	955	1.35	.36

99.213 T8
9/2/94-213.T4
8.30 99-213 T8
LAND QUALITY DIVISION
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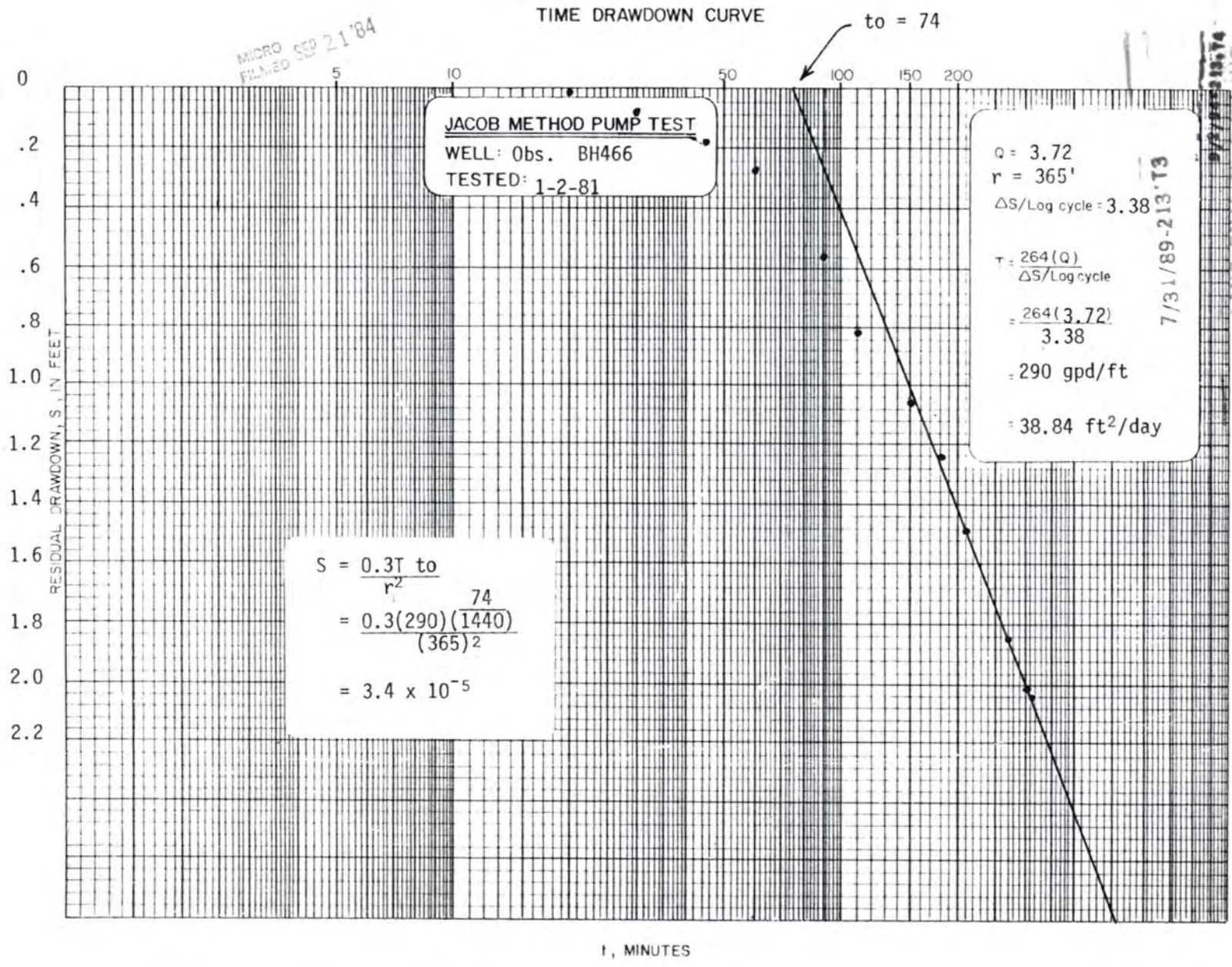
TFN 1 5/293 PERMIT
TFR 6/2/025
RECD 10-25-18

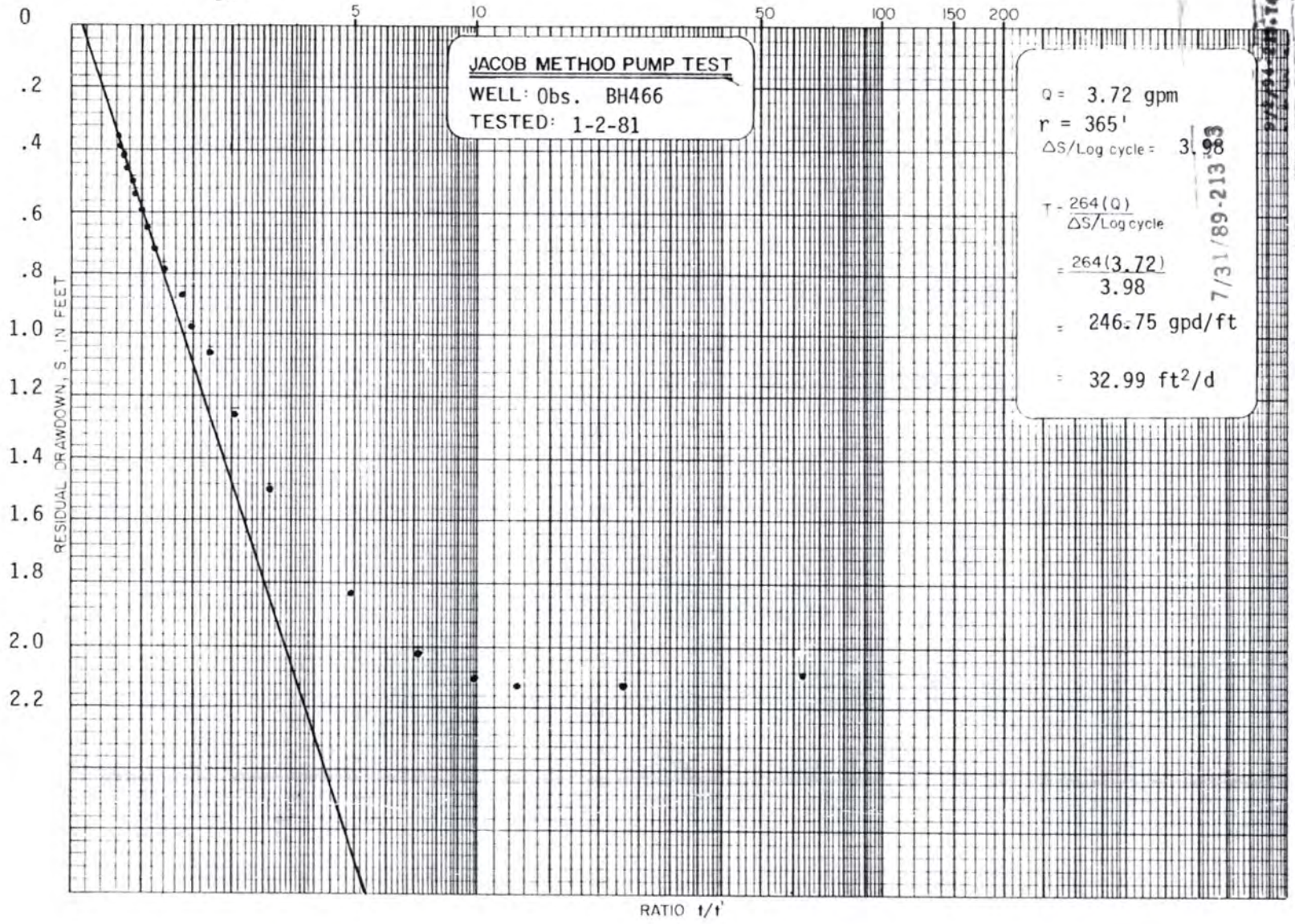

TIME DRAWDOWN CURVE
to = 74
JACOB METHOD PUMP TEST
WELL: Obs. BH466
TESTED: 1-2-81
Q = 3.72
r = 365'
ΔS/Log cycle = 3.38
T = 264(Q) / ΔS/Log cycle
= 264(3.72) / 3.38
= 290 gpd/ft
= 38.84 ft²/day
S = 0.3T to / r²
= 0.3(290)(74/1440) / (365)²
= 3.4 x 10⁻⁵
RESIDUAL DRAWDOWN, S, IN FEET
t, MINUTES
0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
5
10
50
100
150
200

DEQ Ex. 3-1581

Brook Mine

MICRO FILMED SEP 21 '84

TIME RECOVERY CURVE



7/31/89-213
LAND QUALITY DIVISION
RECEIVED DEC 28, 1982
RECD 10-25-18

Addendum D6-14-39

October 2018

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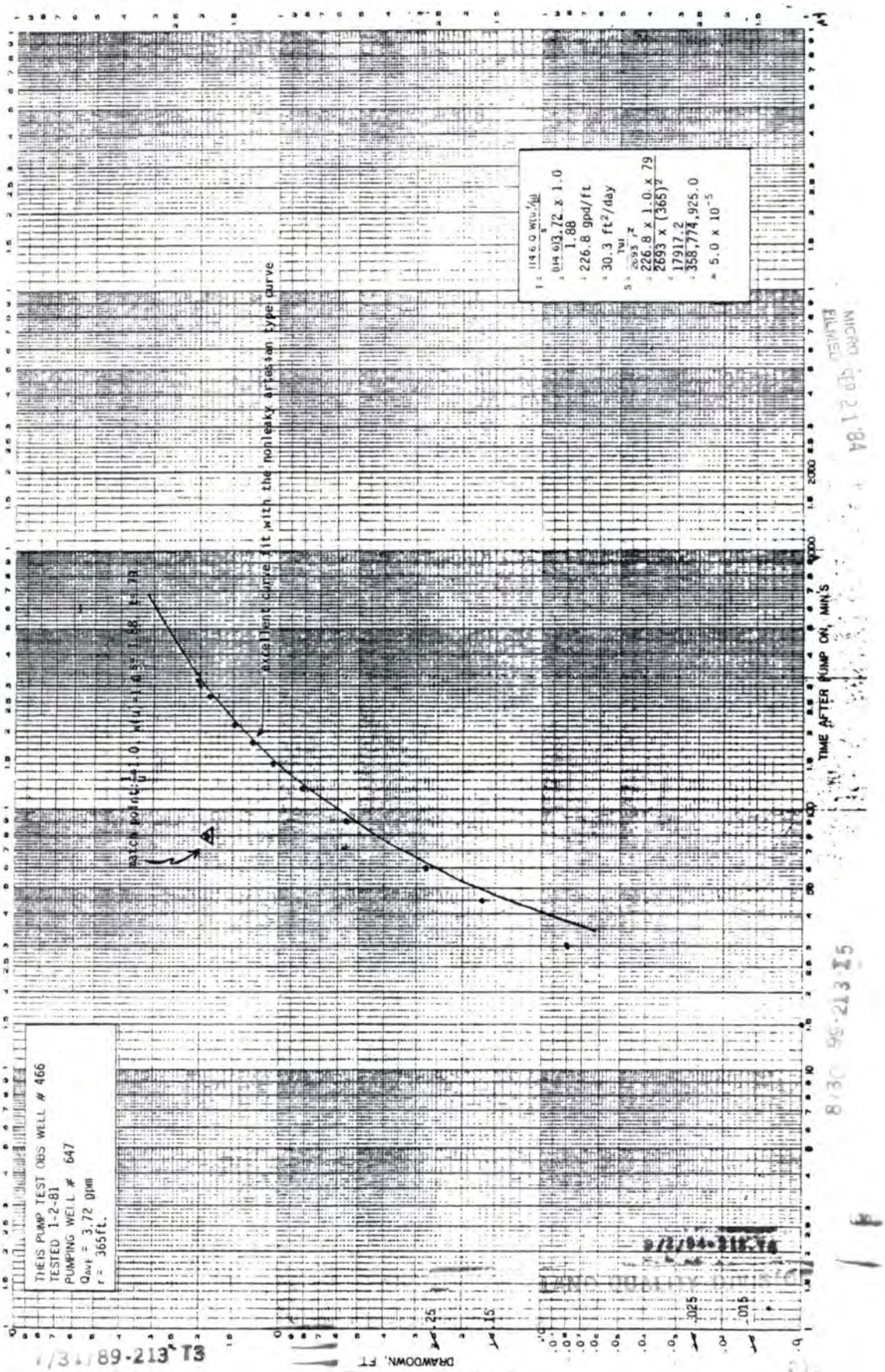

DEQ Ex. 3-1583

TFN 6 2/025
RECD 10-25-18

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MICRO
FILMED SEP 21 '84

SPOIL WELLS

B-30 89-213 T5
7/31/89-213-T3
9/2/94-213-T4
LAND QUALITY DIVISION
TFN 5/293 PERMIT
TFN 5 2/025
RECD 10-25-18

COAL AND EXPLORATION

Wyoming County Sheridan T. 57 (N) S., R. 84 (W), Sec. 22 WELL NO. obs. 655

nel Bondar & Gentry

Test Type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well

Owner PKS 5. Other (Specify)

ss Box 3049 Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 '84

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 172' - 212'

Pump hp & type Pump depth ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 183.80 How measured Galvanometer - Stevens Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7/21/81	0800	183.80	0			0
	0815	184.09	15			0.29
	0830	184.20	30			0.40
	0845	184.26	45			0.46
	0900	184.30	60			0.50
	0915	184.32	75			0.52
	0930	184.35	90			0.55
	0945	184.38	105			0.58
	1000	184.40	120			0.60
	1015	184.42	135			0.62
	1030	184.45	150			0.65
	1045	184.47	165			0.67
	1100	184.49	180			0.69
	1115	184.50	195			0.70
	1130	184.52	210			0.72
	1145	184.53	225	8/30/95-213-T3		0.73
	1200	184.54	240	7/31/89-213-T3		0.74
	1215	184.55	255			0.75
	1230	184.56	270	9/2/94-213-T4 LAND QUALITY DIVISION		0.76
	1245	184.57	285	RECEIVED DEC. 28. 1982		0.77
	1300	184.58	300	D6-353 TFN 1 5/293 PERMIT		0.78

213-T2

TFN 6 2/025

REED 10-25-18

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 (E) W., Sec. 22 WELL NO. obs. 655

Personnel Bondar and Gentry Test Type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well

Owner PKS 5. Other (Specify)

ss Box 3049 Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 '84

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 172' - 212'

Pump hp & type Pump depth ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 183.80 How measured galvanometer - Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1315	184.59	315			0.79
	1330	184.60	330			0.80
	1345	184.61	345			0.81
Pump Off	1400	184.62	360	0		0.82
	1415	184.28	375	15	25.00	0.48
	1430	184.20	390	30	13.00	0.40
	1445	184.16	405	45	9.00	0.36
	1500	184.13	420	60	7.00	0.33
	1515	184.11	435	75	5.80	0.31
	1530	184.09	450	90	5.00	0.29
	1545	184.07	465	105	4.43	0.27
	1600	184.05	480	120	4.00	0.25
	1615	184.04	495	135	3.67	0.24
	1630	184.02	510	150	3.40	0.22
	1645	184.01	525	165	3.18	0.21
	1700	183.99	540	180	3.00	0.19
	1730	183.97	570	210	2.71	0.17
	1800	183.95	600	240	2.50	0.15
	1830	183.94	630	270	2.33	0.14
	1900	183.93	660	300	2.20	0.13
	1930	183.92	690	330	2.09	0.12

9/2/94-213 TS
7/31/89-213 TS
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
D6-354
TFN 6 2/025
TFN 1 5/293 PERMIT
DEQR 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S, R. 84 (W) E, Sec. 22 WELL NO. obs. 655

Personnel Bondar and Gentry

Test Type: (1) Single well drawdown (2) Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ess Box 3049 Sheridan, WY Driller R. Reed

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

RECEIVED SEP 21 '84

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 172' - 212'

Pump hp & type Pump depth ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 183.80 How measured galvanometer - Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	2000	183.91	720	360	2.00	0.11
	2030	183.90	750	390	1.92	0.10
	2100	183.89	780	420	1.86	0.09
	2200	183.88	840	480	1.75	0.08
	2300	183.87	900	540	1.67	0.07
22/81	2400	183.86	960	600	1.60	0.06
	0100	183.85	1020	660	1.55	0.05
	0200	183.85	1080	720	1.50	0.05
	0300	183.84	1140	780	1.46	0.04
	0400	183.84	1200	840	1.43	0.04
	0500	183.83	1260	900	1.40	0.03
	0600	183.83	1320	960	1.38	0.03
	0700	183.82	1380	1020	1.35	0.03
	0800	183.82	1440	1080	1.33	0.02
	0900	183.82	1500	1140	1.32	0.02
	1000	183.82	1560	1200	1.30	0.02

7/31/89-213-T3

9/8/94-213-T4

LAND QUALITY DIVISION

RECEIVED DEC 30 1994

D6-355

213-T2

TFN 6 2/025

RECD 10-25-18

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WATER WELL 654

PUMPING RATE DATA

RECEIVED SEP 21 '84

3/4 h.p. Gould set at 220'. Could not measure drawdown with galvanometer

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7/21/81	0801	9.6	33.13	5.3	1	33.13
	0803	9.9	32.12	5.3	3	96.36
	0806	9.6	33.13	5.3	3	99.39
	0810	9.0	35.33	5.3	4	141.32
	0815	9.6	33.13	5.3	5	165.65
	0820	9.8	32.45	5.3	5	162.25
	0830	9.0	35.33	5.3	10	353.30
	0845	9.2	34.57	5.3	15	518.55
	0900	9.0	35.33	5.3	15	529.95
	0920	9.0	35.33	5.3	20	706.66
	0940	9.0	35.33	5.3	20	706.66
	1000	8.8	36.14	5.3	20	722.80
	1030	8.8	36.14	5.3	30	1084.20
	1100	8.4	37.86	5.3	30	1135.80
	1130	8.3	38.31	5.3	30	1149.30
	1200	8.3	38.31	5.3	30	1149.30
	1230	8.4	37.86	5.3	30	1135.80
	1300	8.2	38.78	5.3	30	1163.40
	1330	8.3	38.31	5.3	30	1149.30
	1400	8.3	38.31	5.3	30	1149.30
				TOTALS	361	13352.42

Total Avg. Q = 13,352.42 gal. / 361 min = 36.99 gal/min

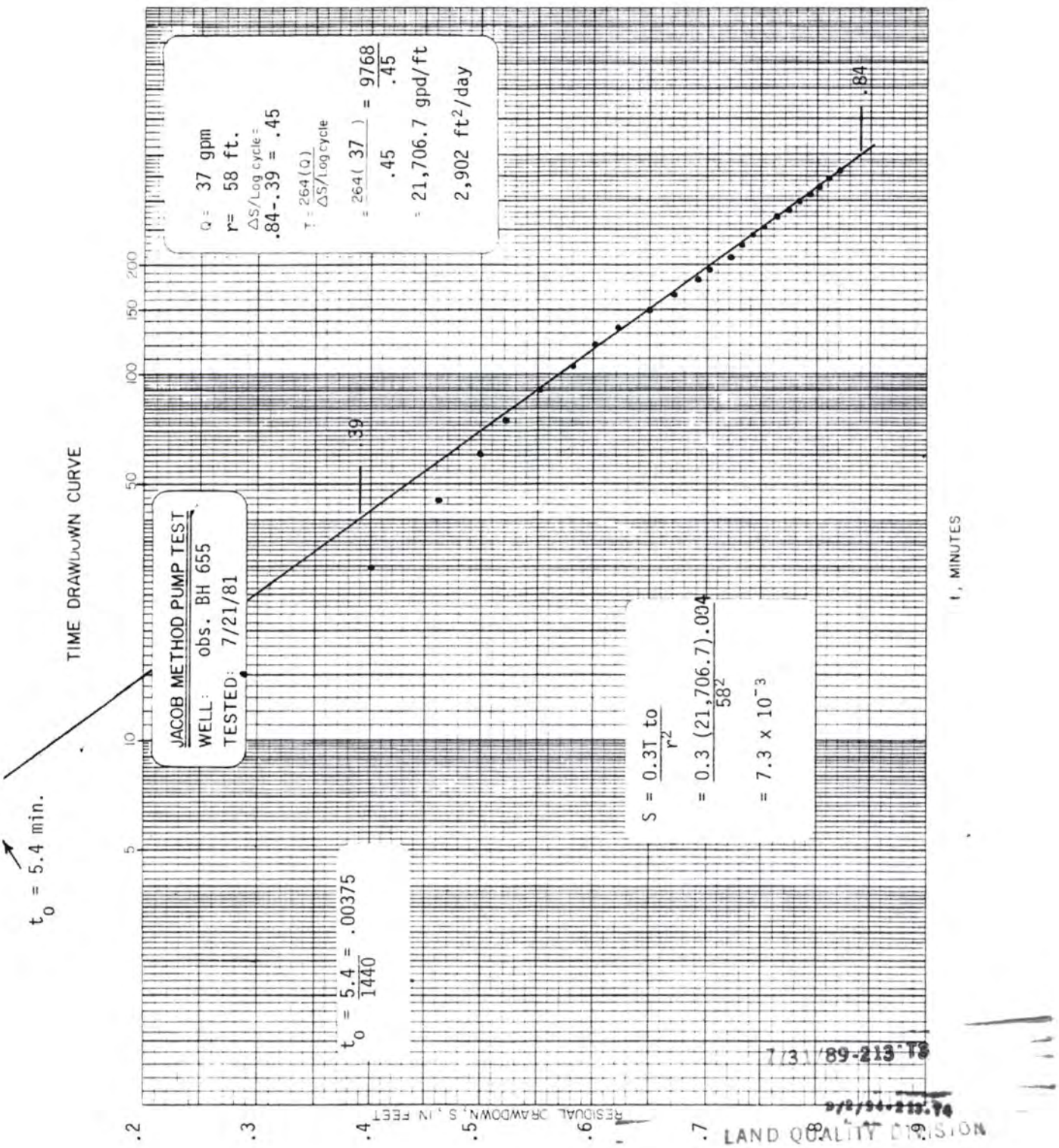
7/31/89-213 T3

9/2/94-213.T4

Specific Capacity, unknown

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
D6-356
TFN I 5/293 PERMIT 213-T2
TFN 6 2/025
RECD 10-25-18

MICRO FILMED SEP 21 '82



7/31/89-213 TS

LAND QUALITY DIVISION
RECEIVED DEC. 28. 1982
TFN 1 5/293 PERMIT

D6-357

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1589

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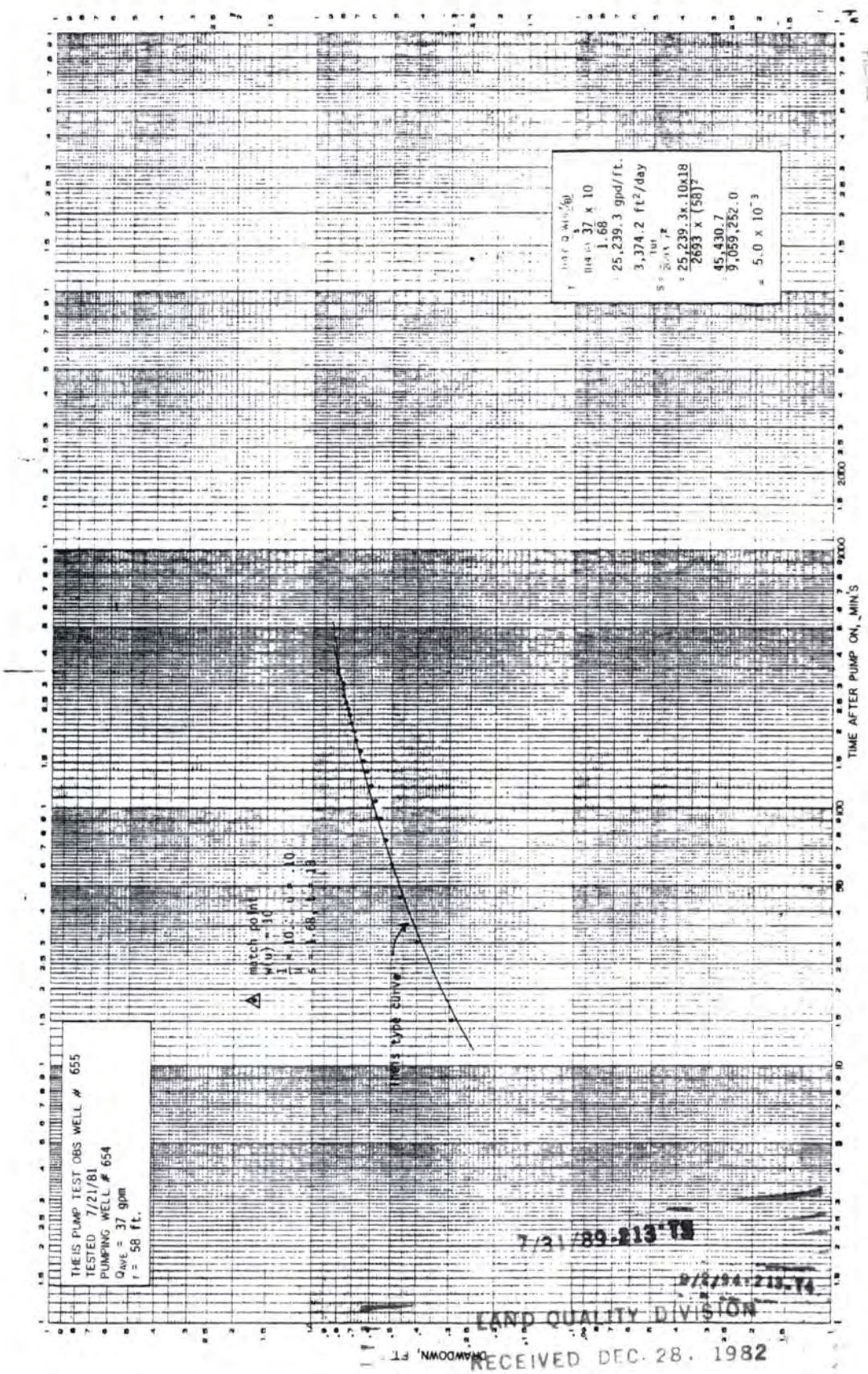


LAND QUALITY DIVISION
RECEIVED DEC. 28. 1982

D6-358

TFN 1 5/293 PERMIT

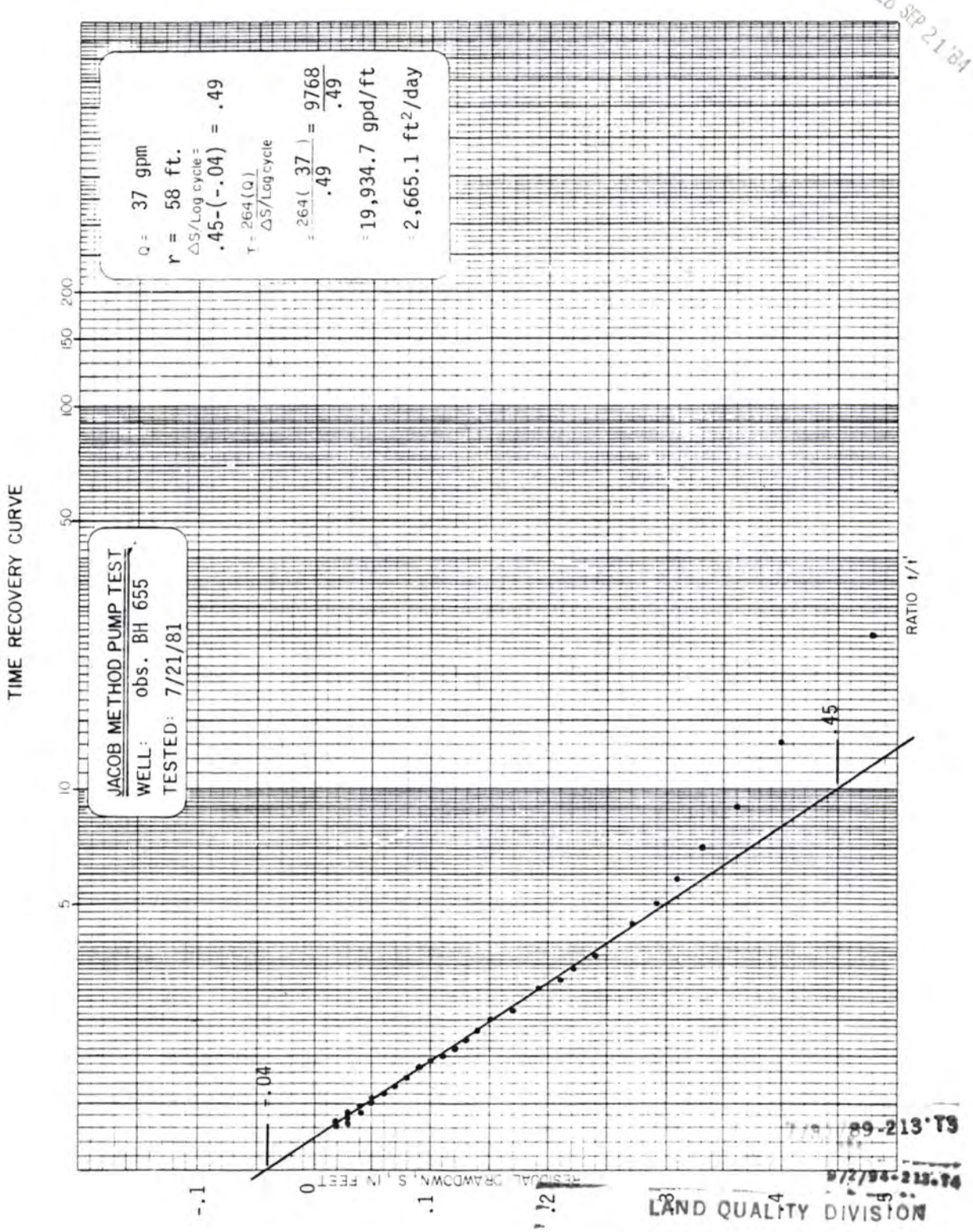
213-T2

TFN 6 2/025

RECD 10-25-18

DEQ Ex. 3-1590

MICRO FILMED SEP 21 84



89-213 TS
9/2/94-213.T4
LAND QUALITY DIVISION
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IFN 1 5/293 PERMIT
8/30 95-213-T5
D6-359
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1591

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MICRO FILMED SEP 21 '84

AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 22 WELL NO. obs. BH-655

Personnel Bondar and Gentry Test Type: (1) Single well drawdown (2) Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well

Owner PKS 5. Other (Specify)

Address P. O. Box 3049 - Sheridan, WY 82801 Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 172' - 212'

Pump hp & type Pump depth ft. Aquifer spoils

Aquifer lithology mixed shales Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP How measured galvanometer - Steven's Recorder

DATE	TIME	s, FT. EXTENDED DRAWDOWN	s', FT. RESIDUAL DRAWDOWN	TIME SINCE PUMP OFF t', MIN.		s - s', FT. CALCULATED RECOVERY
7-21-81	1400	.820	.82	0		
	1415	.830	.48	15		.35
	1430	.835	.40	30		.44
	1445	.842	.36	45		.48
	1500	.850	.33	60		.52
	1515	.850	.31	75		.55
	1530	.863	.29	90		.57
	1545	.870	.27	105		.60
	1600	.878	.25	120		.63
	1615	.882	.24	135		.64
	1630	.890	.22	150		.67
	1645	.896	.21	165		.69
	1700	.901	.19	180		.71
	1730	.910	.17	210		.74
	1800	.918	.15	240		.77
	1830	.925	.14	270		.79
	1900	.932	.13	300	89-213 TS	.80
	1930	.938	.12	330		.82
	2000	.941	.11	360		.83
	2030	.945	.10	390		.85
	2100	.949	.09	420		.86

LAND QUALITY DIVISION
RECEIVED DEC. 28, 1982
TFN 1 5/293 PERMIT
D6-360
TFN 6 2/025
RECD 10-25-18

AQUIFER TEST DATA

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 22 WELL NO. obs. BH-655

Personnel Bondar and Gentry Test Type: (1) Single well drawdown (2) Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well

ner PKS 5. Other (Specify)

A. .s P. O. Box 3049 - Sheridan, WY 82801 Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 '84

Total well depth 220 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slot Interval of screen or perforation 172' -212'

Pump hp & type Pump depth ft. Aquifer spoils

Aquifer lithology mixed shales Altitude of land surface 3740.6

How determined surveyed MP Above Below LSD Altitude MP

WL from MP How measured galvanometer - Steven's Recorder

DATE	TIME	s, FT. EXTENDED DRAWDOWN	s', FT. RESIDUAL DRAWDOWN	TIME SINCE PUMP OFF t', MIN.		s - s', FT. CALCULATED RECOVERY
	2200	.953	.08	480		.87
	2300	.956	.07	540		.89
7-22-81	2400	.962	.06	600		.90
	0100	.965	.05	660		.92
	0200	.970	.05	720		.92
	0300	.972	.04	780		.93
	0400	.973	.04	840		.93
	0500	.975	.03	900		.95

89-213 T3

9/2/94-213.T4

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT 213-T2

D6-361

TFN 6 27025

RECD 10-25-18

DEQ Ex. 3-1593

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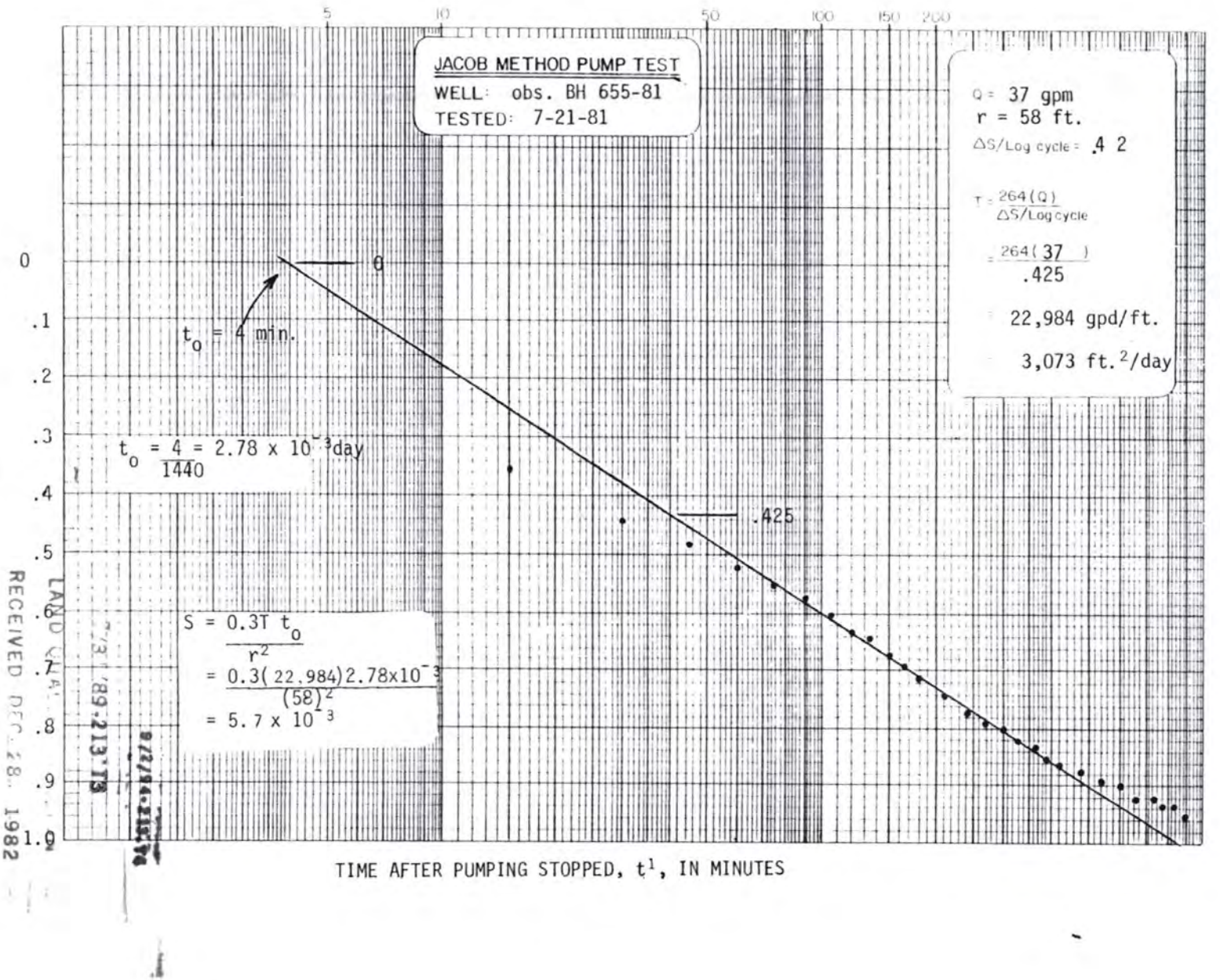
TIME RECOVERY CURVE

MICRO FILMED SEP 21 '84



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TFN 1 5/293 PERMIT
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1594

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N) S., R. 84 (E) W., Sec. 22 WELL NO. 656

Personnel Bondar and Gentry

Test Type: (1) Single well drawdown (2) Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Owner PKS

ss Box 3049 Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

FILMED SEP 21 '84

Total well depth 110 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 70' - 110'

Pump hp & type 3/4 Gould Pump depth 108 ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3653.2

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 75.50 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7/14/81	0910	75.50	0			0
	0911	78.25	1			2.75
	0913	81.10	3			5.60
	0916	85.15	6			9.65
	0920	88.72	10			13.25
	0925	91.63	15			16.13
	0930	91.82	20			16.32
	0935	92.23	25			16.73
	0940	92.49	30			16.99
	0950	94.07	40			18.57
	1000	95.15	50			19.65
	1010	96.31	60			20.81
	1020	97.06	70			21.56
	1030	99.00	80			23.50
	1040	101.85	90			26.35
Pump Off	1041	101.28	91	0		25.78
	1043	100.15	93	2	46.50	24.65
	1046	98.44	96	5	19.20	22.94
	1050	97.00	100	9	11.11	21.50
	1055	96.30	105	14	7.50	20.80
	1100	95.27	110	19	5.79	19.77

89-213 T3

D6-363

TFN 6 2/025

DEQ 10-25-18

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 (N), R. 84 (W), Sec. 22 WELL NO. 656

Personnel Bondar and Gentry

Test Type: (1) Single well drawdown (2) Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner PKS

Address Box 3049 Sheridan, WY

Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 '84

Total well depth 110 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 70' - 110'

Pump hp & type 3/4 Gould Pump depth 108 ft. Aquifer Spoils

Aquifer lithology reclaimed spoils Altitude of land surface 3653.2

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 75.50 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1110	92.12	120	29	4.14	16.62
	1120	90.25	130	39	3.33	14.75
	1130	89.10	140	49	2.86	13.60
	1145	87.45	155	64	2.42	11.95
	1200	85.74	170	79	2.15	10.24
	1220	84.35	190	99	1.92	8.85
	1240	83.50	210	119	1.76	8.00
	1300	82.22	230	139	1.65	6.72
	1320	81.40	250	159	1.57	5.90
	1340	80.27	270	179	1.51	4.77
	1400	79.67	290	199	1.46	4.17
	1420	79.40	310	219	1.42	3.90
	1440	79.23	330	239	1.38	3.73
	1500	79.16	350	259	1.35	3.66

'89-213 T3
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LAND QUALITY DIVISION
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REC'D 10-25-18
213-T2

WATER WELL 656

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7-14-81	0913	45.00	7.07	5.3	3	21.21
	0916	75.00	4.24	5.3	3	12.72
	0920	107.00	2.97	5.3	4	11.76
	0925	107.00	2.97	5.3	5	14.85
	0930	414.00	0.77	5.3	5	3.85
	0935	414.00	0.77	5.3	5	3.85
	0940	414.00	0.77	5.3	5	3.85
	0950	81.00	0.74	1.0	10	7.40
	1000	80.00	0.75	1.0	10	7.50
	1010	81.00	0.74	1.0	10	7.40
	1020	81.00	0.74	1.0	10	7.40
	1030	82.00	0.73	1.0	10	7.30
	1040	83.00	0.72	1.0	10	7.20
				TOTALS	90	116.29

TOTAL AVG. Q= 116.29 gal. / 90 min. = 1.29 gpm

SPECIFIC CAPACITY = 1.29 gpm / 25.78 ft = 0.05 gpm/ft.

1/3 /89-213 TS

LAND QUALITY DIVISION

RECEIVED DEC. 28 1982

TFN 1 6/293 PERMIT

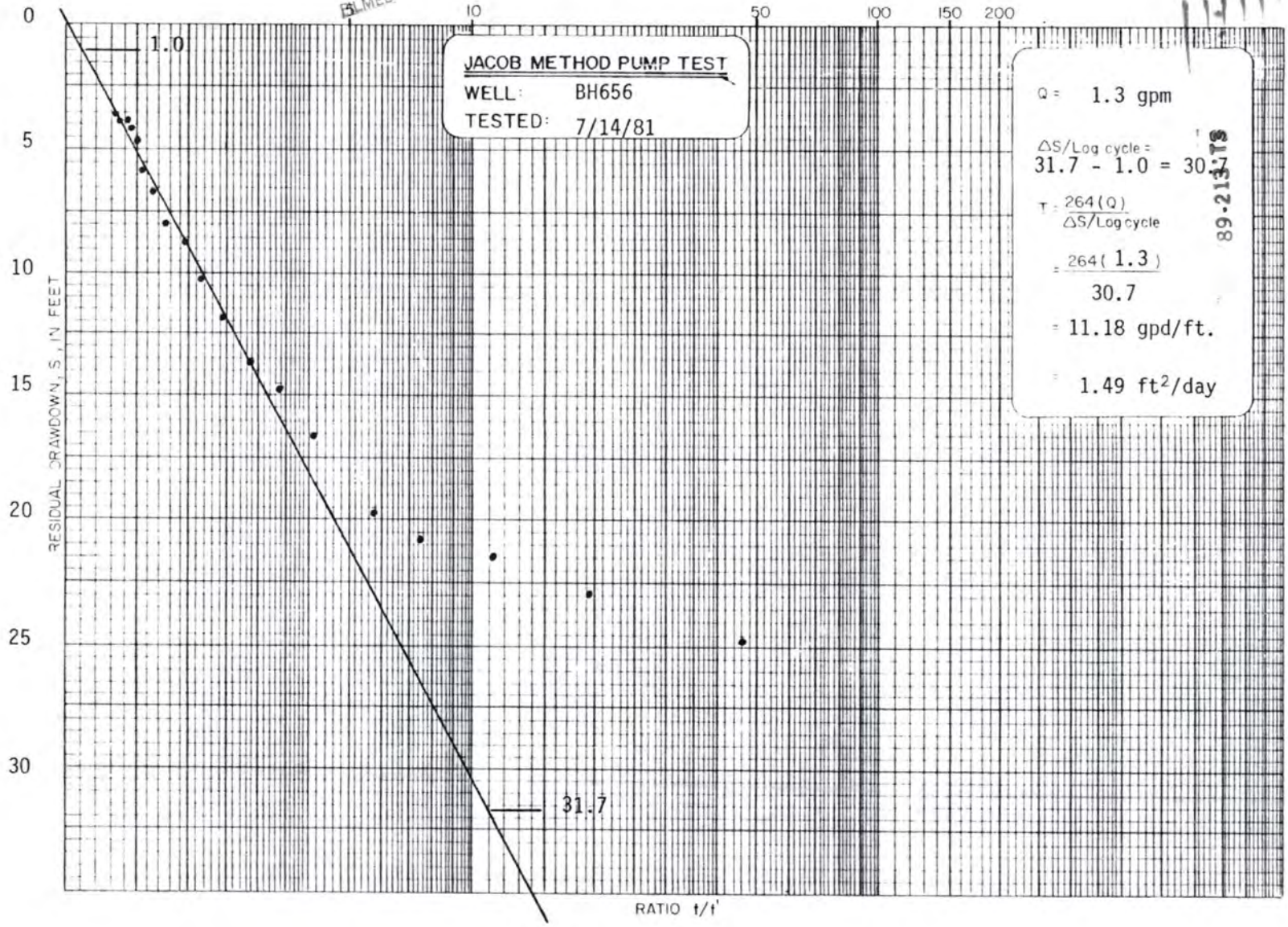
TFN 6 2/025

REED 10-25-18

Brook Mine

MICRO FILMED SEP 21 '84

TIME RECOVERY CURVE



89-213-TS
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
D6-366
TFN 2/025
RECD 10-25-18
8/30 99-213-TS

Addendum D6-14-55

October 2018

RAMACO

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KS RESOURCE DEVELOPMENT

AQUIFER TEST
SLUG METHOD

tate Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 Well No. BH 657-81

ell Owner PKS Test Personnel Collier, Jones

dd Sheridan, WY Driller R. Reed

ot. ell Depth 80 Ft. Well Diameter 7 7/8 in. Casing Diameter 5 in. Casing Type PVC

ype of Screen Perforation saw slots Interval of Screen Perforation 40' - 80'

olume injected/removed 10.6 gal. Pump hp & type 1 hp. Gould's Pump Depth 75 Ft.

quifer reclaimed spoils Aquifer Lithology mixed shales

ltitude of Land Surface 3627.8 How Determined surveyed

WL from MP 67.40 How Measured galvanometer

MICRO FILMED SEP 21 '84

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP OFF, t, min.	TIME SINCE PUMP OFF, t, sec.	H $H=SWL_j-SWL_t$	H/Ho
10-6-81	1351	77.75	0	0	10.35	1.00
	1352	76.77	1	60	9.37	.91
	1353	76.38	2	120	8.98	.87
	1354	75.87	3	180	8.47	.82
	1356	74.79	5	300	7.39	.71
	1358	73.80	7	420	6.40	.62
	1400	72.96	9	540	5.56	.54
	1403	72.10	12	720	4.70	.45
	1406	71.39	15	900	3.99	.39
	1410	70.64	19	1140	3.24	.31
	1415	70.11	24	1440	2.71	.26
	1425	69.45	34	2040	2.05	.20
	1443	69.12	52	3120	1.72	.17
	1503	68.93	72	5184	1.53	.15
	1526	68.68	95	5700	1.28	.12

7/3 /89-213 T3

8/30 99-213 T5 9/3/94-213-T6

LAND

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TFN 1 5/293 PERMIT 213-T2

TFN 5-2/025

RECD 10-25-18

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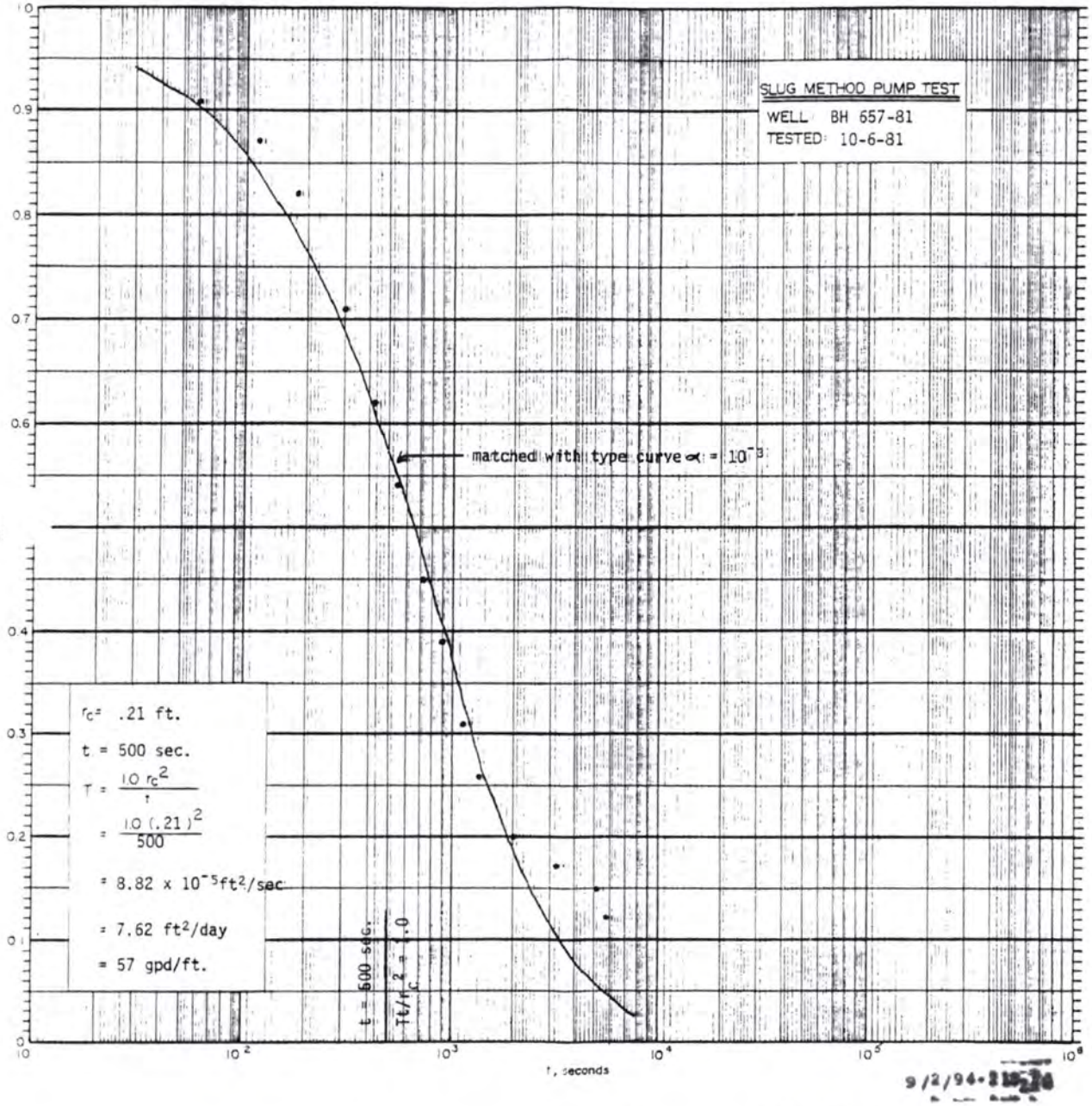
MICRO FILMED SEP 21 '84

INSTANTANEOUS DISCHARGE OR RECHARGE CURVE



9/2/94-BH-36

LAND QUALITY DIVISION
RECEIVED DEC. 28, 1982
TFN 1 5/293 PERMIT 89-213-T3

89-213-T3

TFN 6 2/025
10-25-18

AQUIFER TEST DATA

:S GEOLOGY AND EXPLORATION

:ate Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. BH 657-81

:ersonnel Collier, Bowlby Test Type: (1) Single well drawdown (2) Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well

:ell Owner PKS 5. Other (Specify)

:dr Sheridan, Wyoming Driller R. Reed

:etho. .rilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 '84

:otal well depth 80 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

:ype of screen or perforation saw slots Interval of screen or perforation 40' - 80'

:ump hp & type ½ Goulds Pump depth 78 ft. Aquifer reclaimed spoils

:quifer lithology shales Altitude of land surface 3627.8

:ow determined surveyed MP Above / Below LSD Altitude MP

:WL from MP 70.05 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
-10-82	1230	70.05	0			0
	1232	71.54	2			1.49
	1233	71.71	3			1.66
	1234	71.85	4			1.80
	1235	72.03	5			1.98
	1237	72.22	7			2.17
	1240	72.46	10			2.41
	1245	72.90	15			2.85
	1250	72.99	20			2.94
	1305	73.05	35			3.00
	1315	73.34	45			3.29
	1324	74.00	54			3.95
	1341	74.43	71			4.38
	1400	74.71	90			4.66
	1430	75.02	120			4.97
UMP OFF	1507	75.33	157	0		5.28
	1508	74.95	158	1	158	4.90
	1512	73.25	162	5	32.40	3.20
	1514	72.80	164	7	23.43	2.75
	1518	72.20	168	11	15.27	2.15

LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT

D6-369
TFN 6 2/025
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AQUIFER TEST DATA
CONTINUATION SHEET

Well No. BH 657-81

Test Date 8-10-82

MICRO FILMED SEP 21 '84

Page 2 of 2.

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1524	71.68	174	17	10.24	1.63
	1530	71.27	180	23	7.83	1.22
	1537	70.92	187	30	6.23	0.87
	1545	70.57	195	38	5.13	0.52

89-213 T3

LAND QUALITY DIVISION
RECEIVED DEC 28. 1982
TFN I 5/293 PERMIT 213-T2

WATER WELL BH 657-81 MICRO FILMED SEP 21 '84

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
8-10-82	1240	454	.70	5.3	10	7.00
	1245	46	.65	0.5	5	3.23
	1305	566	.53	5.3	20	10.60
	1324	42	.71	0.5	19	13.57
	1341	46	.65	0.5	17	11.05
	1400	46	.65	0.5	19	12.35
	1430	46	.65	0.5	30	19.50
	1507	46	.65	0.5	37	24.05
				TOTALS	157	101.35

Average Q = $\frac{101.35}{157}$ = 0.65 gpm

Specific capacity - $\frac{0.65 \text{ gpm}}{5.28 \text{ ft.}}$ = .12 gpm/ft.

B/30 99-213 TS

3-89-213-TS

LAND QUALITY DIVISION

RECEIVED DEC. 28, 1982

TFN 1 5/293 PERMIT

TFN'S 2/025

REC'D 10-25-18

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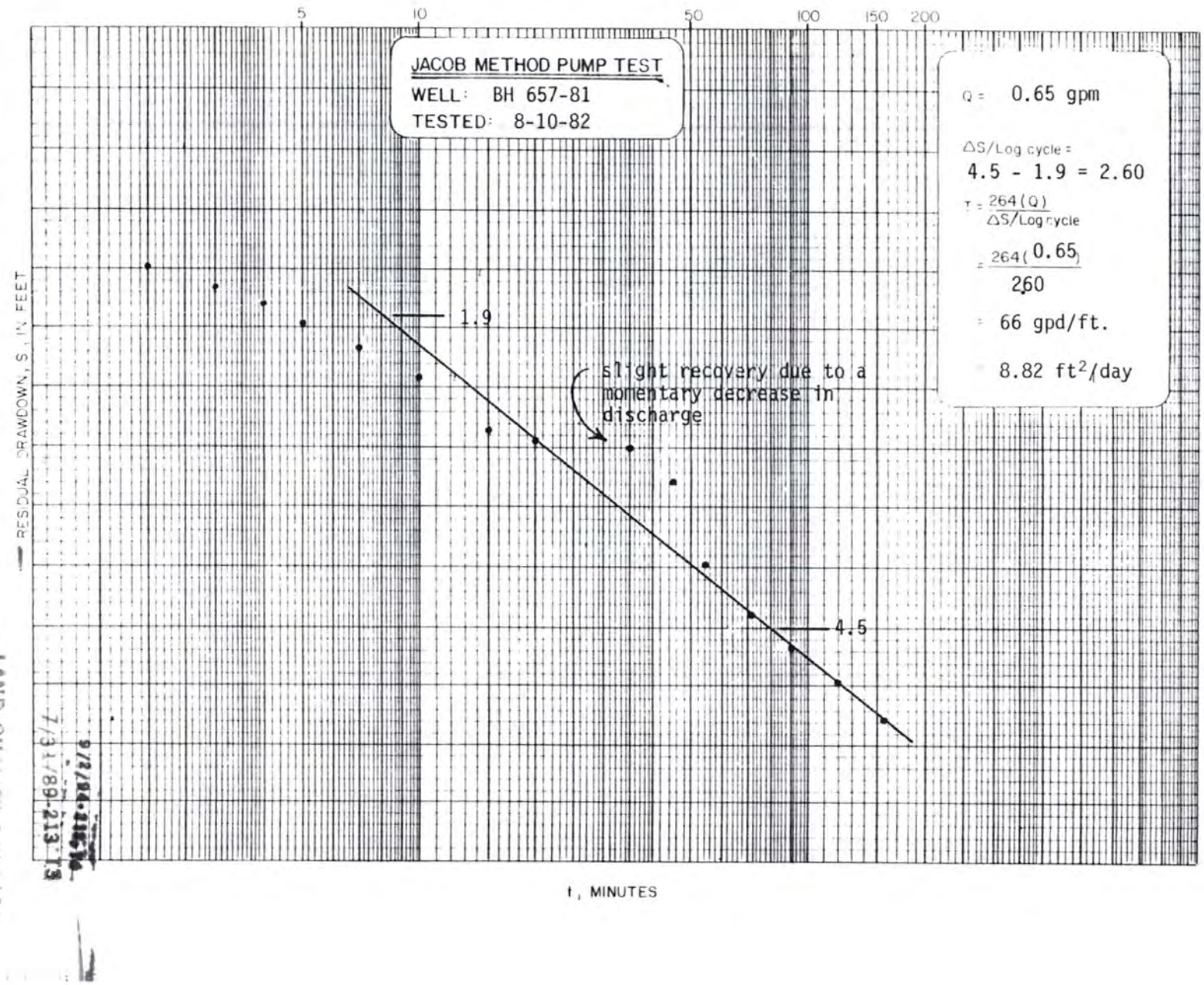
TIME DRA N CURVE

MICRO FILMED SEP 21 '84



LAND QUALITY DIVISION
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TFR 5 27025
RECD 10-25-18

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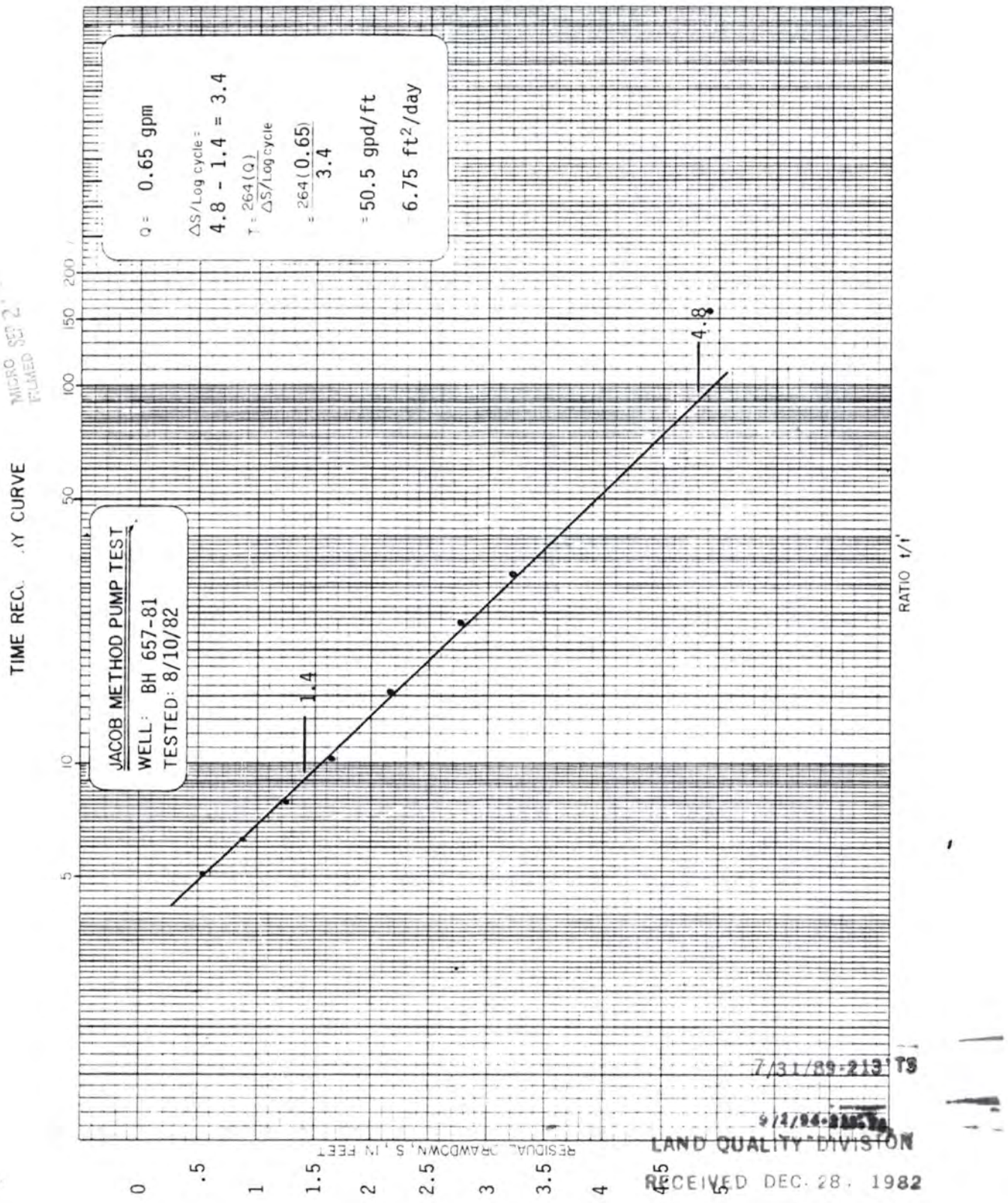

MICRO SEC 2
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7/31/89-213 TS

LAND QUALITY DIVISION
RECEIVED DEC. 28, 1982
TFN 1 5/293 PERMIT

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1605

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KS RESOURCE DEVELOPMENT

AQUIFER TEST
SLUG METHOD

tate Wyoming County Sheridan T. 57 (N) S., R. 84 (E) W., Sec. 15 Well No. BH 658-81

ell Owner PKS Test Personnel Collier, Jones

dd Sheridan, Wyoming Driller R. Reed

ot. ell Depth 80 Ft. Well Diameter 7 7/8 in. Casing Diameter 5 in. Casing Type PVC

ype of Screen Perforation saw slots Interval of Screen Perforation 40' - 80'

olume injected/removed 13.1 gal Pump hp & type 1 hp Goulds Pump Depth 75 Ft.

quifer reclaimed spoils Aquifer Lithology mixed shales

ltitude of Land Surface 3622.5 How Determined surveyed

WL from MP 64.17 How Measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP OFF, t, min.	TIME SINCE PUMP OFF, t, sec.	H $H=SWL_j-SWL_t$	H/Ho
10-6-81	1120	76.99	0	0	12.82	1.00
	1121	76.64	1	60	12.47	.97
	1122	75.87	2	120	11.70	.91
	1123	75.14	3	180	10.97	.86
	1124	74.33	4	240	10.16	.79
	1126	73.04	6	360	8.87	.69
	1128	72.20	8	480	8.03	.63
	1130	71.85	10	600	7.68	.60
	1133	71.10	13	780	6.93	.54
	1136	69.97	16	960	5.80	.45
	1140	69.31	20	1200	5.14	.40
	1145	68.68	25	1500	4.51	.35
	1155	67.75	35	2100	3.58	.28
	1205	67.13	45	2700	2.96	.23
	1220	66.49	60	3600	2.32	.18
	1240	65.77	80	4800	1.60	.12
	1310	65.35	110	6600	1.18	.09
	1315	65.29	115	6900	1.12	.09

MP 39 SEP 21 '84

7/31/89-213-T3

LAND QUALITY DIVISION

RECEIVED DEC 19 1989

TFN 1 5/2 93 PERMIT 213-T2

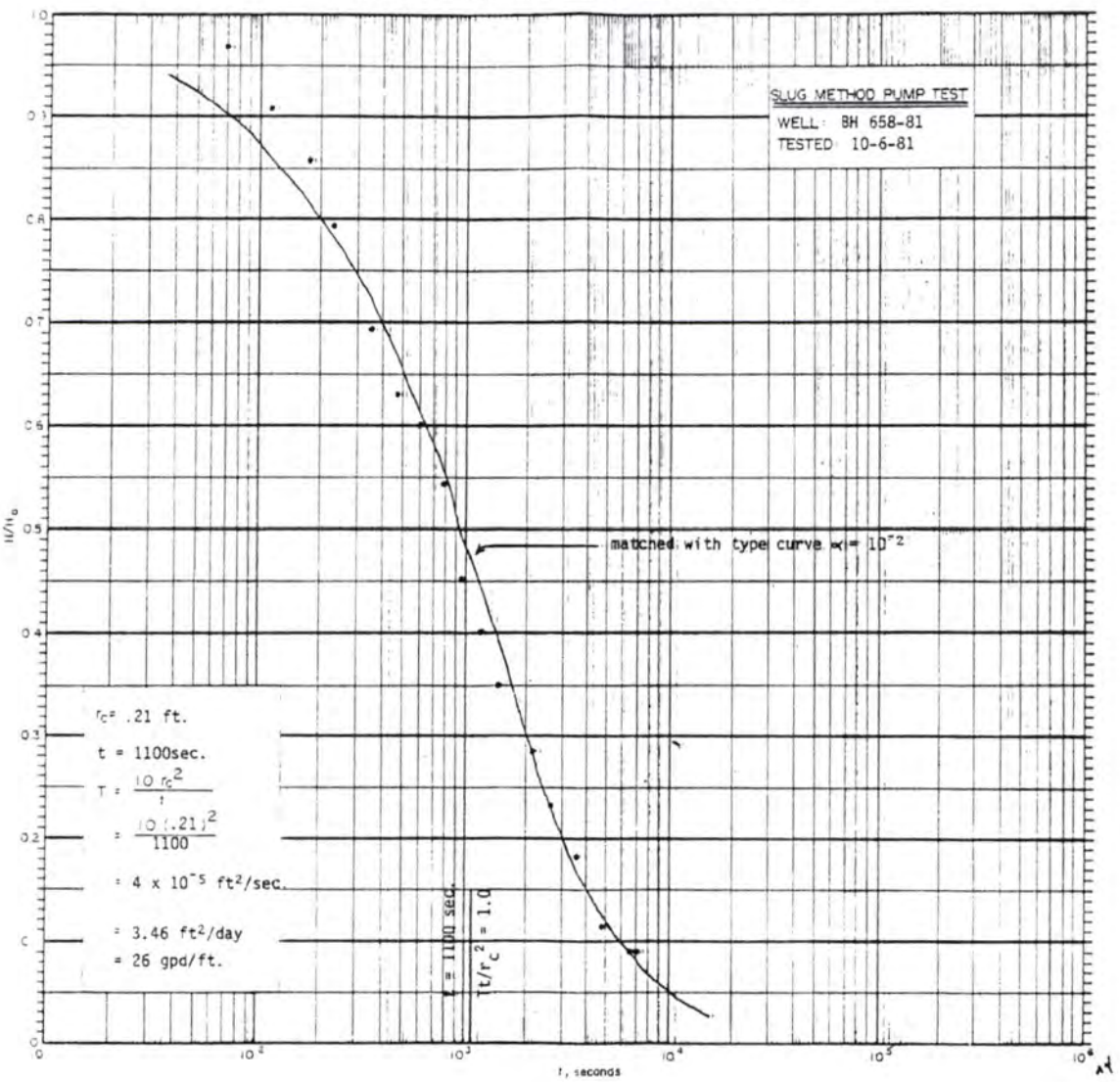
D6-37h

TFN 6 2/025

REED 10-25-18

MICRO FILMED SEP 21 '84

INSTANTANEOUS DISCHARGE OR RECHARGE CURVE



89-213 T3

9/2/94

8/30 99 213 T3

213-T2

D6-375

TFN 6 2/025

10-25-18

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AQUIFER TEST DATA

S GEOLOGY AND EXPLORATION

ate Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. BH 745-82

rsonnel Collier, Andersen Test Type: 1. Single well drawdown 2. Single well recovery (3) Drawdown with obs. well (4) Recovery with obs. well

ll Owner PKS 5. Other (Specify)

di Sheridan, Wyoming Driller D. Fudge

thod drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 '84

tal well depth 84 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

pe of screen or perforation Saw slots Interval of screen or perforation 64' - 84'

mp hp & type 3/4 Goulds Pump depth 78 ft. Aquifer reclaimed spoils

uifer lithology shales Altitude of land surface

w determined MP Above Below LSD Altitude MP

WL from MP 58.50 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7- 9-82	0955	58.50	0			0
	0955:30	59.55	0.5			1.05
	0956	59.78	1			1.28
	0957	59.85	2			1.35
	0959	60.11	4			1.61
	1001	60.51	6			2.01
	1004	60.81	9			2.31
	1008	60.94	12			2.44
	1013	60.82	17			2.32
	1020	60.89	24			2.39
	1030	60.90	34			2.40
	1045	61.09	49			2.59
	1115	61.29	79			2.70
	1200	61.22	124	8/30/89-213 TS		2.72
	1300	61.27	184	7/31/89-213 TS		2.77
Pump Off	1400	61.22	244	0	-	2.72
	1400:30	60.29	244.5	0.5	489	1.79
	1401	59.66	245	1	245	1.16
	1402	58.83	246	2	123	0.33
	1403	58.55	247	3	82.33	0.05

9/2/94-213 TS

LAND QUALITY DIVISION
RECEIVED DEC 28 1992

TFN 6 2/025

AQUIFER TEST DATA
CONTINUATION SHEET

FILMED SEP 21 '84

Well No. BH 745-82

Test Date 7- 9-82

Page 2 of 2 .

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1405:30	58.55	249.5	5.5	45.36	0.05
	1406:30	58.55	250.5	6.5	38.54	0.05
	1410	58.54	254	10	25.40	0.04
	1420	58.53	264	20	13.20	0.03
	1440	58.52	284	40	7.10	0.02

8/30/99-213 T5
7/31/89-213 T5
9/2/94-213 T5
LAND QUALITY DIVISION
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TFN 2 5/293 PERMIT

D6-377

TFN 6 2/025
RECD 10-25-18

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WATER WELL BH 745-81

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7- 9-82	0955:30	23	1.30	0.5	0.5	0.65
	0959	17	1.76	0.5	3.5	6.16
	1004	16	1.88	0.5	5.0	9.40
	1008	19	1.58	0.5	4.0	6.32
	1017	19	1.58	0.5	9.0	14.22
	1030	18	1.67	0.5	13.0	21.71
	1045	18	1.67	0.5	15.0	25.05
	1115	18	1.67	0.5	30.0	50.10
	1200	18	1.67	0.5	45.0	75.15
	1300	18	1.67	0.5	60.0	100.20
	1400	18	1.67	0.5	60.0	100.20
				TOTALS	245	409.16

Average Q = $\frac{409.16}{245}$ = 1.67 gpm

Specific capacity = $\frac{1.67 \text{ gpm}}{2.77 \text{ ft.}}$ = .60 gpm/ft.

7/31/89-213 T3

8/30 95 213 T5

9/2/94-213-T6

LAND QUALITY DIVISION

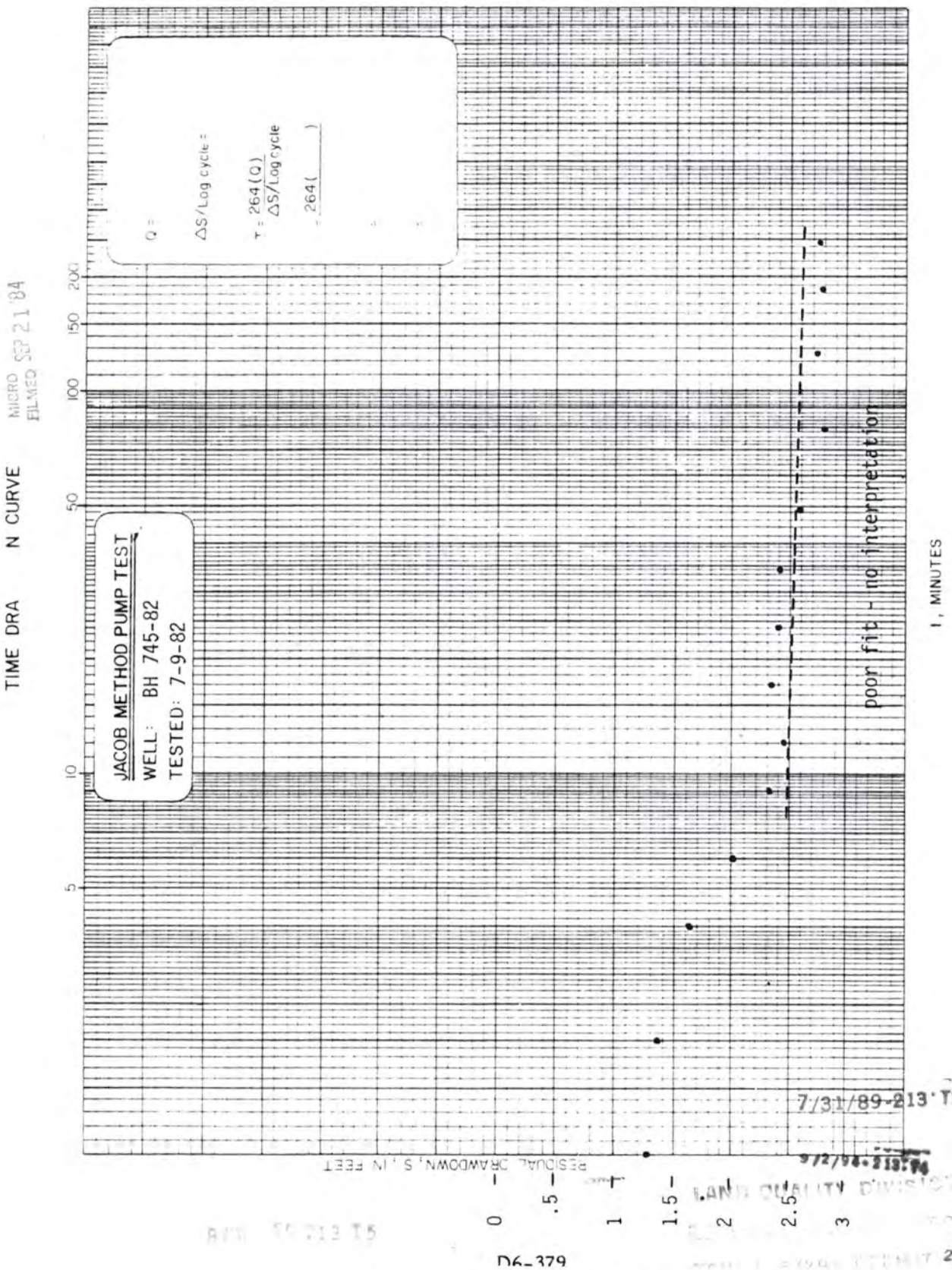
RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT

213-T2

TFN 6 2/025

DECD 10-25-18



DEQ Ex. 3-1611

TFN 6 2/025
RECD 10-25-18

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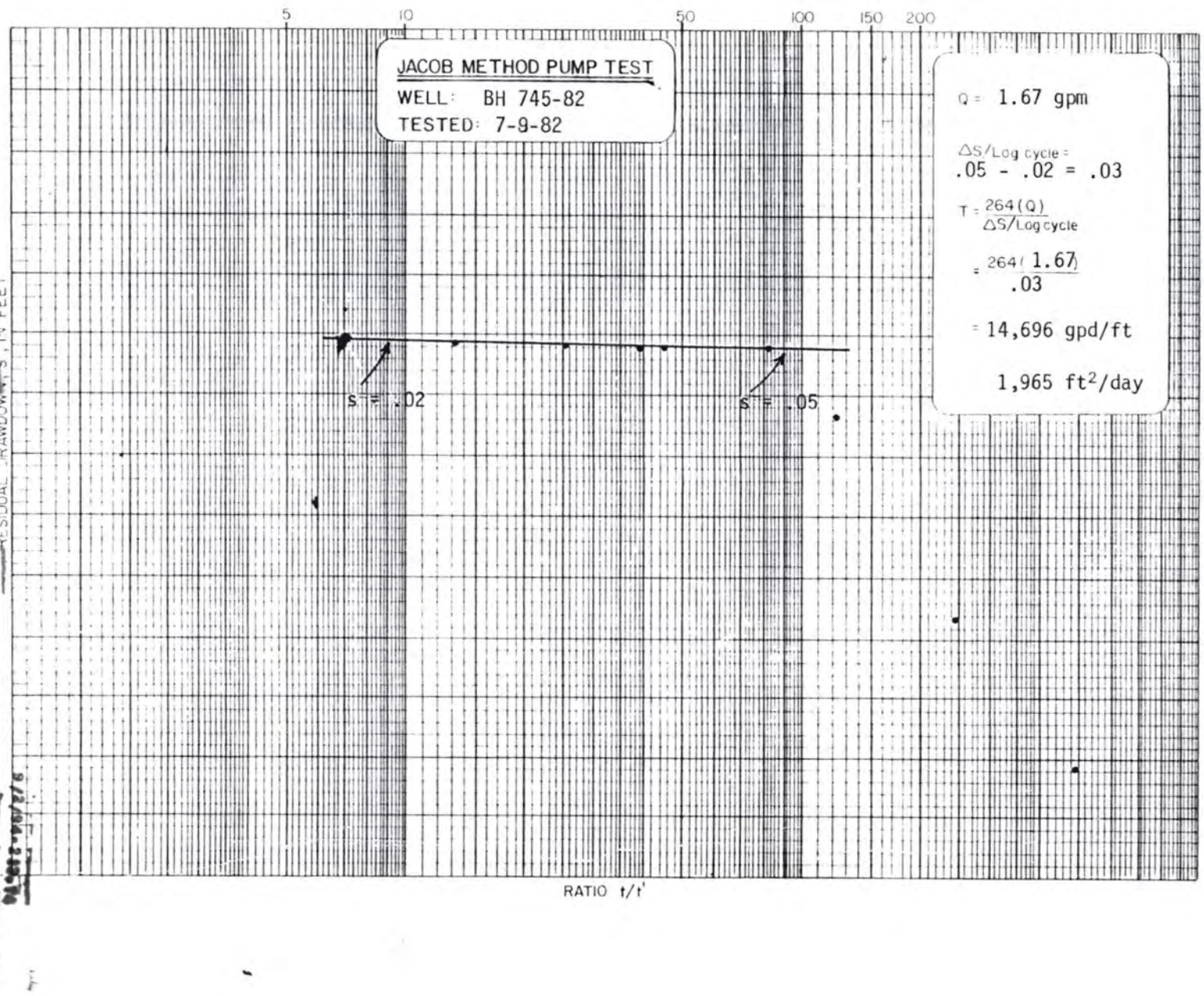
TIME RECOVERY CURVE



7/31/89-213-T3
8 30 89-213 T5
D6-380
TFN 5 2/025
RECD 10-25-18
LAND QUALITY DIVISION
RECEIVED DEC 28, 1982
TFN 1 5/293 PERMIT 21

DEQ Ex. 3-1612

AQUIFER TEST DATA

KS GEOLOGY AND EXPLORATION

tate Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. obs. BH 746-81

ersonnel Collier - Andersen Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5) Other (Specify) obs. well drawdown

ell Owner PKS

dd Sheridan, Wyoming Driller D. Fudge

ethod Drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

otal well depth 83 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

ype of screen or perforation saw slots Interval of screen or perforation 63' - 83'

ump hp & type N/A Pump depth -- ft. Aquifer reclaimed spoils

quifer lithology shales Altitude of land surface

ow determined MP Above Below LSD Altitude MP

WL from MP 60.32 How measured Galvanometer and Stevens Recorder

MICRO FILMED SEP 21 94

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7- 9-82	0956	60.340	1			0.020
	0957	60.348	2			0.028
	1000	60.358	5			0.038
	1005	60.369	10			0.049
	1010	60.372	15			0.052
	1015	60.375	20			0.055
	1020	60.376	25			0.056
	1025	60.378	30			0.058
	1030	60.379	35			0.059
	1035	60.380	40			0.060
	1040	60.380	45			0.060
	1045	60.381	50			0.061
	1050	60.381	60			0.061
	1155	60.382	120			0.062
	1255	60.383	180			0.063
Pump off	1400	60.384	244			0.064

7-9-82-213-T3

8 30 95 213 I5

9/2/94-213-T4

LAND QUALITY DIVISION

213-T2

TFR 6 2/025

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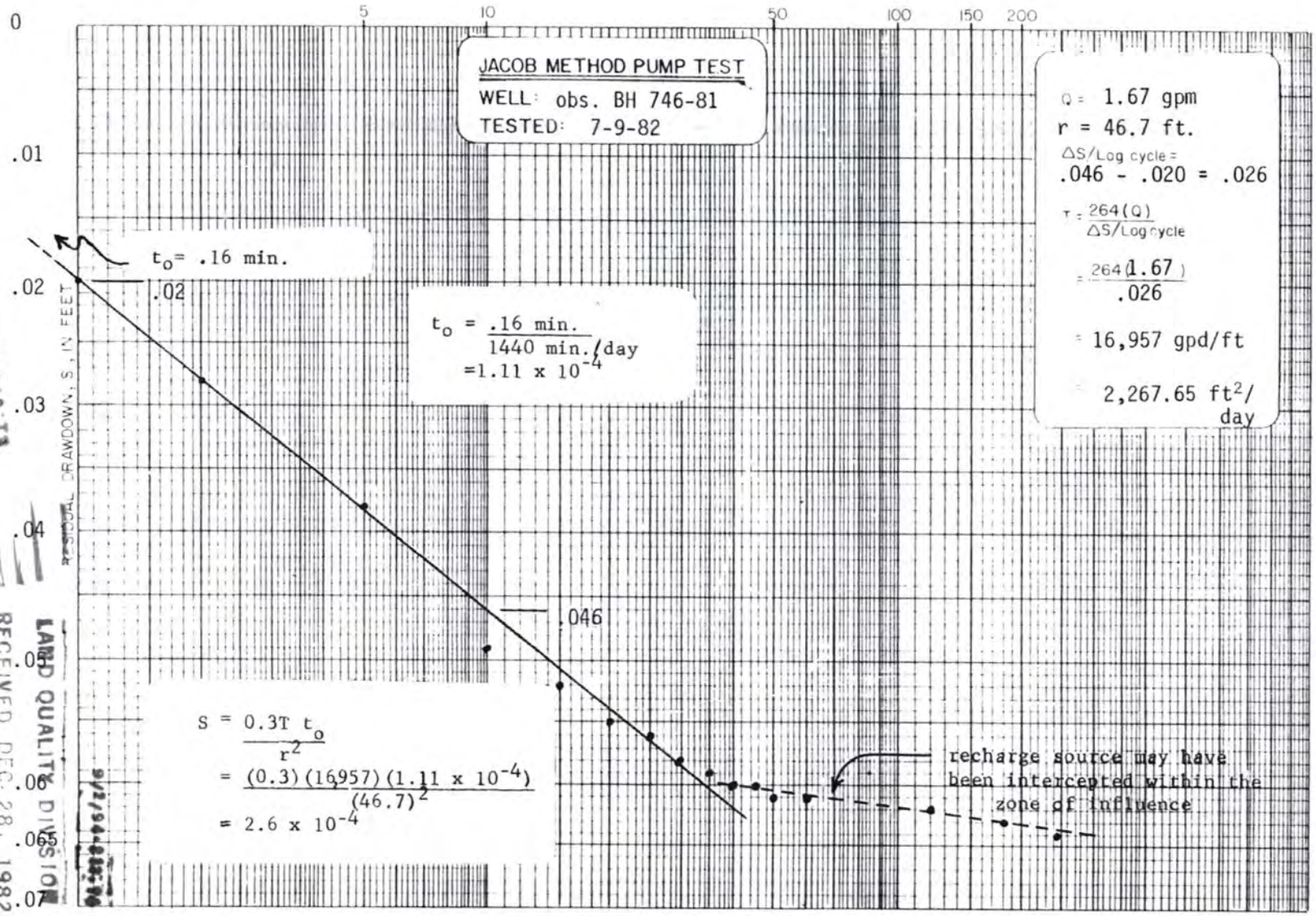
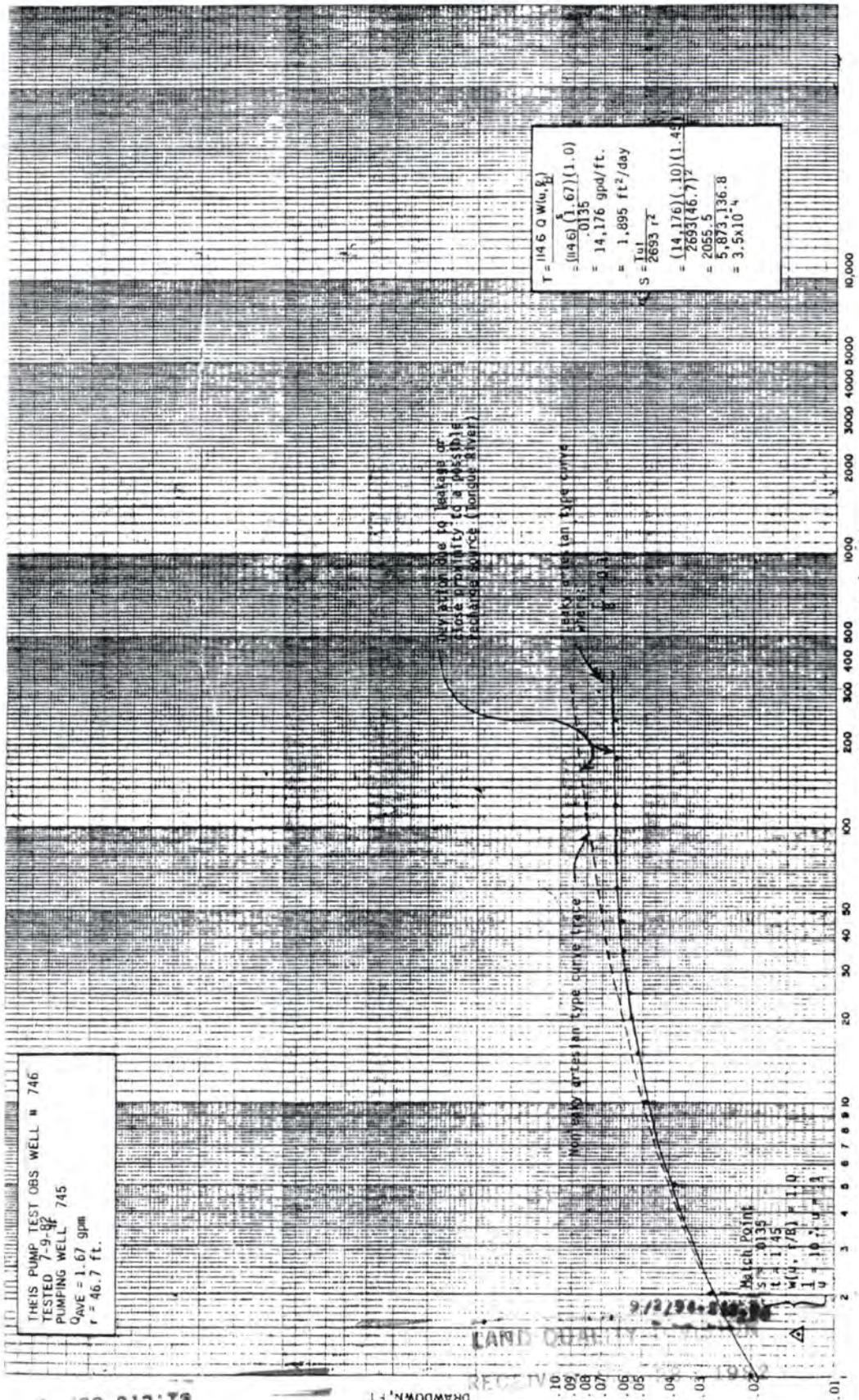
TIME DRAWDOWN CURVE

MICRO FILMED SEP 21 '84



7/31/89-213 T3
TFN 6 2/025
RECEIVED DEC 28 1982
LAND QUALITY DIVISION
RECD 10-25-18
8/30 99-213 I5

DEQ Ex. 3-1614



89-213 T3

D6-383

MICRO FILMED SEP 27 '89

LAND QUALITY DIVISION

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TFN 5 2/25 PERMIT

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1615

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AQUIFER TEST DATA

KS GEOLOGY AND EXPLORATION

tate Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. obs. BH 746-81

ersonnel Collier - Anderson Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well (5) Other (Specify) obs. well recovery

ell Owner PKS

dd Sheridan, WY Driller D. Fudge

ethod Drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

MICRO FILMED SEP 21 '84

otal well depth 83 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

ype of screen or perforation saw slots Interval of screen or perforation 63' - 83'

ump hp & type N/A Pump depth - ft. Aquifer reclaimed spoils

quifer lithology Shales Altitude of land surface

low determined MP Above Below LSD Altitude MP

WL from MP How measured Galvanometer and Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
-9-82	1400	60.384	244	0	-	0.064
	1405	60.355	249	5	49.80	0.035
	1410	60.347	254	10	25.40	0.027
	1415	60.344	259	15	17.27	0.024
	1420	60.342	264	20	13.20	0.022
	1425	60.340	269	25	10.76	0.020
	1430	60.339	274	30	9.13	0.019
	1435	60.339	279	35	7.97	0.019
	1440	60.338	284	40	7.10	0.018
	1445	60.337	289	45	6.42	0.017
	1450	60.337	294	50	5.88	0.017
	1455	60.336	299	55	5.44	0.016
	1500	60.336	304	60	5.07	0.016
	1530	60.335	334	90	3.71	0.015
	1600	60.334	364	120	3.03	0.014
	1800	60.332	484	240	2.02	0.012

9/2/94-213-T2

7/31/89-213-T2

LAND QUALITY DIVISION

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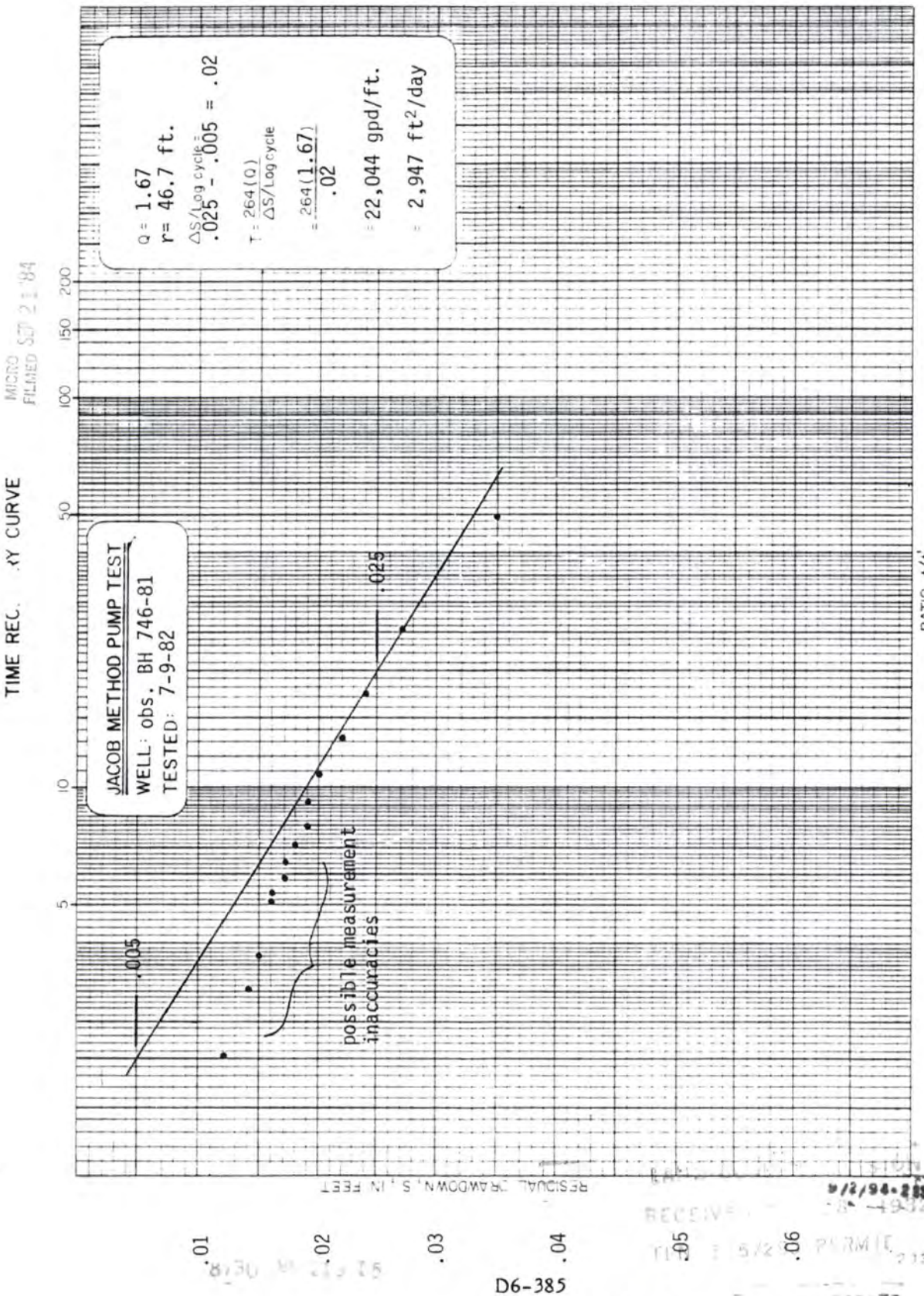
TFN 1 5/293 PERMIT 213-T2

8/30/89-213-T2

TFN 6 2/025

DECD 10-25-18



MICRO FILMED SEP 21 '84

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PERMIT

D6-385

YFN G 2/025
RECD 10-25-18

DEQ Ex. 3-1617

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AQUIFER TEST DATA

KS GEOLOGY AND EXPLORATION

tate Wyoming County Sheridan T. 57 (N) S., R. 84 E. (W), Sec. 15 WELL NO. obs. BH 746-81

ersonnel Collier - Andersen Test Type: 1. Single well drawdown 2. Single well recovery
3. Drawdown with obs. well (4) Recovery with obs. well

ell Owner PKS 5. Other (Specify)

dd Sheridan, Wyoming Driller D. Fudge

ethod Drilled: A. Air-rotary D. Dug P Air-percussion V. Driven
B. Bored or augered (H) Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 '84

otal well depth 83 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

ype of screen or perforation saw slots Interval of screen or perforation 63' - 83'

ump hp & type N/A Pump depth -- ft. Aquifer reclaimed spoils

quifer lithology shales Altitude of land surface

low determined MP Above Below LSD Altitude MP

WL from MP How measured Galvanometer and Steven's Recorder

DATE	TIME	s, FT. EXTENDED DRAWDOWN	s', FT. RESIDUAL DRAWDOWN	TIME SINCE PUMP OFF t', MIN.		s - s', FT. CALCULATED RECOVERY
7-9-82	1400	.064	.064	0		-
	1405	.064	.035	5		.029
	1410	.064	.027	10		.037
	1415	.064	.024	15		.040
	1420	.064	.022	20		.042
	1425	.064	.020	25		.044
	1430	.064	.019	30		.045
	1435	.064	.019	35		.045
	1440	.065	.018	40		.047
	1445	.065	.017	45		.048
	1450	.065	.017	50		.048
	1455	.065	.016	55		.049
	1500	.065	.016	60		.049
	1515	.065	.015	75		.050
	1545	.066	.014	105		.052
	1615	.066	.013	135		.053

9/2/94-213-T2

LAND QUALITY DIVISION

8-30 99-213 T2

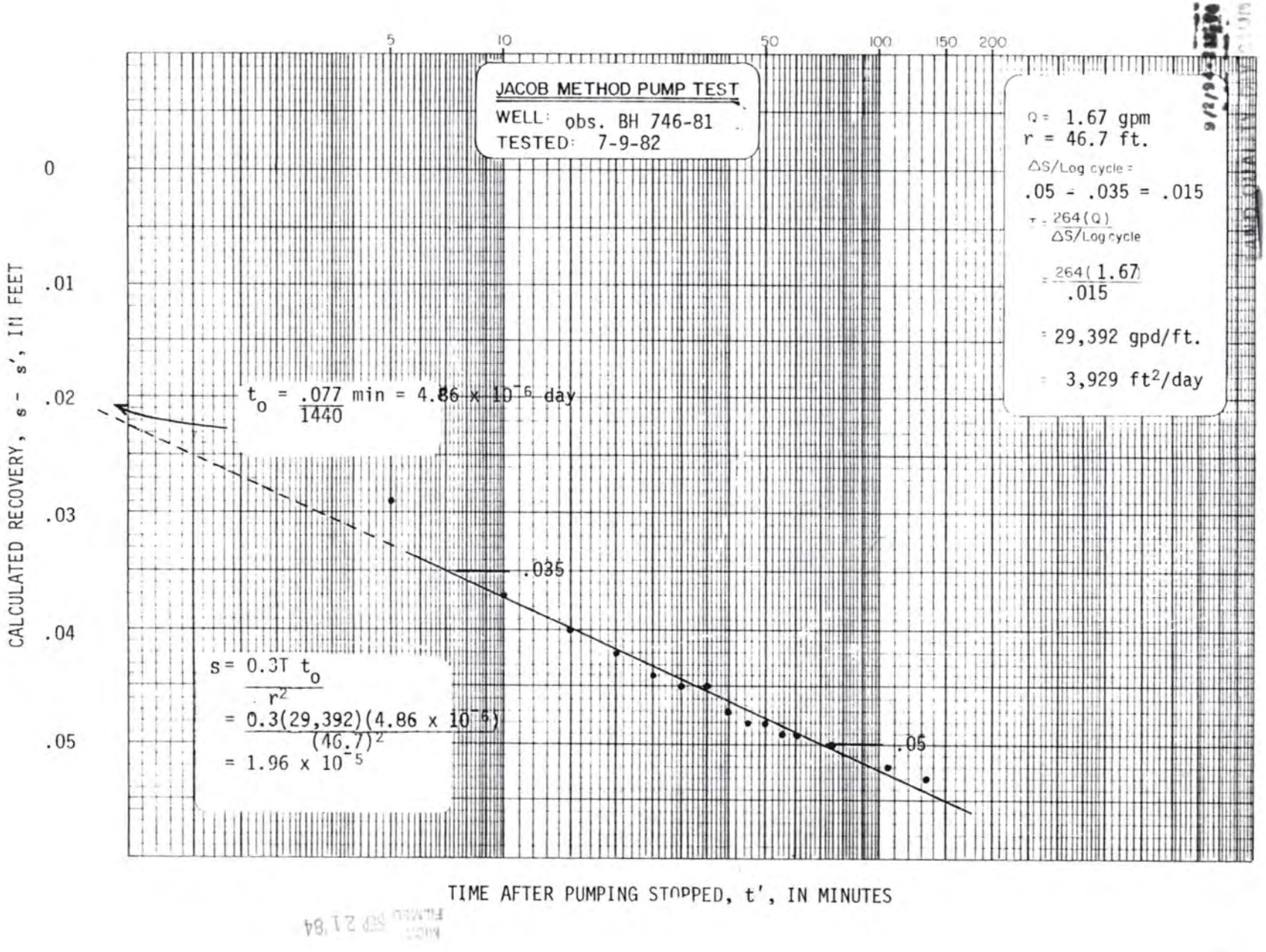
RECEIVED DEC. 28. 1982

JFN I 5/293 PERMIT 213-T2

8-30-99-213-T2

TFN 6 2/025

Brook Mine



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October 2018

Addendum D6-14-76

RECD 10-25-18

DEQ Ex. 3-1619

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MICRO FILMED SEP 21 '84

DIETZ - 3

COAL WELLS

9/2/94-2[illegible]
LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT
8-30 89 213 T3
89-213 T3
TFN 6 2/025

K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 14 WELL NO. 582

Personnel Bondar & Araas

Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
(2) Single well recovery 4. Recovery with obs. well

Well owner P.K.S. Address Sheridan, WY
Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 200 ft. Well diameter 7 7/8 in.
Casing diameter 5 in. Casing type P.V.C.
Type of screen or perforation Saw slots Interval of screen or perforation 165' - 185' Pump hp. & type 3/4 Teel Pump depth 170 ft.
Aquifer Dietz 3 Aquifer lithology coal
Altitude of land surface How determined MP Above Below LSD Altitude MP
WL from MP 81.20 How measured Galvonometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
3/27/80	11:00	81.20	0			0
	11:01	93.44	1			12.24
	11:03	106.11	3			24.91
	11:06	123.84	6			42.64
	11:10	135.98	10			54.78
	11:15	140.89	15			59.69
	11:20	145.33	20			64.13
	11:30	149.00	30			67.80
	11:40	149.47	40			68.27
	11:50	149.50	50			68.30
	12:00	149.82	60			68.62
	12:15	150.18	75			68.98
	12:30	150.38	90			69.18
	12:50	150.38	110			69.18
	13:10	150.46	130			69.26
	13:30	150.46	150			69.26
	14:00	150.38	180			69.18
	14:30	150.41	210			69.21
OFF	14:45	150.38	225	0	0	69.18
	14:46	134.68	226	1	226	53.48
	14:48	117.82	228	3	76	36.62
	14:51	107.20	231	6	38.5	26.00
	14:55	96.96	235	10	23.5	15.76
	15:00	91.01	240	15	16.0	9.81
	15:10	85.92	250	25	10.0	4.72
	15:20	84.24	260	35	7.43	3.04
	15:30	84.03	270	45	6.00	2.83
	15:45	83.67	285	60	4.75	2.47

8/30 99-213 TS
89-213 TS
9/2/94

LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT

TFN 6 2/025
REC'D 10-25-18

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WATER WELL BH - 582

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
3/27/80	11:03	25.00	8.23	3.43	3	24.69
	11:10	23.00	8.95	3.43	7	62.65
	11:15	27.50	7.48	3.43	5	37.40
	11:20	31.00	6.63	3.43	5	33.15
	11:30	35.50	5.80	3.43	10	58.00
	11:40	29.50	6.97	3.43	10	69.70
	11:50	30.50	6.74	3.43	10	67.40
	12:00	29.20	7.04	3.43	10	70.40
	12:30	28.50	7.22	3.43	30	216.60
	12:50	28.50	7.22	3.43	20	144.40
	13:10	30.00	6.86	3.43	20	137.20
	13:30	30.00	6.86	3.43	20	137.20
	14:00	30.00	6.86	3.43	30	205.80
					180	1264.59
				1264.59/180 =7.03		
				TOTAL AVE. Q. = 7.03 gpm		
				Specific capacity = 7.03		
					69.21 = .10 gpm/ft.	

9/2/94-213-T2

3 89-213-T2

8.30 99-213 T2

LAND QUALITY DIVISION

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TFN 1 5/293 PERMIT 213-T2

D6-390

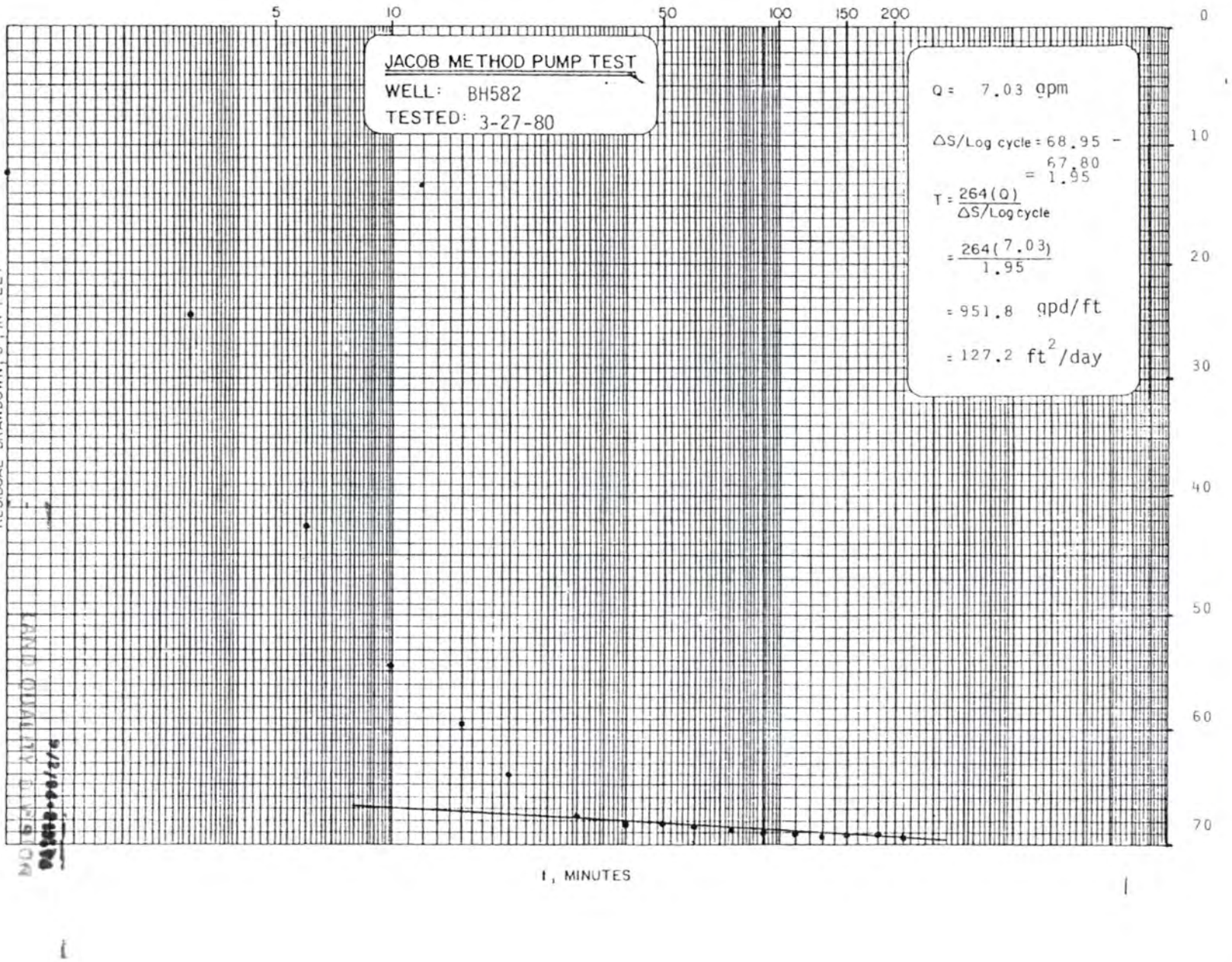
TFN 6 2/025

DEQ Ex. 3-1622

RECD 10-25-18

MICRO FILMED SEP 2 1 '80

TIME DRAWDOWN CURVE



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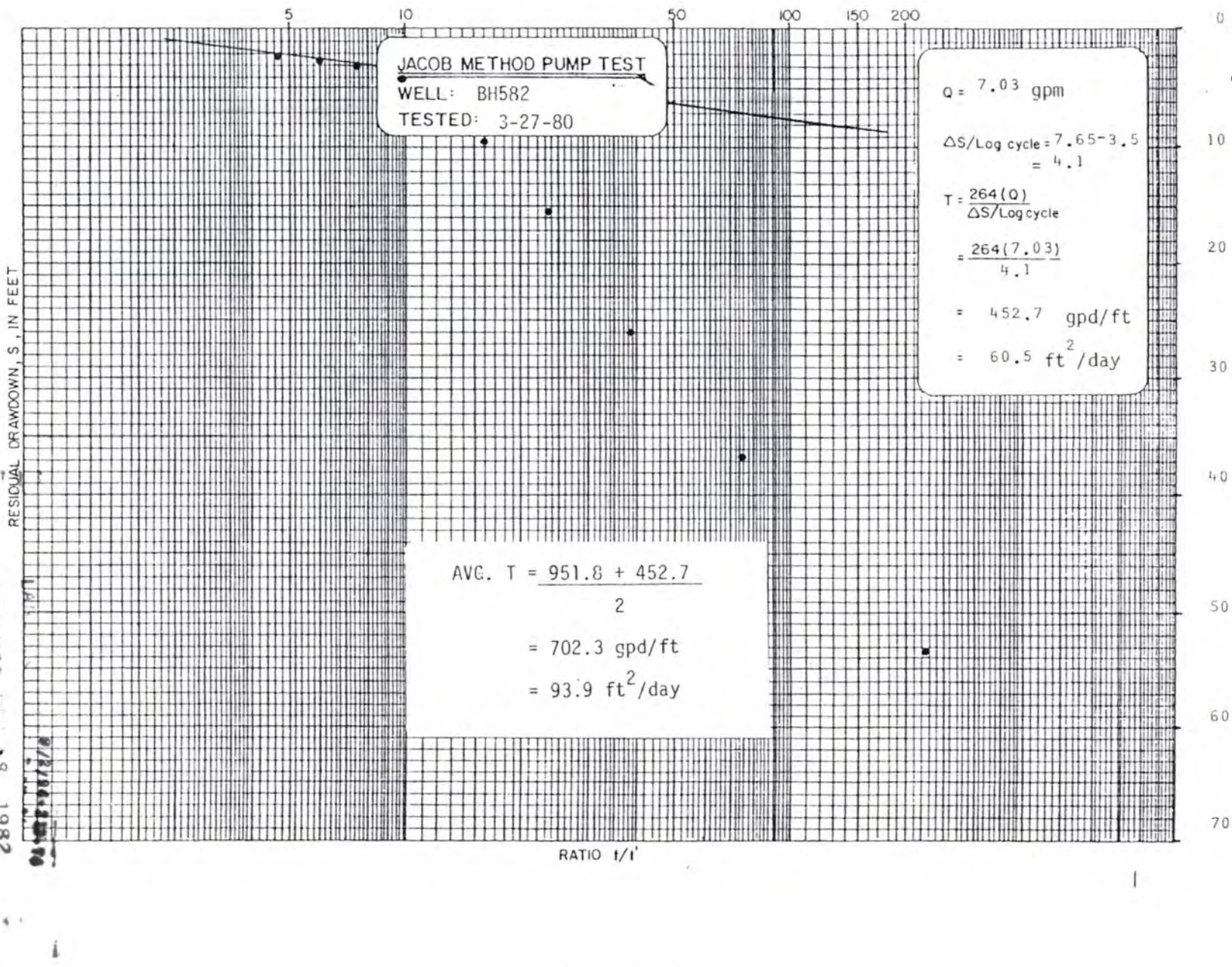
MICRO FILMED SEP 21 '84

TIME RECOVERY CURVE



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OCT 28 1982
DEPT. OF NATURAL RESOURCES
TFN 1 5/293 PERMIT
DE-302
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1624

...S. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State WY County Sheridan T. 57 N. R. 84 E. W. Sec. 14 WELL NO. 468

Personnel ARAAS & Bondar Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

Oil owner PKS Address Sheridan, WY

R. Reed Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Depth 290 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 230' - 270' Pump hp. & type 3/4 feel Pump depth 250 ft.

MICRO FILMED SEP 21 '84

Aquifer Dietz 3 Aquifer lithology coal

Altitude of land surface How determined MP Above Below LSD Altitude MP

MP from MP 68.46 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
2/22/80						
ON	10:30	68.46	0			0
	10:33	88.90	3			20.44
	10:36	101.10	6			32.64
	10:40	106.35	10			37.89
	10:50	110.50	20			42.04
	11:00	112.37	30			43.91
	11:30	113.06	60			44.60
	12:30	113.52	120			45.06
	13:00	113.97	150			45.51
	13:30	114.54	180			46.08
	14:00	115.29	210			46.83
	14:30	116.35	240			47.89
OFF	15:00	116.50	270	0		48.04
	15:01	-	271	1	271	-
	15:03	96.25	273	3	91	27.79
	15:06	85:53	276	6	46	17.07
	15:10	78.90	280	10	28	10.44
	15:15	75.20	285	15	19	6.74
	15:20	73:41	290	20	14.50	4.95
	15:25	72.80	295	25	11.80	4.34
	15:30	72:30	300	30	10	3.84
	15:40	71.78	310	40	7.75	3.32
	15:50	71.42	320	50	6.40	2.96
	16:00	71.17	330	60	5.50	2.71
	16:10	71.00	340	70	4.90	2.54

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9/2/94-219-T0 TFN 1 5/293 PERMIT 219-T2

89 213 15 3 89-213-T3

TFN 6 2/025

RECD 10-25-18

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Brook Mine

October 2018

Addendum D6-14-83

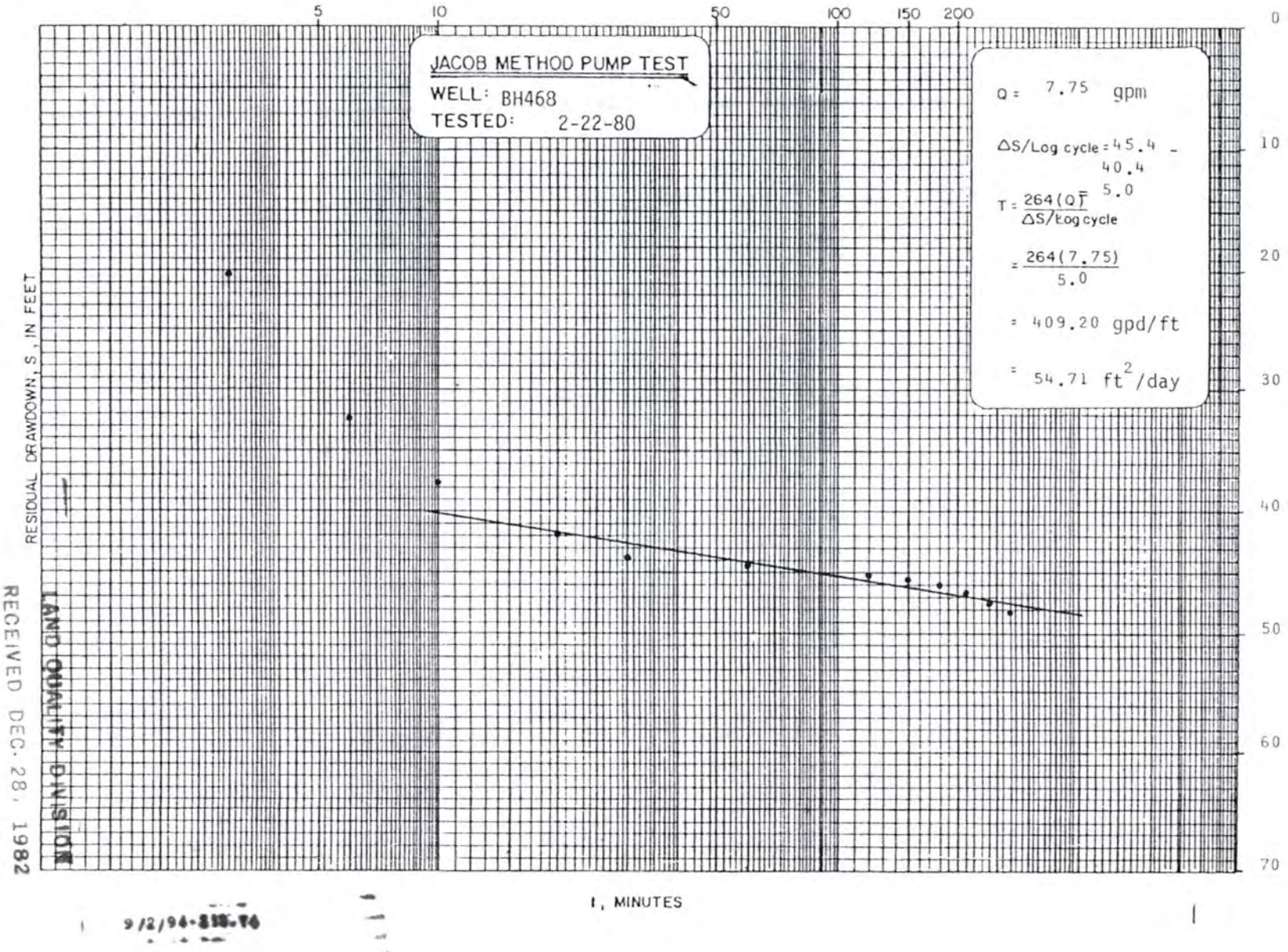
TFN 6 2/025
RECD 10-25-18

TFN 1 5/293 PERMIT

RECEIVED DEC. 28, 1982
LAND QUALITY DIVISION

MICRO FILMED

TIME DRAWDOWN CURVE

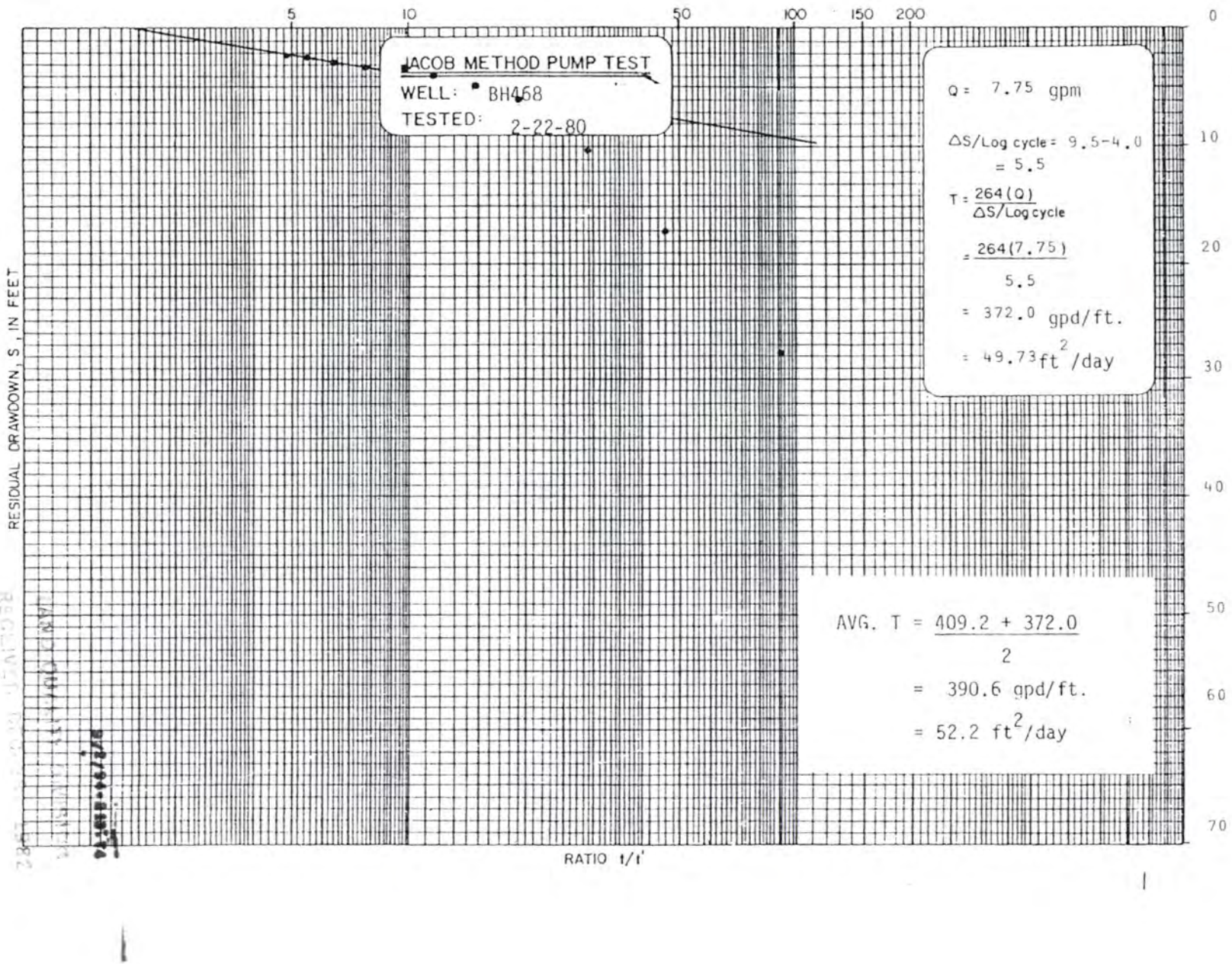


9/2/94-SMR-T6

DEQ Ex. 3-1626

MICRO FILMED SEP 21 '84

TIME RECOVERY CURVE



D6-396
IFN 6 2/025
RECD 10-25-18
8/30 95 213 T5
IFN 1 5/259
1/31/89-213 T3

DEQ Ex. 3-1627

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K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA — Page 1 of 2

ate WYO County Sheridan T. 57 (N) S., R. 84 (W) Sec. 14 , WELL NO. 576

ersonnel BONDAR Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

er PKS Address SHERIDAN, WY

R REED Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

otal well depth 170 ft. Well diameter 7 7/8 in.

asing diameter 5 in. Casing type PVC

ype of screen or perforation saw slots Interval of screen or perforation 140-160' Pump hp. & type/3 Teel Pump depth 155 ft.

MICRO FILMED SEP 21 '84

quifer Z3 Aquifer lithology coal

ltitude of land surface How determined MP Above Below LSD Altitude MP

WL from MP 73.43 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
5/8/80	1000	73.43	0			0
	1001	77.02	1			3.59
	1003	72.47	3			0.96
	1006	77.60	6			4.17
	1010	85.0	10			11.57
	1015	93.82	15			20.39
	1020	99.69	20			26.26
	1025	103.83	25			30.40
	1030	106.46	30			33.03
	1040	103.24	40			29.81
	1050	101.91	50			28.48
	1100	108.65	60			35.22
	1110	122.62	70			39.19
	1120	110.72	80			37.19
	1130	109.33	90			35.90
	1140	112.70	100			39.27
	1150	114.65	110			41.22
	1200	116.15	120			42.72
	1215	117.57	135			44.14
	1230	118.33	150			44.90
	1250	119.13	170			45.70
	1320	119.36	200			45.90
	1350	119.61	230			46.18
	1430	120.43	270			47.00
	15.00	120.45	300		213.12	47.02
OFF	1530	120.45	330			49.02
	1531	117.74	331	1	331.00	44.31
	1533	113.00	333	3	111.00	39.57
	1536	107.0	336	6	56.00	33.57

PLANT QUALITY DIVISION

D6-397

TFN 6 2/025
DEQ Ex. 3-1628
RECD 10-25-18

K.S. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State ______ County ______ T. ______ N./S. R. ______ E./W. Sec. ______ WELL NO. 576

Personnel ______ Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) ______

Owner ______ Address ______

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth ______ ft. Well diameter ______ in.

Casing diameter ______ in. Casing type ______

Type of screen or perforation ______ Interval of screen or perforation ______ Pump hp. & type ______ Pump depth ______ ft.

Aquifer ______ Aquifer lithology ______

Altitude of land surface ______ How determined ______ MP Above/Below LSD ______ Altitude MP ______

WL from MP ______ How measured ______

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
	1540	100.00	340	10	34.00	26.57
	1545	92.78	345	15	23.00	19.35
	1550	87.23	350	20	17.50	13.80
	1600	78.95	360	30	12.00	5.52
	1615	73.45	375	45	8.33	0.02

LAND QUALITY DIVISION
RECEIVED DEC. 28, 1982
TFN 1 5/293 PERMIT 213-T2
89-213-T2
9/2/94-213-T4
8-30-95 213-T5

D6-398

TFN 6 2/025
RECD 10-25-18

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WATER WELL 576

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
5/8/80	10:06	70.30	2.60	3.00	6	15.60
	10:15	88.80	2.03	3.00	9	18.27
	10:20	89.50	2.01	3.00	5	10.05
	10:25	94.10	1.91	3.00	5	9.55
	10:30	96.50	1.90	3.00	5	9.50
	10:40	150.00	1.20	3.00	10	12.00
	10:50	150.00	1.20	3.00	10	12.00
	11:00	93.10	1.93	3.00	10	19.30
	11:10	95.00	1.90	3.00	10	19.00
	11:20	124.00	1.45	3.00	10	14.50
	11:30	126.60	1.42	3.00	10	14.20
	11:40	100.09	1.80	3.00	10	18.00
	10:50	102.80	1.75	3.00	10	17.50
	12:00	103.00	1.75	3.00	10	17.50
	12:15	103.50	1.74	3.00	15	26.10
	12:30	106.50	1.69	3.00	15	25.30
	12:50	104.50	1.72	3.00	20	34.40
	13:20	105.00	1.71	3.00	30	51.30
	13:50	104.20	1.73	3.00	30	51.90
	14:30	103.70	1.74	3.00	40	69.60
	15:00	106.00	1.70	3.00	30	51.00
	15:30	106.30	1.70	3.00	30	51.00
	-				330	567.57
	-			567.57/330 = Total	Ave. Q =	1.72

9/2/94-213 T4

LAND QUALITY DIVISION

Spec. Cap. = 1.72/47.02 = .04 gpm/ft.

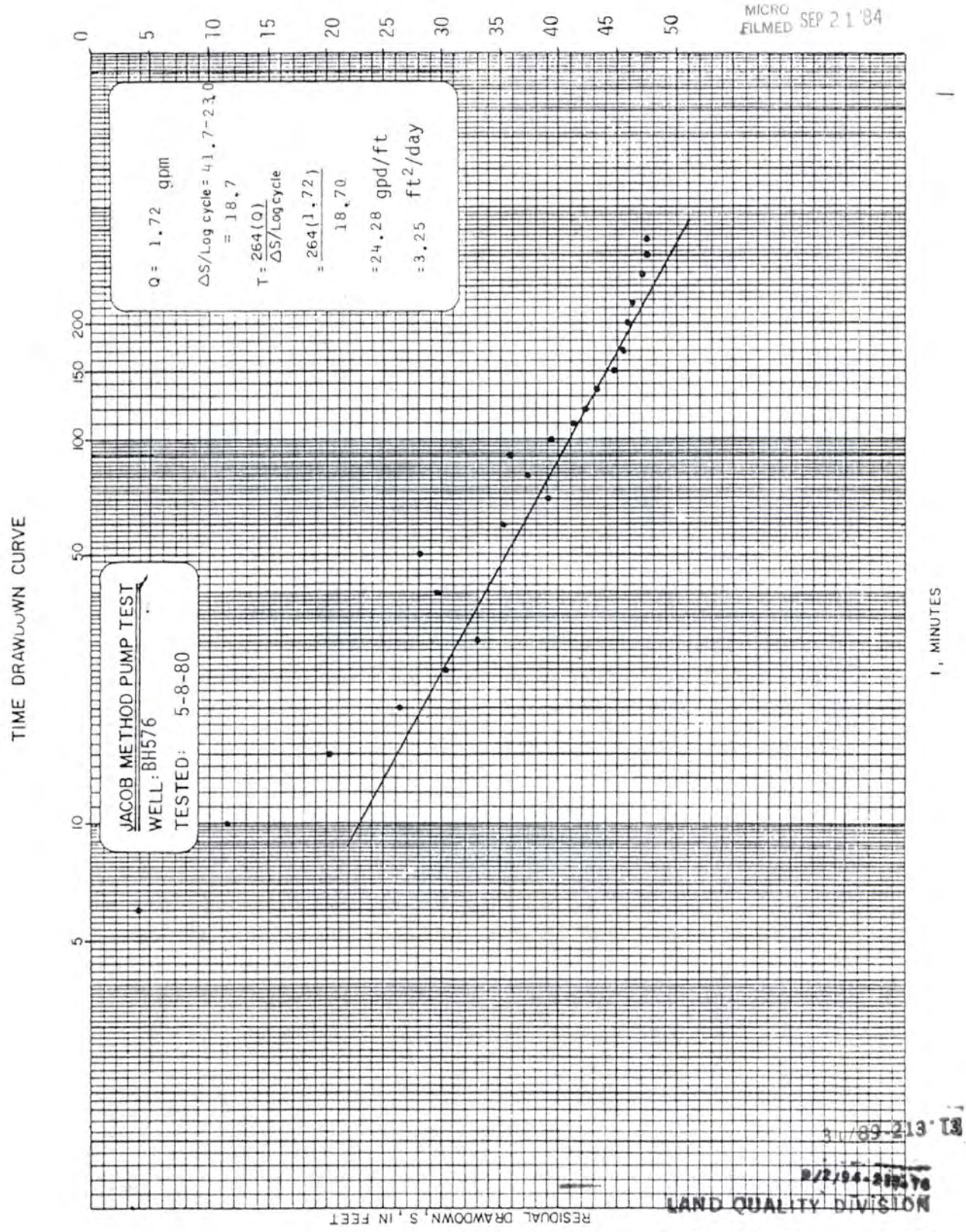
RECEIVED SEP 28 1982

TFN 1 5 293 PERMIT 213 T2

8/30 [illegible] 213 T5 33-213 T3

TFN 6 2/025

RECD 10-25-18



LAND QUALITY DIVISION
RECEIVED DEC 28, 1982
TFN 1 5/293 PERMIT

D6-400

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1631

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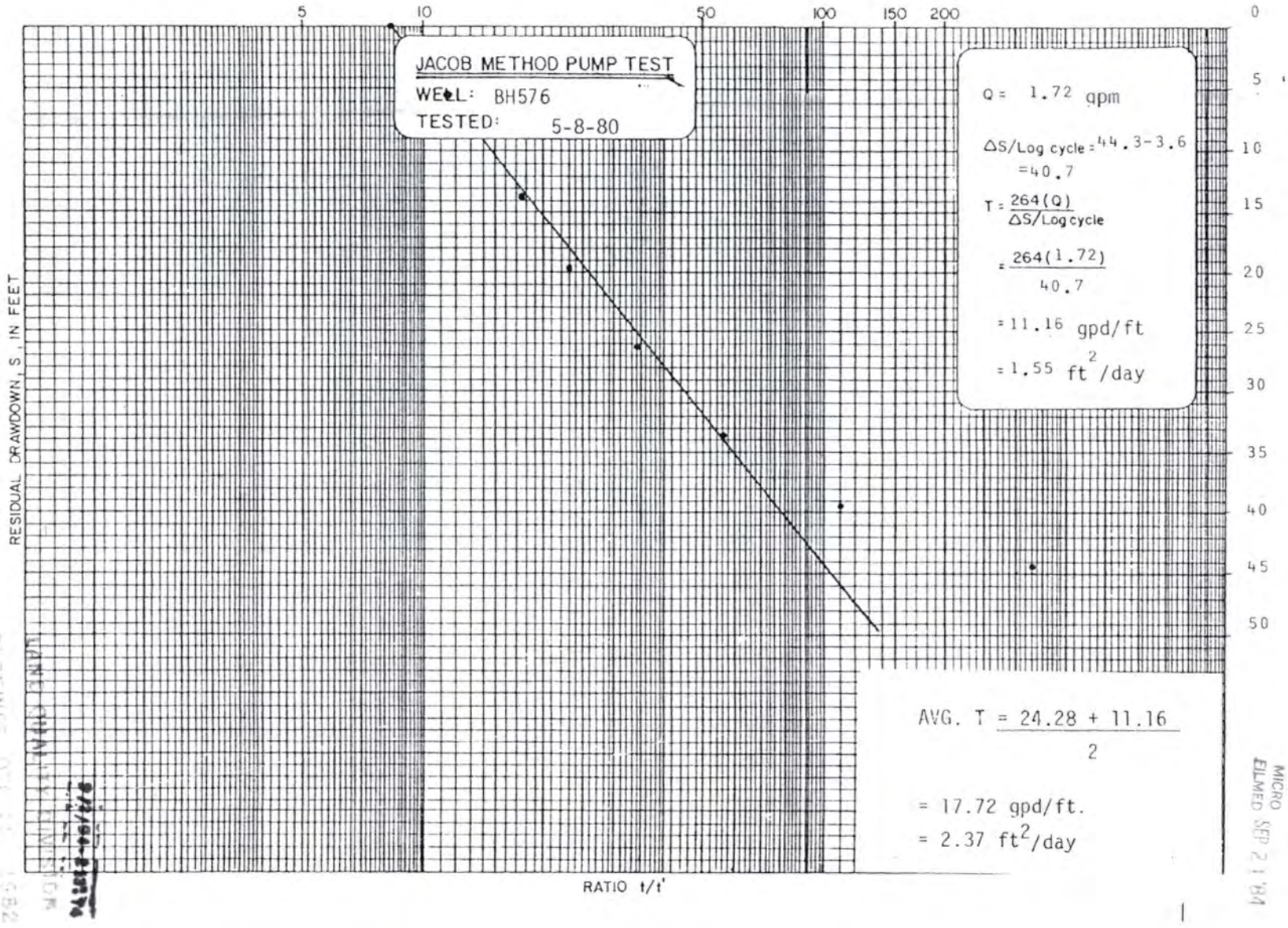
D6-401
RECD 10-25-18

TIME RECOVERY CURVE



MICRO FILMED SEP 21 '84

DEQ Ex. 3-1632

BAILER TEST

MICRO FILMED SEP 21 '84

ate 3/26/80 Personnel Araas & Bondar S.W.L. 132.26 Well # 575-80

Bailer Volume 2.68 gallons

TIME	BAILER VOLUME (GALS.)	TIME IN	TIME OUT (t)	RESIDUAL DRAWDOWN (s')	ELAPSED TIME TO S' (min)	t/t to S' (Day)
Start 1100	2.68	1100	1104		296.00	4.87
	2.68	1104 ½	1106 3/4		293.25	4.91
	2.68	1107	1109 ½		290.50	4.96
	2.68	1110	1112 ½		287.50	5.01
	2.68	1113	1115 ½		284.50	5.06
	2.68	1116	1118 ½		281.50	5.12
	2.68	1119	1121 2/3		278.34	5.17
	2.68	1122	1124 2/3		275.34	5.23
	2.68	1125	1127 3/4		272.25	5.29
	2.68	1128	1130 5/6		269.17	5.35
	2.68	1131 ½	1134 ¼		265.75	5.42
	2.68	1134 3/4	1137 ½		262.50	5.49
	2.68	1138	1140 5/6		259.17	5.56
	2.68	1141 ¼	1144 1/6		255.84	5.63
	2.68	1144 3/4	1147 2/3		252.34	5.71
	0	1148	1151		249.00	5.78
	2.68	1151 ¼	1154 1/3		245.67	5.86
	0	1154 2/3	1157 3/4		242.25	5.94
						96.36

Stop 1157 3/4

1202	172.67
1215	172.34
1230	172.22
1300	171.78
1400	162.54
1500	149.88
1600	141.57

8/18/94-213-T4

LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT 213-T2

8/31/89-213-T3

D6-402
TFN 6 2/025
DEQ 10-25-18

DEQ Ex. 3-1633

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MICRO FILMED SEP 21 '84

$$T = \frac{V}{12.57\,(S')}\left[\frac{1}{t_1} + \frac{1}{t_2} + \frac{1}{t_3} + \ldots \frac{1}{tn}\right]$$

Where: $S' = 141.57' - 132.26' = 9.31'$ at 300 mins.

and $\left[\frac{1}{t_1} + \frac{1}{t_2} + \frac{1}{t_3} \ldots \frac{1}{tn}\right] = 96.36$

so, $T = \frac{2.68}{12.57\,(9.31)}\,[96.36] = 2.21$ gpd/ft $= .30$ ft^2/day

Ave. $Q = \frac{2.68 \text{ gals} \times 16}{57.75 \text{ min.}} = \frac{42.88 \text{ gal.}}{57.75 \text{ min.}} = .743$ gpm.

Total Residual Drawdown = 172.67' - 132.26' = 40.41'

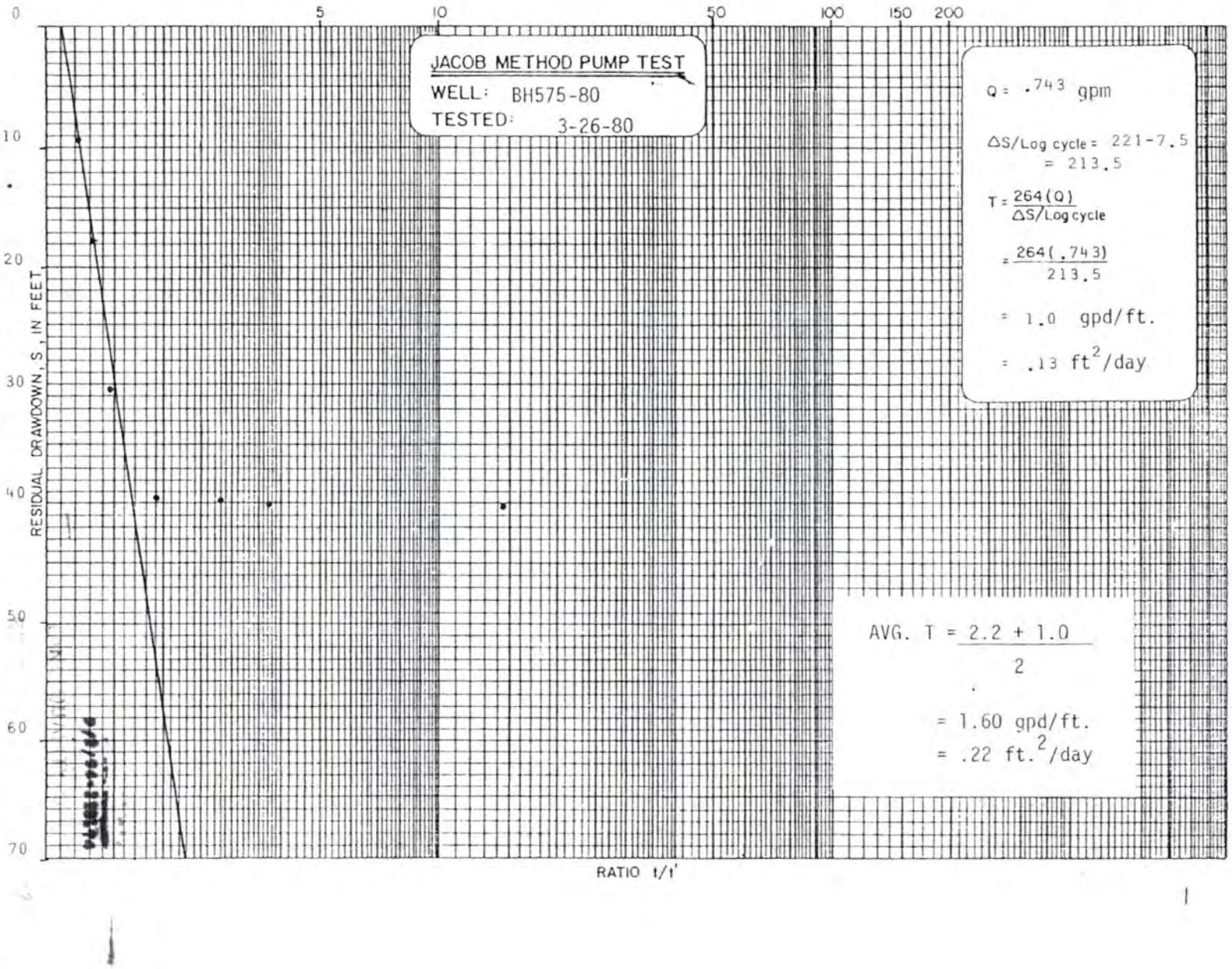
∴specific capacity = .743 gpm/40.41' = .02 gpm/ft.

7/31/89-213 T3
9/2/94-213 T4
LAND QUALITY DIVISION
RECEIVED
8/30/99 213 T5
JAN 2 5/2004
TPN 6 2/025
RECD 10-25-18

D6-404
TFN 6 2/025
RECD 10-25-18

MICR
FILMED SEP 21 04

TIME RECOVERY CURVE



DEQ Ex. 3-1635

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PKS GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 27 WELL NO. BH 462 A

Personnel Bondar, Hill

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify)
2. Single well recovery (4) Recovery with obs. well

Well owner PKS Address Sheridan, WY

D. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 314 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 265' - 304'

Pump hp. & type 3 Teel Pump depth 200 ft.

Aquifer Dietz 3/Mn Aquifer lithology Coal

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 169.81 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-9-80	10:00	169.21				
			Galvanometer stuck in hose line, no data from pumping well.			

MICRO FILMED SEP 21 '84

8/30/99 213 T5

9/2/94-213 T5

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT

213-T2

99-213 T5

TFN 6 2/025

REC'D 10-25-18

WATER WELL BH 462A

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
5/9/80	1003	14.75	12.20	3	3	36.60
	1020	15.25	11.80	3	17	200.60
	1035	16.00	11.25	3	15	168.75
	1050	16.00	11.25	3	15	168.75
	1100	10.60	16.98	3	10	169.80
	1115	10.70	16.82	3	15	252.30
	1135	11.70	15.38	3	20	307.60
	1140	8.00	22.50	3	5	112.50
	1200	9.00	20.00	3	20	400.00
	1230	8.50	21.18	3	30	635.40
	1300	9.00	20.00	3	30	600.00
	1330	8.50	21.18	3	30	635.40
	1400	8.50	21.18	3	30	635.40
	1430	8.50	21.18	3	30	635.40
	1500	8.50	21.18	3	30	635.40
	1505	8.00	22.50	3	5	112.50
	1530	8.00	22.50	3	25	562.50
	1600	8.00	22.50	3	30	675.00
OFF	1620	8.00	22.50	3	20	450.00
					380.00	7393.90

7393.9/380 = 19.46

Total Ave. Q = 19.46 gpm

9/2/94-213-TN
LAND QUALITY DIVISION
RECEIVED SEP 1982
TFN 1 5/25H PERMIT
8-30 94 213 TS
9-213-TS 213-TN

D6-406

TFN 6 2/025
RECD 10-25-18

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K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA — observation well

ate WY County Sheridan T. 57 (N) S. R. 84 (E) W Sec. 27 WELL NO. BH 462

rsonnel Bondar, Hill

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify)
2. Single well recovery (4) Recovery with obs. well

ell owner PKS Address Sheridan, WY
Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

pth. epth 313 ft. Well diameter 7 7/8 in.
asing diameter 5 in. Casing type PVC
ype of screen or perforation saw slots Interval of screen or perforation 265' - 305' Pumping well 74' away Pump hp. & type N/A Pump depth ____ ft.

MICRO FILMED SEP 21 '84

quifer Dietz 3/Mn Aquifer lithology coal (pumping well # BH 462 A)

ltitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP 166.12 How measured Stevens F-68 continuous recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-9-80						
On	10:00	166.12	0			
	10:15	169.19	15			3.07
	10:30	170.10	30			3.98
	10:45	170.57	45			4.45
	11:00	171.20	60			5.08
	11:15	172.51	75			6.39
	11:30	172.95	90			6.83
	11:45	173.44	105			7.32
	12:00	174.71	120			8.59
	12:15	175.21	135			9.09
	12:30	175.70	150			9.58
	12:45	176.15	165			10.03
	13:00	176.40	180			10.28
	13:15	176.64	195			10.52
	13:30	176.88	210			10.76
	13:45	177.12	225			11.00
	14:00	177.36	240			11.24
	14:15	177.53	255			11.41
	14:30	177.69	270			11.57
	14:45	177.85	285			11.73
	15:00	178.01	300			11.89
	15:15	178.16	315			12.04
	15:30	178.32	330			12.20
	15:45	178.47	345			12.35
	16:00	178.58	360			12.46
	16:15	178.64	375			12.52
Off	16:20	178.65	380			12.53

TFN 6 2/025

RECD 10-25-18

PKS GEOLOGY AND EXPLORATION — AQUIFER TEST DATA — observation well

State WY County Sheridan T. 57 (N) S. R. 84 (E) W Sec. _____ WELL NO. BH 462

Personnel Bondar, Hill

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify)
2. Single well recovery (4) Recovery with obs. well _____

Well owner PKS Address Sheridan, WY

Reed Method drilled: A. Air-rotary B. Bored or augered (H) Hyd.-rotary C. Cable-tool D. Dug J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Depth _____ ft. Well diameter _____ in.

Casing diameter 5 in. Casing type PVC Pumping well 74' away

Type of screen or perforation saw slots Interval of screen or perforation _____ Pump hp. & type N/A Pump depth _____ ft.

Aquifer Dietz 3/Mn Aquifer lithology Coal (Pumping well # BH 462A)

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured Stevens F-68 continuous reorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-9-80	1620	178.65	380, OFF	0	0	12.53
	1630	177.57	390	10	39	11.45
	1637.5	174.68	397.5	17.5	22.71	8.56
	1645	173.10	405.0	25	16.20	6.98
	1652.5	172.15	412.5	32.5	12.69	6.03

89-213 TS

LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT 213-T2
8/30 89 213 TS

TFN 6 2/025
REC'D 10-25-18

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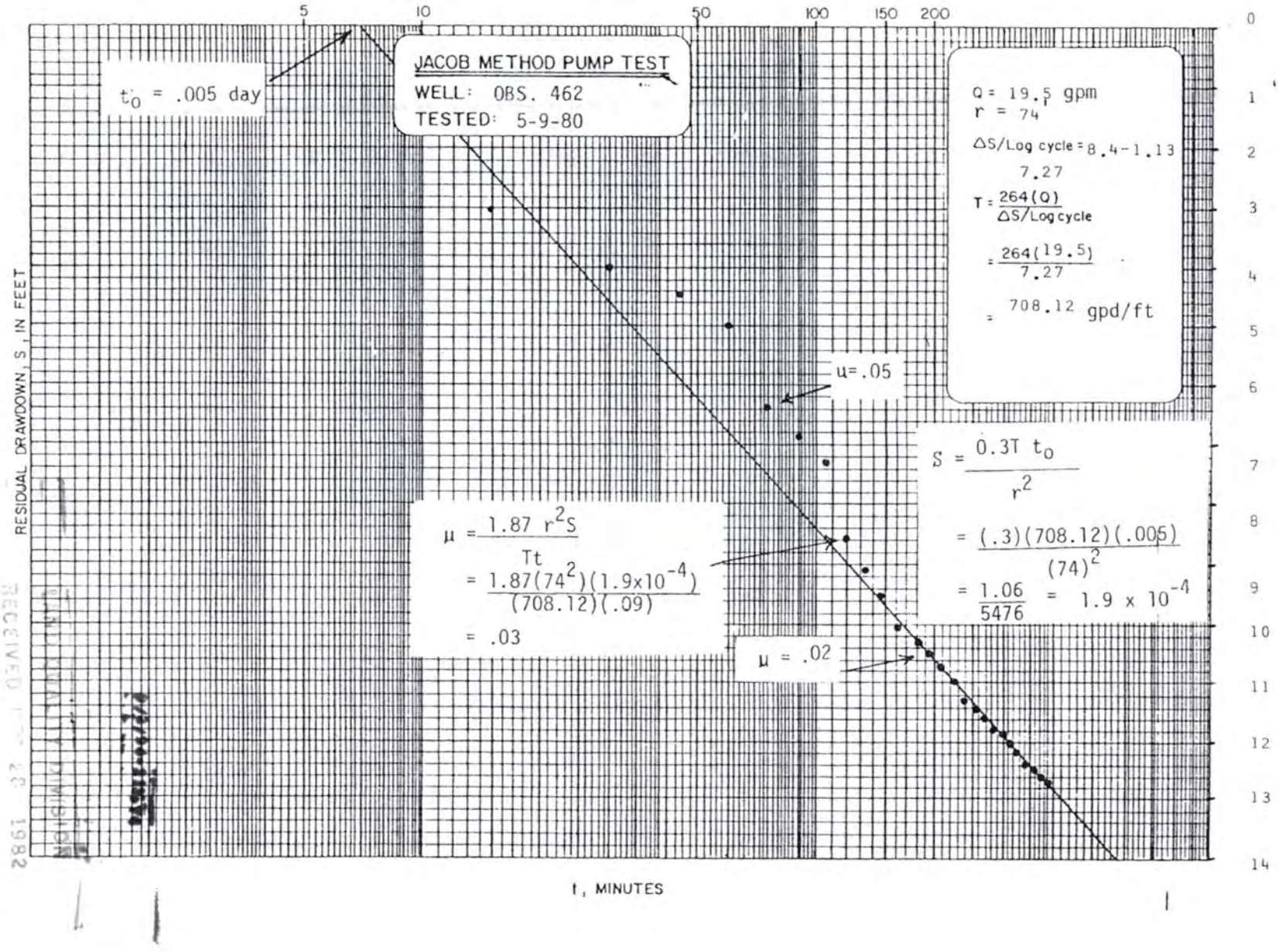
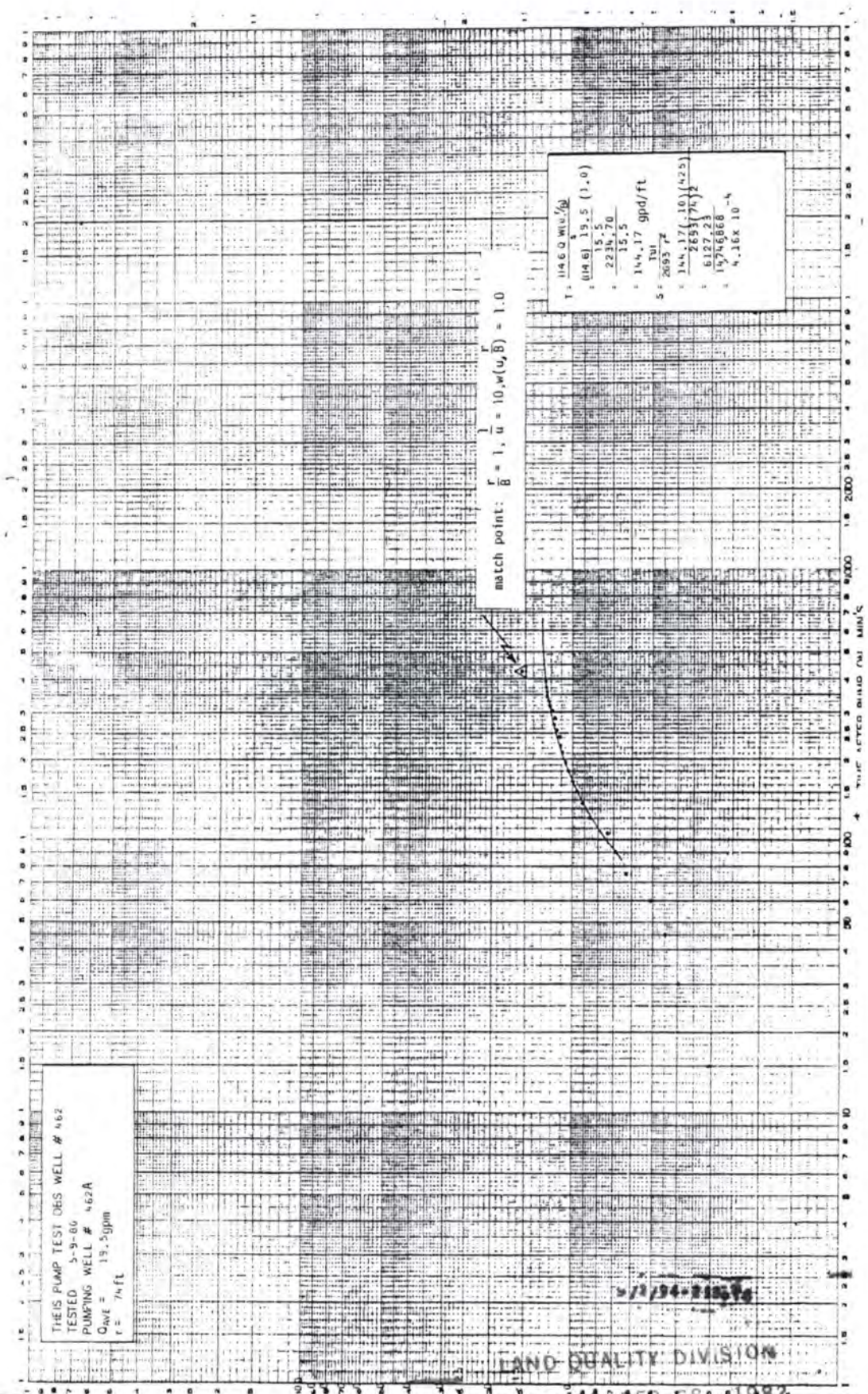
MICRO FILMED SEP 21 '84

TIME DRAWDOWN CURVE



8/30 99-213 T5
T6-408
2/025
RECD 10-25-18
89-213 T3
RECEIVED OCT 23 1982

DEQ Ex. 3-1640



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LAND QUALITY DIVISION

89-213 T3

D6-410

TFN 6 2/025

RECD 10-25-18

DEQ Ex. 3-1641

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MICRO FILMED SEP 21 '84

MONARCH COAL

WELLS

8/30 99-213 T3

9/2/94-213.T2

LAND QUALITY DIVISION

RECLAIMED DEC 25 1992

213-T2

D6-411

10-25-18

?K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

tate WYO County Sheridan T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. 231

ersonnel Gerlach-Wolf

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

/ell owner Big Horn Coal Address ____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

o... depth 85 ft. Well diameter 7 7/8 in.

asing diameter 5 in. Casing type PVC

ype of screen or perforation Saw Slot Interval of screen or perforation 65-85 Pump hp. & type Teel ½ hp Pump depth 60 ft.

MICRO FILMED SEP 21 '84

quifer Lower Monarch Coal Aquifer lithology Coal

ltitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP top casing How measured galvanometer (casing 1.78' above ground)

DATE/ HOUR	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4/21/77 9	45	31.95	-	-	-	-
9	50		-	-	-	-
9	52		0	-	-	-
9	55		3	-	-	-
9	57	Pump Dry-Off	5	0	0	0
9	59	59.45	7	2	3.50	27.50
10	01	57.79	9	4	2.25	25.84
10	02	56.51	10	5	2.0	24.56
10	03	55.52	11	6	1.83	23.57
10	05	54.33	13	8	1.63	22.38
10	08	52.54	16	11	1.45	20.59
10	10	51.24	18	13	1.38	19.29
10	15	48.35	23	18	1.28	16.40
10	20	46.38	28	23	1.22	14.43
10	25	44.40	33	28	1.18	12.45
10	30	43.08	38	33	1.15	11.13
10	35	41.33	43	38	1.13	9.38
10	40	40.37	48	43	1.12	8.42
10	45	39.16	53	48	1.10	7.21
10	50	38.33	58	53	1.094	6.38
10	55	37.52	63	58	1.086	5.57
11	05	36.00	73	68	1.074	4.05
11	15	35.00	83	78	1.064	3.05
11	30	34.02	98	93	1.054	2.07
11	48	33.16	116	111	1.045	1.21

Q = 6.8 gpm

Specific Capacity = 6.8gpm/27.50 = .25 gpm/ft.

7/31/89-213 T3

8/30/89-213 I5

213-12

D6-412

TFN 6 2/025

DEQ 10-25-18

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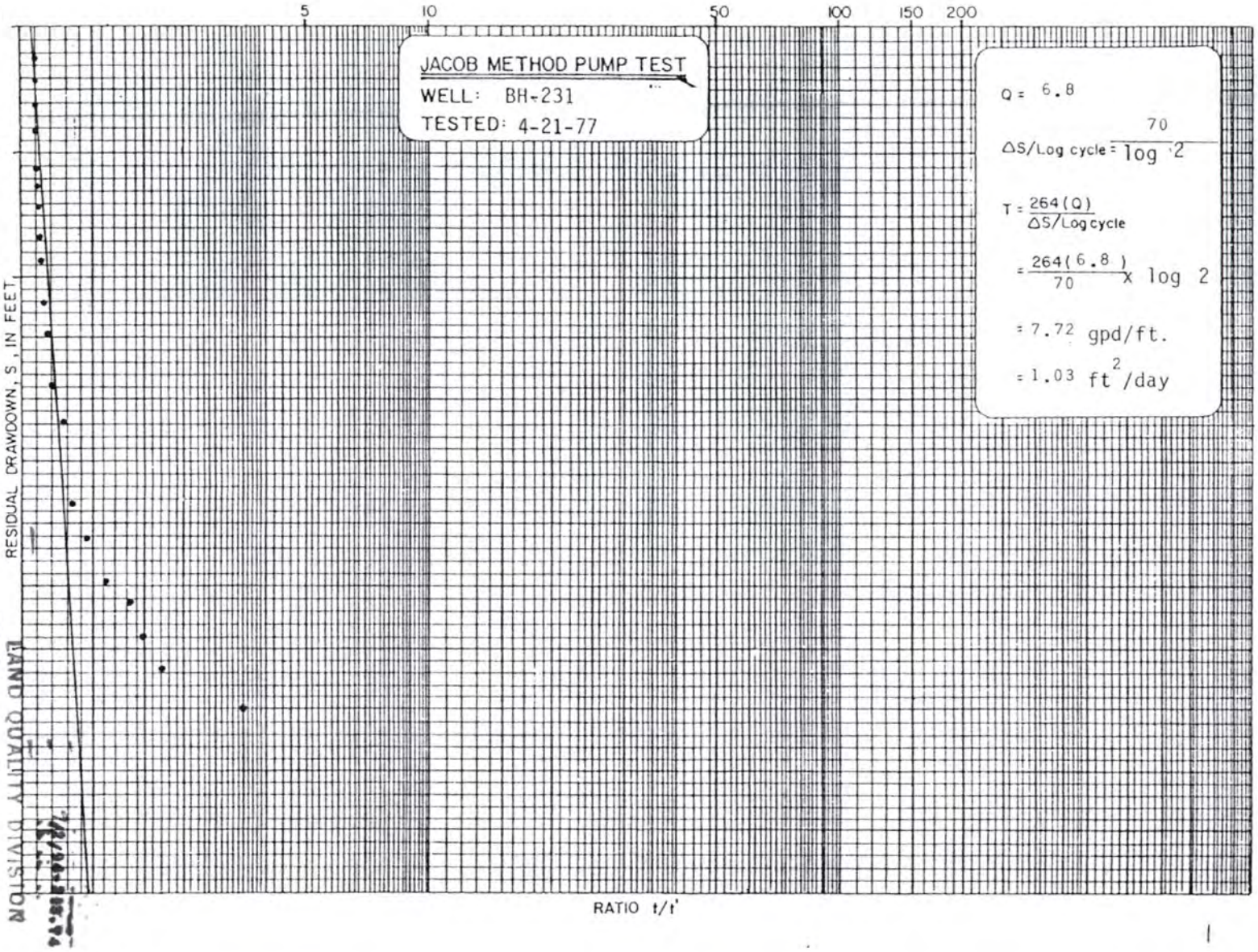
TIME RECOVERY CURVE



7/31/89-213-T3
D6-413
RECEIVED DEC. 28, 1982
LAND QUALITY DIVISION
TFN 8 2/025
RECD 10-25-18
TFN 1 5/293 PERMIT
MICRO FILMED SEP 2 1 '84

DEQ Ex. 3-1644

K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

ate WY County Sheridan T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. 232

rsonnel Gerlach - Wolf

Test type: (1.) Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) ____

ell owner Big Horn Coal Co. Address ____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H.) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

ota. epth 98 ft. Well diameter 7 7/8 in.

sing diameter 5 in. Casing type PVC

ype of screen or perforation Saw slot Interval of screen or perforation 78-98

Pump hp. & type Teel 1/2 hp. Pump depth 70 ft.

MICRO FILMED SEP 21 '84

quifer Low. monarch Aquifer lithology coal

ltitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

VL from MP Top Casing How measured Galvanometer (Casing 1.95' above grd)

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	s_1 FT. RESIDUAL DRAWDOWN
4-21-77	1:34	36.53	-	-	-	-
On 1	1:40		0	-	-	-
1	43	38.75 Q = 3.5	3	-	-	-
1	46	46.30	6	-	-	-
1	48	49.13 Q = 4.6	8	-	-	-
1	51	52.81	11	-	-	-
1	53	56.10	13	-	-	-
2	03	60.80	23	-	-	-
2	08	61.71	28	-	-	-
2	16	62.50	36	-	-	-
2	19	62.70	39	-	-	0
2	20	Pump Off	40	0	0	0
2	21	58.76	41	1	41.0	22.23
2	22	54.98	42	2	21.0	18.45
2	23	51.85	43	3	14.33	15.32
2	24	49.29	44	4	11.0	12.76
2	26	45.14	46	6	7.67	8.61
2	28	42.77	48	8	6.00	6.24
2	30	41.02	50	10	5.00	4.49
2	32	39.79	52	12	4.33	3.26
2	34	39.20	54	14	3.86	2.67
2	38	38.16	58	18	3.22	1.63
2	45	37.70	65	25	2.60	1.17

Specific Capacity = 4.5 gpm/26.17 = .17 gpm/ft.

7/31/89-213-T4

LAND QUALITY DIVISION

7/31'89-213-T3

RECEIVED DEC 20 1982

TFN 1 5/205 PERMIT 213-T2

D6-414

TFN 8 2/025

RECD 10-25-18

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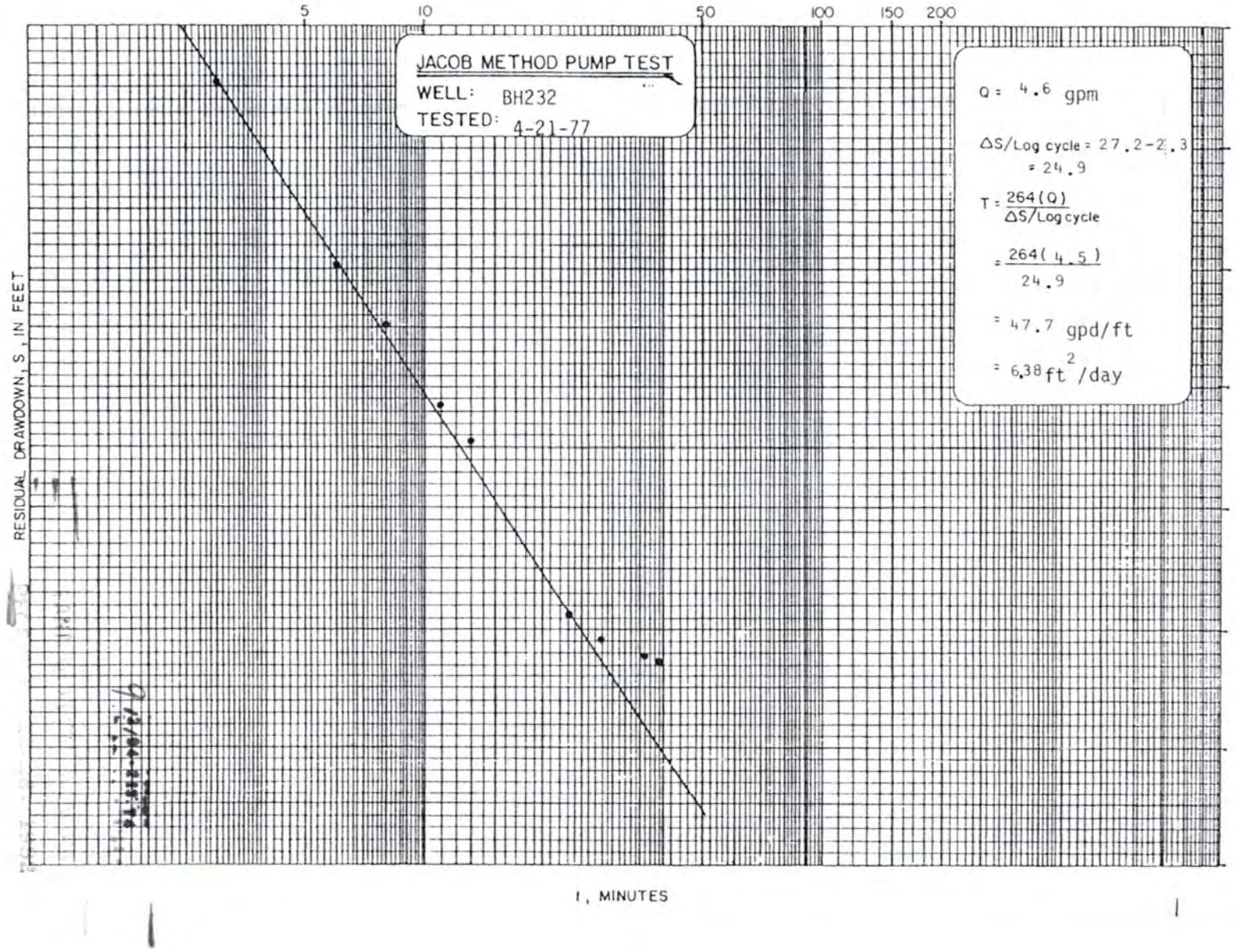
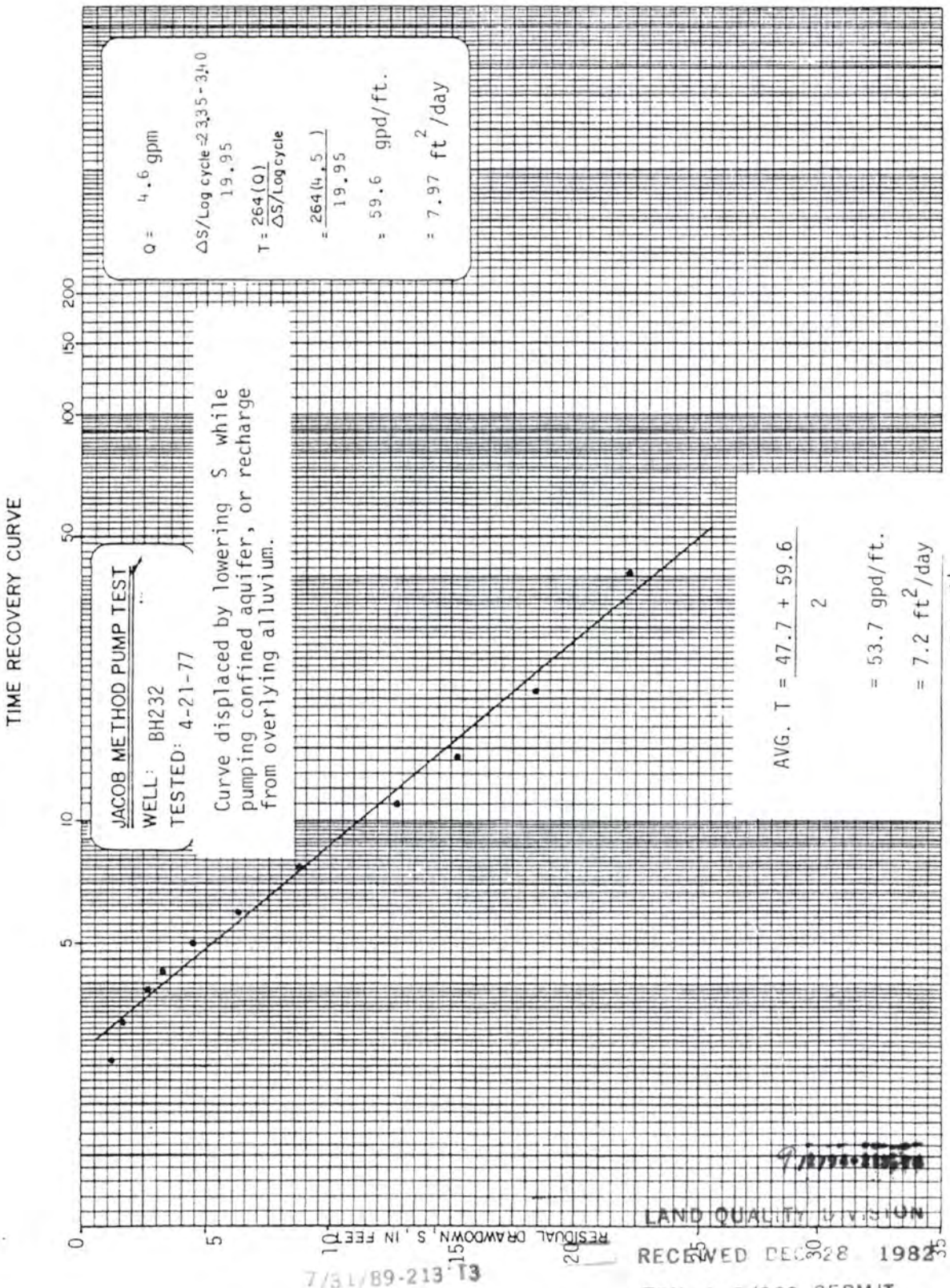
TIME DRAWDOWN CURVE



MICRO FILMED SEP 21 '84
89-213 T3
D6-415
RECD 10-25-18
2/025

DEQ Ex. 3-1646

MICRO FILMED SEP 21 '84



LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT
7/31/89-213 T3
8/30 82.3.25
D6-416
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1647

Scanned, 02/26/2020

P.K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 24 WELL NO. BH 467

Personnel Araas & Bondar Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

Owner P.K. S. Address Sheridan, WY

Reed Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 380 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 343-364 Pump hp. & type 3/4 Teel Pump depth 250 ft.

Aquifer Monarch Aquifer lithology Coal

Altitude of land surface 3619.09 How determined surveyed MP Above Below LSD Altitude MP

SWL from MP 100.00 How measured Galvonometer

MICRO FILMED SEP 21 04

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
2-26-80	10:30	100.00	0			0
	10:31	108.37	1			8.37
	10:33	115.97	3			15.97
	10:36	121.30	6			21.30
	10;40	123.75	10			23.75
	10;45	125.23	15			25.23
	10;50	125.92	20			25.92
	11;00	126.45	30			26.45
	11;20	126.50	50			26.50
	11;40	127.60	70			27.60
	12;00	127.92	90			27.92
	12:20	127.72	110			27.72
	12;40	127.60	130			27.60
	13:00	127.72	150			27.72
	13:20	127.82	170			27.82
	13;40	128.00	190			28.00
	14;00	128.11	210			28.11
	14:20	128.16	230			28.16
	14:40	128.43	250			28.43
	15:00	128.30	270			28.30
Off	15:01		271	0	0	
	15:02	116.71	272	1	272	16.71
	15:04	106.19	274	3	91.33	6.19
	15:07	104.73	277	6	46.16	4.73
	15:10	104.00	280	9	31.11	4.00
	15:15	103.33	285	14	20.35	3.33
	15:25	102.76	295	24	12.29	2.76
	15:35	102.43	305	34	8.97	2.43
	15:45	102.15	315	44	7.15	2.15
	16:00	101.96	330	59	5.59	1.96

RECEIVED 2/025

WATER WELL BH 467

PUMPING RATE DATA

MICRO FILMED SEP P.1 '84

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
2/26/80	1031	28.40	7.24	3.43	1	7.24
	1033	24.70	8.33	3.43	2	16.66
	1036	28.00	7.35	3.43	3	22.05
	1040	27.50	7.48	3.43	4	29.92
	1045	26.10	7.88	3.43	5	39.40
	1050	27.00	7.62	3.43	5	38.10
	1100	26.10	7.88	3.43	10	78.80
	1120	27.00	7.62	3.43	20	152.40
	1140	27.00	7.62	3.43	20	152.40
	1200	26.60	7.73	3.43	20	154.60
	1220	26.80	7.67	3.43	20	153.40
	1240	26.80	7.67	3.43	20	153.40
	1300	27.10	7.59	3.43	20	151.80
	1320	27.20	7.56	3.43	20	151.20
	1340	26.40	7.79	3.43	20	155.80
	1400	26.90	7.65	3.43	20	153.00
	1420	26.50	7.76	3.43	20	155.20
	1440	25.80	7.97	3.43	20	159.40
	1500	26.30	7.82	3.43	20	156.04
					270	2081.17

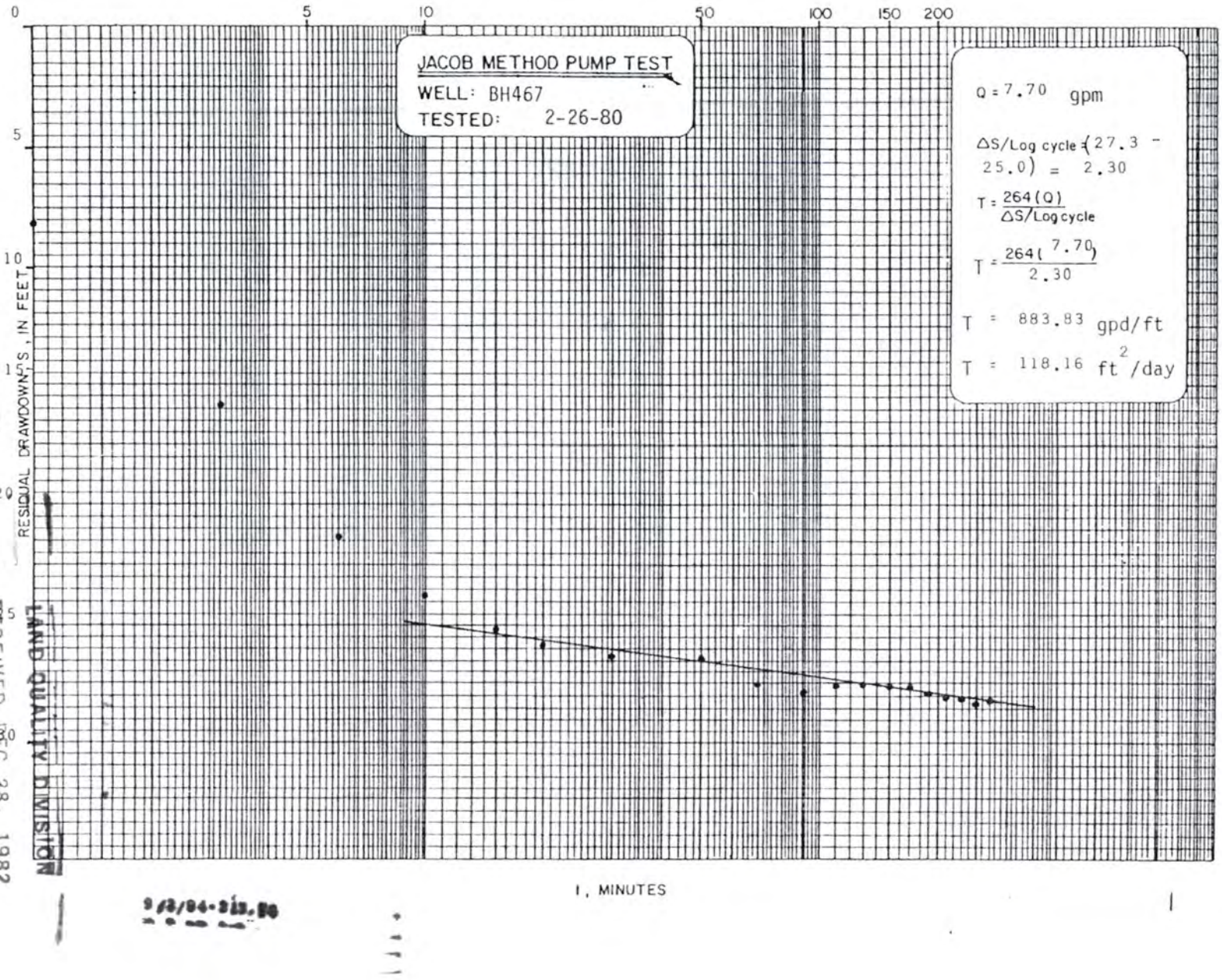
2081.17/270 = Total Q of 7.70

Specific Capacity = 7.70/28.30 = .27 gpm/ft.

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT 213-T2
TFN 6 2/025
DEQ 10-25-18

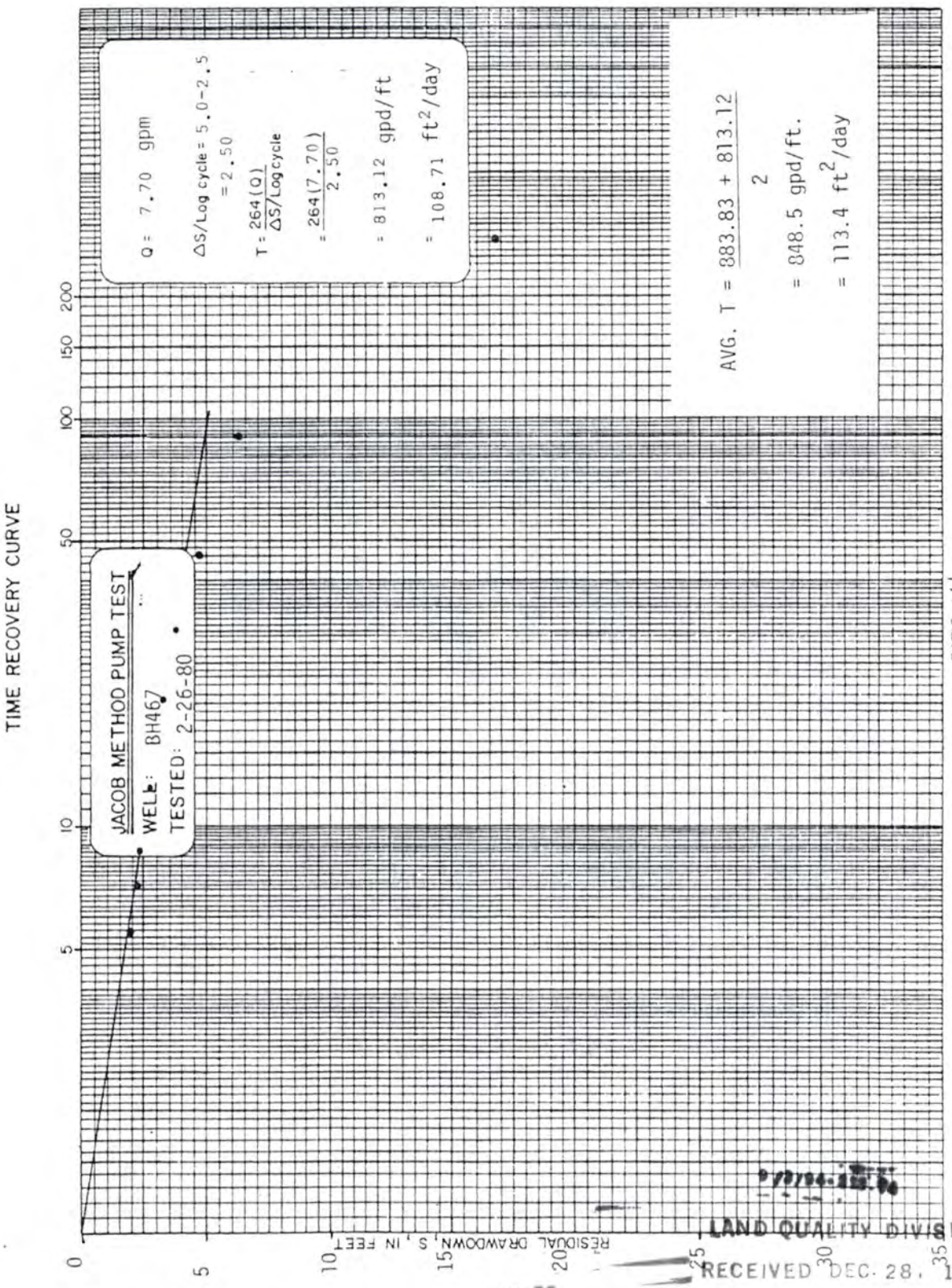
Scanned, 02/26/2020

TIME DRAWDOWN CURVE



8130 95-213 T5
7/31/89-213-T3
D6-419
TFN 5 2/025
ECD 10-25-18
RECEIVED DEC. 28, 1982
TFN 1 5/293 PERMIT 213-T2
LAND QUALITY DIVISION
MICRO FILMED SEP 21 '84

DEQ Ex. 3-1650



MICRO FILMED 9-21-84

LAND QUALITY DIVISION
RECEIVED DEC. 28, 1982
TFN 1 5/293 PERMIT 89-213-T3

D6-420

DEQ Ex. 3-1651

RECD 10-25-18

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P.K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S., R. 84 E. (W) Sec. 14 , WELL NO. 496

Personnel Dondar & Araas

Test type: (1) Single well drawdown (2) Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify)

Well owner P.K.S. Address Sheridan, WY

m Kekich

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Depth 278 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 245' - 270' Pump hp. & type 3/4 Teel Pump depth 250 ft.

Aquifer Lower Monarch Aquifer lithology Coal

Altitude of land surface 3687.6 How determined Surveyed MP Above Below LSD Altitude MP

WL from MP 167.10 How measured Galvonometer

MICRO FILMED SEP 2 1 '84

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S' FT. RESIDUAL DRAWDOWN
	On					
4-3-80	10:15	167.10	0			0
	10:16	179:54	1			12.44
	10:18	187.18	3			20.08
	10:21	193.46	6			26.36
	10:25	199:88	10			32.78
	10:30	201.34	15			34.24
	10:40	201.35	25			34.25
	10:50	201.24	35			34.14
	11:00	202.82	45			35.72
	11:15	202.72	60			35.62
	11:30	202.94	75			35.84
	11:45	203.45	90			36.35
	12:00	203.50	105			36.40
	12:15	204.76	120			37.66
	12:30	206.68	135			39.58
	12:45	206.75	150			39.65
	14:00	207.12	165			40.02
	14:20	207.24	185			40.14
Off	14:30	207.24	195	0	0	40.14
	14:31	193.63	196	1	196	26.53
	14:36	175.07	201	6	33.50	7.97
	14:40	172.65	205	10	20.50	5.55
	14:45	171.08	210	15	14.00	3.98
	14:50	170.35	215	20	10.75	3.25
	14:55	170.00	220	25	8.80	2.90
	15:00	169.74	225	30	7.50	2.64
	15:10	169.49	235	40	5.87	2.39
	15:30	169.22	255	60	4.25	2.12
	16:00	169.03	285	90	3.17	1.93

89-213 13
9/8/94-213:94
LAND QUALITY DIVISION RECEIVED
TFN 1 5/4 PERMIT
D6-42 TFN 6 2/025
RECD 10-25-18

WATER WELL 496

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
4/3/80	1018	41.00	5.02	3.43	3	15.06
	1021	42.20	4.88	3.43	3	14.64
	1025	43.00	4.79	3.43	4	19.16
	1030	59.20	3.47	3.43	5	17.35
	1040	59.20	3.47	3.43	10	34.70
	1050	60.50	3.40	3.43	10	34.00
	1100	62.00	3.31	3.43	10	33.10
	1115	60.00	3.43	3.43	15	51.45
	1130	60.00	3.43	3.43	15	51.45
	1145	59.00	3.49	3.43	15	52.35
	1200	63.50	3.24	3.43	15	48.60
	1215	55.30	3.72	3.43	15	55.80
	1230	53.80	3.82	3.43	15	57.30
	1345	60.00	3.43	3.43	15	51.45
	1300	62.00	3.31	3.43	15	49.65
	1315	57.30	3.59	3.43	15	53.85
	1330	56.00	3.68	3.43	15	55.20
	1345	55.00	3.74	3.43	15	56.10
	1400	56.00	3.68	3.43	15	55.20
	1420	57.00	3.61	3.43	20	72.20
OFF	1430	57.00	3.61	3.43	10	36.10
					250	914.71

914.71/250 = 3.66, Total Ave. Q = 3.66

Specific Capacity = 3.66/40.14 = .09 gpm/ft.

89-213-T3

9/2/94-213-T4

LAND QUALITY DIVISION

RECEIVED DEC 28, 1982

TFN 1 5/293 PERMIT 213-T2

D6-422

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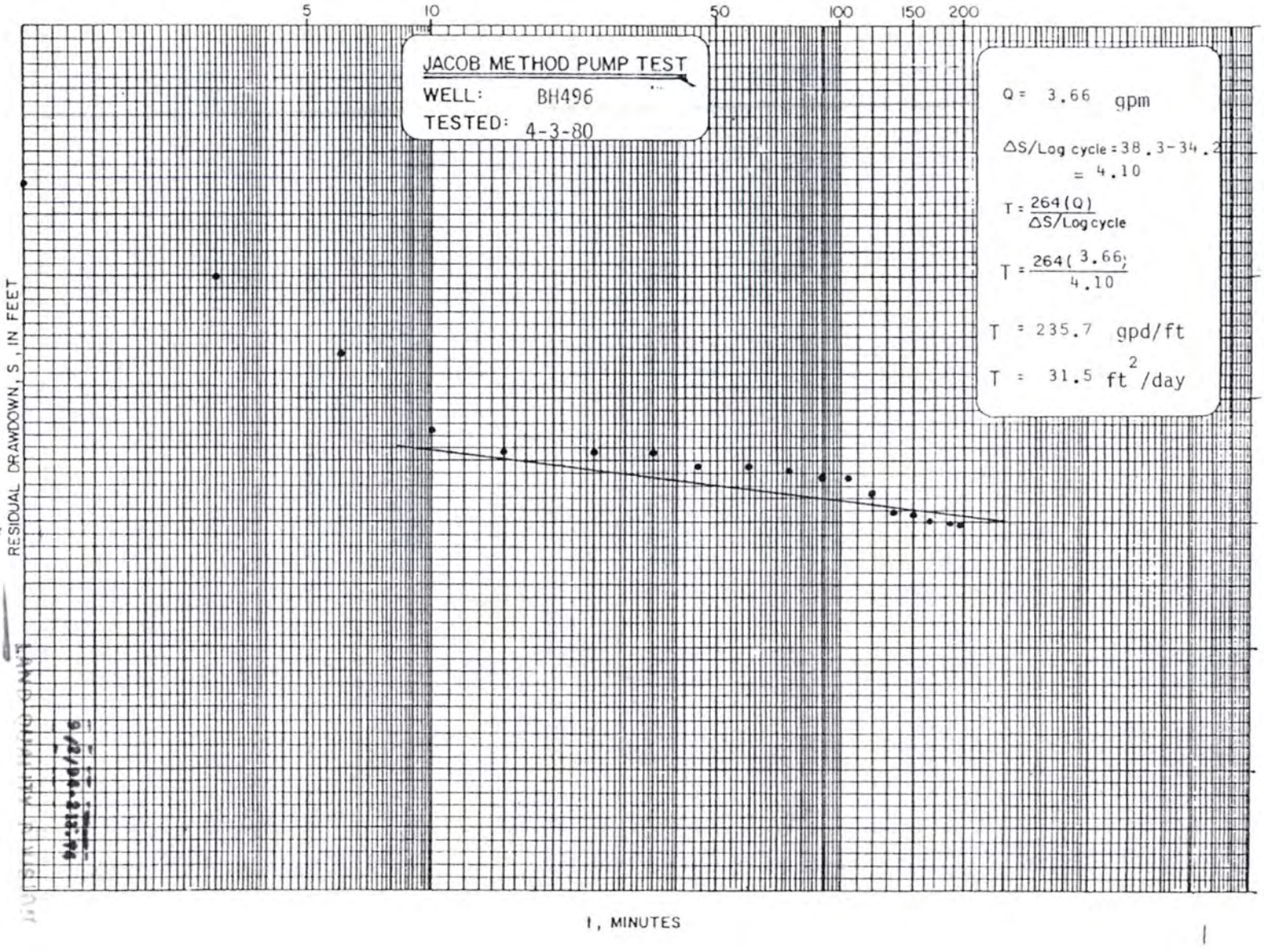
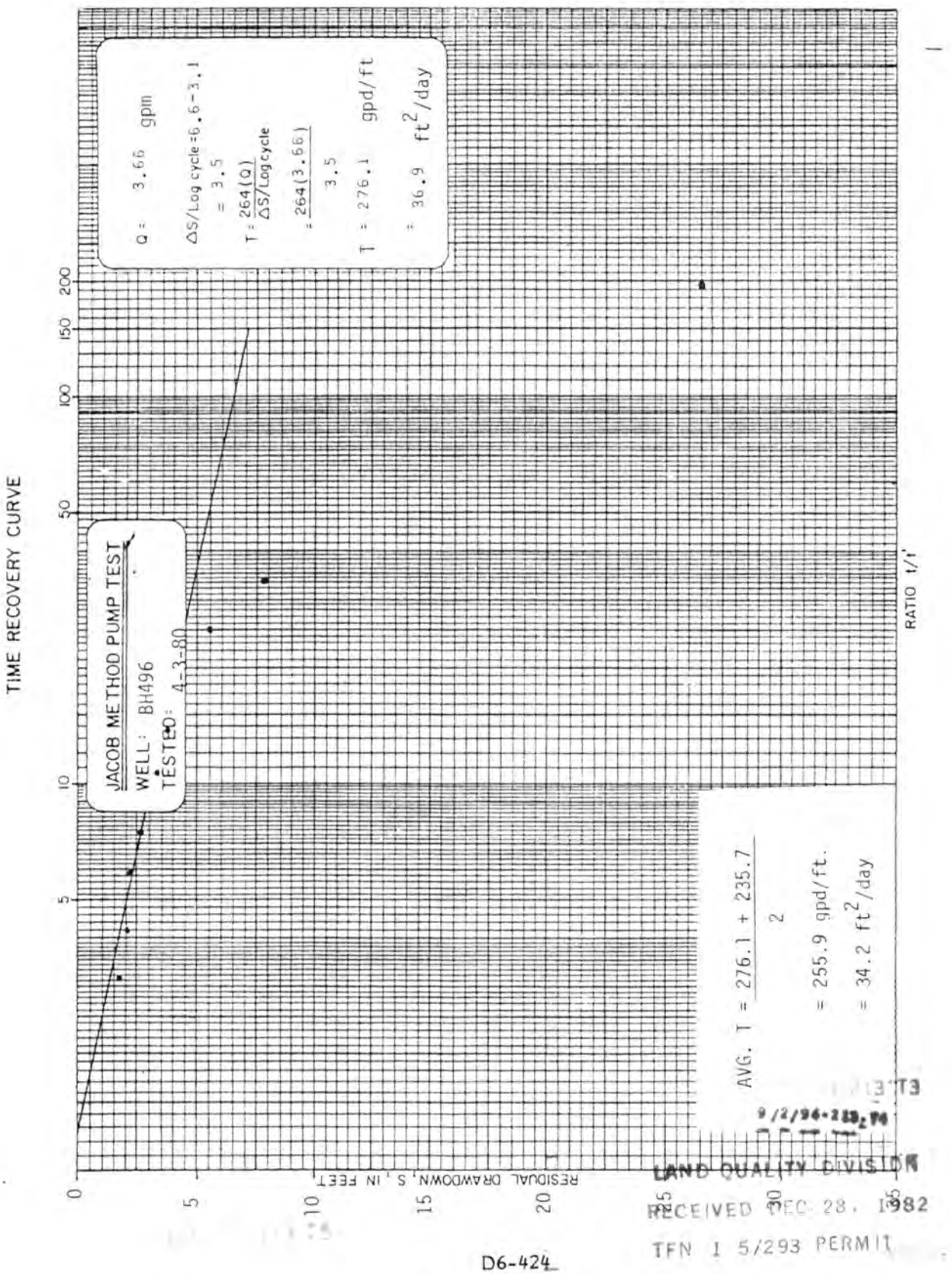
TIME DRAWDOWN CURVE



D6-423
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1654



D6-424

LAND QUALITY DIVISION
RECEIVED DEC 28, 1982
TFN I 5/293 PERMIT

DEQ Ex. 3-1655

Scanned, 02/26/2020

RAMACO

Brook Mine

U.S. GEOLOGICAL SURVEY — WATER-RESOURCES INVESTIGATIONS

State WY County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 14 WELL NO. 584

Personnel Bondar

Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
(2) Single well recovery 4. Recovery with obs. well

All owner P.K.S. Address Sheridan, WY

Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total depth 340 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 303' - 327'

Pump hp. & type 3/4 Teel (sub.) Pump depth 250 ft.

MICRO FILMED SEP 21 '94

Aquifer Monarch Aquifer lithology coal

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP 105.95 How measured Galvonometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4-9-80	10:30	105.95	0			0
	10:33	124.23	3			18.28
	10:36	139.19	6			33.24
	10:40	141.27	10			35.32
	10:45	145.51	15			39.56
	10:50	147.80	20			41.85
	11:00	149.36	30			43.41
	11:15	150.43	45			44.48
	11:30	150.74	60			44.79
	11:45	151.04	75			45.09
	12:00	151.10	90			45.15
	12:20	151.46	110			45.51
	13:00	151.77	150			45.82
	13:30	152.08	180	R.B. 99 213 T5 3 T3		46.13
	14:00	152.10	210			46.15
Off	14:35	152.13	245	0	0	46.18
	14:36	136.45	246	1	246.0	30.50
	14:38	120.32	248	3	82.7	14.37
	14:41	113.81	251	6	41.83	7.86
	14:45	110.31	255	10	25.5	4.36
	14:50	108.70	260	15	17.33	2.75
	14:55	108.42	265	20	13.25	2.47
	15:00	108.15	270	25	10.80	2.20
	15:10	107.80	280	35 9/2/94 T2, T4	8.00	1.85
	15:20	107.58	290	45	6.40	1.63
	15:30	107.40	300	55 LAND QUALITY DIVISION	5.45	1.45
	15:40	107.27	310	65 RECEIVED	4.80	1.32
	15:50	107.18	320	75 TFN 1 5/93 PERMIT	4.26	1.23
	16:00	107.09	330	85 213-T2	3.90	1.14

D6-425

TFN 6 2/025

WATER WELL BH 584

PUMPING RATE DATA

FILMED SEP 21 '04

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
4-9-80	1033	22.50	9.15	3.43	3	27.45
	1040	23.40	8.80	3.43	7	61.60
	1045	24.50	8.40	3.43	5	42.00
	1050	24.30	8.50	3.43	5	42.50
	1100	25.20	8.16	3.43	10	81.60
	1115	25.70	8.00	3.43	15	120.00
	1130	24.00	8.58	3.43	15	128.70
	1145	25.50	8.07	3.43	15	121.05
	1200	26.30	7.83	3.43	15	117.45
	1220	26.00	7.92	3.43	20	158.40
	1300	25.70	8.00	3.43	40	320.00
	1330	25.50	8.07	3.43	30	242.10
	1400	25.50	8.07	3.43	65	524.55
FF	1435				245	1987.4

1987.4/245 = 8.11, Total Ave. Q = 8.11

Specific Capacity = 8.11/46.18 = .18 gpm/ft.

3 TS

LAND QUALITY DIVISION

RECEIVED DEC 28 1983

TEN 1 5/293 PERMIT

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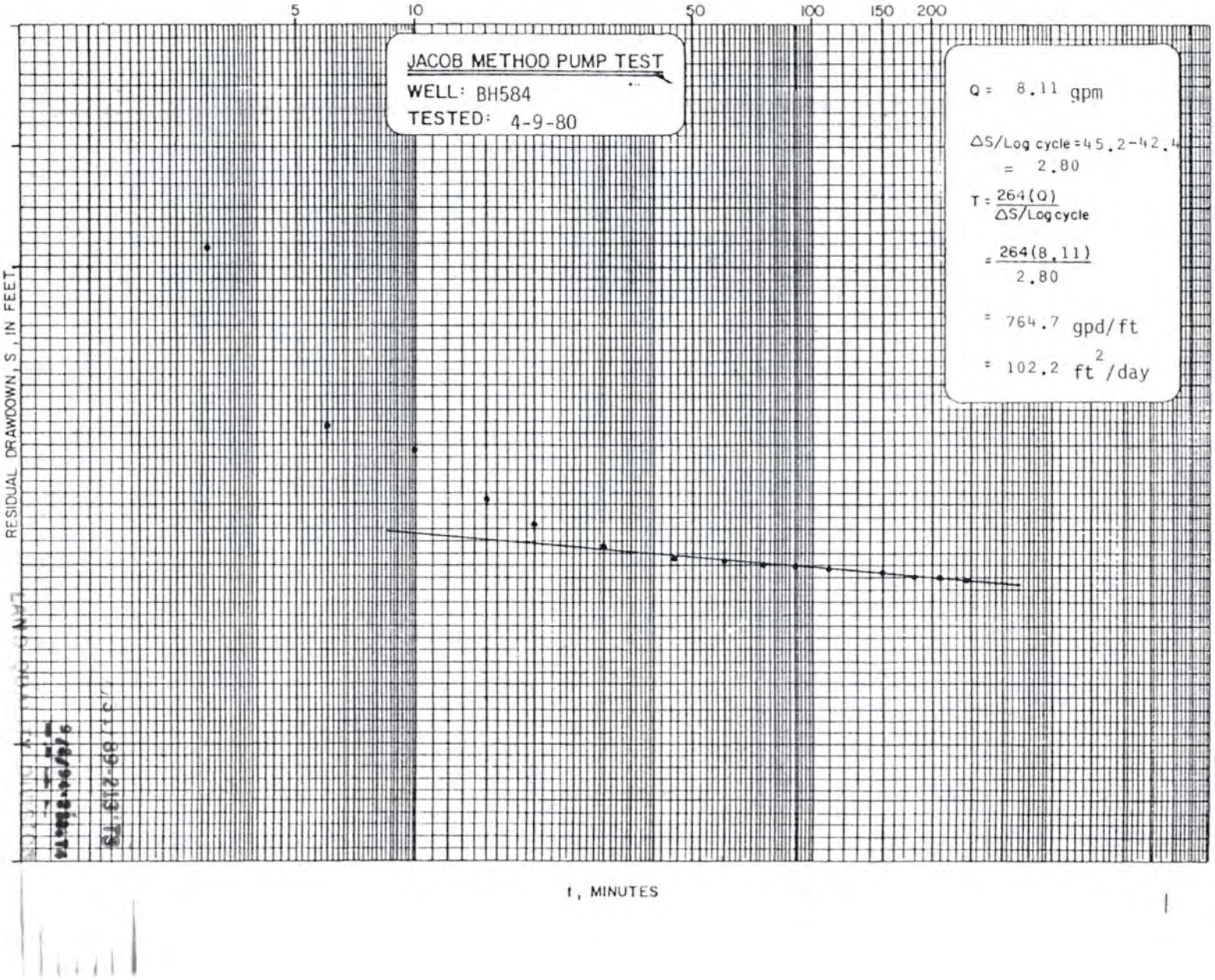
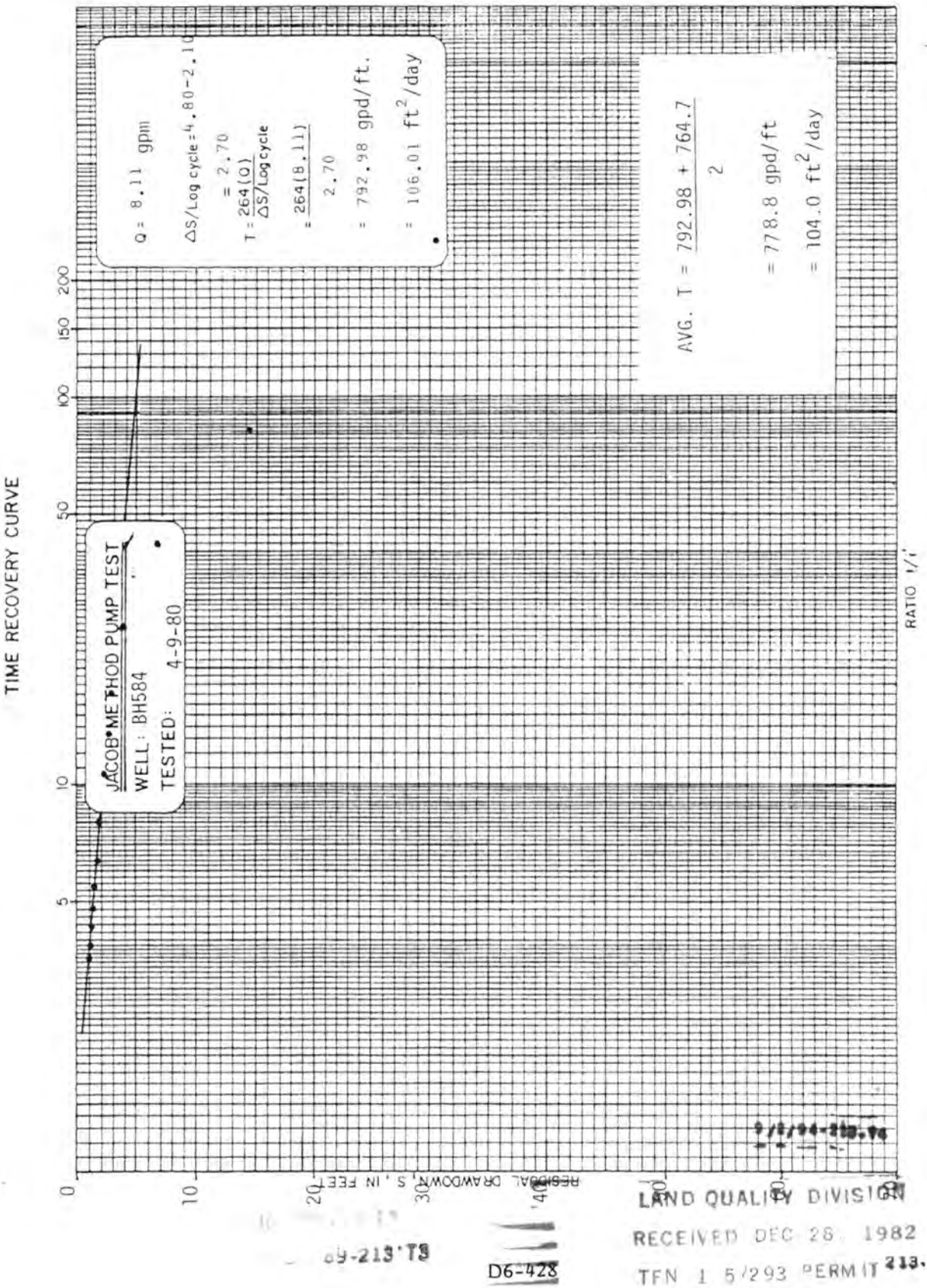
TIME DRAWDOWN CURVE



D6-427
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1658



LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT 213-T2
D6-428

DEQ Ex. 3-1659

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MICRO FILMED SEP 21 '84

ADDENDUM D6-5

AQUIFER TEST DATA AND CALCULATIONS

PIT 4

9/2/94-213.T4
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT 213-T2
TFN 6 2/025

BAILER TEST

Well # WW390-79

Date: 11/14/79 Personnel: Gerlach, Araas

S.W.: 61.32' Bailer Volume: 2.68 gal.

TIME IN	TIME OUT	BAILER VOLUME (GALS)	ELAPSED TIME t, TO S'(MIN)	t, TO S'(DAY)	REGIONAL DRAWDOWN S'(FT)	VOL(GAL.) / t (DAY)	COMMENTS
13:28	13:29	2.68	114.00	.079		33.85	
13:30	13:31	1.34	112.00	.078		17.23	
13:32	13:33	0	110.00	.076		0	
13:34	13:35	0.67	108.00	.075		8.93	
13:35	13:36	2.68	107.00	.074		36.07	
13:36	13:38	2.68	105.00	.073		36.74	
13:38	13:39	2.68	104.00	.072		36.12	
13:39	13:41	2.68	102.00	.071		37.84	
13:41	13:42½	2.68	100.50	.070		38.40	
13:42½	13:43 3/4	2.68	99.25	.069		38.89	
13:44	13:45¼	2.68	97.75	.068		39.48	
13:45½	13:46 3/4	2.68	96.25	.067		40.09	
13:47	13:48¼	2.68	94.75	.066		40.74	
13:48½	13:49 3/4	2.68	93.25	.065		41.38	
13:50	13:51½	2.68	91.75	.064		42.05	
13:51½	13:53 3/4	2.68	90.25	.063		42.77	
13:53	13:54¼	2.68	88.75	.062		43.50	
13:54½	13:56	2.68	87.00	.060		44.35	
13:56¼	13:57	2.68	85.50	.059		45.13	
13:573/4	13:59¼	1.34	83.75	.058		23.03	
13:59½	14:01	2.68	82.00	.057		47.06	
14:01¼	14:02 3/4	2.68	80.25	.056		48.08	
14:03	14:04½	2.68	78.50	.055		49.15	
14:043/4	14:06¼	2.68	76.75	.053		50.28	
14:06½	14:08	2.68	75.00	.052		51.46	
14:08½	14:09 3/4	0.67	73.25	.051		13.17	
						Σ=946.79	
RECOVERY							
14:15			68.00		98.65		
14:32½			50.50		97.81		
14:50½			27.50		97.32		
15:11			12.00		95.62		
15:23			0				

SOLUTION TO WW390 BAILER TEST

$$T = \frac{1}{4\pi(S')}\left\{\frac{V_1}{t_1} + \frac{V_2}{t_2} = \frac{V_3}{t_3} + \ldots \frac{V_n}{t_n}\right\}$$

Where S'=95.28'-61.32'=33.96' at 115 minutes, so $T = \frac{1}{(12.57)(33.96')}$ (946.79 gal/day)

= 2.22 gpd/ft = 0.3 ft^2/day

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BAILER TEST

Well # WW390-79

MICRO FILMED SEP 21

Date: 11/14/79 Personnel: Gerlach, Araas

S.W.: 61.32' Bailer Volume: 2.68 gal.

PAGE 2

TIME IN	TIME OUT	BAILER VOLUME (GALS)	ELAPSED TIME t, TO S'(MIN)	t, TO S'(DAY)	REGIONAL DRAWDOWN S'(FT)	VOL(GAL.) / t (DAY)	COMMENTS

Ave. Q = $\frac{60.30 \text{ gals}}{41.75 \text{ min.}}$ = 1.44 gpm

Total Residual Drawdown = 98.65'-61.32' = 37.33'

∴ Specific Capacity = $\frac{1.44 \text{ gpm}}{37.33'}$ = 0.04 gpm/ft

8/30 99 213 T5

9/2/94-213.T4

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT 213-T2

7/31/89-213 T3

D6-431

TFN 6 2/025

REC'D 10-25-18

BAILER TEST

Well # WW391-79

MICRO FILMED

Date: 11/15/79 Personnel: Gerlach, Araas

S.W.: 47.47' Bailer Volume: 2.68 gal.

TIME IN	TIME OUT	BAILER VOLUME (GALS)	ELAPSED TIME t, TO S'(MIN)	t, TO S'(DAY)	REGIONAL DRAWDOWN S'(FT)	VOL(GAL.) / t (DAY)	COMMENTS
12:97	12:08	2.68	162.00	.113		23.82	
12:08	12:09	2.68	161.00	.111		23.97	
12:09	12:10	2.68	160.00	.111		24.12	
12:10	12.11	2.68	159.00	.110		24.27	
12:11½	12:12½	2.68	157.75	.109		24.46	
12:12½	12:13½	2.68	156.75	.109		24.62	
12:13½	12:14½	2.68	155.75	.108		24.78	
12:14½	12:16	2.68	154.00	.107		25.06	
12:16	12:17	2.68	153.00	.106		25.22	
12:17½	12:18½	2.68	151.75	.105		25.43	
12:18½	12:19½	2.68	150.50	.105		25.64	
12:19	3/412:20	3/4 2.68	149.25	.104		25.86	
12:21	12:22	2.68	148.00	.103		26.08	
12:22	12:23½	2.68	146.75	.102		26.30	
12:23½	12:24½	2.68	145.50	.101		26.52	
12:25	3/412:27½	2.68	142.50	.099		27.08	
12:27	3/412:29	2.68	141.00	.098		27.37	
12:30½	12:31½	2.68	138.50	.096		27.86	
12:31	3/412:32	3/4 2.68	137.25	.095		28.12	
12:33	12:34	2.68	136.00	.094		28.38	
12:34½	12:35½	2.68	134.75	.094		28.64	
12:35½	12:36	3/4 2.68	133.25	.093		28.96	
12:37	12:38½	2.68	131.75	.092		29.29	
12:38½	12:39½	2.68	130.50	.091		29.57	
12:39½	12:40	3/4 2.68	129.25	.090		29.86	
12:42	3/412:44½	2.68	125.75	.087		30.69	
12:44½	12:45	3/4 2.68	124.25	.086		31.06	
12:46	12:47½	2.68	122.75	.085		31.44	
						Σ=754.47	
RECOVERY							
12:49			121.00		79.26		
13:13			97.00		79.06		
13:45			65.00		78.88		
14:50			0		78.64		

SOLUTION TO WW391 BAILER TEST

$$T = \frac{1}{4\pi(S')}\left[\frac{V_1}{t_1} + \frac{V_2}{t_2} + \frac{V_3}{t_3} + \cdots \frac{V_n}{t_n}\right]$$

Where S' = 78.64'-47.47' = 31.17', so $T = \left(\frac{1}{(12.57)(31.17')}\right)$ 754.47 gal/day

= 1.93 gpd/ft = .25 ft^2/day

D6-432

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BAILER TEST

Well # WW391-79

MICRO FILMED SEP 21 '84

Date: 11/15/79 Personnel: Gerlach, Araas

S.W.: 47.47' Bailer Volume: 2.68 gal

PAGE 2

TIME IN	TIME OUT	BAILER VOLUME (GALS)	ELAPSED TIME t, TO S'(MIN)	t, TO S'(DAY)	REGIONAL DRAWDOWN S'(FT)	VOL(GAL.) / t (DAY)	COMMENTS

Ave. $Q = \frac{75.04 \text{ gal}}{40.25 \text{ min.}} = 1.86$ gpm.

Total Residual Drawdown = 79.26' - 47.47' = 31.79'

$\therefore$ Specific Capacity = $\frac{1.86 \text{ gpm}}{31.79'} = .06$ gpm/ft.

8/30/99 213 T4

9/2/94-213.T4

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT 212-1A

89-213 T3

TFN 6 2/025

RECD 10-25-18

U.S. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State WY County Sheridan T. 57 N. S. R. 84 E. W. Sec. 9 WELL NO. WW 392-79

Personnel Bondar, Araas, Veenstra, Collier Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well

Well owner Peter Kiewit Sons' Address P. O. Box 3049, Sheridan, WY 82801

R. Reed (PKS) Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Depth 50.0 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 27-50'

FILMED SEP 2 1 84

Pump hp. & type 1.5 hp Barnes Pump depth 44 ft.

Aquifer Ft. Union Fm. Aquifer lithology Sandy clay and fine grained sandstone

Altitude of land surface 3698.5 How determined surveyed MP Above Below LSD Altitude MP 1.85

WL from MP 20.40 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
2/26/79						
on	1600	20.40	0.0			0.0
	01	39.78	1.0			19.38
	02	39.70	2.0			19.30
	03	39.78	3.0			19.38
	04	39.77	4.0			19.37
	05	39.80	5.0			19.40
	10	39.73	10.0			19.33
	20	39.80	20.0			19.40
	30	39.74	30.0			19.34
	1700	39.83	60.0			19.43
	30	39.80	90.0			19.40
	1800	39.75	120.0			19.35
	1900	39.62	180.0			19.22
	2000	39.80	240.0			19.40
	2100	39.75	300.0			19.35
	2200	39.47	360.0			19.07
	2300	39.51	420.0			19.11
	2400	39.40	480.0			19.00
2/27/79	0100	39.39	540.0			18.99
	0200	39.50	600.0			19.10
	0300	39.43	660.0			19.03
Pump off						

9/2/94-213T6

LAND QUALITY DIVISION

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TFN I 5/293 PERMIT 213-T2

89-213 T3

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P.K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 N. S. R. 84 E. W. Sec. 9 WELL NO. WW 392-79

Personnel Bondar, Araas, Veenstra, Collier

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specif
2. Single well recovery (4) Recovery with obs. well

Well owner Peter Kiewit Sons' Address P. O. Box 3049, Sheridan, WY 82801
R. Reed (PKS)

Method drilled: (A) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

MICRO FILMED SEP 21 '84

Depth 50.0 ft. Well diameter 7 7/8 in.
Casing diameter 5 saw in. Casing type PVC
Type of screen or perforation slots Interval of screen or perforation 27-50'
Pump hp. & type 1.5 hp Barnes Pump depth 44 ft.
Aquifer Ft. Union Fm. Aquifer lithology Sandy clay and fine grained sandstone
Altitude of land surface 3698.5 How determined surveyed MP Above Below LSD Altitude MP 1.85
WL from MP 20.40 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
2/27/79						
off	0302:00	39.43	662.0	0.0	-----	19.03
	0302:35	26.10	662.58	0.58	1142.38	5.70
	0303:44	21.07	663.73	1.73	383.66	0.67
	0305:13	20.68	665.22	3.22	206.59	0.28
	0307:00	20.57	667.00	5.00	133.40	0.17
	0312:00	20.55	672.00	10.00	67.20	0.15
	0328:00	20.53	688.00	26.00	26.46	0.13
	0411:00	20.48	731.00	69.00	10.59	0.08
	0449:00	20.43	769.00	107.00	7.19	0.03

9/2/94-213.T4

LAND QUALITY DIVISION
RECEIVED JUL 28 1992
PERMIT 213-T2

8/30 89-213 T3

89-213 T3

REC'D 2/025

WATER WELL WW392-79

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
2/26/79	1601	79.2	41.67	55	1	41.67
	1606	81.8	40.34	55	5	201.70
	1621	83.6	39.47	55	15	592.05
	1630	84.0	39.29	55	9	353.61
	1700	84.7	38.96	55	30	1168.80
	1730	85.0	38.82	55	30	1164.60
	1800	84.5	39.05	55	30	1171.50
	1900	85.4	38.64	55	60	2318.40
	2000	84.4	39.10	55	60	2346.00
	2100	84.4	39.10	55	60	2346.00
	2200	88.5	37.29	55	60	2237.40
	2300	85.3	38.69	55	60	2321.40
	2400	86.8	38.02	55	60	2281.20
2/27/79	0100	86.4	38.19	55	60	2291.40
	0200	85.9	38.42	55	60	2305.20
	0300	87.5	37.71	55	60	2262.60
				TOTALS	660	25,403.53

9/2/94-213-T4

25,403.53 ÷ 660 = 38.49

Total Ave. Q = 38.49 gpm

Specific Capacity = 38.5 gpm / 19.03 ft = 2.02 gpm/ft

99-213 T3

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Results of Aquifer Test Conducted 2/26/79

Pumping Well WW 392-78
Obs. wells WW 393-78 & WW 394-78
Q = 38.5 gpm
r_{393} = 96.7 ft, r_{394} = 174.2 ft.

MICRO FILMED

1. Attempted modified Jacob method Drawdown and Recovery Curve analyses on pumping well 392. For both attempts, the point scatter was very great and the results are inconclusive. May need more data points or there was turbulent flow.

2. Attempted Jacob Time/Drawdown analysis for observation well 393. Plot of points shows great scatter and the results inconclusive.

3. Attempted Theis Time/Drawdown analyses for both observation wells. Well 393 yielded a leaky curve with T = 16,958 gpd/ft. and S = 4.4×10^{-4}. Well 394 yielded a late non-leaky type curve with T = 55,150 gpd/ft. and S = 0.013. Well efficiency calculations for well 393, using the Theis method, calculated to 25% for well 393 and 8% for well 394. The 25% efficiency is very reasonable. Data for well 394 shows insufficient drawdown for any type of test calculation. Therefore, the hydraulic coefficients calculated for well 393 are taken as representative for the aquifer in this area.

9/2/94-213.T4
LAND QUALITY DIVISION
RECEIVED DEC 28. 1982
TFN 1 5/293 PERMIT 213-T2
89-213:T3
D6-437
TFN 8 2/025
RECD 10-25-18

Pumped Well Efficiency Calculations Using Data From Obs. Wells 393 and 394

Theis Test Pumping Well 392; Obs. Wells 393 and 394: Tested 2/26/79

WW 394

$$u = \frac{1.87\ 1^2\ S}{Tt}$$

r = .21 ft.
S = .013
T = 555150 gpd/ft.
t = .46 day (use max. length of test)

$$u = \frac{(1.87)(.21)^2(.013)}{(55,150)(.46)} = 4.75 \times 15^{9}, \quad w(u) = 18.58$$

$$S(\text{after 660 min} = \frac{(114.6)(38.5)}{55,150}(18.58) = 1.49 \text{ ft, but } \frac{1.49}{19.03} = .08 = 8\% \text{ well}$$

efficiency, therefore, T value probably too high.

Obs. Well 393

r = .21 ft.
S = 4.4×10^{-4}
T = 16958 gpd/ft
t = use .46 day (length of test)

$$u = \frac{(1.87)(.21)^2(4.4\times10^{-4})}{(16,958)(.46)} = 4.65\times10^{-9}, \quad w(u) - 18.61$$

$$\therefore S = \frac{114GQ}{T} \quad w(u) = \frac{(114.6)(38.5)(18.61)}{16,958} = 4.84 \text{ ft, but } \frac{4.84}{19.03} = 25\% \text{ well}$$

efficiency - reasonable

9/2/94-213-T4

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7/31/89-213-T3

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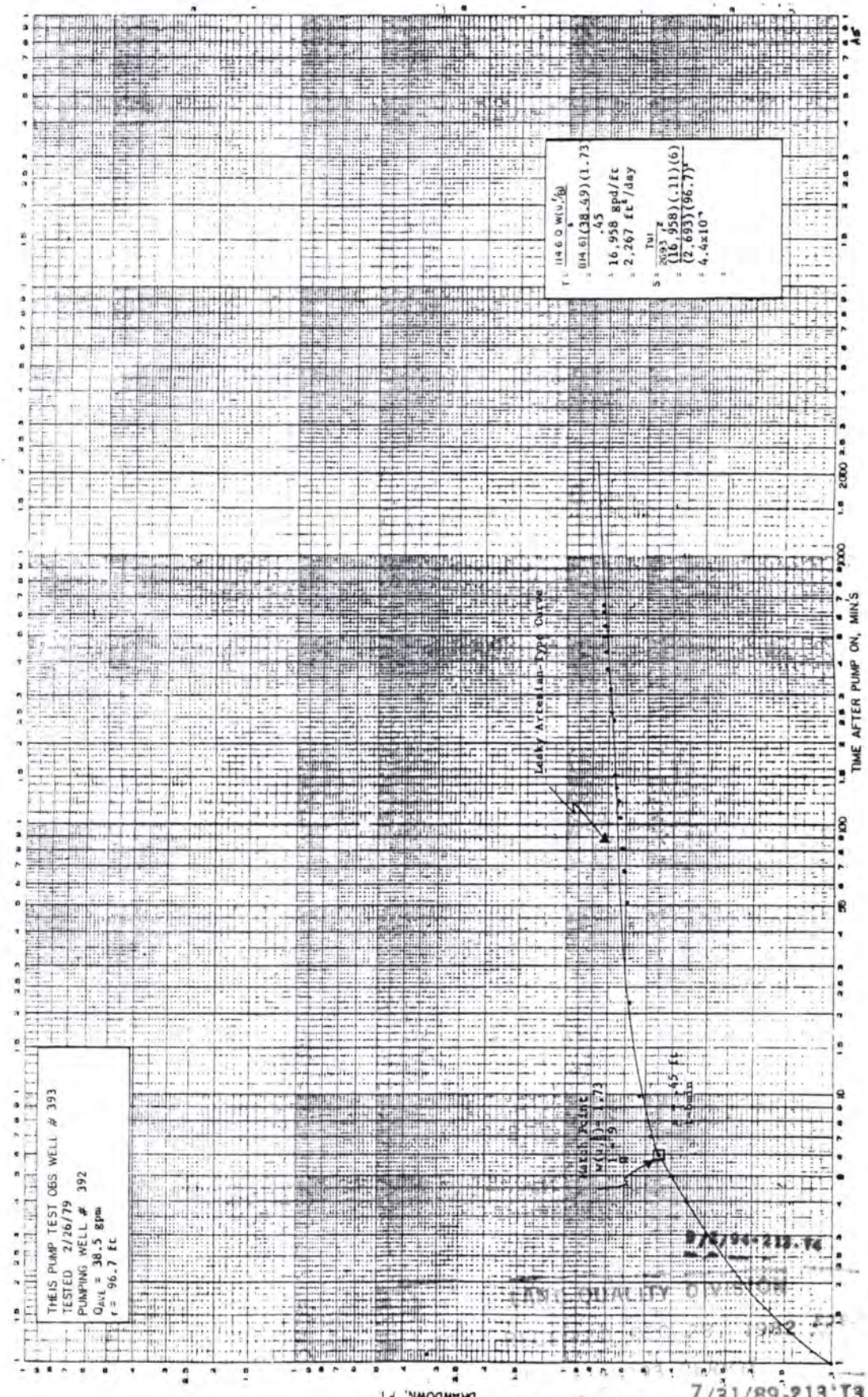
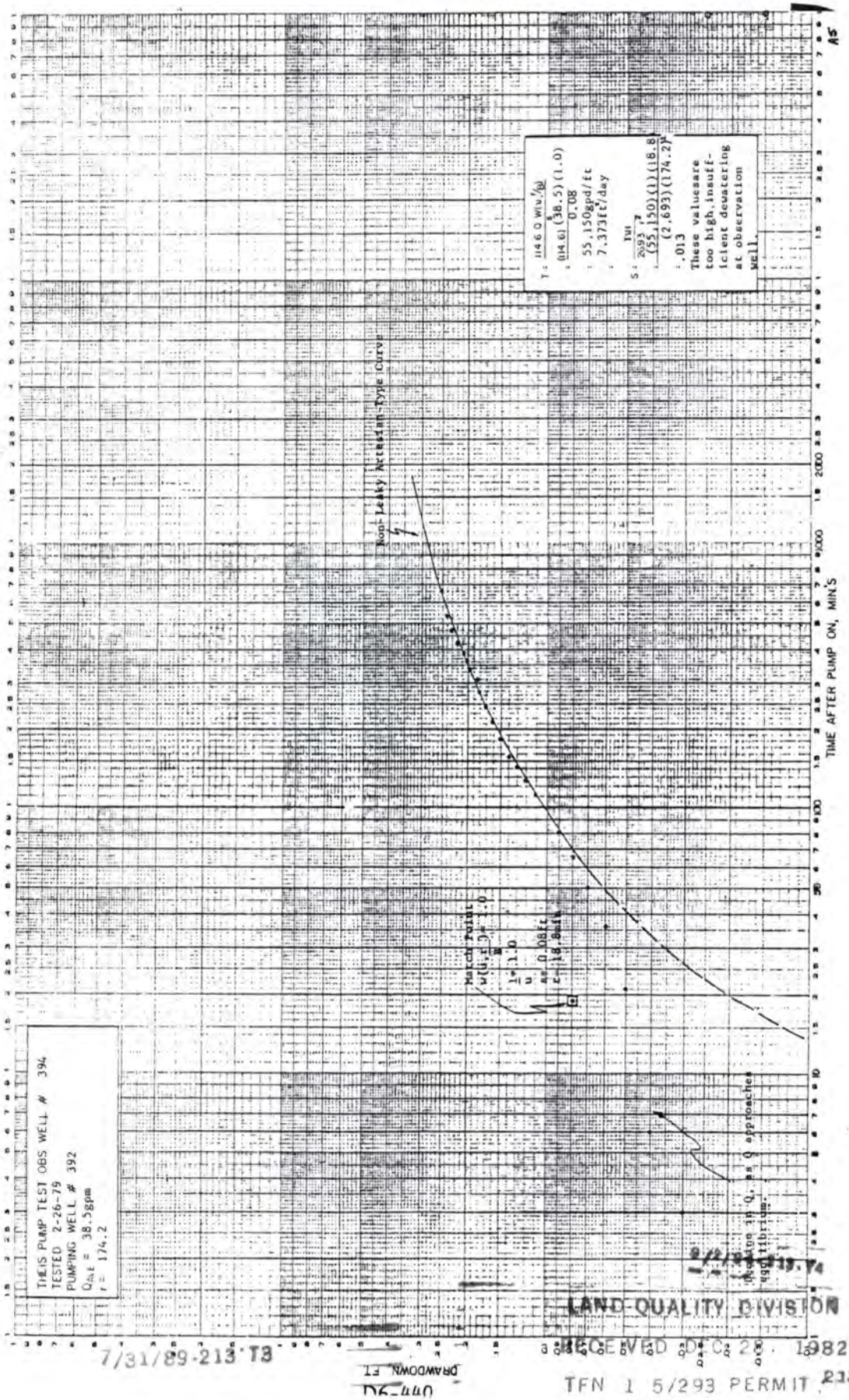


D6-439
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1670



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7/31/89-213-T3

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TFN I 5/293 PERMIT 213-12

DEQ Ex. 3-1671

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tate WY County Sheridan T. 57 N. S. R. 84 E. W. Sec. 15 WELL NO. WW 395-79

ersonnel Bondar, Araas, Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specif
2. Single well recovery 4. Recovery with obs. well

/ell owner Peter Kiewit Sons' Address P. O. Box 3049, Sheridan, WY 82801
R. Reed (PKS) Method drilled: (A) Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

o. epth 60.0 ft. Well diameter 7 7/8 in.
asing diameter 5 in. Casing type PVC
ype of screen saw
or perforation slots Interval of screen or perforation 42-60'
quifer Alluvium Aquifer lithology unconsolidated deposits of local origin.
Pump hp. & type 1.5 hp Barnes Pump depth 58 ft.

MICRO FILMED SEP 21 '84

ltitude of land surface 3666.4 How determined surveyed MP Above Below LSD Altitude MP 3666.4
WL from MP 8.25 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4/20/79						
on	1240	8.25	0			0.0
	41	17.92	1			9.67
	42	28.33	2			20.08
	43	33.70	3			25.45
	44	36.83	4			28.58
	45	38.87	5			30.62
	47	41.11	7			32.86
	50	42.03	10			33.78
	55	42.05	15			33.80
	1300	42.09	20			33.84
	10	41.78	30			33.53
	20	44.65	40			36.40
	30	51.30	50			43.05
	40	52.97	60			44.72
	50	52.12	70			43.87
	1400	53.67	80			45.42
	15	53.92	95			45.67
	40	55.46	120			47.21
	50	55.88	130			47.63
	1500	56.38	140			48.13
	10	56.04	150			47.79
	45	56.08	185			47.86
	55	56.78	195			48.53

7/8 WW-3-T3

9/2/94 218.T4

LAND QUALITY DIVISION
RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT 218.T5

D6-441

TFN 6 2/025

tate WY County Sheridan T. 57 N. S., R. 84 E. W., Sec. 15, WELL NO WW 395-79

ersonnel Bondar, Araas, Test type: (1) Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify)

ell owner Peter Kiewit Sons' Address P. O. Box 3049, Sheridan, WY 82801

R. Reed (PKS) Method drilled: (A) Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

pth 60.0 ft. Well diameter 7 7/8 in.

asing diameter 5 in. Casing type PVC

ype of screen or perforation saw slots Interval of screen or perforation 42-60' Pump hp. & type 1.5 hp Barnes Pump depth 58 ft.

quifer Alluvium Aquifer lithology unconsolidated deposits of local origin.

ltitude of land surface 3666.4 How determined surveyed MP Above Below LSD Altitude MP 3666.4

WL from MP 8.25 How measured galvanometer

MICRO FILMED SEP 21 '84

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4/20/79						
off	1600	56.78	200	0	0.0	48.53
	01	40.55	201	1	201	32.30
	02	27.38	202	2	101	19.13
	03	17.98	203	3	67.70	9.73
	04	12.65	204	4	51.00	4.40
	05	10.48	205	5	41.00	2.23
	06	10.00	206	6	34.33	1.75
	07	8.64	207	7	29.58	.39
	08	8.29	208	8	26.00	.04
	09	8.23	209	9	23.22	0.0

7/31/89-213-T3

9/2/94-213.94

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D6-442

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WATER WELL WW 395-79

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
4/20/79	1245	214.60	15.38	55	5	76.90
	1300	214.60	15.38	55	15	230.70
	1320	208.50	15.83	55	20	316.60
	1325	178.8	18.46	55	5	92.30
	1350	201.00	16.42	55	25	410.50
	1430	207.20	15.93	55	40	637.20
	1500	215.80	15.29	55	30	458.70
	1515	212.40	15.54	55	15	233.10
	1530	210.30	15.69	55	15	235.35
	1550	218.30	15.12	55	20	302.40
				TOTALS	190	2993.75

7/31/89-213 TS

8/30 99-213 T2

9/2/94-213.T4

2993.75 gals / 190 min. = 15.76 gpm

Specific Capacity = 15.76 gpm / 48.53 ft. = 0.32 gpm/ft.

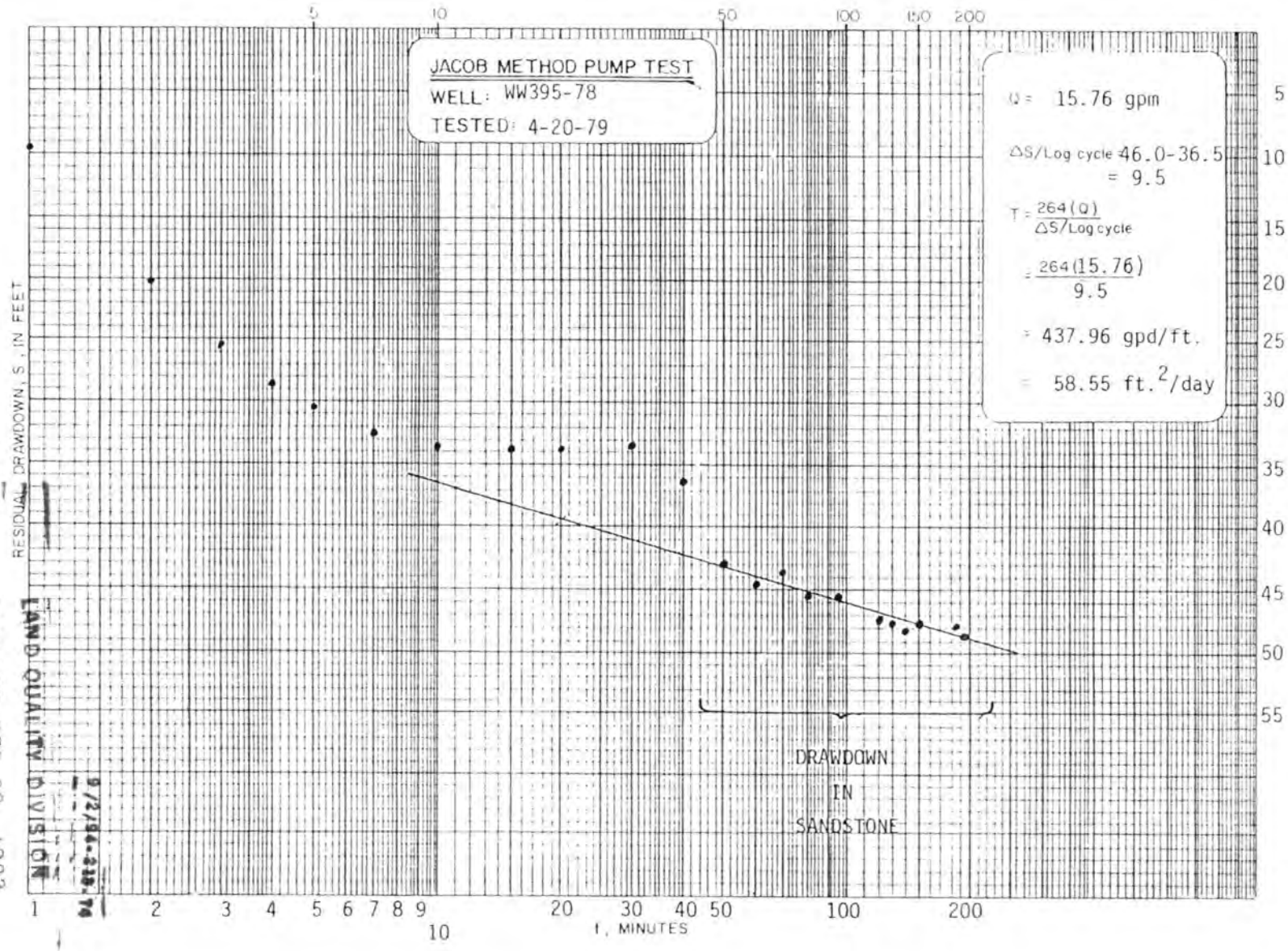
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TDH 1 6293 PERMIT

213-T2

D6-443

TPRS 27025
RECD 10-25-18

TIME DRAW DOWN CURVE



7/31/89-213-T3
D6-444
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT
LAND QUALITY DIVISION

DEQ Ex. 3-1675

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MICRO FILMED SEP 21 '84

ADDENDUM D6-6

AQUIFER TEST DATA AND CALCULATIONS

PIT 5

9/2/94-213.T4

LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT

7/31/89-213.T3

D6-445
TFN 6 2/025
RECD 10-25-18

BAILER TEST
WELL # WW408-79

Date 12-19-79 Personnel Bondar,Araas,Volk S.W.L. 213.08'
Bailer Volume 2.68 gals.

Time In	Time Out	Bailer Volume (Gals.)	Elapsed Time, t, To S'(Min.)	t, To S'(Day)	Residual Drawdown S' (Ft.)	Vol.(Gal.) t(Day)	Comments
1126:00	1129:20	0.67	241	0.167		4.01	
1129:45	1133:20	2.68	237	0.165		16.24	
1133:35	1137:20	0	233	0.162		--	Bailer valve
1137:45	1141:25	0	229	0.159		--	sticking
1142:45	1146:30	2.01	224	0.156		12.89	
1146:45	1150:25	0	220	0.153		--	"
1150:50	1154:40	2.68	216	0.150		17.87	"
1154:55	1158:30	0	212	0.147		--	"
1159:10	1203:10	0.67	207	0.144		4.65	"
1203:25	1207:15	0	203	0.141		--	"
1207:40	1211:25	2.68	199	0.138		19.42	
1211:55	1215:35	0	195	0.135		--	"
1216:05	1219:50	0	191	0.133		--	"
						75.08	
Recovery							
1230:00			180		219.05		
1330:00			120		218.82		
1430.00			60		218.65		
1530:00			0		218.59		

D6-446

7/31/89-213'T3
213-T2

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MICRO FILMED SEP 21 '84

Solution to WW408 Bailer Test

$$T = \frac{1}{4\pi(S')}\left[\frac{V_1}{t_1} + \frac{V_2}{t_2} + \frac{V_3}{t_3} + \ldots \frac{V_n}{t_n}\right]$$

Where S' = 218.59' - 213.08' = 5.51' at 244 mins.

$$\text{so, } T = \frac{1}{(12.57)(5.51')}\left[75.08 \frac{\text{Gal.}}{\text{Day}}\right]$$

$$= 1.08 \text{ gpd/ft.} = 0.14 \text{ ft.}^2\text{/day}$$

$$\text{Ave. } Q = \frac{11.39 \text{ gals.}}{53.83 \text{ mins.}} = 0.21 \text{ gpm}$$

Total Residual Drawdown = 219.05' - 213.08'
= 5.97'

∴ specific capacity = 0.21 gpm/5.97' = 0.04 gpm/ft.

9/2/94-213.T4

7/31/89-213.T3

D6-447

TFR 6 2/025

RECD 10-25-18

MICRO FILMED SEP 21 '94

BAILER TEST
WELL # WW555-80

Date 3-4-80 Personnel Volk, Bondar S.W.L. 36.10'
Bailer Volume 2.68 gals.

Time In	Time Out	Bailer Volume (Gals.)	Elapsed Time, t, To S'(Min.)	t, To S'(Day)	Residual Drawdown S' (Ft.)	Vol.(Gal.) t(Day)	Comments
1110:00	1112:05	2.68	107.92	0.075		35.73	
1112:30	1114:30	2.68	105.50	0.073		36.71	
1114:45	1116:55	2.68	103.08	0.072		37.22	
1117:15	1119:15	2.68	100.75	0.070		38.29	
1120:00	1122:05	2.68	97.92	0.068		39.41	
1122:30	1124:35	2.68	95.42	0.066		40.61	
1124:55	1127:05	2.68	92.92	0.065		41.23	
1127:20	1129:35	2.68	90.42	0.063		42.54	
1129:50	1132:10	2.68	87.83	0.061		43.93	
1132:25	1134:45	2.68	82.25	0.059		45.42	
						401.09	
Recovery							
1134:45			85.25		44.45		
1150:00			70.00		43.05		
1210:00			50.00		41.40		
1230:00			30.00		40.19		
1300:00			0		38.63		

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TFN 1 5/293 PERMIT
7/31/89-213-T3
D6-448

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MICRO FILMED SEP 21 '84

Solution To WW555 Bailer Test

$$T = \frac{1}{4\pi (S')} \left[\frac{V_1}{t_1} + \frac{V_2}{t_2} + \frac{V_3}{t_3} + \ldots \frac{V_n}{t_n} \right.$$

Where S' = 38.63' - 36.10' - 2.53' at 110 mins.

$$\text{So, } T = \frac{1}{(12.57)(2.53')} \left[401.09 \frac{\text{Gal.}}{\text{Day}}\right]$$

$$= 12.61 \text{ gpd/ft.} = 1.69 \text{ ft}^2\text{/day}$$

$$\text{Ave. Q} = \frac{2.68 \text{ gals. x } 10}{24.75 \text{ mins.}} = \frac{26.8 \text{ gals.}}{24.75 \text{ mins.}} = 1.08 \text{ gpm}$$

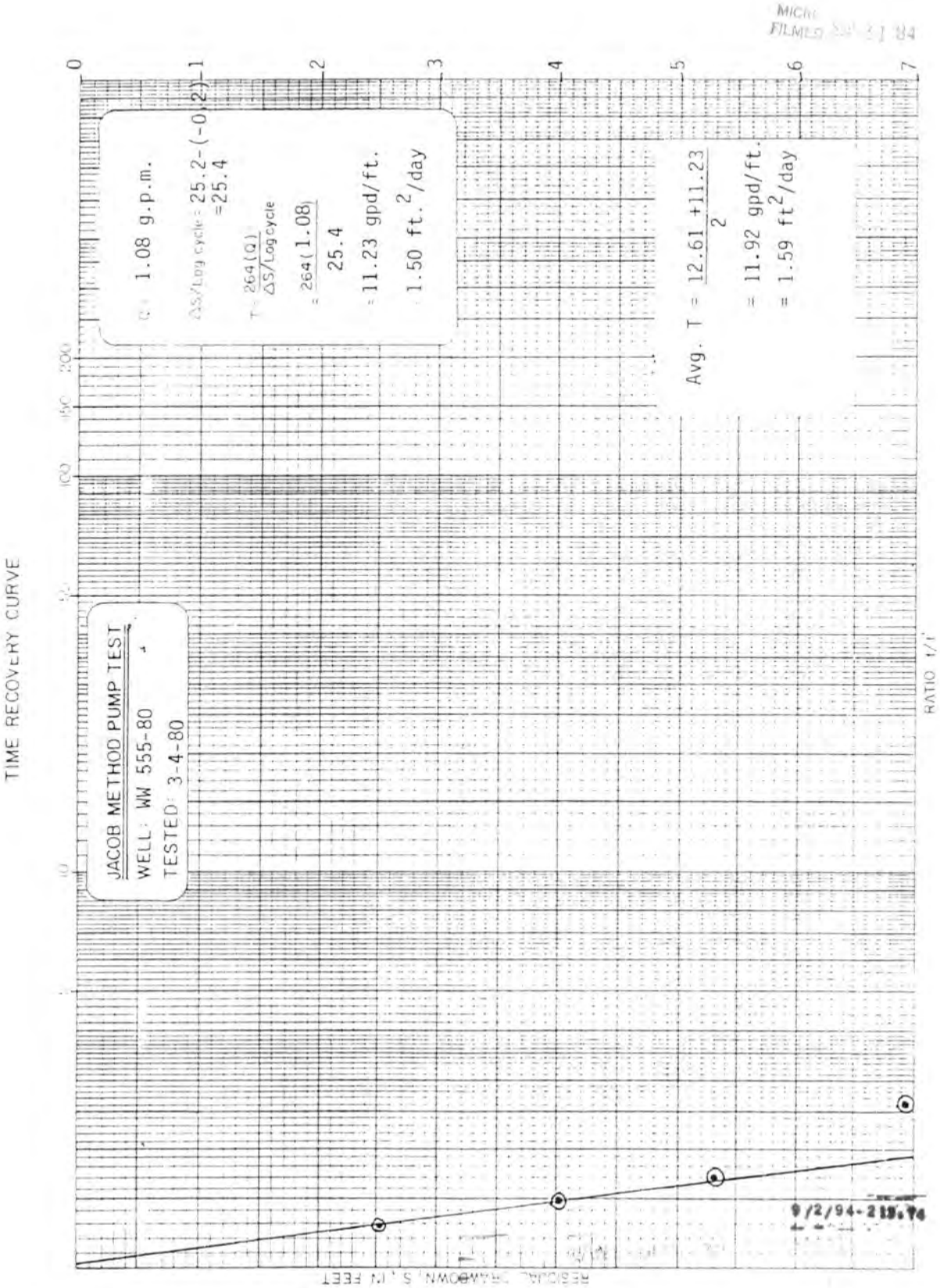
Total Residual Drawdown = 44.45' - 36.10'
= 8.35'

∴ Specific capacity = 1.08 gpm/8.35' = 0.13 gpm/ft.

Jacob Time Recovery

Time since bailing began, t, (Min.)	Time since bailing ended, t', (Min.)	t/t'	Residual Drawdown, S
24.75	0	--	8.35
40	15.25	2.62	6.95
60	35.25	1.70	5.30
80	55.25	1.45	4.09
110	85.25	1.29	2.53

9/2/94-
LAND QUALITY DIVISION
213-T2
89-213-T3
D6-449
TFN 6 2/025
DEQA 10-25-18


JACOB METHOD PUMP TEST
WELL: WW 555-80
TESTED: 3-4-80
Q = 1.08 g.p.m.
ΔS/Log cycle = 25.2-(-0.2) = 25.4
T = 264(Q) / ΔS/Log cycle
= 264(1.08) / 25.4
= 11.23 gpd/ft.
= 1.50 ft.²/day
Avg. T = 12.61 + 11.23 / 2
= 11.92 gpd/ft.
= 1.59 ft²/day
TIME RECOVERY CURVE
RATIO t/t'
RESIDUAL DRAWDOWN, S', IN FEET
9/2/94-213.T4
89-213 T3
D6-450

DEQ Ex. 3-1681

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BAILER TEST
WELL # WW562-80

Date 3-5-80   Personnel Volk, Bondar   S.W.L. 97.67'

Bailer Volume 2.68 gals.

Time In	Time Out	Bailer Volume (Gals.)	Elapsed Time, t, To S'(Min.)	t, To S'(Day)	Residual Drawdown S' (Ft.)	Vol.(Gal.) / t(Day)	Comments
1112:00	1115:50	2.68	224.17	0.156		17.18	
1116:25	1120:10	0	219.83	0.153		--	
1120:50	1124:00	0	216.00	0.150		--	
1124:15	1127:10	2.68	212.83	0.148		18.11	
1127:25	1130:15	0	209.75	0.146		--	
1130:30	1133:25	2.68	206.58	0.144		18.61	
1134:00	1137:40	2.68	202.33	0.141		19.01	
1138:10	1141:20	2.01	198.67	0.138		14.57	
						87.48	

Recovery

1200:00			180		106.30		
1230:00			150		106.17		
1330:00			90		106.04		
1430:00			30		105.90		
1500:00			0		105.85		

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TFN 1 5/293 PERMIT
RECD 10-25-18
89-213 T3
9/2/94-213.T4

Solution to WW562 Bailer Test

$$T = \frac{1}{4\pi (S')} \left[\frac{V_1}{t_1} + \frac{V_2}{t_2} + \frac{V_3}{t_3} + \cdots \frac{V_n}{t_n} \right]$$

Where $S' = 105.85' - 97.67' = 8.18'$ at 228 mins.

So, $T = \frac{1}{(12.57)(8.18')} \left[87.48 \frac{\text{Gal.}}{\text{Day}} \right]$

$= \underline{0.85 \text{ gpd/ft}} = 0.11 \text{ ft}^2/\text{day}$

Ave. $Q = \frac{12.73 \text{ gals.}}{29.33 \text{ min.}} = 0.43 \text{ gpm}$

Total residual drawdown = 106.30' - 97.67'
= 8.63'

∴ Specific capacity = 0.43 gpm/8.63' = 0.05 gpm/ft.

DEQ Ex. 3-1683

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ADDENDUM D11-C

ALLUVIAL AQUIFER PUMP TEST

CURVES AND DATA

LAND QUALITY
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TFN 1 6/25

D11-232
TFN 6 2/025
RECD 10-25-18

PAST LOCATION AND EXPLORATION

AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. OBS. 398

Personnel Bondar, Collier, Harris

Test type: 1. Single well drawdown X 3. Drawdown with obs. well 5. Other (specify)
2. Single well recovery X 4. Recovery with obs. well

Well owner ____ Address ____

r ____ Method drilled: A. Air-rotary D. Dug F. Air-percussion V. Driven
B. Bored or augered X. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

al well depth ____ ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 9.22 How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4-30-80	1315	9.220	0			0
ON	30	9.222	15			.002
	45	9.222	30			.002
	1400	9.222	45			.002
	30	9.225	75			.002
	1500	9.226	105			.005
	30	9.226	135			.006
	1600	9.230	165			.01
	1700	9.230	225			.01
	1800	9.238	285			.018
	1900	9.249	345			.029
	2000	9.249	405			.029
	2100	9.249	465			.029
	2200	9.250	525			.03
	2300	9.250	585			.03
	2400	9.257	645			.037
5-1-80	0100	9.257	705			.037
	0200	9.260	765			.04
	0300	9.268	825			.048
	0400	9.270	885			.05
	0500	9.280	945			.06
	0600	9.280	1005			.06
	0700	9.280	1065			.06
	0800	9.280	1125			.06
OFF	0830	9.280	1155	0	∞	.06
	45	9.280	1170	15	70.00	.06
	0900	9.280	1185	30	39.50	.06
	30	9.270	1215	60	20.25	.05
	1000	9.264	1245	90	13.83	.044

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D11-233

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U.S. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. OBS.398

Personnel Bondar, Collier, Harris Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) ____

Well owner ____ Address ____

r ____ Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug X. Hyd.-rotary J. Jetted F. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

al well depth ____ ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 9.22 How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
	30	9.256	1275	120	10.63	.036
	1100	9.247	1305	150	8.70	.027
	30	9.239	1335	180	7.42	.019
	1200	9.230	1365	210	6.50	.01
	30	9.222	1395	240	5.81	0
	1300	9.218	1425	270	5.28	0
	30	9.210	1455	300	4.85	0
	1400	9.203	1485	330	4.50	0
	30	9.198	1515	360	4.20	0
	1500	9.190	1545	390	3.96	0

MICRO FILMED SEP 21 '84

EQ-213-T3

LAND QUALITY DIVISION
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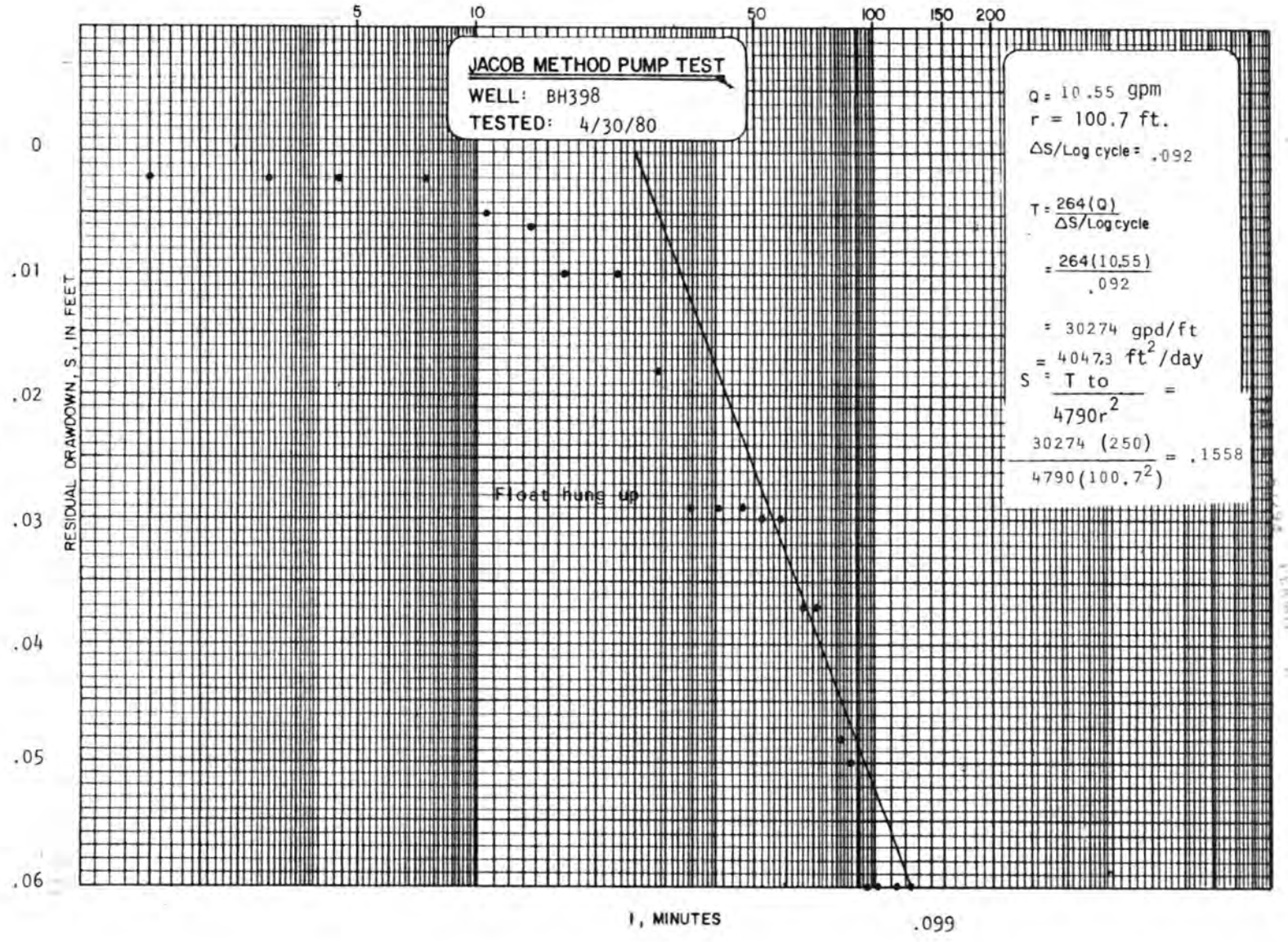
D11-234

213-T2

TFR 1 5/293 PERMIT

TFR 6 2/025
RECD 10-25-18

TIME DRAWDOWN CURVE



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[illegible] AQUIFER TEST DATA

State WYO. County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. OBS. 399

Personnel Bondar, Collier, Harris Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well ____

Well owner ____ Address ____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth ____ ft. Well diameter ____ in.

Casing diameter ____ in. Casing type ____

Type of screen or perforation ____ Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 9.54 How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4-30-80	1315	9.540	0			0
ON	20	9.540	5			0
	25	9.543	10			.003
	30	9.550	15			.01
	45	9.560	30			.02
	1400	9.563	45			.02
	15	9.570	60			.03
	30	9.576	75			.04
	45	9.581	90			.04
	1500	9.583	105			.04
	30	9.587	135			.05
	1600	9.593	165			.05
	30	9.601	195			.06
	1700	9.607	225			.07
	30	9.611	255			.07
	1800	9.620	285			.08
	1900	9.629	345			.09
	2000	9.635	405			.10
	2100	9.642	465			.10
	2200	9.652	525			.11
	2300	9.660	585			.12
	2400	9.670	645			.13
5-1-80	0100	9.679	705			.14
	0200	9.685	765			.15
	0300	9.694	825			.15
	0400	9.699	885			.16
	0500	9.701	945			.16
	0600	9.708	1005			.17
	0700	9.708	1065			.17

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LAND QUALITY DIVISION
D11-236
TFN 1 5/293 PERMIT
TFR 6 2/025
RECD 10-25-18

AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. OBS. 399

Personnel Bondar, Collier, Harris

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) ____
2. Single well recovery 4. Recovery with obs. well

Well owner ____ Address ____

r ____ Method drilled: A. Air-rotary D. Dug F. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

al well depth ____ ft. Well diameter ____ in.

Casing diameter ____ in. Casing type ____

Type of screen or perforation ____ Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 9.54 How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-1-80	0800	9.708	1125			.17
OFF	30	9.708	1155	0	∞	.17
	35	9.704	1160	5	232	.16
	40	9.70	1165	10	116.5	.16
	45	9.695	1170	15	78	.16
	50	9.69	1175	20	58.75	.15
	0900	9.68	1185	30	39.50	.14
	10	9.675	1195	40	29.88	.14
	20	9.668	1205	50	24.10	.13
	40	9.66	1225	70	17.50	.12
	1000	9.65	1245	90	13.83	.11
	30	9.636	1275	120	10.63	.10
	1100	9.625	1305	150	8.70	.09
	30	9.615	1335	180	7.42	.08
	1200	9.605	1365	210	6.50	.07
	30	9.598	1395	240	5.81	.06
	1300	9.59	1425	270	5.28	.05
	30	9.584	1455	300	4.85	.04
	1400	9.58	1485	330	4.50	.04
	30	9.572	1515	360	4.21	.03
	1500	9.568	1545	390	3.96	.03
	20	9.565	1565	410	3.82	.03

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213-72

D11-237

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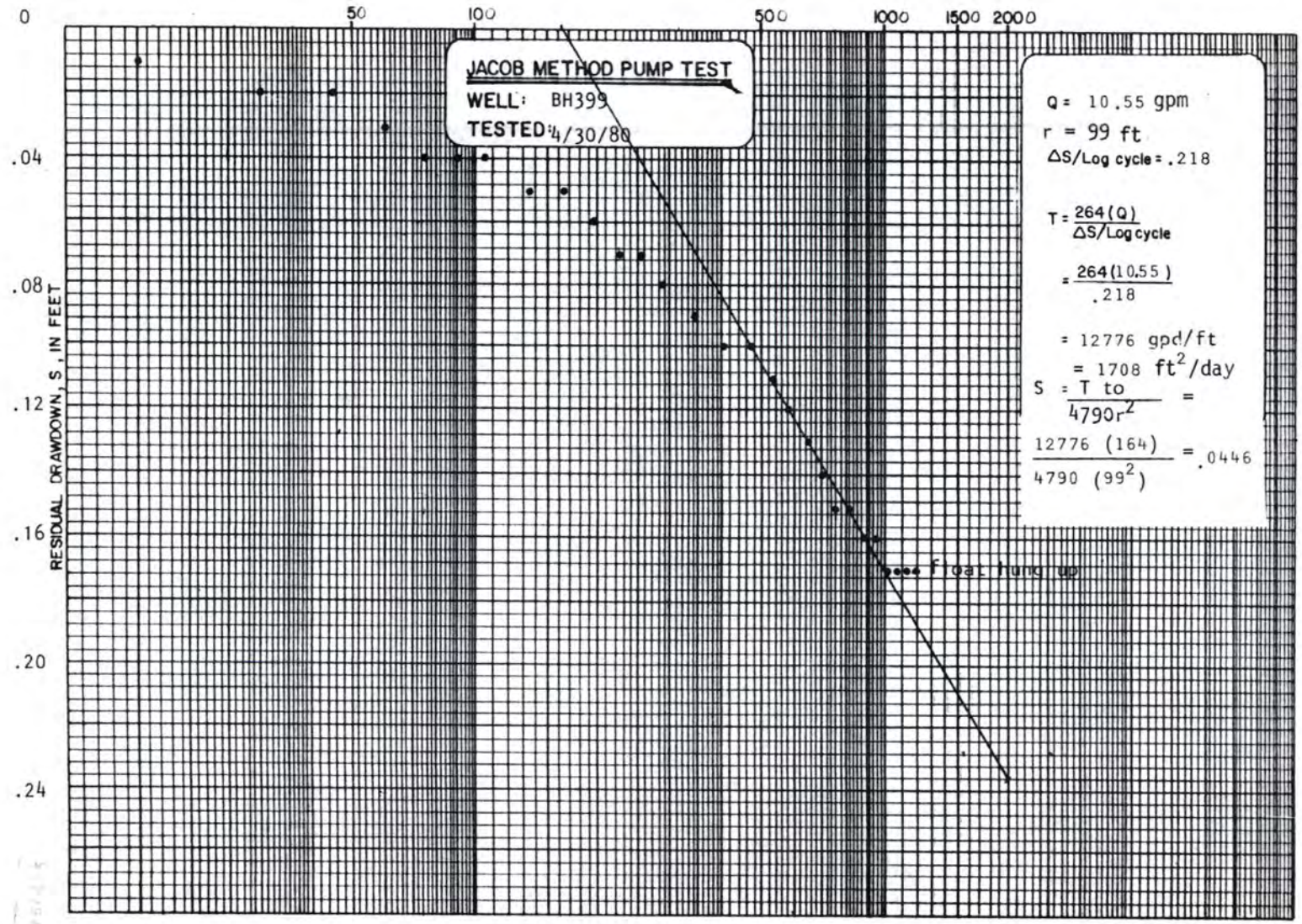
D11-238

TFN 6 2/0 25

RECD 10-25-18

TIME DRAWDOWN CURVE



LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT 213-T2

DEQ Ex. 3-1690

WELL LOCATION AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. OBS. 400

Personnel Bondar, Collier, Harris

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify)
2. Single well recovery 4. Recovery with obs. well ____

Well owner ____ Address ____

Method drilled: A. Air-rotary D. Dug F. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Well depth ____ ft. Well diameter ____ in.

Casing diameter ____ in. Casing type ____

Type of screen or perforation ____ Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 9.34 How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4-30-80	1315	9.34	0			0
	16	9.35	1			.01
	18	9.37	3			.03
	21	9.38	6			.04
	25	9.39	10			.05
	30	9.405	15			.065
	35	9.41	20			.07
	40	9.415	25			.075
	50	9.425	35			.085
	1400	9.43	45			.09
	15	9.44	60			.10
	30	9.45	75			.11
	45	9.46	90			.12
	1500	9.467	105			.127
	30	9.478	135			.138
	1600	9.49	165			.15
	30	9.50	195			.16
	1700	9.51	225			.17
	1800	9.525	285			.185
	1900	9.54	345			.20
	2000	9.55	405			.21
	2100	9.565	465			.225
	2200	9.575	525			.235
	2300	9.583	585			.243
	2400	9.594	645			.254
1-80	0100	9.602	705			.262
	0200	9.61	765			.27
	0300	9.617	825			.277
	0400	9.620	885			.28

LAND QUALITY DIVISION
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D11-239

TFN 1 5/293 PERMIT

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RAMACO

Brook Mine

AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. OBS. 400

Personnel Bondar, Collier, Harris

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) ____
2. Single well recovery 4. Recovery with obs. well

Well owner ____ Address ____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth ____ ft. Well diameter ____ in.

Casing diameter ____ in. Casing type ____

Type of screen or perforation ____ Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 9.34 How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-1-80	0500	9.62	945			.280
	0600	9.62	1005			.280
	0700	9.62	1065			.280
	0800	9.62	1125			.280
OFF	0830	9.63	1155	0	∞	.290
	33	9.615	1158	3	386.00	.273
	36	9.595	1161	6	193.50	.255
	45	9.58	1170	15	78.00	.240
	0900	9.563	1185	30	39.50	.223
	15	9.55	1200	45	26.70	.210
	30	9.535	1215	60	20.25	.195
	1000	9.515	1245	90	13.83	.175
	30	9.50	1275	120	10.63	.160
	1100	9.48	1305	150	8.70	.140
	30	9.47	1335	180	7.42	.130
	1200	9.46	1365	210	6.50	.120
	30	9.448	1395	240	5.81	.108
	1300	9.44	1425	270	5.30	.100
	30	9.428	1455	300	4.85	.088
	1400	9.42	1485	330	4.50	.080
	30	9.414	1515	360	4.21	.074
	1500	9.41	1545	390	3.96	.070
	20	9.405	1565	420	3.73	.065

7/21 E9-213 T3

LAND QUALITY DIVISION

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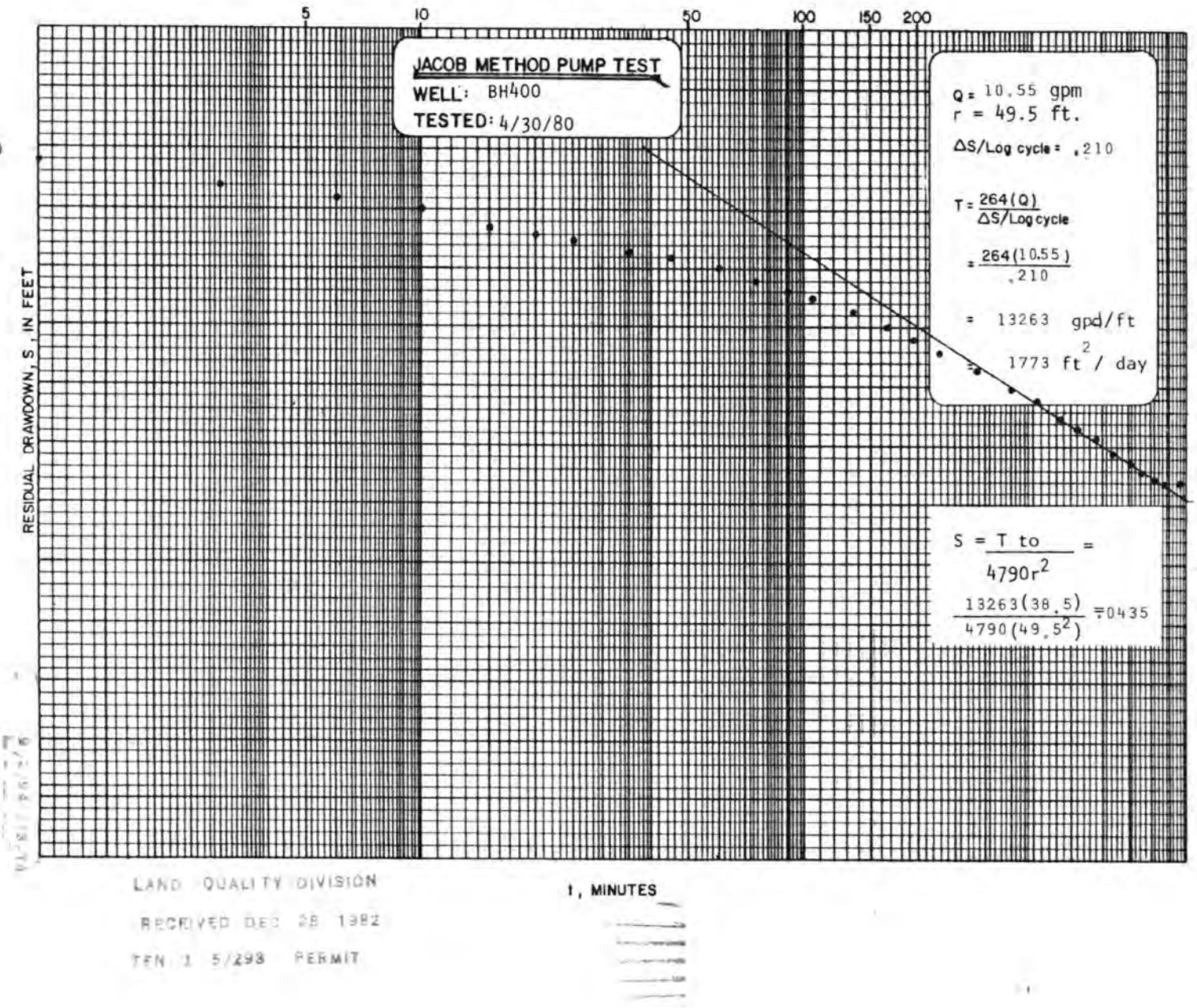
D11-240

TFN 5/293 PERMIT

TFN 6 27 25

RECD 10-25-18

TIME DRAWDOWN CURVE



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D11-241

DEQ Ex. 3-1693

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PKS, GEOLOGY AND EXPLORATION AQUIFER TEST DATA

MICRO FILMED SEP 21 '84

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. 401

Personnel ____ Test type: 1. Single well drawdown X. Drawdown with obs. well 5. Other (specify) 2. Single well recovery X. Recovery with obs. well ____

Well owner ____ Address ____

iller ____ Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

.otal well depth ____ ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer Alluvial Aquifer lithology alluvium

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 9.22 How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4-30-80	1315	9.220	0			0
ON	30	9.221	15			.001
	1400	9.222	45			.002
	30	9.223	75			.003
	1500	9.229	105			.009
	30	9.232	135			.012
	1600	9.239	165			.019
	1700	9.249	225			.029
	1800	9.259	285			.039
	1900	9.267	345			.047
	2000	9.278	405			.058
	2100	9.287	465			.067
	2200	9.293	525			.073
	2300	9.297	585			.077
	2400	9.307	645			.087
5-1-80	0100	9.316	705			.096
	0200	9.320	765			.100
	0300	9.329	825			.109
	0400	9.333	885			.113
	0500	9.338	945			.118
	0600	9.347	1005			.127
	0700	9.350	1065			.130
	0800	9.356	1125			.136

LAND QUALITY DIVISION
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213-T3
213-T2
DII-242
TFN 5 2/0 35 PERMIT
RECD 10-25-10

PRS GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. 401

Personnel ____ Test type: 1. Single well drawdown X Drawdown with obs. well 5. Other (specify)
2. Single well recovery X Recovery with obs. well ____

Well owner ____ Address ____

Driller ____ Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered X. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth ____ ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation ____ Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer Alluvial Aquifer lithology alluvium

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 9.22 How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-1-80						
OFF	30	9.363	1155	0	∞	.143
	45	9.363	1170	15	78.00	.143
	0900	9.365	1185	30	39.50	.145
	1000	9.370	1245	90	13.83	.150
	1100	9.368	1305	150	8.70	.148
	1200	9.365	1365	210	6.50	.145
	1300	9.360	1425	270	5.30	.140
	1400	9.350	1485	330	4.50	.130
	1500	9.344	1545	390	3.96	.124

LAND QUALITY DIVISION
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D11-243 TFN 1 6/293 PERMIT

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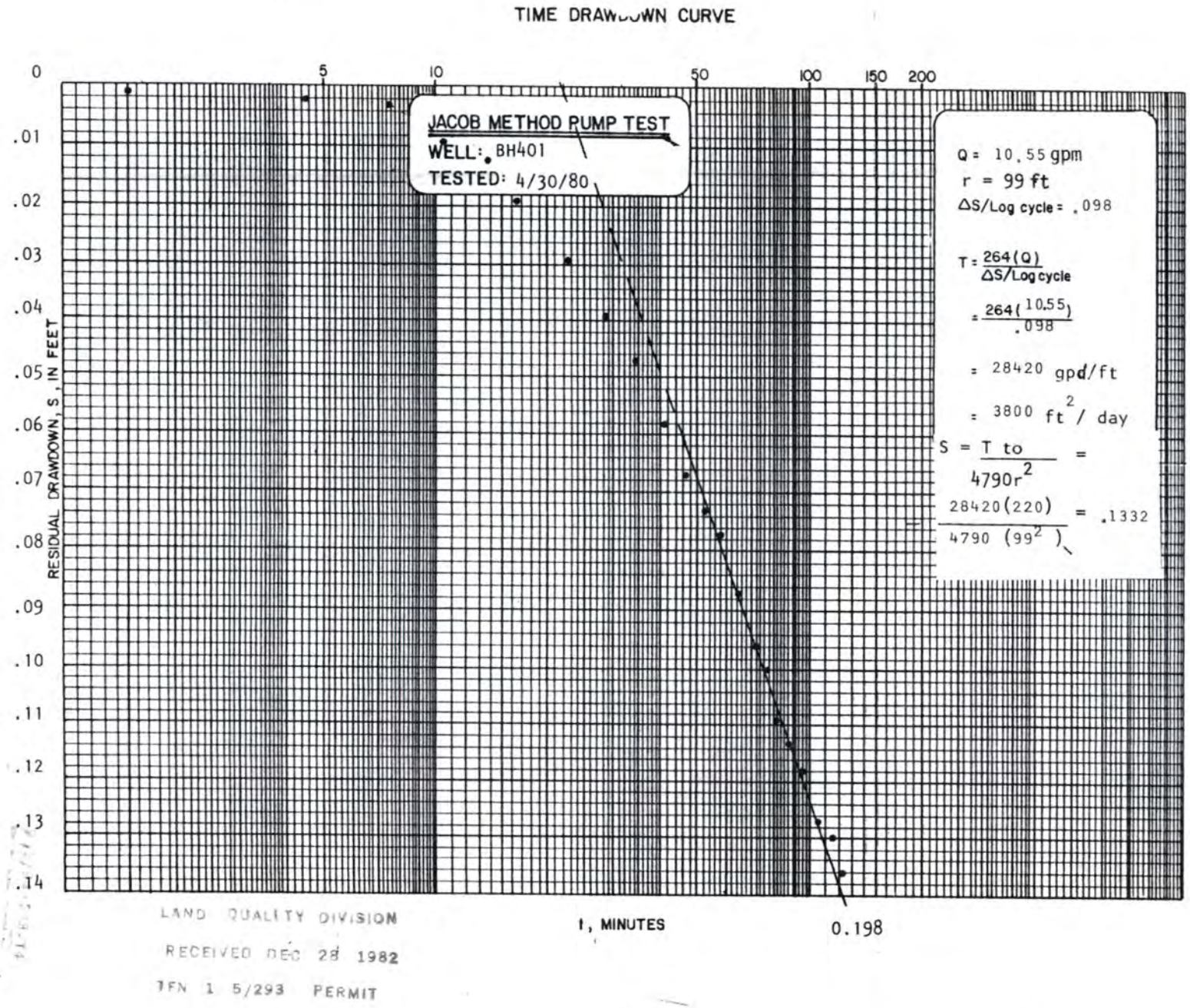

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D11-244

TFN 6 2/025
RECD 10-25-18

89-213-T3

DEQ Ex. 3-1696

PKS GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. 403

Personnel Bondar, Collier, Harris

Test type: 1. Single well drawdown X. Drawdown with obs. well 5. Other (specify)
2. Single well recovery X. Recovery with obs. well

Well owner ____ Address ____

Driller ____ Method drilled: A. Air-rotary D. Dug F. Air-percussion V. Driven
B. Bored or augered X. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth ____ ft. Well diameter ____ in.

Casing diameter ____ in. Casing type ____

Type of screen or perforation ____ Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 8.60 How measured Galvonometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4-30-80						
on	1315	8.60	0			0
	16	10.53	1			1.93
	18	12.52	3			3.92
	21	13.45	6			4.85
	25	13.45	10			4.85
	30	13.45	15			4.85
	35	13.45	20			4.85
	40	13.45	25			4.85
	50	13.45	35			4.85
	1400	13.46	45			4.86
	15	13.46	60			4.86
	30	13.46	75			4.86
	45	13.46	90			4.86
	1500	13.47	105			4.87
	30	13.47	135			4.87
	1600	13.48	165			4.88
	30	13.48	195			4.88
	1700	13.48	225			4.88
	1800	13.48	285			4.88
	1900	13.49	345			4.89
	2000	13.50	405			4.90
	2100	13.50	465			4.90
	2200	13.50	525			4.90
	2300	13.50	585			4.90
	2400	13.50	645			4.90
5-1-80	0100	13.50	705			4.90
	0200	13.50	765			4.90
	0300	13.50	825			4.90

7/31/89 213-T2

9/28/84-213-T4

LAND QUALITY DIVISION

RECEIVED DEC 28 1982 213-T2

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PKS. GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. 403

Personnel Bondar, Collier, Harris Test type: 1. Single well drawdown X. Drawdown with obs. well 5. Other (specify)
2. Single well recovery Y. Recovery with obs. well

Well owner ____ Address ____

ller ____ Method drilled: A. Air-rotary D. Dug F. Air-percussion V. Driven
B. Bored or augered IX. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

otal well depth ____ ft. Well diameter ____ in.

Casing diameter ____ in. Casing type ____

Type of screen or perforation ____ Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP ____ How measured Galvonometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-1-80	0100	13.50	885			4.90
	0500	13.50	945			4.90
	0600	13.50	1005			4.90
	0700	13.50	1065			4.90
	0800	13.50	1125			4.90
OFF	0830	13.50	1155	0	∞	4.90
	31	11.33	1156	1	1156.00	2.73
	33	9.85	1158	3	386.00	1.25
	36	9.50	1161	6	193.50	.90
	40	9.40	1165	10	116.50	.80
	45	9.35	1170	15	78.00	.75
	50	9.29	1175	20	58.75	.69
	0900	9.22	1185	30	39.50	.62
	15	9.15	1200	45	26.67	.55
	30	9.10	1215	60	20.25	.50
	1000	9.05	1245	90	13.83	.45
	30	9.00	1275	120	10.63	.40
	1100	8.97	1305	150	8.70	.37
	1200	8.93	1365	210	6.50	.33
	1300	8.88	1425	270	5.28	.28
	1415	8.83	1500	345	4.35	.23
	45	8.82	1530	375	4.08	.22

7/31/89-213-T3
8/2/94-213-T4

LAND QUALITY DIVISION
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D11-246

TFN 1 5/293 PERMIT 233-T2

RECD 10-25-18

WATER WELL BH-403

PUMPING RATE DATA

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT 213-T2

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
4-30-80	1316	15.00	12.00	3.00	1	12.00
	18	14.40	12.50	3.00	2	25.00
	21	15.90	11.32	3.00	3	33.96
	30	11.70	15.38	3.00	9	138.42
	50	15.00	12.00	3.00	10	120.00
	1400	16.70	10.80	3.00	10	108.00
	15	17.60	10.23	3.00	15	153.45
	30	17.00	10.60	3.00	15	159.00
	45	15.80	11.40	3.00	15	171.00
	1500	17.50	10.30	3.00	15	154.50
	30	17.80	10.11	3.00	30	303.30
	1600	18.10	9.94	3.00	30	298.20
	30	18.00	10.00	3.00	30	300.00
	1700	16.00	11.25	3.00	30	337.50
	1800	18.50	9.73	3.00	60	583.80
	1900	18.80	9.60	3.00	60	576.00
	2000	16.10	11.20	3.00	60	672.00
	2100	18.80	9.60	3.00	60	576.00
	2200	18.70	9.63	3.00	60	577.80
	2300	20.00	9.00	3.00	60	540.00
	2400	18.60	9.70	3.00	60	582.00
5-1-80	0100	16.50	10.91	3.00	60	654.60
	0200	16.00	11.25	3.00	60	675.00
	0300	16.00	11.25	3.00	60	675.00
	0400	16.00	11.25	3.00	60	675.00
	0500	16.00	11.25	3.00	60	675.00
	0600	16.50	10.91	3.00	60	654.60
	0700	17.00	10.60	3.00	60	636.60
	0800	16.00	11.25	3.00	90	1012.50

D11-247

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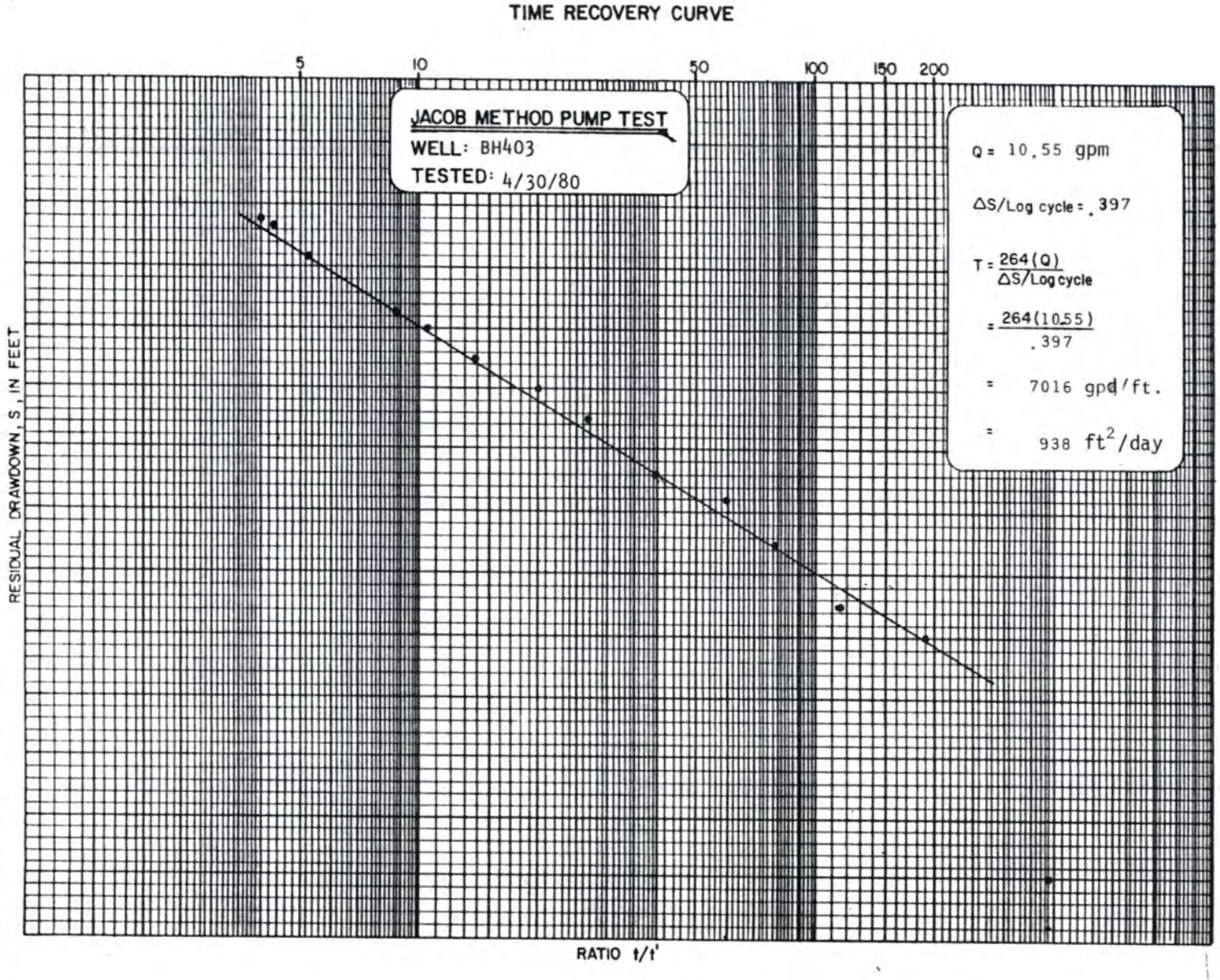

LAND QUALITY DIVISION
RECEIVED DEC 29 1982
IFN 1 5/293 PERMIT

SEP 21 '84

IFN 2 2025
RECD 10-25-18

D11-248

DEQ Ex. 3-1700

AQUIFER TEST DATA

State WYO County SHERIDAN T. 57 N. R. 84 W. Sec. 22 WELL NO. Obs. 404

Personnel Bondar & Collier

Test type: 1. Single well drawdown 3. Drawdown with obs. well X Other (specify) drawdown
2. Single well recovery 4. Recovery with obs. well w/ 3 obs. wells

Well owner PKS Address Sheridan, Wyoming

Driller R.Reed Method drilled: A. Air-rotary D. Dug F. Air-percussion V. Driven
B. Bored or augered X. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Well depth 16.5 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 4'-16.5' Pump hp. & type _____ Pump depth _____ ft.

Aquifer Alluvium Aquifer lithology gravel matrix with floating sand and silt

Altitude of land surface 3630.6 How determined surveyed MP Above ~~Below~~ LSD _____ Altitude MP 2.25'

SWL from MP 12.90' How measured from Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-8-79	1220	12.90	0			0
	1250	12.90	30			0
	1300	12.902	40			.002
	1310	12.905	50			.005
	1320	12.908	60			.008
	1330	12.909	70			.009
	1340	12.911	80			.011
	1350	12.912	90			.012
	1400	12.914	100			.014
	1410	12.915	110			.015
	1420	12.916	120			.016
	1430	12.918	130			.018
	1440	12.919	140			.019
	1440	12.921	150			.021
	1500	12.922	160			.022
	1510	12.924	170			.024
	1520	12.926	180			.026
OFF	1523	12.927	183			.027

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D11-249

TFN 1 8/293 PERMIT

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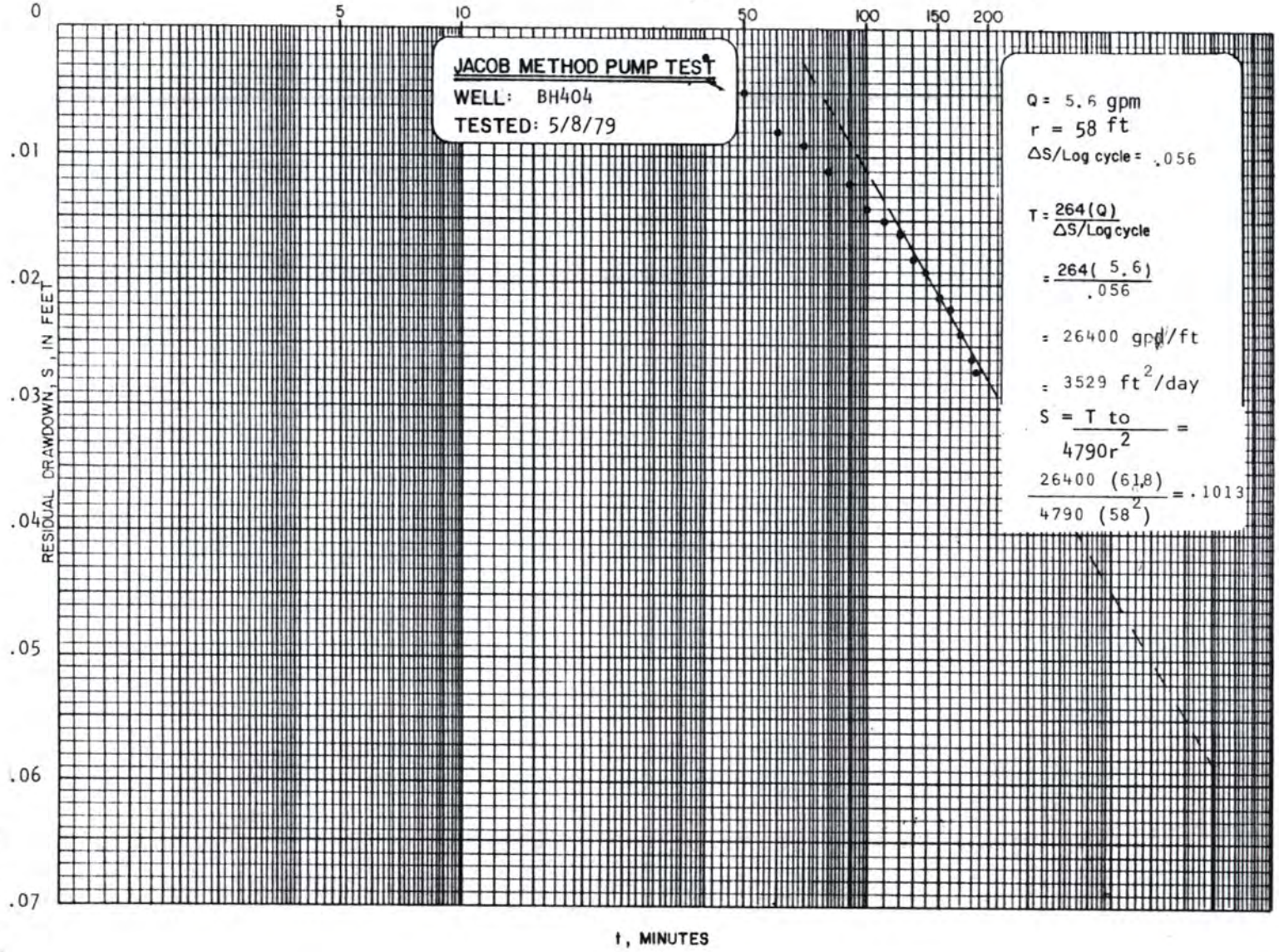
TIME DRAWDOWN CURVE



RECEIVED DEC 28 1982
DFN 1 6/293 PERMIT 213-T2

TFR 6 2/025
RECD 10-25-18

D11-250

DEQ Ex. 3-1702

[illegible] AND EXPLORATION AQUIFER TEST DATA

State WYO County SHERIDAN T. 57 N. R. 84 W. Sec. 22 WELL NO. pump well #405

Personnel Bondar & Collier Test type: X 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well

Well owner PKS Address Sheridan, Wyo.

R. Reed Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug X. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 18.5 ft. Well diameter 11 in.

Casing diameter 8 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 2'-15' Pump hp. & type 1½ Barnes Pump depth 20 ft.

Aquifer Alluvium Aquifer lithology Gravel matrix with floating sand

Altitude of land surface 3632.7 How determined surveyed MP Above Below LSD Altitude MP 2.87'

SWL from MP How measured

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-8-79	1220	14.90	0			0
ON	1220.5	15.68	.5			.78
	1221	15.98	1.0			1.08
	1221.5	16.24	1.5			1.34
	1222	16.42	2.0			1.52
	1222.5	16.61	2.5			1.71
	1223	16.75	3.0			1.85
	1224	16.92	4.0			2.02
	1225	17.14	5.0			2.24
	1227	17.36	7.0			2.46
	1230	17.51	10.0			2.61
	1234	17.62	14.0			2.72
	1239	17.67	19.0			2.77
	1245	17.75	25.0			2.85
	1300	17.87	40.0			2.97
	1315	18.00	55.0			3.10
	1330	18.10	70.0			3.20
	1350	18.20	90.0			3.30
	1410	18.32	110.0			3.42
	1430	18.45	130.0			3.55
	1450	18.55	150.0			3.65
	1520	18.92	180.0			4.02

[illegible] 89-219-T8

LAND QUALITY DIVISION

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D11-251

TFN 1 5/293 PERM [illegible] 9.72

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RAMACO

Brook Mine

WATER RESOURCES DIVISION — GROUND WATER SECTION — AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. BH405

Personnel ____

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) ____
2. Single well recovery 4. Recovery with obs. well

Well owner ____ Address ____

____ Method drilled: A. Air-rotary D. Dug F. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

al well depth ____ ft. Well diameter ____ in.

Casing diameter ____ in. Casing type ____

Type of screen or perforation ____ Interval of screen or perforation ____ Pump hp. & type ____ Pump depth ____ ft.

Aquifer ____ Aquifer lithology ____

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP ____ How measured ____

DATE	TIME	DEPTH TO WATER LEVEL Recovery	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-8-79	1523	18.75	183	0	∞	3.85
OFF	1523.5	18.02	183.5	0.5	367	3.12
	1524	17.55	184	1	184	2.65
	1524.5	16.63	184.5	1.5	123	1.73
	1525	16.02	185	2	92.5	1.12
	1525.5	15.83	185.5	2.5	74.2	0.93
	1526	15.66	186	3	62	0.76
	1526.5	15.50	186.5	3.5	53.29	0.60
	1527	15.38	187	4	46.75	0.48
	1528	15.23	188	5	37.60	0.33
	1529	15.17	189	6	31.5	0.27
	1530	15.13	190	7	27.14	0.23
	1531	15.10	191	8	23.88	0.20
	1532	15.08	192	9	21.33	0.18
	1535	15.07	195	12	16.25	0.17
	1540	15.04	200	17	11.76	0.14
	1545	15.02	205	22	9.32	0.12
	1600	15.00	220	37	5.95	0.10
	1610	15.00	230	47	4.89	0.10

7/31/89-213-T3

9/2/94-213-T4

LAND QUALITY DIVISION

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213-T2

D11-252 TFN 1 5/293 PERMIT

TFR 6 2/025

DEED 10-25-18

WATER WELL #405

PUMPING RATE DATA

Pump Test
Started at 1220 MST, 5-8-79

LAND QUALITY DIVISION
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IFN 1 6/293 PERMIT

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
5-8-79	1221	42	5.71	4	1	5.71
	1223	41.5	5.78	4	2	11.56
	1227	42	5.71	4	4	22.84
	1234	43	5.58	4	7	39.06
	1300	43	5.58	4	26	145.08
	1330	43	5.58	4	30	167.40
	1430	42.8	5.61	4	60	336.60
	1520	43	5.58	4	50	279.00
					T = 180	T=1007.25
				1007.25 ÷ 180 = Q = 5.60		

D11-253

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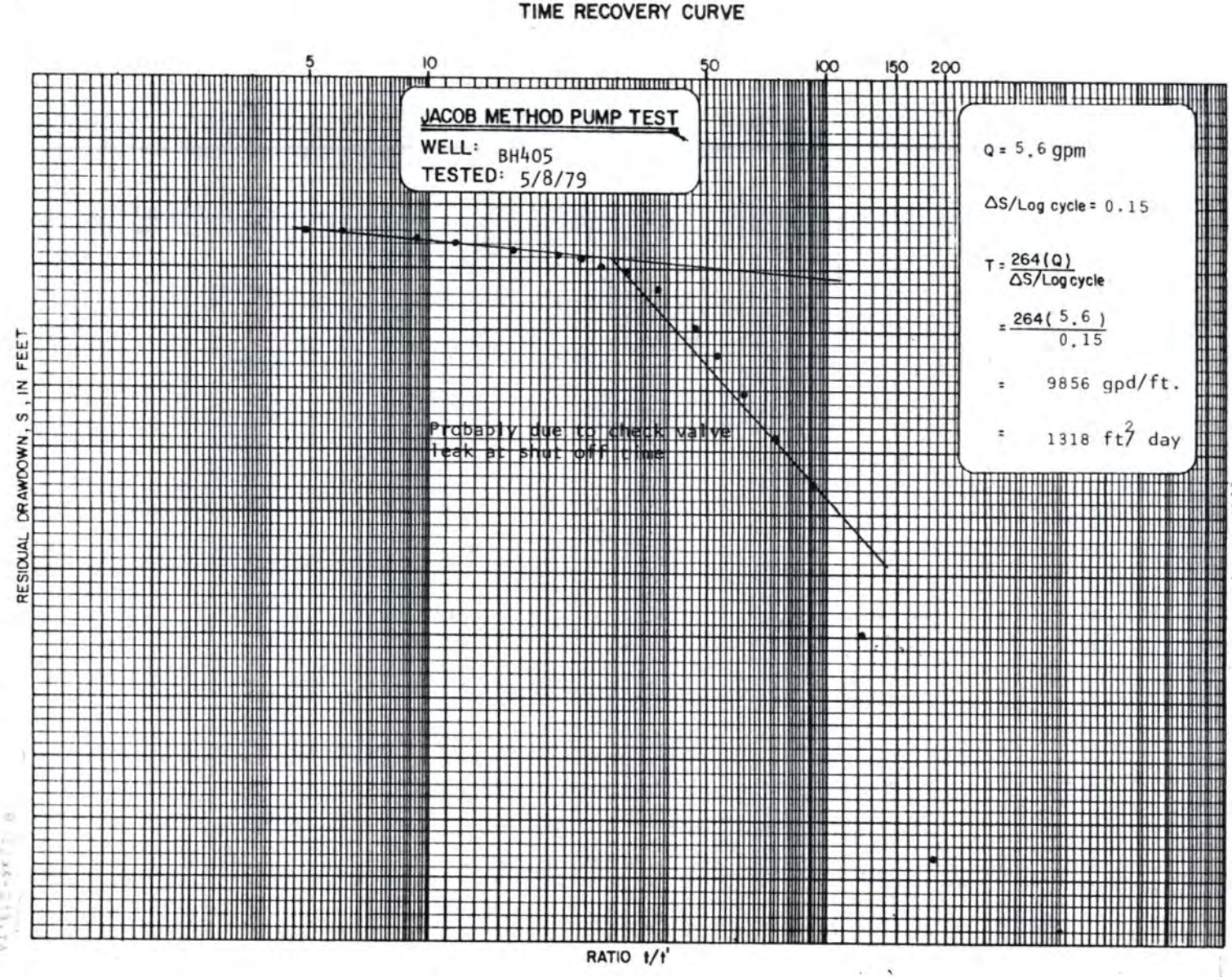

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
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RECD 10-25-18

LAND QUALITY DIVISION
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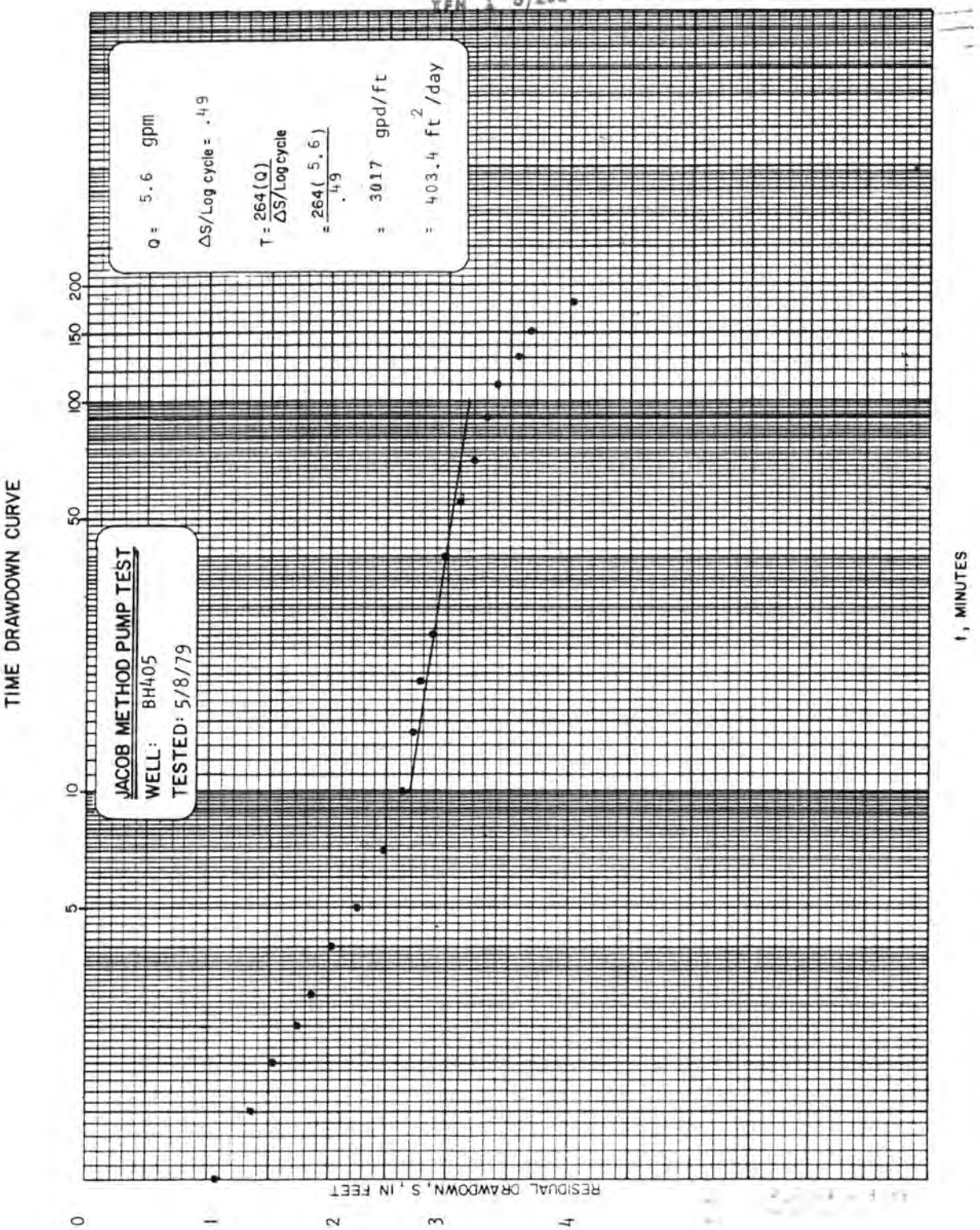

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DEQ Ex. 3-1707

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RAMACO

Brook Mine

KS GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WYO County SHERIDAN T. 57 N. R. 84 W. Sec. 22 WELL NO. OBS. 406

Personnel Bondar & Collier

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well X. Other (specify) drawdown w/ 3 obs. well

Well owner PKS Address Sheridan, Wyo.

r R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 19 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 8.5' - 19' Pump hp. & type Pump depth ft.

Aquifer Alluvium Aquifer lithology Gravel matrix with floating sand

Altitude of land surface 3631.1' How determined surveyed MP Above ~~Below~~ LSD Altitude MP 2.64'

SWL from MP 15.22' How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-8-79	1220	15.220	0			0
ON	1245	15.220	25			0
	1250	15.222	30			.002
	1300	15.226	40			.006
	1310	15.229	50			.009
	1320	15.231	60			.011
	1330	15.235	70			.015
	1340	15.238	80			.018
	1350	15.240	90			.020
	1400	15.243	100			.023
	1410	15.245	110			.025
	1420	15.247	120			.027
	1430	15.249	130			.029
	1440	15.250	140			.030
	1450	15.252	150			.032
	1500	15.254	160			.034
	1510	15.255	170			.035
	1520	15.257	180			.037
OFF	1523	15.258	183			.038

T/3/89-213-T3

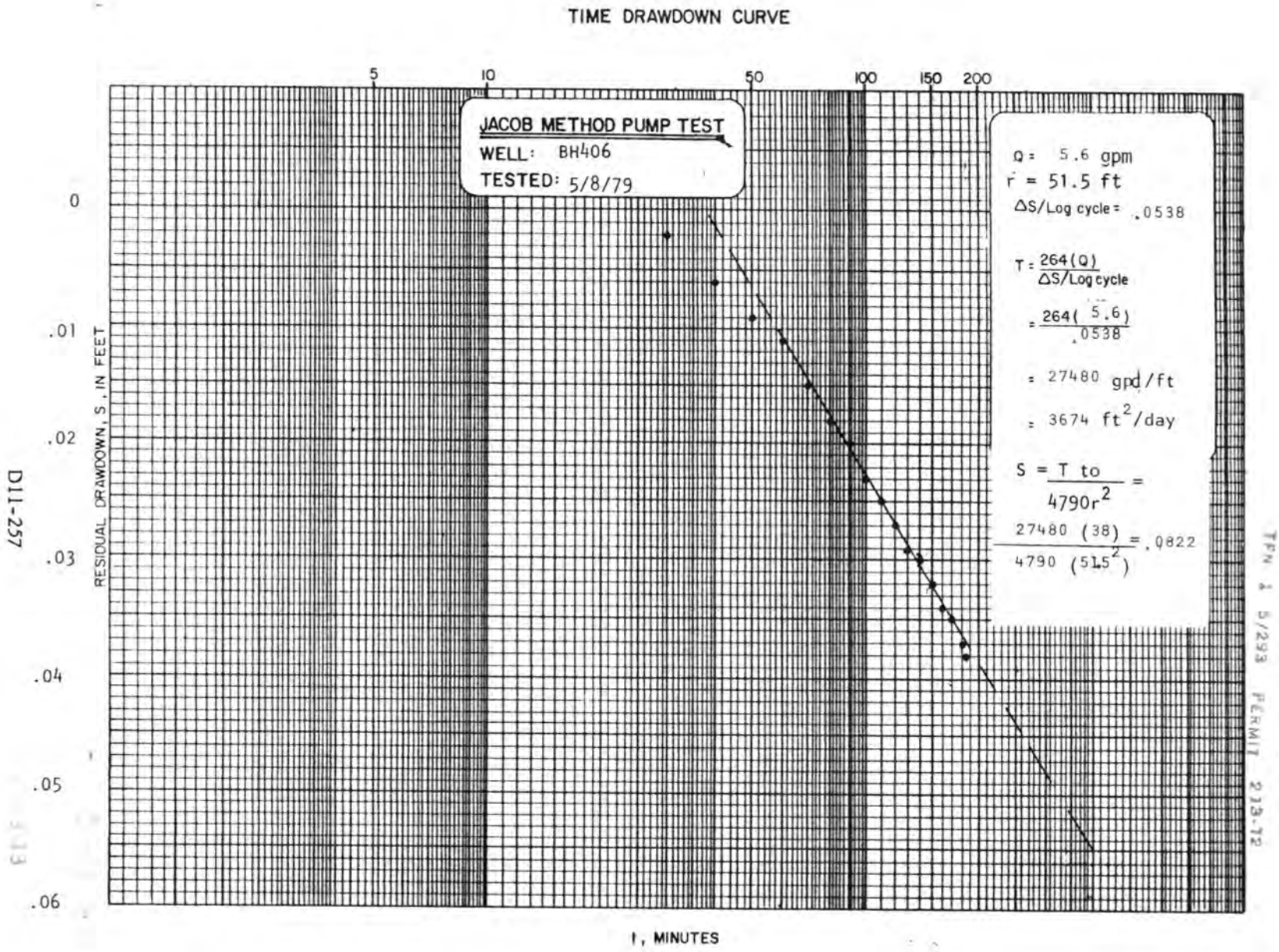
LAND QUALITY DIVISION

RECEIVED DEC 28 1982

D11-256 TFN 1 5/293 PERMIT

TFN 6 2/025

DEQ 10-25-18



LAND QUALITY DIVISION
RECEIVED DEC 28 1992
TFN 4 5/293 PERMIT 213-72

DEQ Ex. 3-1709

Scanned, 02/26/2020

PKS GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State WYO County SHERIDAN T. ____ N. S. R. ____ E. W. Sec. ____ WELL NO. OBS.407

Personnel Collier & Bondar Test type: 1. Single well drawdown 3. Drawdown with obs. well X. Other (specify) drawdown w/3 obs. well
2. Single well recovery 4. Recovery with obs. well

Well owner PKS Address SHeridan, Wyo.

er R.Reed Method drilled: X Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered X. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

l well depth 19 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 9'-19' Pump hp. & type ____ Pump depth ____ ft.

Aquifer Alluvium Aquifer lithology gravel matrix w/floating sand and silt

Altitude of land surface 3631.2 How determined surveyed MP Above ~~Below~~ LSD ____ Altitude MP 2.10'

SWL from MP 15.13 How measured F-68 Recorder

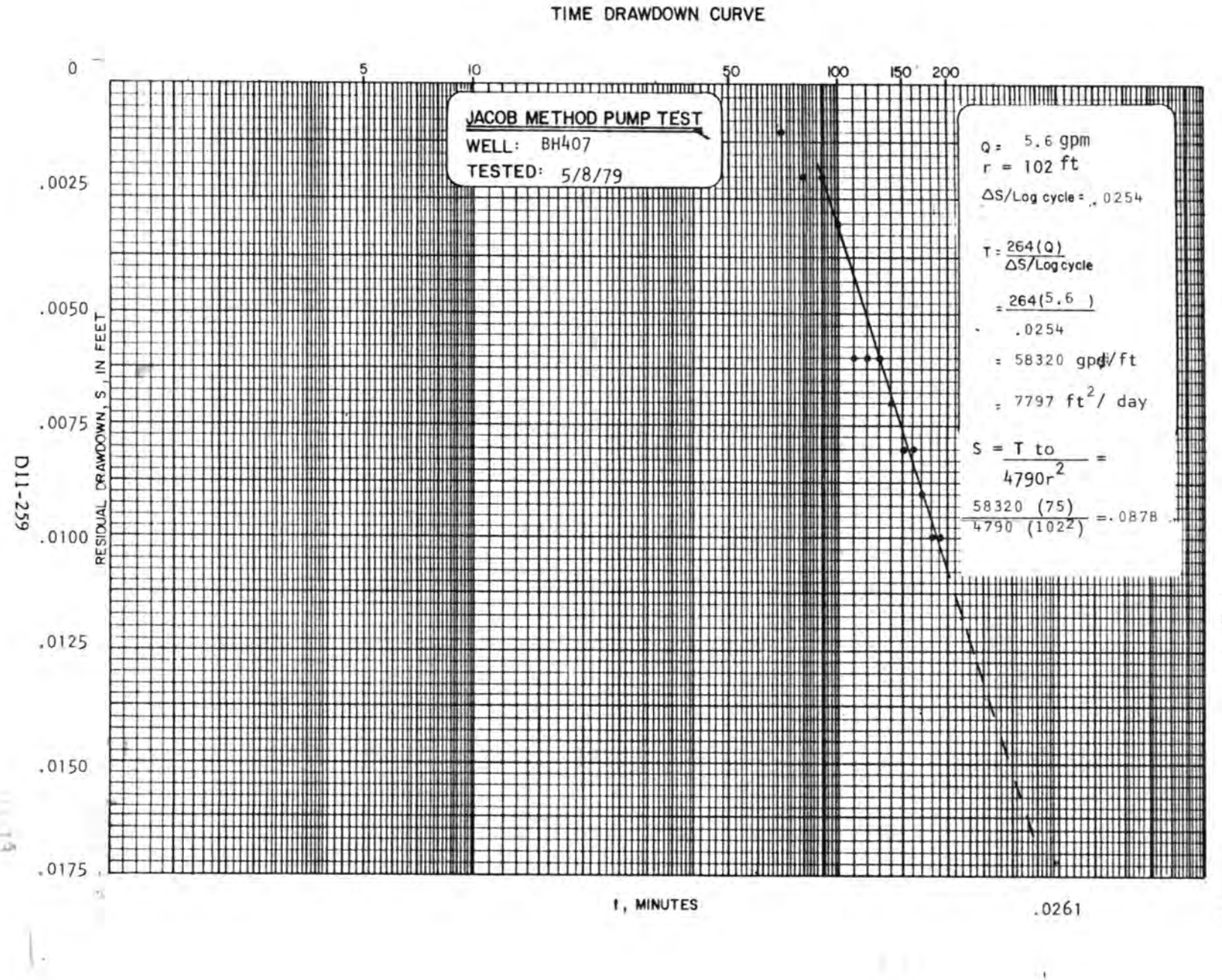
DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-8-79	1220	15.130	1			0
ON	1230	15.130	10			0
	1240	15.130	20			0
	1250	15.130	30			0
	1300	15.130	40			0
	1310	15.130	50			0
	1320	15.130	60			0
	1330	15.131	70			.001
	1340	15.132	80			.002
	1350	15.132	90			.002
	1400	15.133	100			.003
	1410	15.136	110			.006
	1420	15.136	120			.006
	1430	15.136	130			.006
	1440	15.137	140			.007
	1450	15.138	150			.008
	1500	15.138	160			.008
	1510	15.139	170			.009
	1520	15.140	180			.010
	1523	15.140	183			.010

LAND QUALITY DIVISION
RECEIVED DEC 28 1982

D11-258

TFN 1 5/293 PERMIT 213-72

TFN 6 2/025


TIME DRAWDOWN CURVE
JACOB METHOD PUMP TEST
WELL: BH407
TESTED: 5/8/79
Q = 5.6 gpm
r = 102 ft
ΔS/Log cycle = .0254
T = 264(Q) / ΔS/Log cycle
= 264(5.6) / .0254
= 58320 gpd/ft
= 7797 ft²/ day
S = T to / 4790r² =
58320 (75) / 4790 (102²) = .0878
RESIDUAL DRAWDOWN, S, IN FEET
0
.0025
.0050
.0075
.0100
.0125
.0150
.0175
5
10
50
100
150
200
t, MINUTES
.0261

DEQ Ex. 3-1711

Scanned, 02/26/2020

AQUIFER TEST DATA

State _____ County _____ T. _____ N. S. R. _____ W. Sec. _____ WELL NO. BH507

Personnel _____ Test type: 1. Single well drawdown 3. Drawdown with obs well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well _____

Well owner _____ Address _____

er _____ Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

al well depth _____ ft. Well diameter ____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth _____ ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-29-80	0900	2.25	0			0
ON	0905	2.25	5			0
	0915	2.25	15			0
	0945	2.26	45			.01
	1030	2.27	90			.02
	1100	2.28	120			.03
	1200	2.30	180			.05
	1230	2.32	210			.07
	1330	2.33	270			.08
	1400	2.335	300			.085
	1500	2.340	360			.090
	1600	2.350	420			.100
	1700	2.365	480			.115
	1730	2.375	510			.125
	1800	2.385	540			.135
	1900	2.400	600			.150
	2000	2.405	660			.155
	2100	2.410	720			.160
	2200	2.412	780			.162
OFF	2230	2.412	810	6	135.00	.162
	2300	2.410	840	36	23.33	.160
	2315	2.405	855	51	16.76	.155
	2330	2.400	870	66	13.18	.150
5-30-80	2400	2.380	900	96	9.38	.130
	0030	2.365	930	126	7.38	.115
	0100	2.350	960	156	6.15	.100
	0130	2.340	990	186	5.32	.090
	0200	2.330	1020	216	4.72	.080
	0300	2.310	1080	276	3.91	.060

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT 213-12

D11-260

TFN 6 2/025
DEQ 10-25-18

State _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO BH507

Personnel _____ Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) _____
2. Single well recovery 4. Recovery with obs. well

Well owner _____ Address _____

Driller _____ Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth _____ ft. Well diameter _____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth _____ ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-30-80	0400	2.295	1140	336	3.39	.045
	0500	2.280	1200	396	3.03	.030
	0600	2.250	1260	456	2.76	.000

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

D11-261

JFN 1 5/293 PERMIT 213-12

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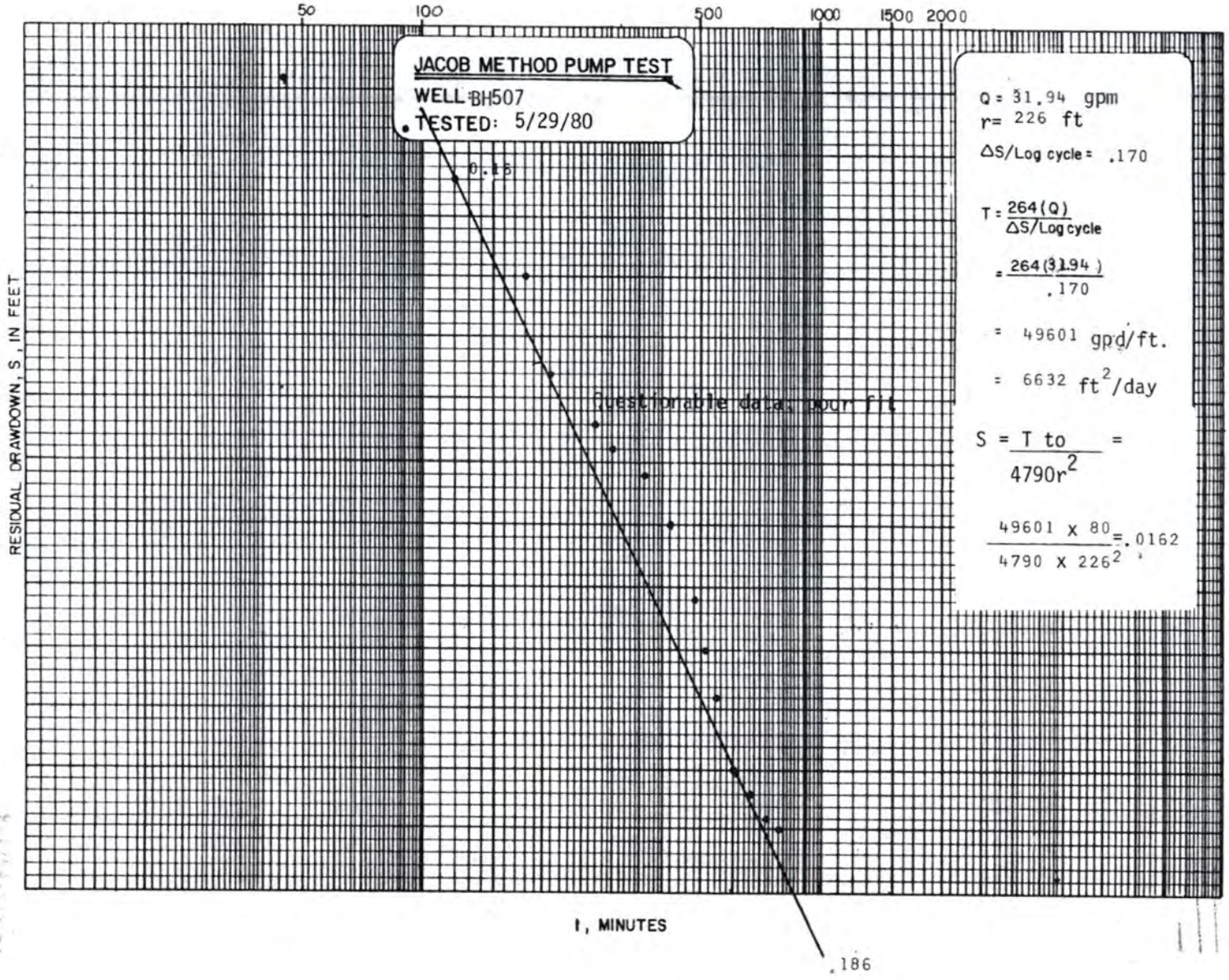
TIME DRAWDOWN CURVE



LAND QUALITY DIVISION
RECEIVED DEC 28 1992
IFN 1 5/293 PERMIT 213-T2

D11-262
IFN 5 2/025
RECD 10-25-18
89-213-T3

AQUIFER TEST DATA

State _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO BH508

Personnel _____ Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) _____
2. Single well recovery 4. Recovery with obs. well

Well owner _____ Address _____

er _____ Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

al well depth _____ ft. Well diameter ____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth 15 ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5/29/80	2224	6.10	804	0	∞	2.50
OFF	2225	5.10	805	1	805	1.50
	2226	4.55	806	2	403	.95
	2227	4.45	807	3	269	.85
	2228	4.45	808	4	202	.85
	2230	4.41	810	6	135	.81
	2232	4.37	812	8	101.50	.77
	2233	4.35	813	9	90.33	.75
	2235	4.35	815	11	74.09	.75
	2237	4.34	817	13	62.85	.74
	2239	4.30	819	15	54.60	.70
	2242	4.26	822	18	45.67	.66
	2244	4.24	824	20	41.20	.64
	2246	4.23	826	22	37.55	.63
	2250	4.21	830	26	31.92	.61
	2255	4.16	835	31	26.94	.56
	2300	4.11	840	36	23.33	.51
	2305	4.10	845	41	20.61	.50
	2315	4.04	855	51	16.76	.44
	2324	3.99	864	60	14.40	.39
	2334	3.98	874	70	12.49	.38

LAND QUALITY

RECEIVED DEC 28 1982

D11-263

IFN 1 8/298 PERMIT S-2F-75

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State _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO. BH508

Personnel _____ Test type: 1. Single well drawdown 3. Drawdown with obs well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well _____

Well owner _____ Address _____

or _____ Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

al well depth _____ ft. Well diameter ____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth 15 ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-29-80	0900	3.60	0			0
	0901	5.63	1			2.03
	0902	4.44	2			.84
	0903	4.08	3			.48
	0904	4.10	4			.50
	0905	5.55	5			1.95
	0906	5.65	6			2.05
	0907	5.68	7			2.08
	0910	5.71	10			2.11
	0913	5.80	13			2.20
	0920	5.90	20			2.30
	0930	5.97	30			2.37
	0945	6.06	45			2.46
	1000	6.15	60			2.55
	1030	6.18	90			2.58
	1100	6.28	120			2.68
	1200	6.38	180			2.78
	1300	6.52	240			2.92
	1400	6.58	300			2.98
	1500	6.64	360			3.04
	1600	6.80	420			3.20
	1700	6.70	480			3.10
	1800	6.70	540			3.10
	1900	6.71	600			3.11
	2000	6.76	660			3.16
	2100	6.79	720			3.19
	2200	6.80	780			3.20

LAND QUALITY DIVISION

RECEIVED DEC 29 1982

D11-264

TFN 1 5/293 PERMIT 213-T2

TFN 6 2/025

WATER WELL BH-508

PUMPING RATE DATA

LAND QUALITY

RECEIVED DEC 28 1982

TFN 1 5/293 PERMIT

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
5-29-80	0910	5.5	32.73	3	10	327.3
	0920	5.8	31.03	3	10	310.3
	0945	5.6	32.14	3	25	803.57
	1000	5.3	33.96	3	15	509.43
	1030	6.5	27.69	3	30	830.77
	1100	5.8	31.03	3	30	931.03
	1200	5.4	33.33	3	60	2000.00
	1300	5.5	32.73	3	60	1963.64
	1500	6.1	29.51	3	120	3540.98
	1600	5.6	32.14	3	60	1928.57
	1700	6.0	30.00	3	60	1800.00
	1800	5.4	33.33	3	60	2000.00
	1900	5.3	33.96	3	60	2037.74
	2000	5.4	33.33	3	60	2000.00
	2100	5.5	32.73	3	60	1963.64
	2200	5.5	32.73	3	60	1963.64
					ΣT=780	ΣQ=24910.61

Avg. Q = $\frac{24910.61}{780}$ = 31.94 gpm

7/31/89 213 13

D11-265

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D11-266

TFN 6 2/025

RECD 10-25-18

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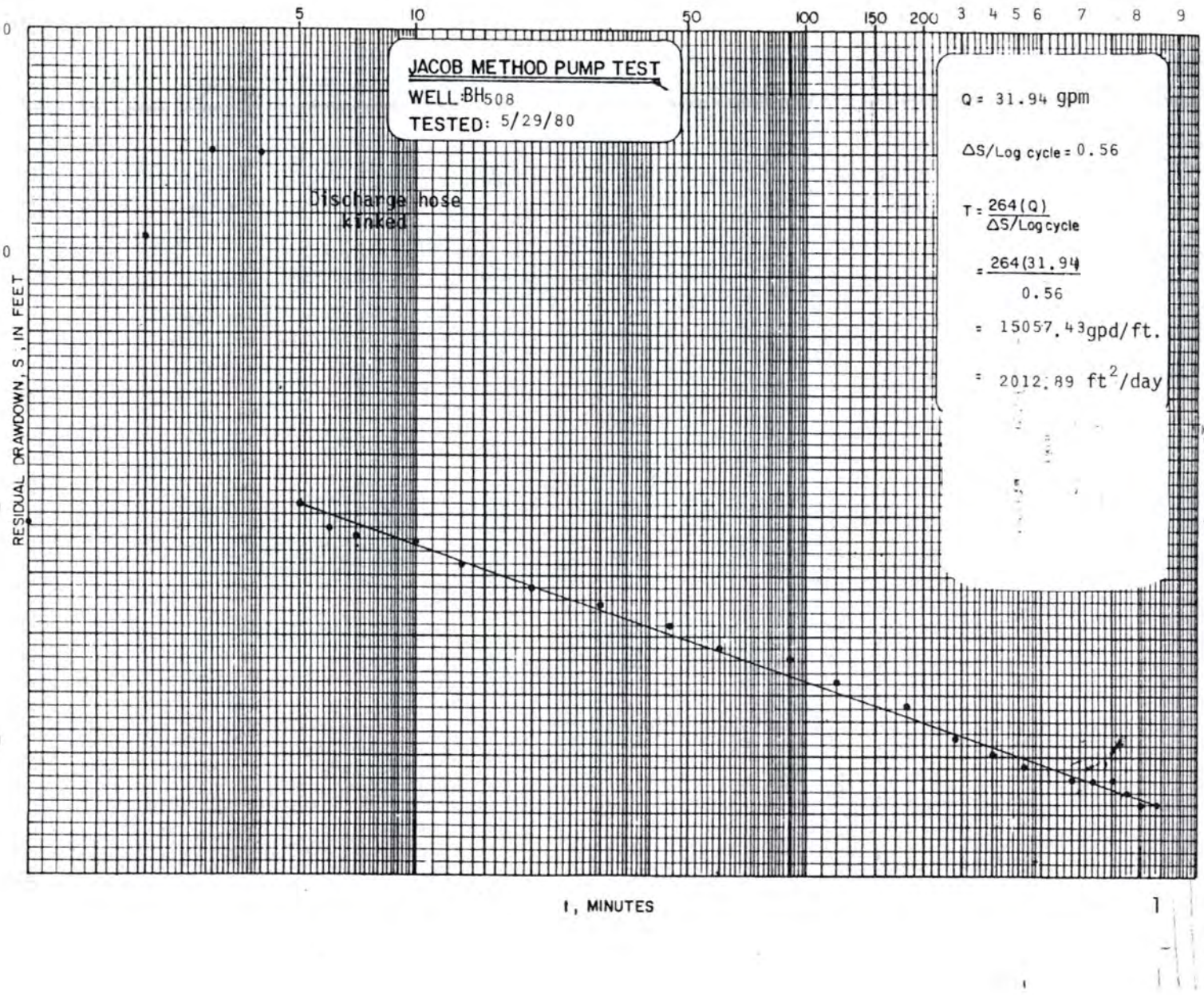
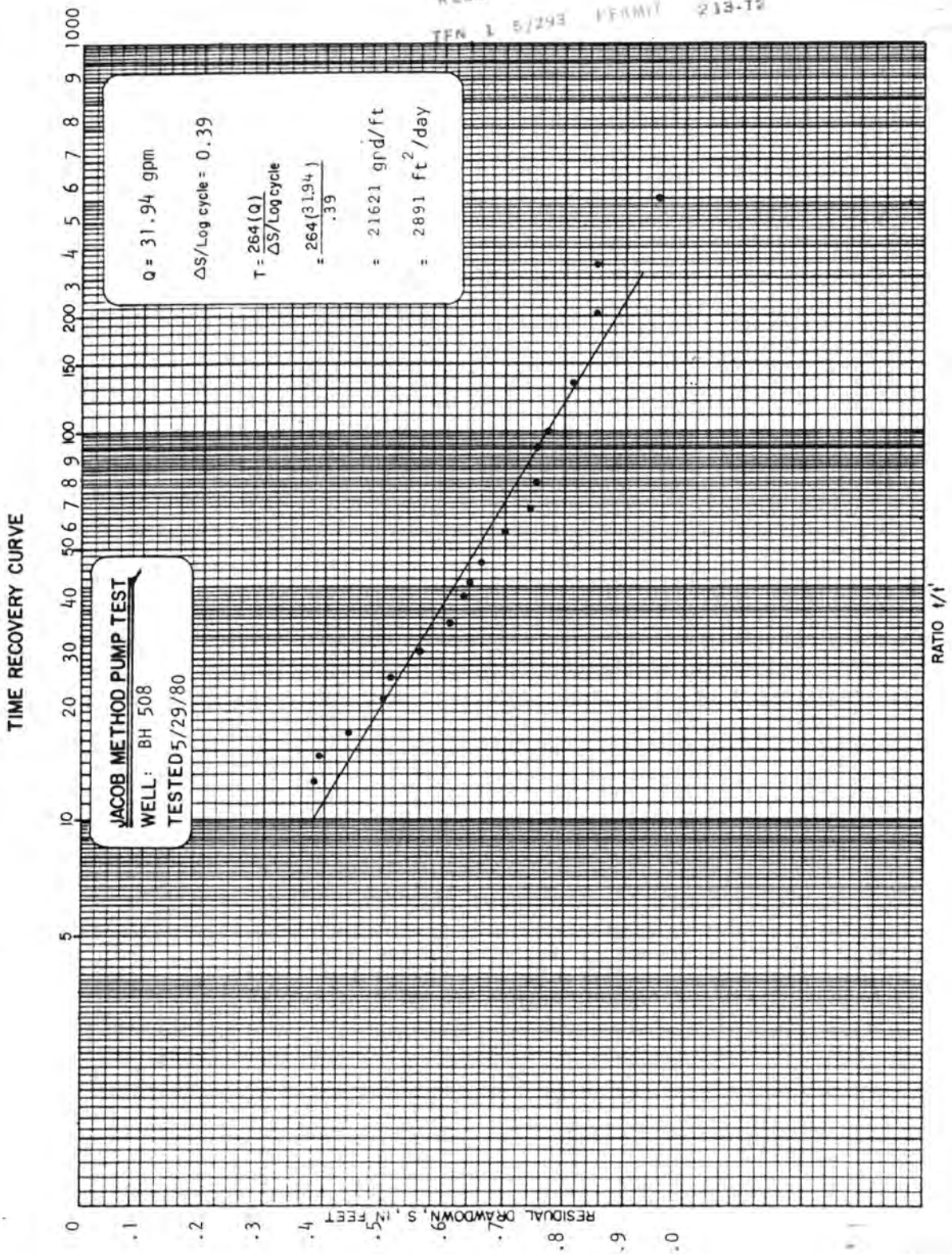
TFN 1 5/293 PERMIT

TIME DRAWDOWN CURVE



DEQ Ex. 3-1718

LAND QUALITY
RECEIVED
TEN 1 5/293 PERMIT 213-T2



D11-267

DEQ Ex. 3-1719

Scanned, 02/26/2020

MKS GEOLOGY AND EXPLORATION AQUIFER TEST DATA

State _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO. BH509

Personnel _____ Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify _____)
2. Single well recovery 4. Recovery with obs. well

Well owner _____ Address _____

iller _____ Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

otal well depth _____ ft. Well diameter ____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth _____ ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-29-80	0900	4.17	0			0
ON	0905	4.20	5			.03
	0910	4.21	10			.04
	0915	4.26	15			.09
	0920	4.27	20			.10
	0925	4.29	25			.12
	0930	4.30	30			.13
	0935	4.31	35			.14
	0945	4.34	45			.17
	1000	4.37	60			.20
	1015	4.41	75			.24
	1030	4.43	90			.26
	1045	4.45	105			.28
	1100	4.46	120			.29
	1130	4.49	150			.32
	1200	4.51	180			.34
	1230	4.54	210			.37
	1300	4.55	240			.38
	1330	4.57	270			.40
	1400	4.59	300			.42
	1430	4.60	330			.43
	1500	4.62	360			.45
	1600	4.64	420			.47
	1700	4.66	480			.49
	1800	4.67	540			.50
	1900	4.68	600			.51
	2000	4.69	660			.52
	2100	4.695	720			.52
	2200	4.70	780			.53

LAND QUALITY DIVISION
RECEIVED

D11-268

TFN 6 2/025
RECD 10-25-18

PKS GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

State _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO. BH-509

Personnel _____ Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) _____

Well owner _____ Address _____

Driller _____ Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth _____ ft. Well diameter ____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth _____ ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-29-80	2224	4.70	804	0	∞	.53
OFF	2230	4.65	810	6	135.00	.48
	2235	4.61	815	11	74.09	.44
	2240	4.58	820	16	51.25	.41
	2245	4.56	825	21	39.29	.39
	2250	4.54	830	26	31.92	.37
	2255	4.52	835	31	26.94	.35
	2300	4.50	840	36	23.33	.33
	2315	4.46	855	51	16.76	.29
	2330	4.43	870	66	13.19	.26
	2345	4.38	885	81	10.93	.21
	2400	4.35	900	96	9.38	.18
	2415	4.33	915	111	8.24	.16
	2430	4.31	930	126	7.38	.14
	2445	4.29	945	141	6.70	.12
5-30-80	0100	4.27	960	156	6.15	.10
	0130	4.24	990	186	5.32	.07
	0200	4.22	1020	216	4.72	.05
	0230	4.20	1050	246	4.27	.03
	0300	4.18	1080	276	3.91	.01

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

DII-269

TFN 1 5/293 PERMIT

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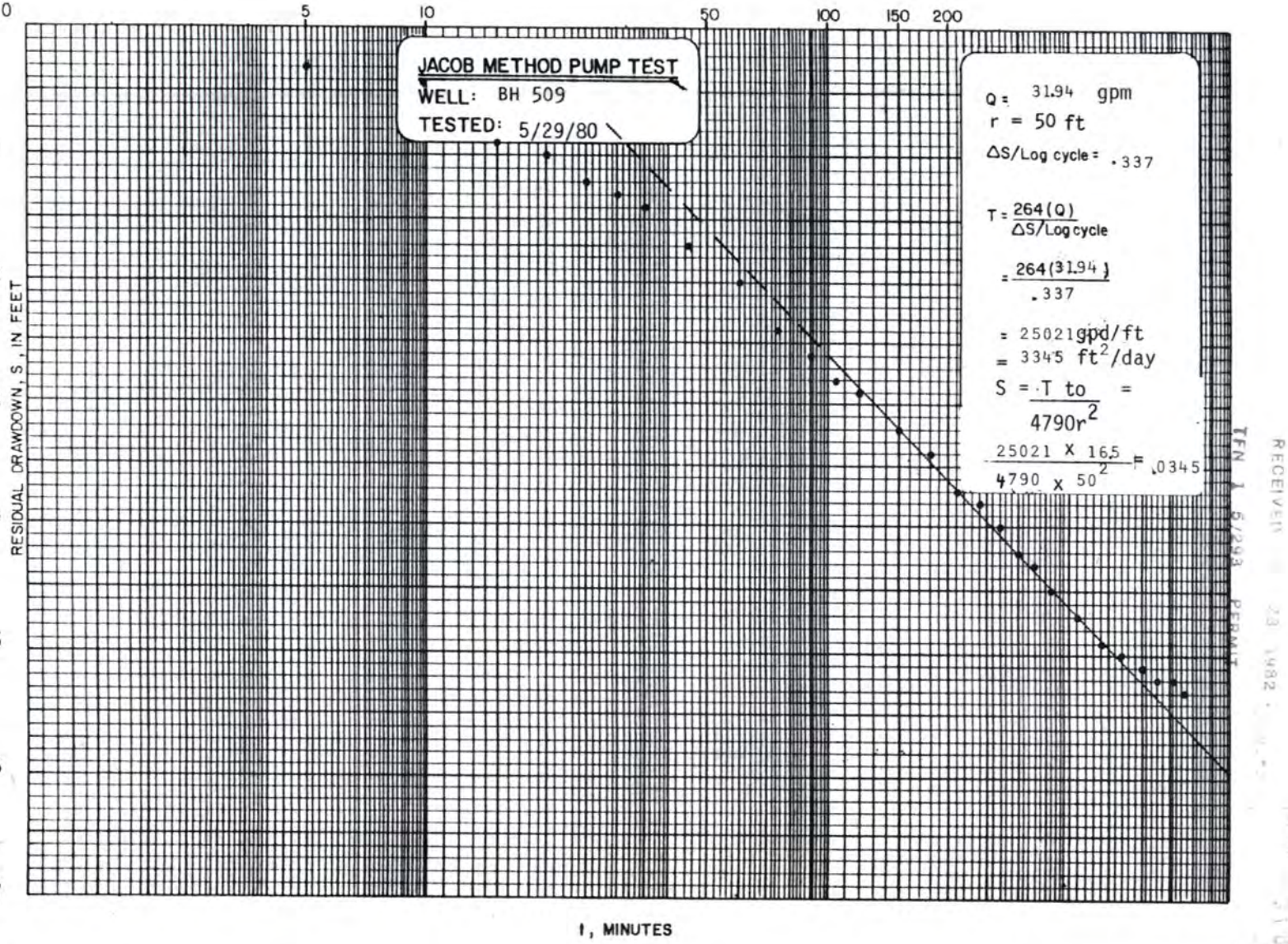
D11-270
TFN 6 2/025
RECD 10-25-18

TIME DRAWDOWN CURVE



TFN 1 5/293 PERMIT

WATER QUALITY DIVISION
RECEIVED
JUN 23 1982

DEQ Ex. 3-1722

PRS GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

State _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO. BH510

Personnel _____

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) _____
2. Single well recovery 4. Recovery with obs. well

Well owner _____ Address _____

or _____ Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

al well depth _____ ft. Well diameter ____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth ____ ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-29-80	0900	4.45	0			0
	0905	4.46	5			.01
	0915	4.48	15			.03
	0930	4.51	30			.06
	0945	4.53	45			.08
	1000	4.54	60			.09
	1015	4.56	75			.11
	1030	4.58	90			.13
	1045	4.59	105			.14
	1100	4.61	120			.16
	1130	4.62	150			.17
	1200	4.64	180			.19
	1300	4.66	240			.21
	1400	4.69	300			.24
	1500	4.71	360			.26
	1600	4.73	420			.28
	1700	4.74	480			.29
	1800	4.74	540			.29
	1900	4.75	600			.30
	2000	4.76	660			.31
	2100	4.76	720			.31
	2200	4.76	780			.31
OFF	2224	4.76	804	0	∞	.31
	2230	4.75	810	6	135	.30
	2245	4.70	825	21	39.29	.25
	2300	4.67	840	36	23.33	.22
	2330	4.62	870	66	13.18	.17
	2400	4.56	900	96	9.38	.11
5-30-80	0030	4.53	930	126	7.38	.08

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TRH 1 5/293 PERMIT 213-T2

D11-271

7/31/89-213 T3

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RAMACO

Brook Mine

PKS GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

State _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO. BH510

Personnel _____ Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify _____)
2. Single well recovery 4. Recovery with obs. well

Well owner _____ Address _____

iller _____ Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

otal well depth _____ ft. Well diameter ____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth _____ ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

SWL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
5-30-80	0100	4.50	960	186	5.16	.05
	0200	4.45	1020	246	4.15	0

LAND QUALITY DIVISION

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D11-272

TFN 1 5/293 PERMIT

TFN S 2/025

RECD 10-25-18

LAND QUALITY DIVISION
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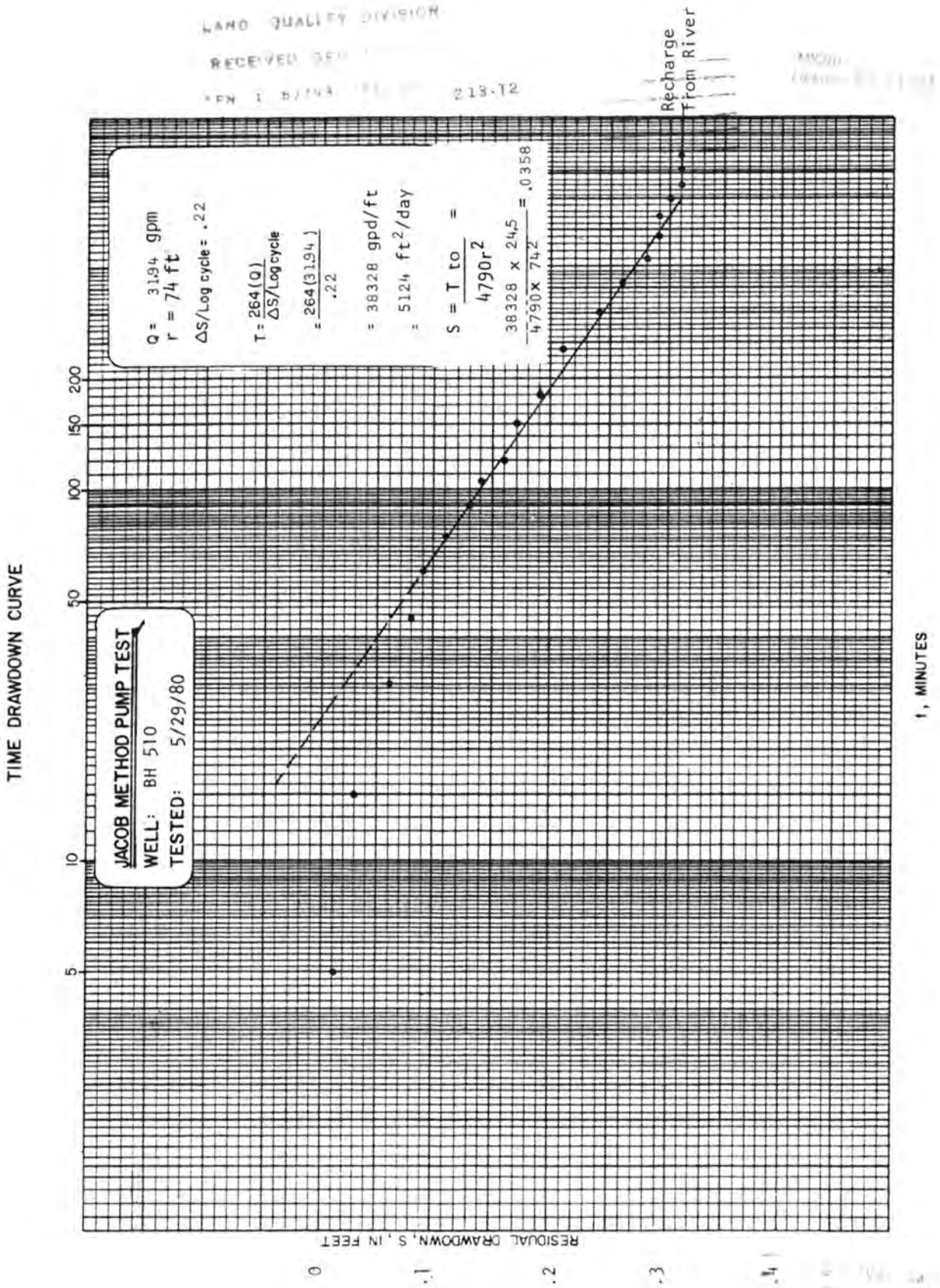
JAN 1 8/1984



D11-273

DEQ Ex. 3-1725

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K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S. R. 84 (E) W Sec. 14 WELL NO. 207A

Personnel Bondar, Araas — Test type: (1) Single well drawdown 3. Drawdown with obs. well 5. Other (specify) (2) Single well recovery 4. Recovery with obs. well

Owner PKS Address Sheridan, WY

D. Fudge Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 27 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 5' - 25' Pump hp. & type 3/4 Teel Pump depth 25 ft.

Aquifer Alluvium Aquifer lithology mixed sand and gravel

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

SWL from MP 11.95 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
4-24-80	10:00	11.95	0			0
	10:01	13.31	1			1.36
	10:03	13.37	3			1.42
	10:06	13.38	6			1.43
	10:10	13.48	10			1.53
	10:15	13.50	15			1.55
	10:20	13.50	20			1.55
	10:30	13.52	30			1.57
	10:40	13.52	40			1.57
	10:50	13.53	50			1.58
	11:00	13.53	60			1.58
	11:45	13.54	105			1.59
	12:00	13.56	120			1.61
	12:15	13.56	135			1.61
	12:30	13.56	150			1.61
	12:45	13.56	165			1.61
	13:00	13.56	180			1.61
Off	13:06	13.56	186	0	0	1.61
	13:08	12.11	188	2	94	.16
	13:10	12.09	190	4	47.5	.14
	13:12	12.08	192	6	32.0	.13
	13:15	12.07	195	9	21.70	.12
	13:20	12.06	200	14	14.30	.11
	13:30	12.04	210	24	8.75	.09
	13:40	12.02	220	34	6.50	.07
	13:50	12.01	230	44	5.23	.06
	14:00	12.00	240	54	4.44	.05
	14:15	11.99	255	69	3.70	.04
	14:30	11.97	270	84	3.21	.02

LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT 213-T2
D11-274
TFN 6 2/025
RECD 10-25-18

WATER WELL 207A

PUMPING RATE DATA

MICRO FILMED SEP 21 '84

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
4/24/80	1003	14.50	12.41	3.00	3	37.23
	1006	13.00	13.85	3.00	3	41.55
	1010	12.90	14.00	3.00	4	56.00
	1015	12.50	14.40	3.00	5	72.00
	1020	12.50	14.40	3.00	5	72.00
	1030	12.50	14.40	3.00	10	144.00
	1040	12.50	14.40	3.00	10	144.00
	1050	12.70	14.20	3.00	10	142.00
	1100	13.00	13.85	3.00	10	138.50
	1145	12.80	14.10	3.00	45	634.50
	1200	12.70	14.20	3.00	15	213.00
	1215	12.90	14.00	3.00	15	210.00
	1230	12.70	14.20	3.00	15	213.00
	1245	13.00	13.85	3.00	15	207.75
	1300	12.80	14.10	3.00	15	211.50
					180.0	2537.03

Q = 2537.03/180.0 = 14.10 gpm

Spec. Cap. = $\frac{14.10}{1.61}$ = 8.67 gpm/ft.

LAND QUALITY DIVISION
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TFN 1 5/293
TFN 6 2/025
REC'D 10-25-18

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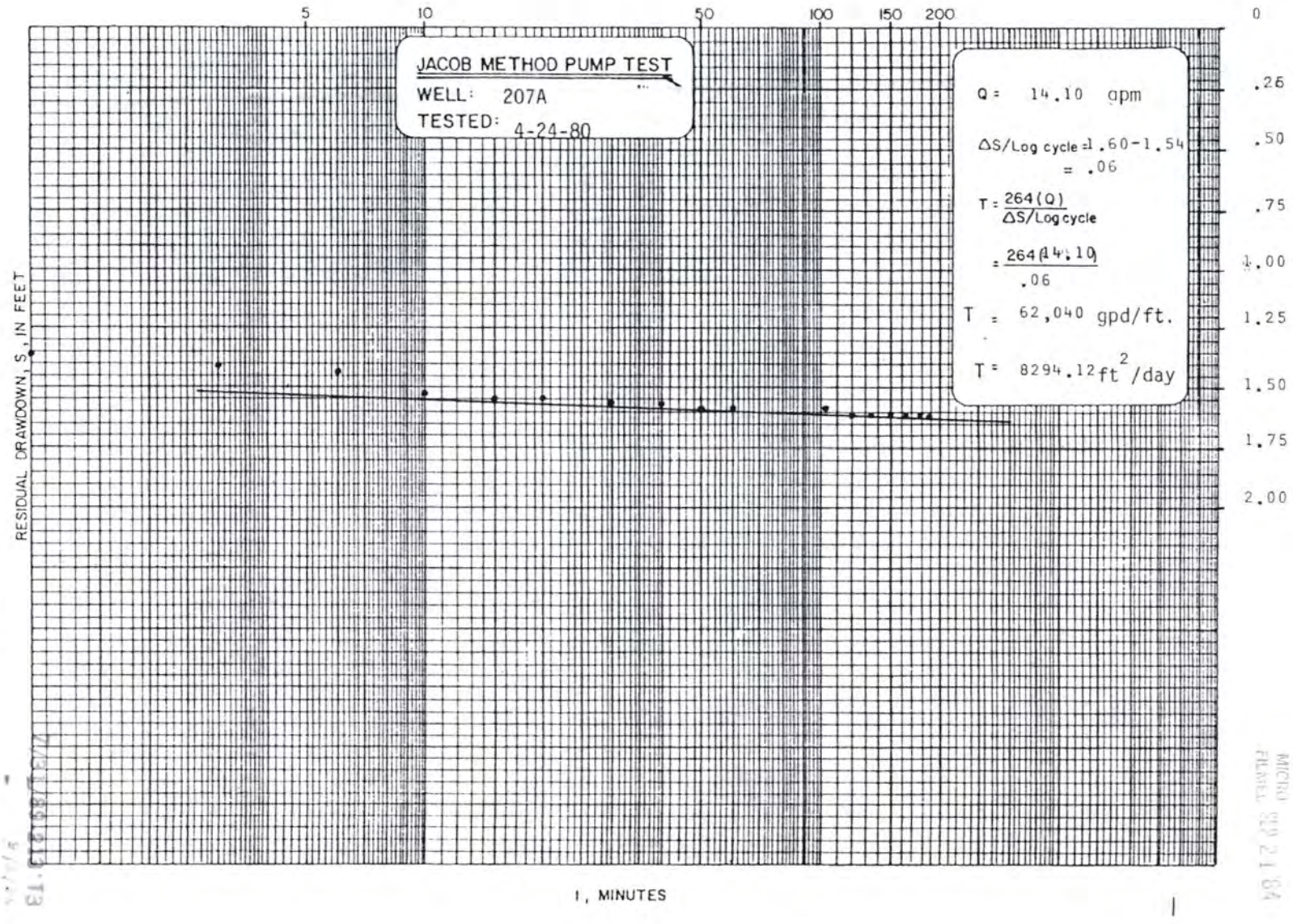
TIME DRAWDOWN CURVE



LAND QUALITY DIVISION
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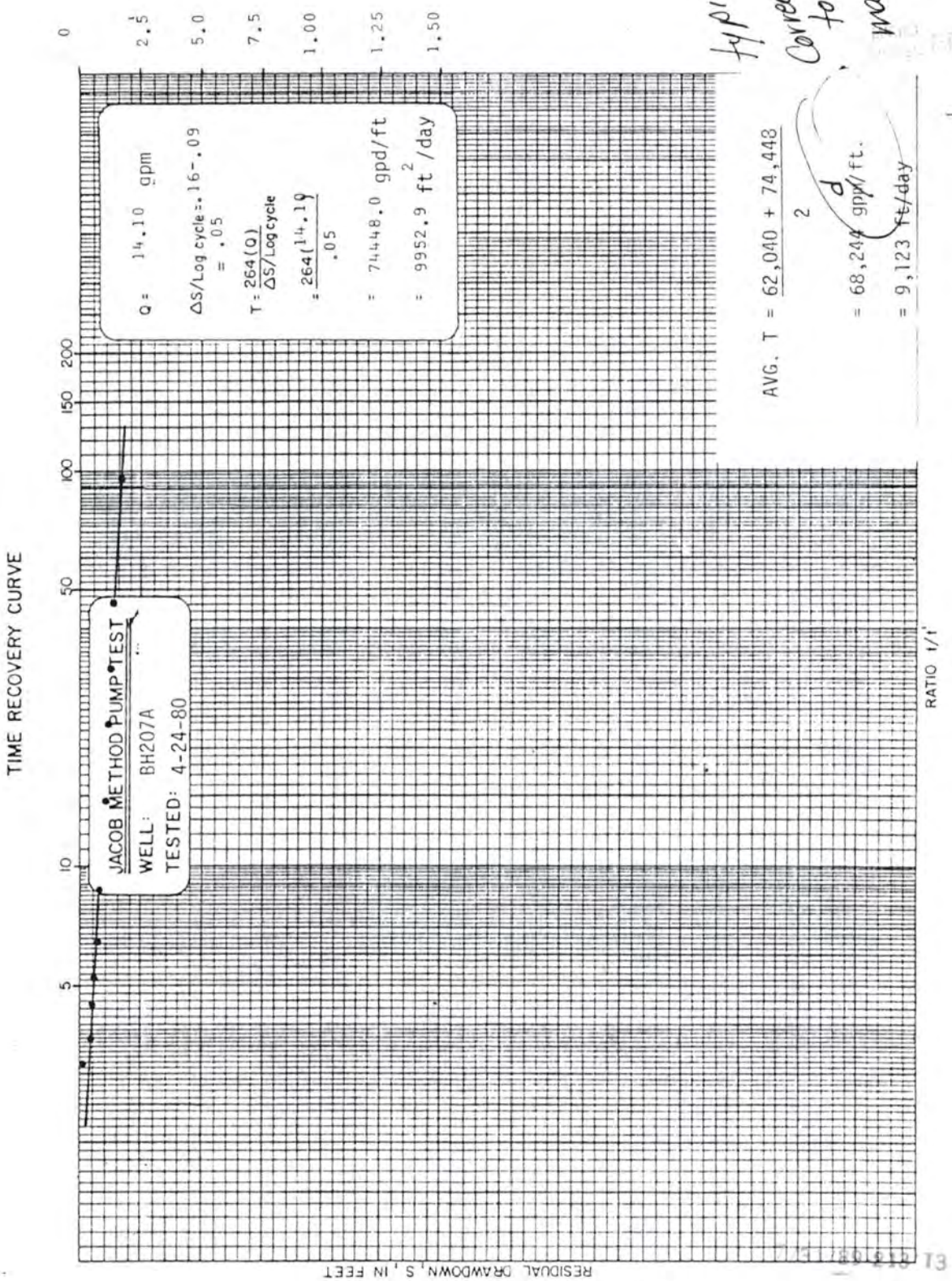
D11-276
TFN 1 5/293 PERMIT
TFN 6 2/025
RECD 10-25-13



LAND QUALITY DIVISION
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D11-277
TFN 1 5/293
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1729

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K.S. GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

tate WYO County Sheridan T. ____ N. S., R. ____ E. W., Sec. ____, WELL NO. 230

ersonnel Gerlach - Wolf

Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify)

ll owner Big Horn Coal Address ____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

otal well depth 58 ft. Well diameter 7 7/8 in.

asing diameter 5 in. Casing type PVC

ype of screen or perforation Saw Slot Interval of screen or perforation 20-58 Pump hp. & type Teel- 1½ hp Pump depth 50 ft.

quifer Alluvium Aquifer lithology Sand & Gravel

ltitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP top casing How measured galvanometer (Casing 2.31' above ground)

DATE / HOUR	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
4/22/77 11	10	18.20	-	-		-
11	15		0	-		-
11	20	18.80	5	-		-
11	24	18.8	9	-		-
11	32	18.8	17	-		-
12	05	18.8	50	-		-
12	34	18.8	79	-		-
12	35	Pump Off	80	0	0	-
12	35 ¼	18.39	80 ¼	0.25	321.0	0.19
12	35 ½	18.36	80 ½	0.5	161.0	0.16
12	36	18.31	81	1.0	81.0	0.11
12	36 ½	18.31	81 ½	1.5	54.33	0.11
12	37	18.28	82	2.0	41.00	0.08
12	37 ½	18.25	82 ½	2.5	33.00	0.05
12	38	18.23	83	3.0	27.67	0.03
12	38 ½	18.22	83 ½	3.5	23.86	0.02
12	39	18.22	84	4.0	21.00	0.02
12	39 ½	18.22	84 ½	4.5	18.78	0.02
12	40 ½	18.22	85 ½	5.5	15.55	0.02

Q = 15 gpm

Specific Capacity = 15 gpm/ .60 = 25.0 gpm/ft.

LAND QUALITY DIVISION
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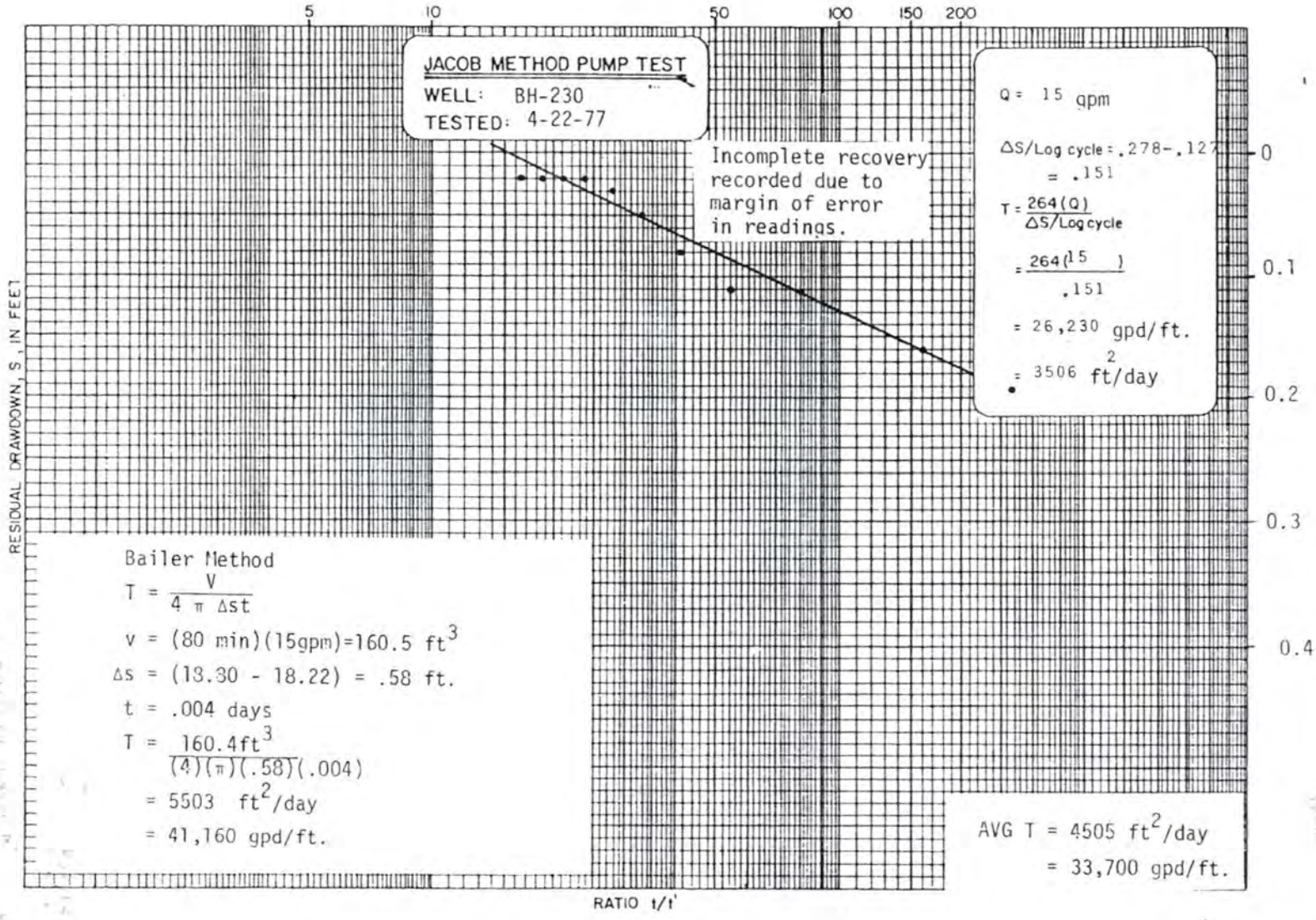
TFN 1 6/283

D11-278

TFN 6 2/025
RECD 10-25-18

7/31/89-213'T3

TIME RECOVERY CURVE



D11-279

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TFN 1 5/293 PERMIT 213-72

TFN 6 2/025

RECD 10-25-18

DEQ Ex. 3-1731

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PKS GEOLOGY AND EXPLORATION — AQUIFER TEST DATA

State WY County Sheridan T. 57 (N) S. R. 84 (E) W. Sec. 14 WELL NO. BH 397WW

Personnel Collier, Volk, Bondar, Araas — Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well

Well owner Peter Kiewit Sons' Address Sheridan, WY P.O. Box 3049

R. Reed (PKS) — Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug (H) Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 30.0 ft. Well diameter 7 7/8 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation Saw slots Interval of screen or perforation 8' - 24' Pump hp. & type 2 hp. Red Jacket Pump depth 29.4 ft.

Aquifer Alluvium Aquifer lithology Pebble gravel matrix w/floating coarse sand

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP 12.22 How measured Galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
2-19-79	10:45	12.22	0.0			
	10:46	16.37	1.0			4.15
	10:47	16.40	2.0			4.18
	10:48	16.40	3.0			4.18
	10:49	16.62	4.0			4.40
	10:50	16.62	5.0			4.40
	10:55	16.76	10.0			4.54
	11:00	16.93	15.0			4.71
	11:10	17.05	25.0			4.83
	11:25	17.97	40.0			5.75
	11:50	18.07	65.0			5.85
	12.10	18.08	85.0			5.86
	12:30	18.19	105.0			5.97
	13:00	18.28	135.0			6.06
	13:30	17.72	165.0			5.50
	14:00	17.73	195.0			5.51
	14:30	17.91	225.0			5.69
	15:00	17.94	255.0			5.72
	15:30	17.95	285.0			5.73
	16:00	17.98	315.0			5.76
	16:30	17.94	345.0			5.72
	17:00	17.95	375.0			5.73
	17:30	17.77	405.0			5.55
	18:00	18.84	435.0			6.62
	18:30	18.38	465.0			6.16
	19:00	18.30	495.0			6.08
	19:30	18.24	525.0			6.02
	20:00	18.16	555.0			5.94

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D11-280
TFN 8 2/025
RECD 10-25-18

K.S. GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

ate _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO. BH 397 WW

ersonnel _____

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) _____
2. Single well recovery 4. Recovery with obs. well

ell owner _____ Address note: obs. well (#198) 134.5' away

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

ell depth _____ ft. Well diameter _____ in.

asing diameter _____ in. Casing type _____

ype of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth _____ ft.

quifer _____ Aquifer lithology _____

ltitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

WL from MP _____ How measured _____

DATE 2-19-80	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
Off	20:15		570.0	0.0		
	20:50	13.00	605.0	35.0	17.29	.78
	21:00	12.90	615.0	45.0	13.67	.68
	21:10	12.88	625.0	55.0	11.36	.66
	21:20	12.81	635.0	65.0	9.77	.59
	21:30	12.75	645.0	75.0	8.60	.53
	21:40	12.70	655.0	85.0	7.71	.48
	21:50	12.67	665.0	95.0	7.00	.45
	22:00	12.63	675.0	105.0	6.43	.41
	22:10	12.60	685.0	115.0	5.96	.38
	22:20	12.59	695.0	125.0	5.56	.37
	22:35	12.54	710.0	140.0	5.07	.32
	22:45	12.48	720.0	150.0	4.80	.26
	22:58	12.43	733.0	163.0	4.50	.21
	23:13	12.38	748.0	178.0	4.20	.16

LAND QUALITY DIVISION
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213-12

D11-281

TFN S 2/025
RECD 10-25-18

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WATER WELL BH 397WW

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SECONDS	GALLONS PER MINUTE	VOLUME OF DISCHARGE GALLONS	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
2/19/79	1046	41.5	79.5	55	1	79.5
	1055	41.5	79.5	55	9	715.5
	1110	42.0	78.6	55	15	1179.0
	1126	42.0	78.6	55	16	1257.6
	1210	44.0	75.0	55	39	2925.0
	1300	46.5	71.0	55	50	3550.0
	1342	48.0	68.7	55	42	2885.4
	1410	48.5	68.04	55	27	1837.08
	1500	49.0	67.35	55	50	3367.5
	1600	49.5	66.7	55	60	4002.0
	1700	50.5	65.35	55	60	3921.0
	1802	48.6	67.9	55	62	4209.8
	1902	49.2	67.07	55	60	4024.2
	2002	48.9	67.5	55	60	4050.0
					551	38003.58

AVG Q = 38,003.58 ÷ 551 = 68.97

Specific Capacity = 68.97/6.62 = 10.94 gpm/ft.

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PKS GEOLOGY AND EXPLORATION — AQUIFER TEST DATA — observation well

State Wyoming County Sheridan T. 57 (N) S. R. 84 (E) W Sec. 14 WELL NO. 198

Personnel Collier, Velk, Bondar, Araas

Test type: 1. Single well drawdown (3) Drawdown with obs. well 5. Other (specify) ____
2. Single well recovery 4. Recovery with obs. well

Well owner PKS Address Sheridan, WY

R. Reed Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered (H) Hyd.-rotary R. Rev.-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 29 ft. Well diameter 4 3/4 in.

Casing diameter 4 in. Casing type PVC

Type of screen or perforation Saw slots Interval of screen or perforation 9' - 29' Pump hp. & type NA Pump depth ____ ft.

Aquifer Alluvium Aquifer lithology mixed sand and gravel

Altitude of land surface ____ How determined ____ MP Above Below LSD ____ Altitude MP ____

WL from MP ____ How measured Stevens F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t^1, MIN.	t/t^1	S_1 FT. RESIDUAL DRAWDOWN
2-19-79	10:45	8.40	0.0			0.00
	10:46	8.43	1.0			.03
	10:48	8.45	3.0			.05
	10:50	8.46	5.0			.06
	10:52	8.47	7.0			.07
	10:55	8.49	10.0			.09
	11:00	8.50	15.0			.10
	11:15	8.55	30.0			.15
	11:30	8.58	45.0			.18
	11:45	8.59	60.0			.19
	12:00	8.61	75.0			.21
	12:15	8.62	90.0			.22
	12:30	8.63	105.0			.23
	12:45	8.64	120.0			.24
	13:00	8.66	135.0			.26
	13:15	8.67	150.0			.27
	13:30	8.69	165.0			.29
	13:45	8.71	180.0			.31
	14:00	8.72	195.0			.32
	14:15	8.74	210.0			.34
	14:30	8.74	225.0			.34
	14:45	8.75	240.0			.35
	15:00	8.75	255.0			.35
	15:15	8.76	270.0			.36
	15:30	8.77	285.0			.37
	15:45	8.78	300.0			.38
	16:00	8.78	315.0			.38
	16:15	8.79	330.0			.39
	16:30	8.79	345.0			.39

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D11-283

TFR G 2/025 RECD 10-25-18

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U.S. GEOLOGICAL SURVEY AQUIFER TESTING obs. well

State _____ County _____ T. _____ N. S. R. _____ E. W. Sec. _____ WELL NO. 198 (cont)

Personnel _____ Test type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (specify) _____

Well owner _____ Address _____

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Well depth _____ ft. Well diameter _____ in.

Casing diameter _____ in. Casing type _____

Type of screen or perforation _____ Interval of screen or perforation _____ Pump hp. & type _____ Pump depth _____ ft.

Aquifer _____ Aquifer lithology _____

Altitude of land surface _____ How determined _____ MP Above Below LSD _____ Altitude MP _____

WL from MP _____ How measured _____

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S_1 FT. RESIDUAL DRAWDOWN
	16:45	8.80	360.0			.40
	17:00	8.81	375.0			.41
	17:15	8.81	390.0			.41
	17:30	8.82	405.0			.42
	17:45	8.83	420.0			.43
	18:00	8.83	435.0			.43
	18:15	8.84	450.0			.44
	18:30	8.84	465.0			.44
	18:45	8.84	480.0			.44
	19:00	8.85	495.0			.45
	19:15	8.85	510.0			.45
	19:30	8.86	525.0			.46
	19:45	8.86	540.0			.46
	20:00	8.87	555.0			.47
	20:15	8.87	570.0			.47
Off	20:18	8.87	573.0			.47

LAND QUALITY
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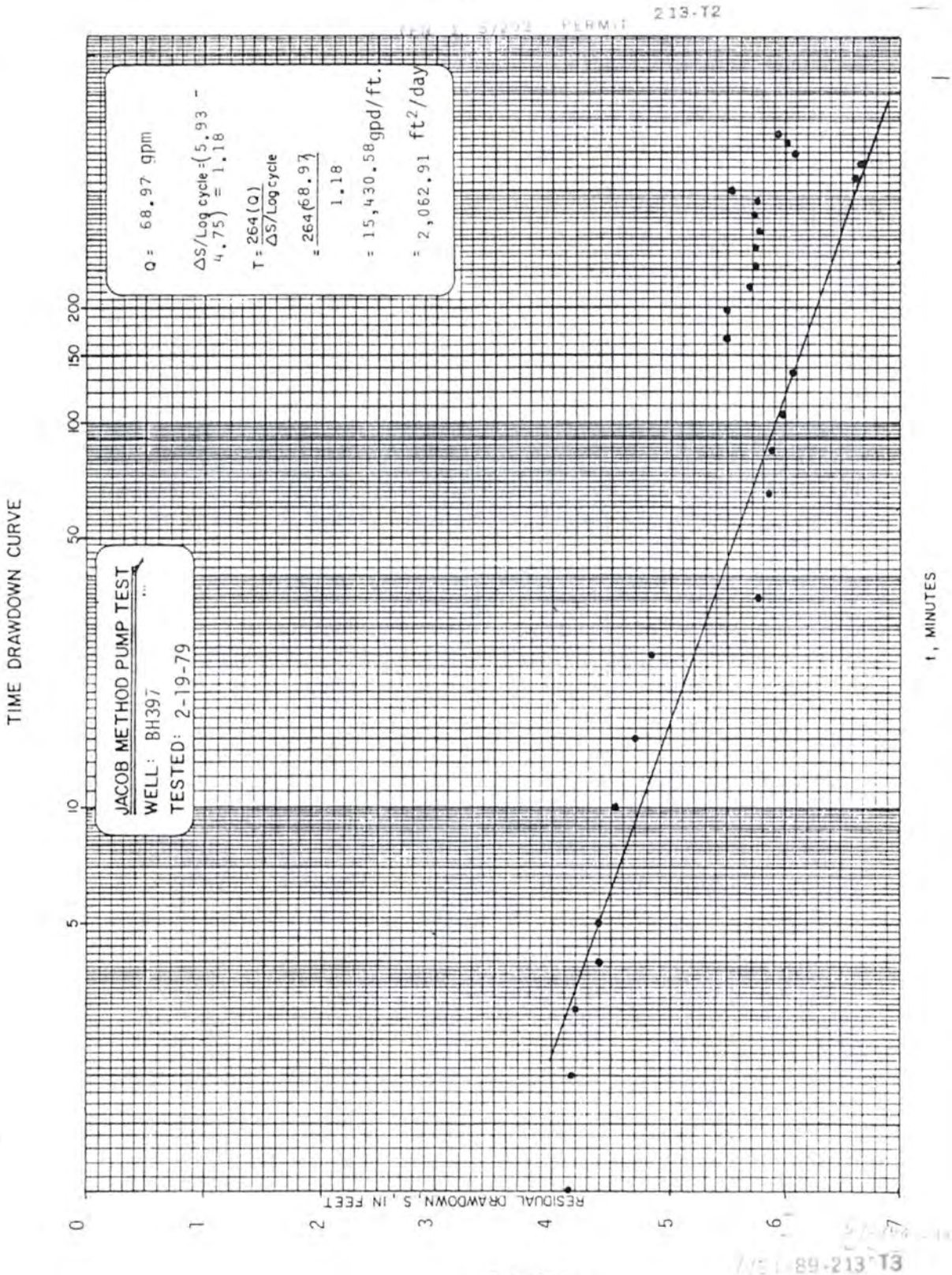
TFN 1 8/293

213-72

D11-284
TFN 6 2/025
RECD 10-25-18



89-213 T3

D11-285

TFN 6 2/025

RECD 10-25-18

DEQ Ex. 3-1737

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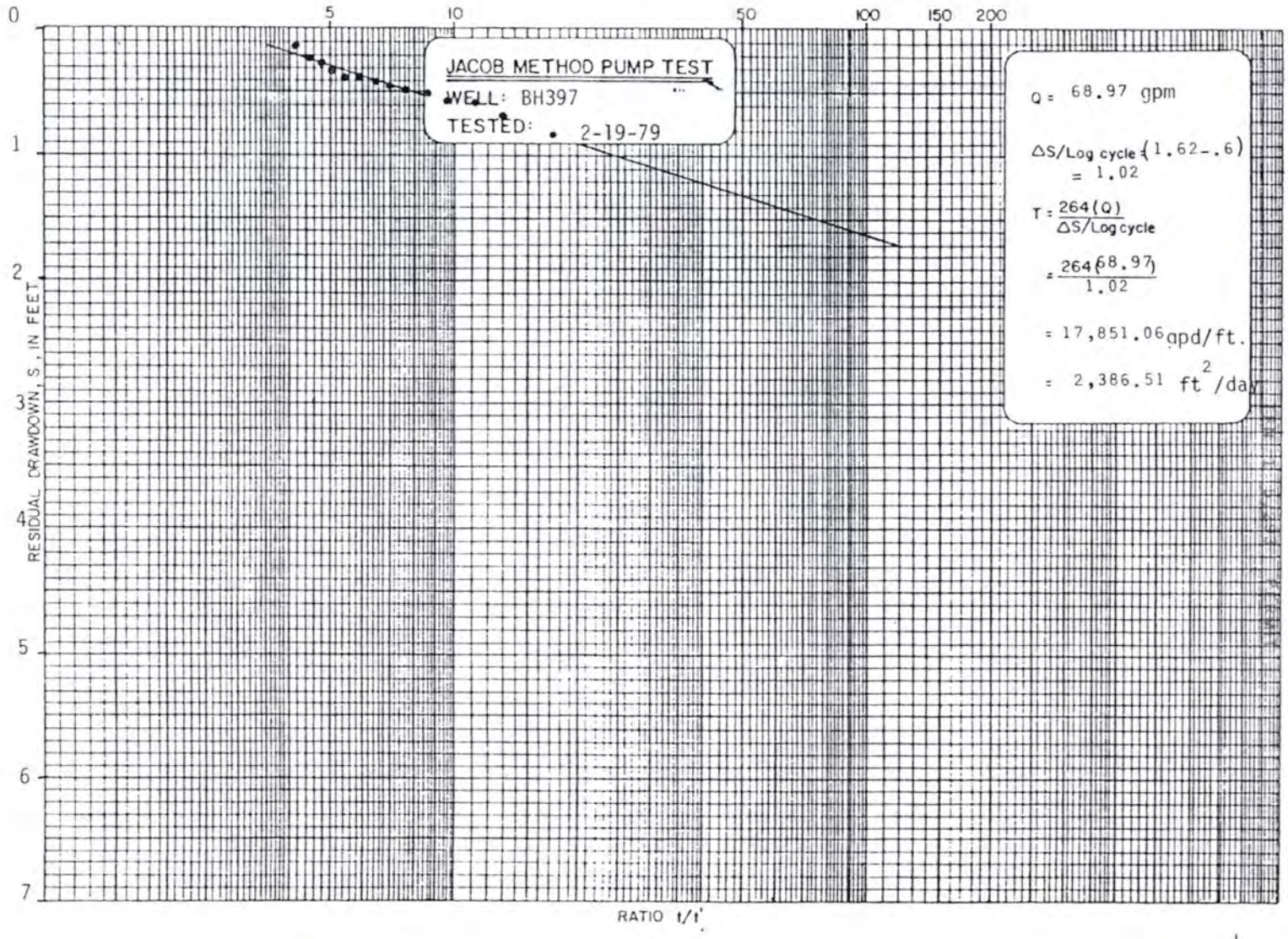
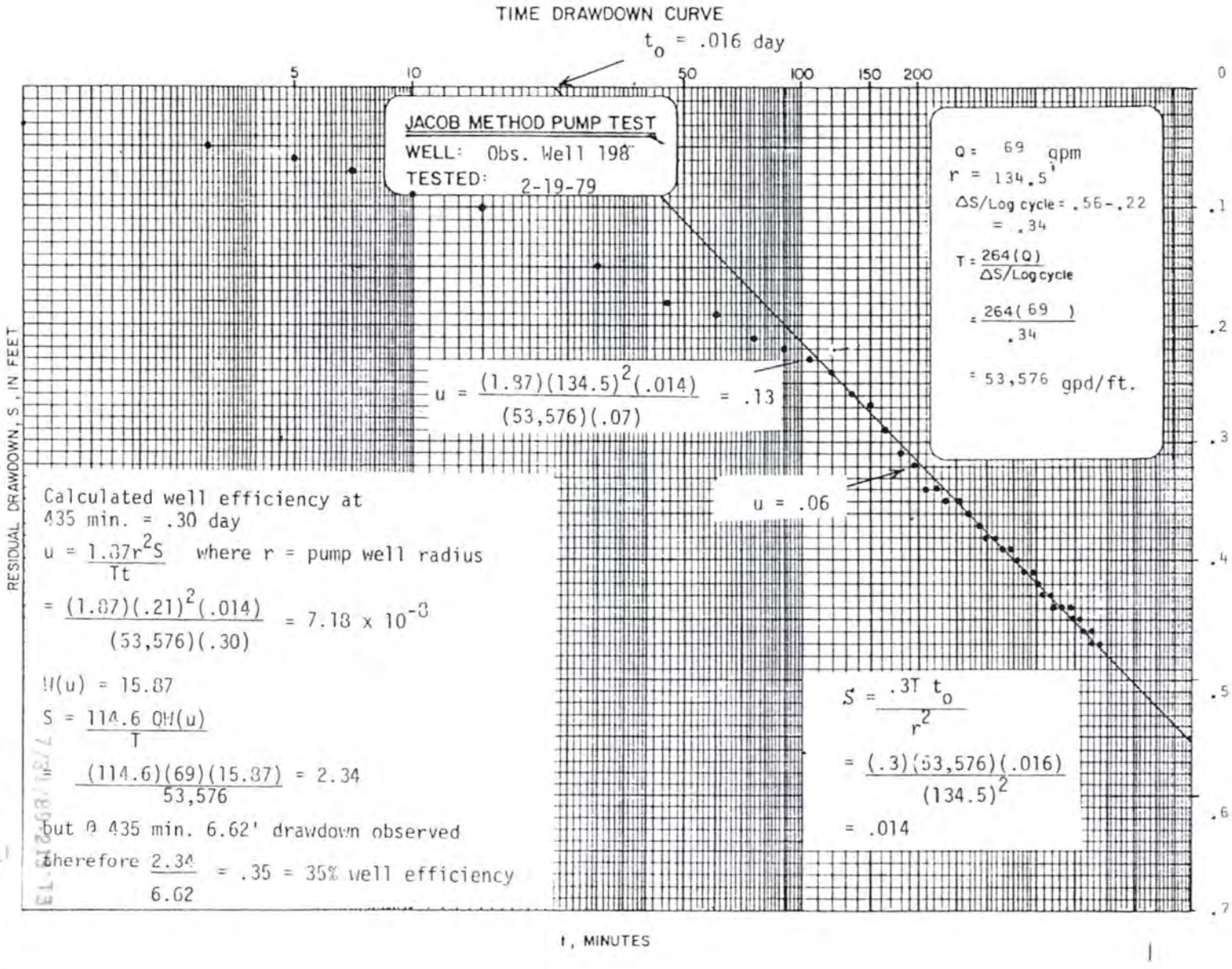
D11-286
TFN 6 2/025
RECD 10-25-18

TIME RECOVERY CURVE



DEQ Ex. 3-1738



October 2018
D11-287
TFN 6 2/025
RECD 10-25-18
Addendum D6-14-196

DEQ Ex. 3-1739

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ADDENDUM D11-H

PUMP TEST DRAWDOWN, DISCHARGE,

AND RECOVERY INFORMATION

9/2/94-21814

TFN 6 2/025
RECD 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., Sec. 13 WELL NO. BH 627

Personnel Bondar, Holm, Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY Driller D. Fudge

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 20 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation saw slots

Pump hp & type 2 Gould Pump depth 11 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3583.9

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.08 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-3-81	0930	12.08	0			0
	0931	13.60	1			1.52
	0933	13.70	3			1.62
	0936	13.81	6			1.73
	0940	13.81	10			1.73
	0950	13.75	20			1.67
	1000	13.83	30			1.75
	1020	13.94	50			1.86
	1040	13.96	70			1.88
	1100	14.00	90			1.92
	1130	14.10	120			2.02
	1200	14.05	150			1.97
	1300	14.05	210			1.97
	1400	14.05	270			1.97
	1500	14.00	330			1.92
	1600	14.03	390			1.95
	1700	14.12	450			2.04
	1800	14.28	510			2.20
	1900	14.27	570			2.19
	2000	14.26	630			2.18
	2100	14.00	690			1.92

LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT 213-12

D11-446

TFN 6 2/025
RECD 10-25-18

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., Sec. 13 WELL NO. BH 627

Personnel Bondar, Holm, Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY Driller D. Fudge

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 20 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation saw slots

Pump hp & type 2 Gould Pump depth 11 ft. Aquifer Alluvium

Aquifer lithology sands and gravel Altitude of land surface 3583.9

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.08 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	2200	13.98	750			1.90
	2300	14.23	810			2.15
	2400	14.37	870			2.29
8-4-81	0100	14.38	930			2.30
	0200	14.45	990			2.37
	0300	14.41	1050			2.33
	0400	14.45	1110			2.37
	0500	14.48	1170			2.40
	0600	14.48	1230			2.40
	0700	14.47	1290			2.39
OFF	0710	14.40	1300	0		2.32
	0711	12.50	1301	1	1301.0	0.42
	0713	12.43	1303	3	434.3	0.35
	0716	12.41	1306	6	217.7	0.33
	0720	12.39	1310	10	131.0	0.31
	0725	12.38	1315	15	87.7	0.30
	0730	12.36	1320	20	66.0	0.28
	0740	12.34	1330	30	44.3	0.26
	0750	12.33	1340	40	33.5	0.25
	0800	12.32	1350	50	27.0	0.24
	0815	12.31	1365	65	21.0	0.23

9/2/94-213-T4

D11-447

TFN 6 27 25

RECD 10-25-13

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., Sec. 13 WELL NO. BH 627

Personnel Bondar, Holm, Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY

Driller D. Fudge

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 20 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation saw slots

Pump hp & type 2 Gould Pump depth 11 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3583.9

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.08 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-4-81	0830	12.30	1380	80	17.3	0.22
	0850	12.29	1400	100	14.0	0.21
	0910	12.29	1420	120	11.8	0.21
	0930	12.27	1440	140	10.3	0.19
	1000	12.26	1470	170	8.6	0.18

LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT

D11-448 9/2/94-213-14

TFN 6 2/025
RECD 10-25-18

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WATER WELL BH 627

PUMPING RATE DATA

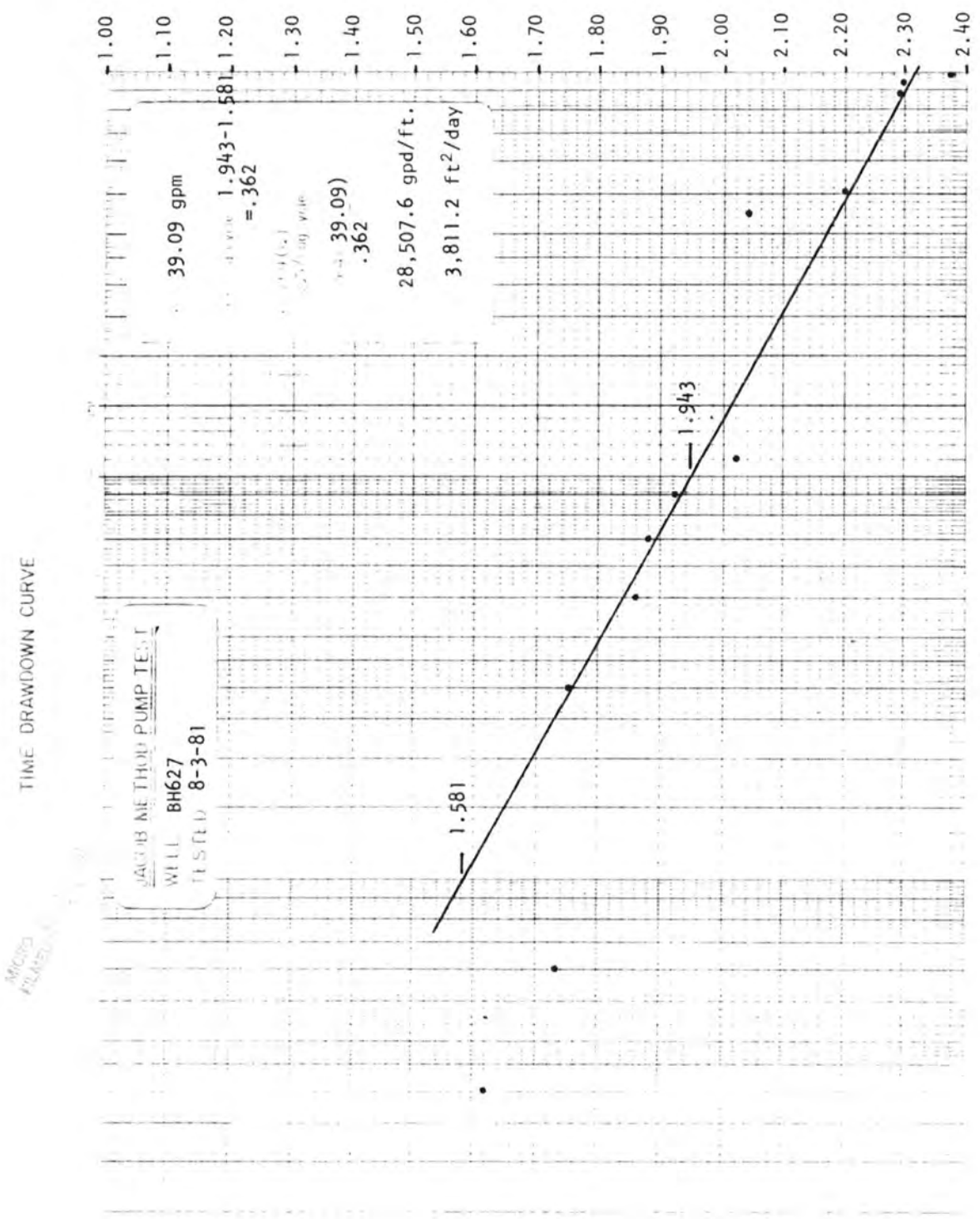
Specific Capacity = $\frac{39.09 \text{ gpm}}{2.40 \text{ ft.}}$ = 16.29 gpm/ft.

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
8-3-81	0936	8.5	37.41	5.3	6	224.46
	1000	8.5	37.41	5.3	4	149.64
	1020	8.3	38.31	5.3	20	766.20
	1040	8.0	39.75	5.3	20	795.00
	1100	8.0	39.75	5.3	20	795.00
	1130	8.2	38.78	5.3	30	1163.40
	1200	8.0	39.75	5.3	30	1192.50
	1300	8.4	37.86	5.3	60	2271.60
	1400	8.0	39.75	5.3	60	2385.00
	1500	8.5	37.41	5.3	60	2244.60
	1600	8.2	38.78	5.3	60	2326.80
	1700	8.0	39.75	5.3	60	2385.00
	1800	8.0	39.75	5.3	60	2385.00
	1900	8.1	39.25	5.3	60	2355.00
	2000	8.0	39.75	5.3	60	2385.00
	2100	8.2	38.78	5.3	60	2326.80
	2200	8.1	39.25	5.3	60	2355.00
	2300	8.1	39.25	5.3	60	2355.00
	2400	8.1	39.25	5.3	60	2355.00
8-4-81	0100	8.0	39.75	5.3	60	2385.00
	0200	8.2	38.78	5.3	60	2326.80
	0300	8.2	38.78	5.3	60	2326.80
	0400	8.0	39.75	5.3	60	2385.00
	0500	8.2	38.78	5.3	60	2326.80
	0600	8.1	39.25	5.3	60	2355.00
	0700	8.2	38.78	5.3	60	2326.80
Off	0710			TOTALS	1270	49,648.20

$\overline{Q} = \frac{49,648.20}{1270} = 39.1$ gpm

LAND QUALITY DIVISION
RECEIVED DEC 28 1982

D11-449
9/2/98-213.T2
JFN 1 5/293 PERMIT 213.T2
JFN 6 2/025
RECD 10-25-13



TIME DRAWDOWN CURVE

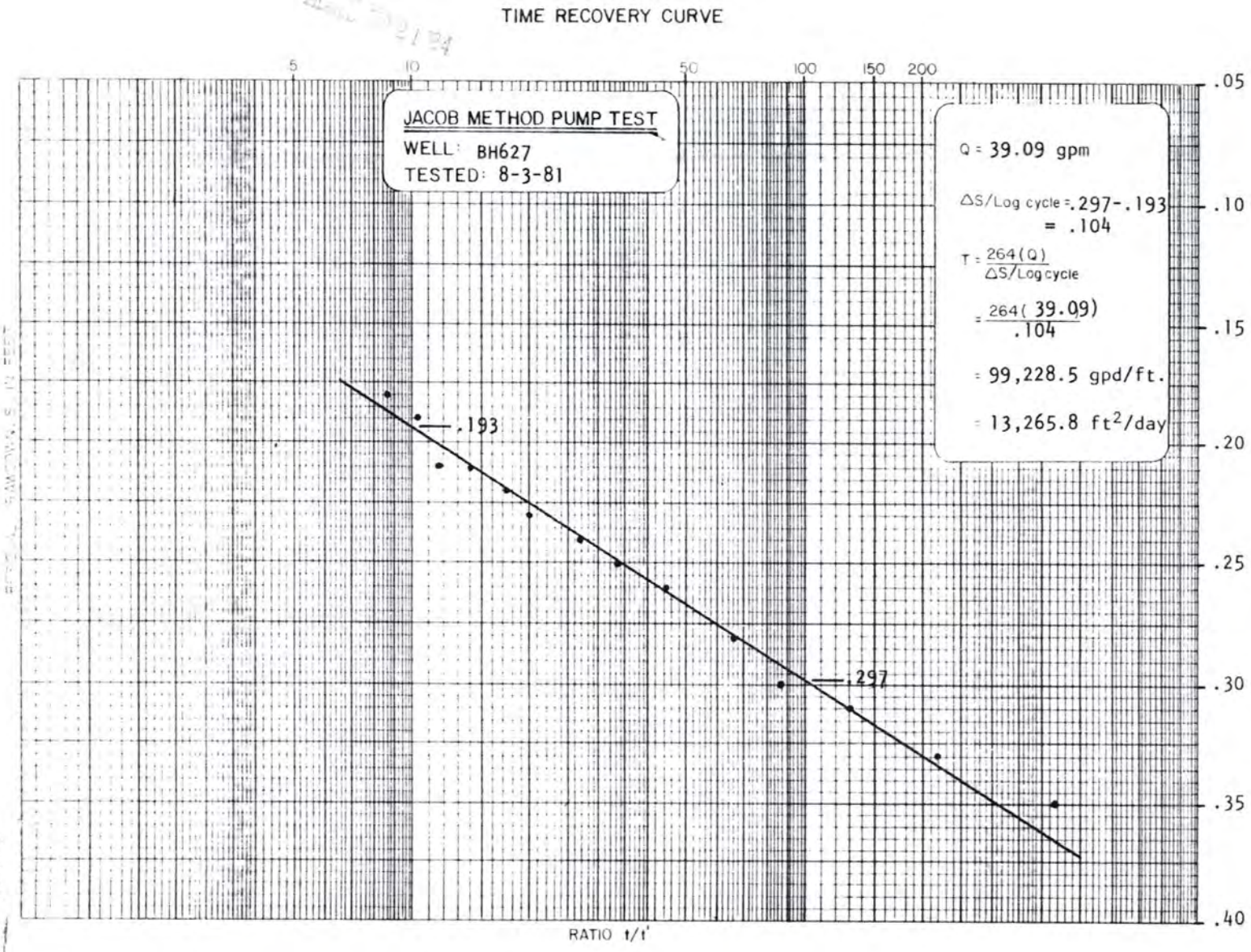
DEQ Ex. 3-1745

9/2/94-213.14

D11-450

YPN G 2/025
RECD 10-25-18

Scanned, 02/26/2020



D11-451
RECD 10-25-13
9/2/94-213.74

DEQ Ex. 3-1746

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., Sec. 11 WELL NO. 635
Personnel Bondar, Jones, Tittle
Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)
Well Owner BHC
ss Sheridan, WY Driller D. Fudge
Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other
Total well depth 28 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC
Type of screen or perforation slotted Interval of screen or perforation 8' - 28'
Pump hp & type 3hp Gould Pump depth 27 ft. Aquifer Alluvium
Aquifer lithology sands and gravels Altitude of land surface 3567.9
How determined surveyed MP Above Below LSD Altitude MP
WL from MP 8.68 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-6-81	0930	8.68	0			0
	0931	9.80	1			1.12
	0933	9.85	3			1.17
	0936	9.95	6			1.27
	0940	9.95	10			1.27
	0950	9.97	20			1.29
	1000	10.00	30			1.32
	1020	10.06	50			1.38
	1040	10.10	70			1.42
	1100	10.13	90			1.45
	1130	10.14	120			1.46
	1200	10.20	150			1.52
	1300	10.27	210			1.59
	1400	10.34	270			1.66
	1500	10.38	330			1.70
	1600	10.40	390			1.72
	1700	10.43	450			1.75
	1800	10.45	510			1.77
	1900	10.48	570			1.80
	2000	10.51	630			1.83
	2100	10.55	690			1.87

9/2/94-213.T4

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D11-452

TFN 6 2/5/293 PERMIT

TFN 6-27-25

RECD 10-25-18

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. R. 84 E. Sec. 11 WELL NO. 635

Personnel Bondar, Jones, Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner BHC

ss Sheridan, WY Driller D. Fudge

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 28 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slotted Interval of screen or perforation 8' - 28'

Pump hp & type 3hp Gould Pump depth 27 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3567.9

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 8.68 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	2200	10.58	750			1.90
	2300	10.64	810			1.96
	0100	10.67	930			1.99
	0300	10.72	1050			2.04
	0500	10.76	1170			2.08
	0700	10.80	1290			2.12
OFF	0800	10.80	1350			2.12
	0801	9.54	1351	1	1351	.86
	0803	9.51	1353	3	451	.83
	0806	9.49	1356	6	226	.81
	0810	9.42	1360	10	136	.74
	0815	9.37	1365	15	91	.69
	0820	9.34	1370	20	68.50	.66
	0830	9.27	1380	30	46.0	.59
	0850	9.22	1400	50	28.0	.54
	0910	9.17	1420	70	20.29	.49
	0930	9.13	1450	90	16.11	.45
	1000	9.12	1480	120	12.33	.44
	1100	9.04	1540	180	8.56	.36
	1200	8.99	1600	240	6.67	.31
	1300	8.96	1660	300	5.53	.28

9/2/94-218:T4
LAND QUALITY DIVISION
DII-453
TFN 6 2/025
MSCD 10-25-18

WATER WELL 635

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
8-6-81	0931	9.0	35.33	5.3	1	35.33
	0933	8.5	37.41	5.3	2	74.82
	0950	8.5	37.41	5.3	17	635.97
	1020	8.2	38.78	5.3	30	1163.40
	1100	8.4	37.86	5.3	40	1514.40
	1200	8.5	37.41	5.3	60	2244.60
	1300	8.2	38.78	5.3	60	2326.80
	1400	8.3	38.31	5.3	60	2298.60
	1500	8.5	37.41	5.3	60	2244.60
	1600	8.7	36.55	5.3	60	2193.00
	1700	8.9	35.73	5.3	60	2143.80
	1800	8.7	36.55	5.3	60	2193.00
	2000	8.5	37.41	5.3	120	4489.20
	2200	8.2	38.78	5.3	120	4653.60
	2400	8.3	38.31	5.3	120	4597.20
8-7-81	0200	8.0	39.75	5.3	120	4770.00
	0400	8.1	39.26	5.3	120	4711.20
	0600	8.0	39.75	5.3	120	4770.20
	0800	8.0	39.75	5.3	120	4770.20
				TOTALS	1350.00	51,829.92

Average Q = 38.39 gpm

Specific Capacity = $\frac{38.39 \text{ gpm}}{2.12 \text{ ft}}$ = 18.11 gpm/ft.

9/2/94-213.14

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

D11-454 TFN 1 5/203 PERMIT

TFN 2/025

WVED 10-25-18

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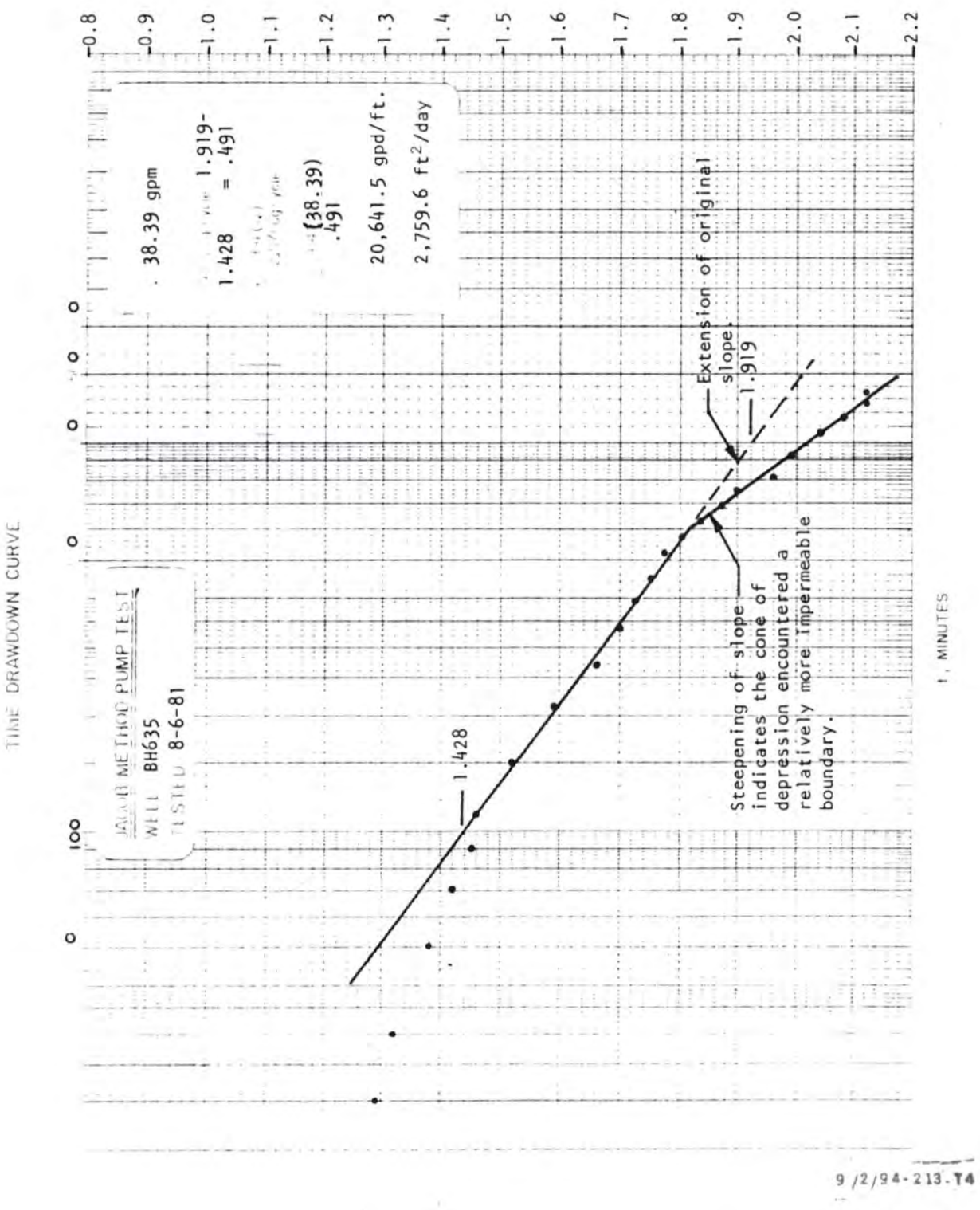
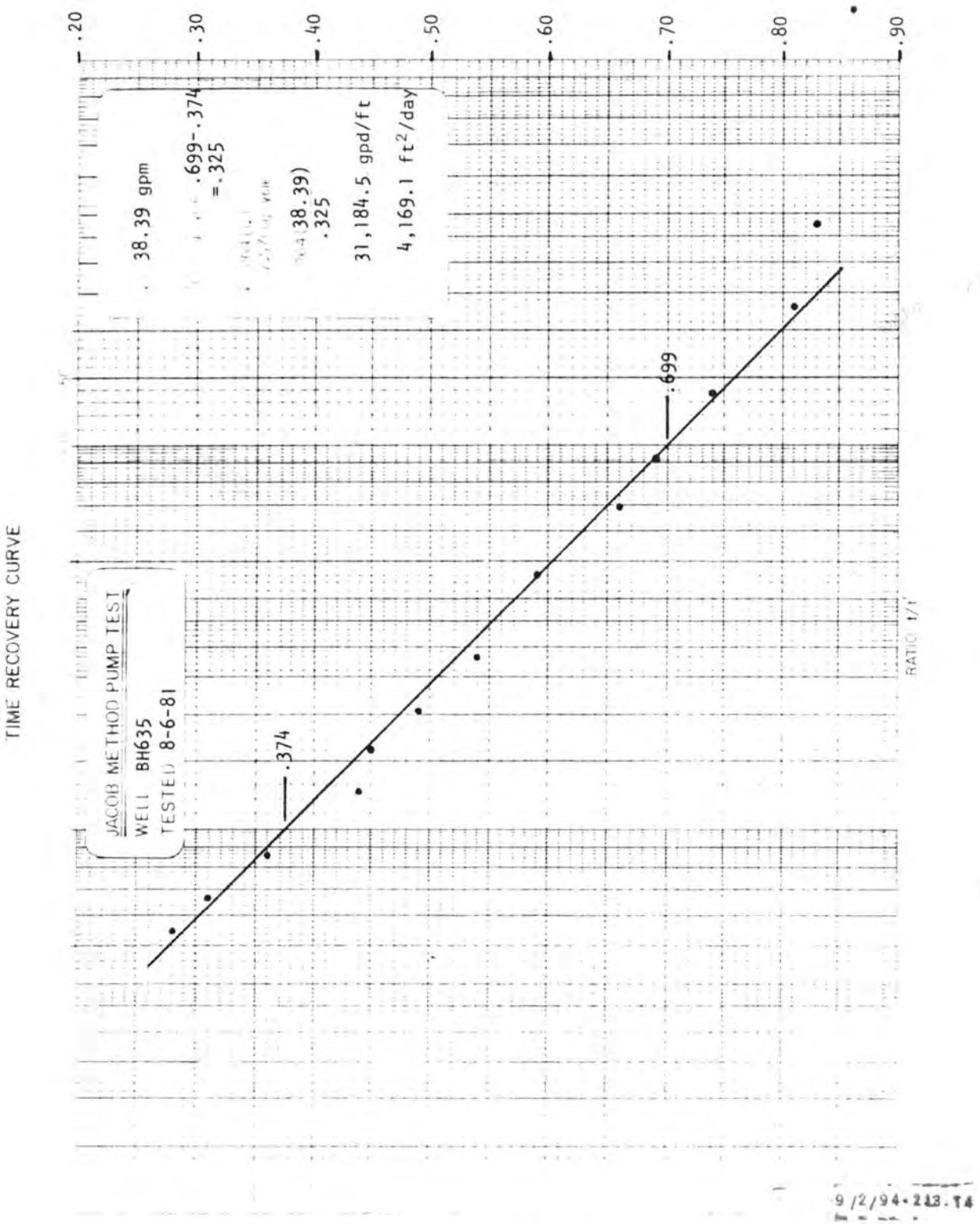


LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT
D11-455
TFN 6 2/025
RECD 10-25-13

DEQ Ex. 3-1750



D11-456

DEQ Ex. 3-1751

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., Sec. WELL NO. 634
Personnel Bondar-Jones-Tittle Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well
Well Owner BHC 5. Other (Specify)
ss Sheridan, WY Driller D. Fudge
...od drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven B. Bored or augered H. Hyd-rotary R. Rev-rotary W. Drive-wash C. Cable-tool J. Jetted T. Trenching Z. Other
Total well depth 27 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC
Type of screen or perforation slotted Interval of screen or perforation 5' - 25'
Pump hp & type N/A Pump depth ft. Aquifer Alluvium
Aquifer lithology sands and gravels Altitude of land surface 3568.3
How determined surveyed MP Above Below LSD Altitude MP
WL from MP 8.19 How measured E-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-6-81	0930	8.19	0			0
	1000	8.19	30			0
	1100	8.19	90			0
	1200	8.19	150			0
	1300	8.20	210			.01
	1400	8.20	270			.01
	1500	8.21	330			.02
	1600	8.21	390			.02
	1700	8.22	450			.03
	1800	8.23	510			.04
	1900	8.24	570			.05
	2000	8.25	630			.06
	2100	8.26	690			.07
	2200	8.27	750			.08
	2300	8.27	810			.08
	2400	8.28	870			.09
8-7-81	0100	8.29	930			.10
	0200	8.29	990			.10
	0300	8.30	1050			.11
	0400	8.31	1110			.12
	0500	8.32	1170			.13

MICRO

9/2/94-218-TH

LAND QUALITY DIVISION
RECEIVED DEC 28 1932
TFN 1 5/293 PERMIT

D11-457

TFN 6 2/525
RECD 10-25-13

State Wyoming County Sheridan T. 57 N. R. 84 E. Sec. WELL NO. 634

Personnel Bondar-Jones-Tittle

Well Owner BHC

Address Sheridan, WY

Test Type: 1. Single well drawdown 2. Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Driller D. Fudge

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 27 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slotted Interval of screen or perforation 5' - 25'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3568.3

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 8.19 How measured F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	0600	8.32	1230			.13
	0700	8.33	1290			.14
	0800	8.34	1350			.15

9/2/94-213.74

D11-458

RECD 10-25-18

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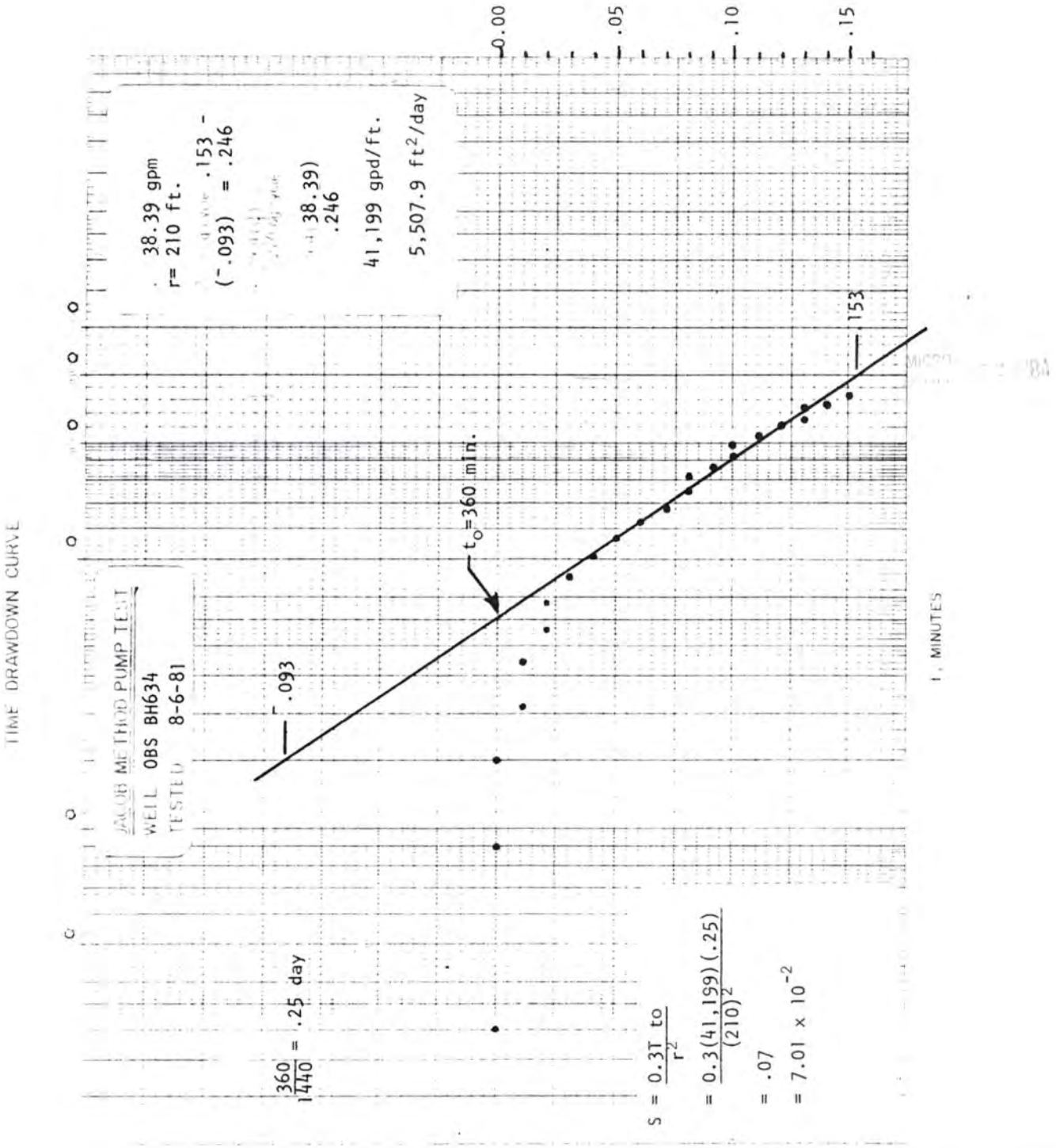

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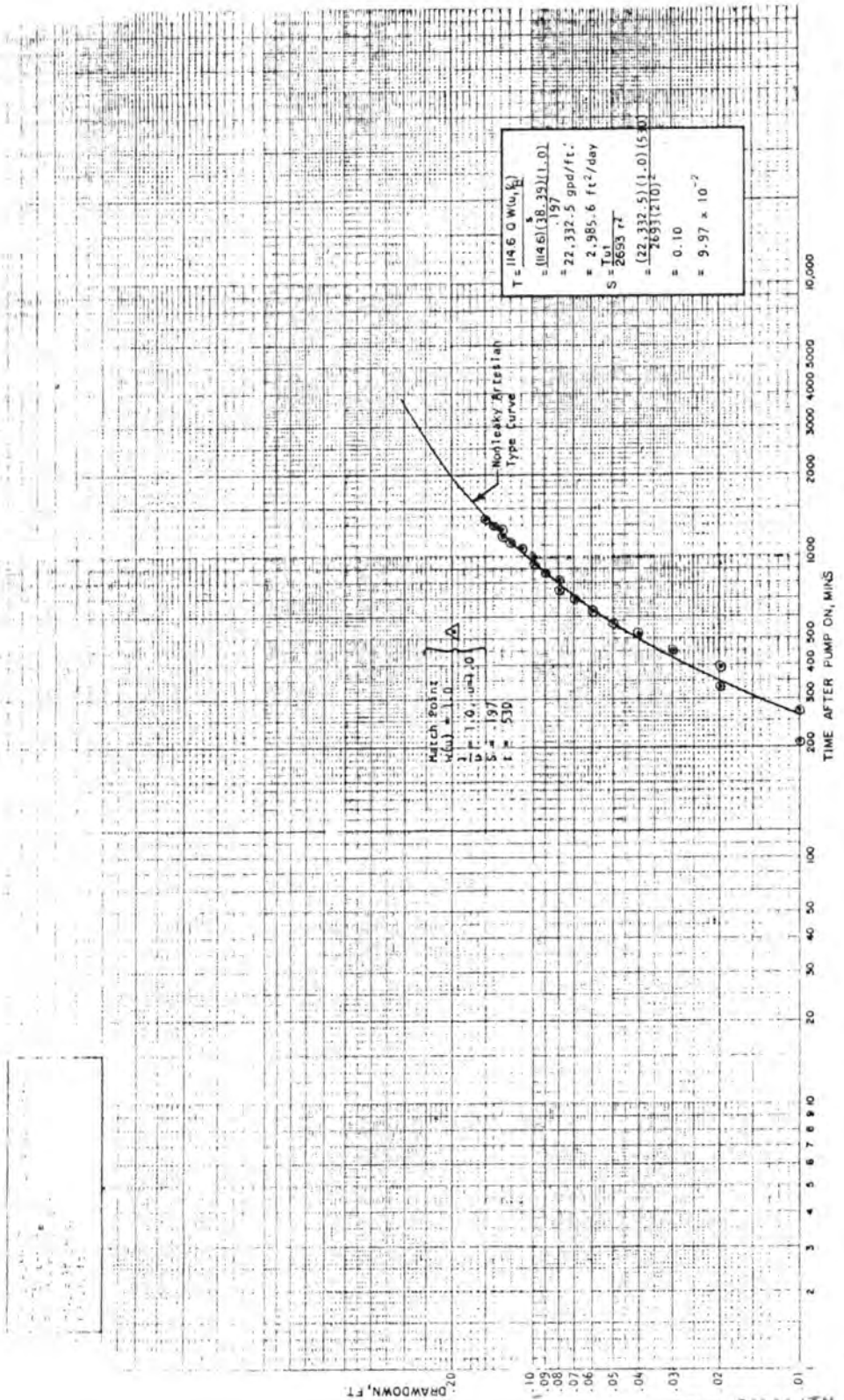
DEQ Ex. 3-1754

TFN 6 2/025
RECD 10-25-18



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LAND QUALITY DIVISION

RECEIVED DEC 28 1982

TFN I 5/293 PERMIT

218-72

TFN 6 2/025

RECD 10-25-18

D11-460

DEQ Ex. 3-1755

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 11 WELL NO. 639

Personnel Bondar Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY Driller R. Reed

iod drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 22 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 0' - 20'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3569.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.07 How measured galvanometer/steven's recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-4-81	1415	12.07				0
	1600	12.08	105			.01
	1700	12.10	165			.03
	1800	12.12	225			.05
	2000	12.15	345			.08
	2200	12.18	465			.11
	2400	12.21	585			.14
8-5-81	0200	12.24	705			.17
	0400	12.26	825			.19
	0600	12.28	945			.21
OFF	0743	12.30	1213			.23
	0930	12.30	1155	107	10.79	.23
	1100	12.28	1245	197	6.32	.21
	1200	12.27	1305	257	5.08	.20
	1300	12.26	1365	317	4.31	.19
	1400	12.25	1425	377	3.78	.18
	1500	12.24	1485	437	3.40	.17
	1700	12.23	1605	557	2.88	.16
	2100	12.21	1845	797	2.31	.14
8-6-81	0100	12.20	2085	1037	2.01	.13
	0500	12.19	2325	1277	1,82	.12

D11-461

TFN 6 2/025

REED 10-25-13

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 11 WELL NO. 639

Personnel Bondar-Jones-Tittle BHC

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner

ss Sheridan, WY Driller D. Fudge

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 22 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slotted Interval of screen or perforation 0 - 20'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3569.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.21 How measured F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-6-81	0930	12.21	0			0
	1000	12.21	30			0
	1100	12.21	90			0
	1200	12.21	150			0
	1300	12.22	210			.01
	1400	12.23	270			.02
	1500	12.24	330			.03
	1600	12.24	390			.03
	1700	12.25	450			.04
	1800	12.26	510			.05
	1900	12.27	570			.06
	2000	12.28	630			.07
	2100	12.28	690			.07
	2200	12.29	750			.08
	2300	12.30	810			.09
	2400	12.30	870			.09
8-7-81	0100	12.31	930			.10
	0200	12.32	990			.11
	0300	12.32	1050			.11
	0400	12.33	1110			.12
	0500	12.33	1170			.12

9/2/94-213.14

LAND QUALITY DIVISION
RECEIVED DEC 28 1982

D11-462

TFN 1 5/293 PERMIT

TFN 6 2/025

Scanned, 02/26/2020

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 11 WELL NO. 639

Personnel Bondar-Jones-Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner BHC

ess Sheridan

Driller D. Fudge

iod drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 22 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slotted Interval of screen or perforation 0 - 20'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3569.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.21 How measured E-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	0600	12.34	1230			.13
	0700	12.34	1290			.13
OFF	0800	12.35	1350			.14
8-7-81	0800	12.35	1350			.14
	0900	12.35	1410	60	23.50	.14
	1000	12.35	1470	120	12.25	.14
	1100	12.35	1530	180	8.50	.14
	1200	12.34	1590	240	6.63	.13
	1300	12.34	1650	300	5.50	.13
	1400	12.33	1710	360	4.75	.12
	1500	12.32	1770	420	4.21	.11
	1600	12.32	1830	480	3.81	.11
	1700	12.31	1890	540	3.50	.10
	1800	12.31	1950	600	3.25	.10
	1900	12.31	2010	660	3.05	.10
	2000	12.31	2070	720	2.88	.10
	2100	12.30	2130	780	2.73	.09
	2200	12.30	2190	840	2.61	.09
	2300	12.30	2250	900	2.50	.09
	2400	12.30	2310	960	2.41	.09
8-8-81	0100	12.29	2370	1020	2.32	.08

MICRO FILMED 12/2/94-21344

LAND QUALITY DIVISION

RECEIVED DEC 28 1982

D11-463

TFN 6 2/025

REC'D 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. R. 84 E. Sec. 11 WELL NO. 639

Personnel Bondar-Jones-Tittle Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner BHC

ss Sheridan, WY Driller D. Fudge

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 22 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slotted Interval of screen or perforation 0 - 20'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3569.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.21 How measured F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	0200	12.29	2430	1080	2.25	.08
	0300	12.29	2490	1140	2.18	.08
	0400	12.29	2550	1200	2.13	.08
	0500	12.29	2610	1260	2.07	.08
	0600	12.28	2670	1320	2.02	.07
	0700	12.28	2730	1380	1.98	.07
	0800	12.28	2790	1440	1.94	.07

9/2/94-213.14

LAND QUALITY DIVISION

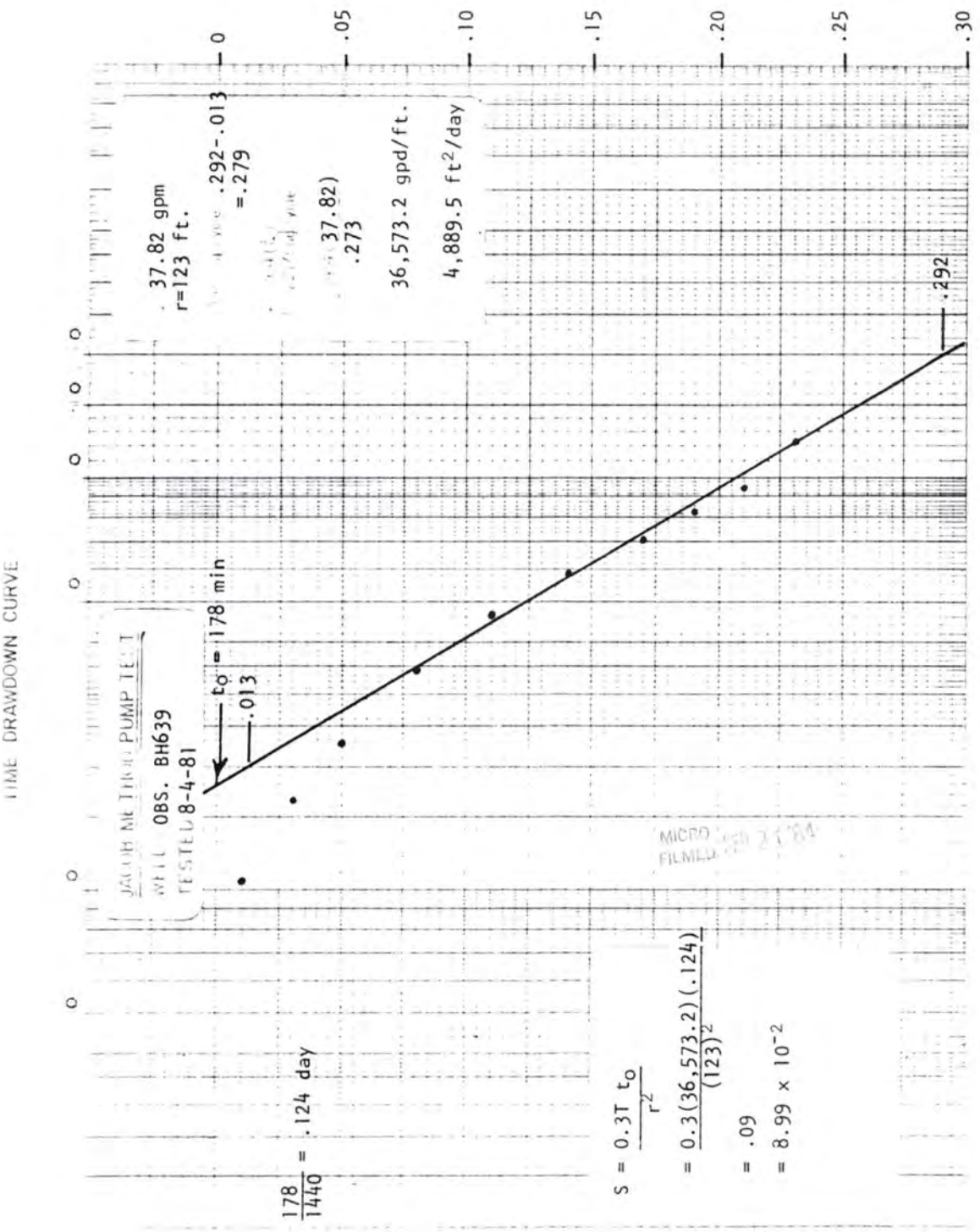
RECEIVED

D11-464

TFN 6 2/025

RECD 10-25-18

Scanned, 02/26/2020



MICRO FILMED

9/2/94 213-14

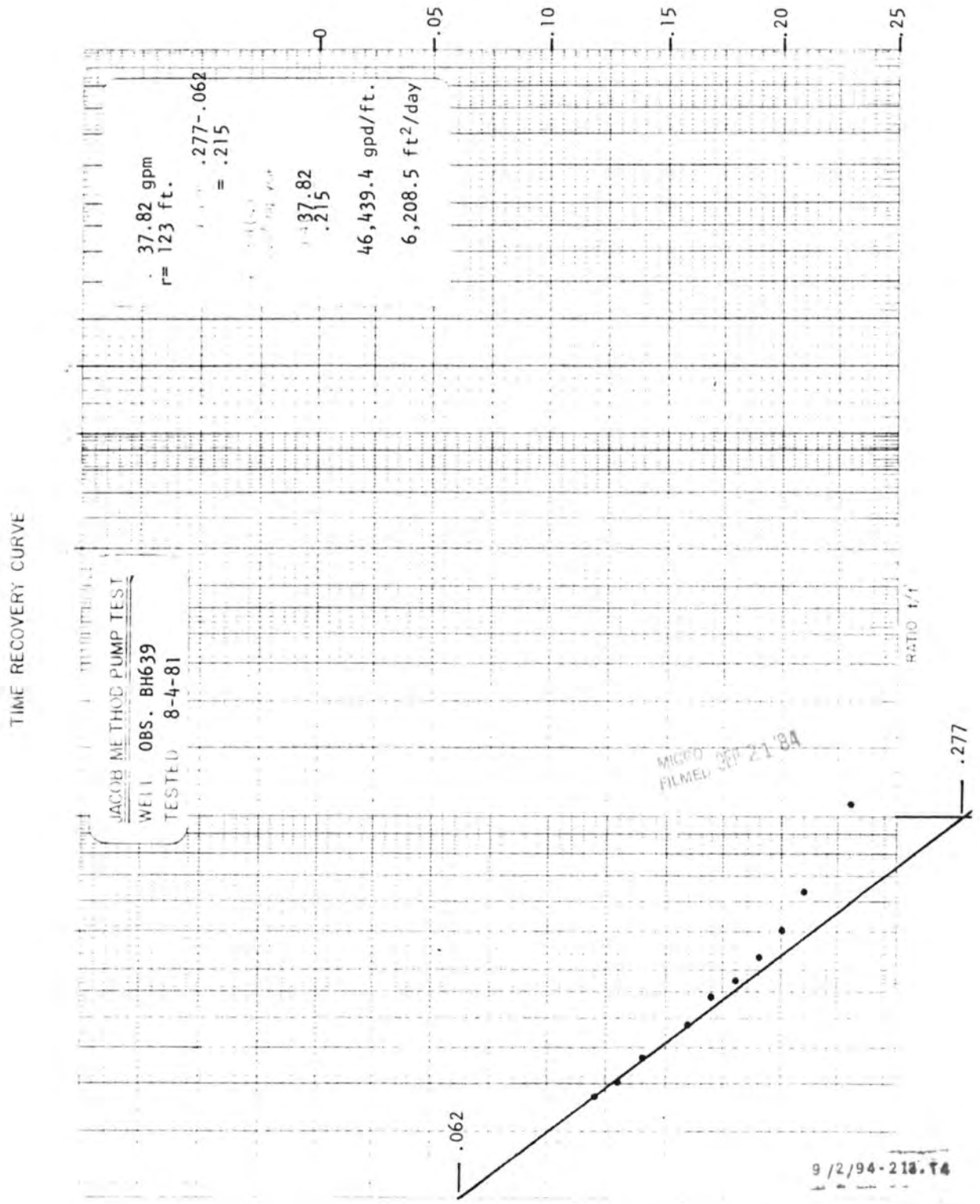
LAND QUALITY DIVISION
RECEIVED DEC. 28 1982
TFN 1 5/293 PERMIT 213-12

D11-465

7/31/85 213-13

TFN 6 2/025
RECD 10-25-18

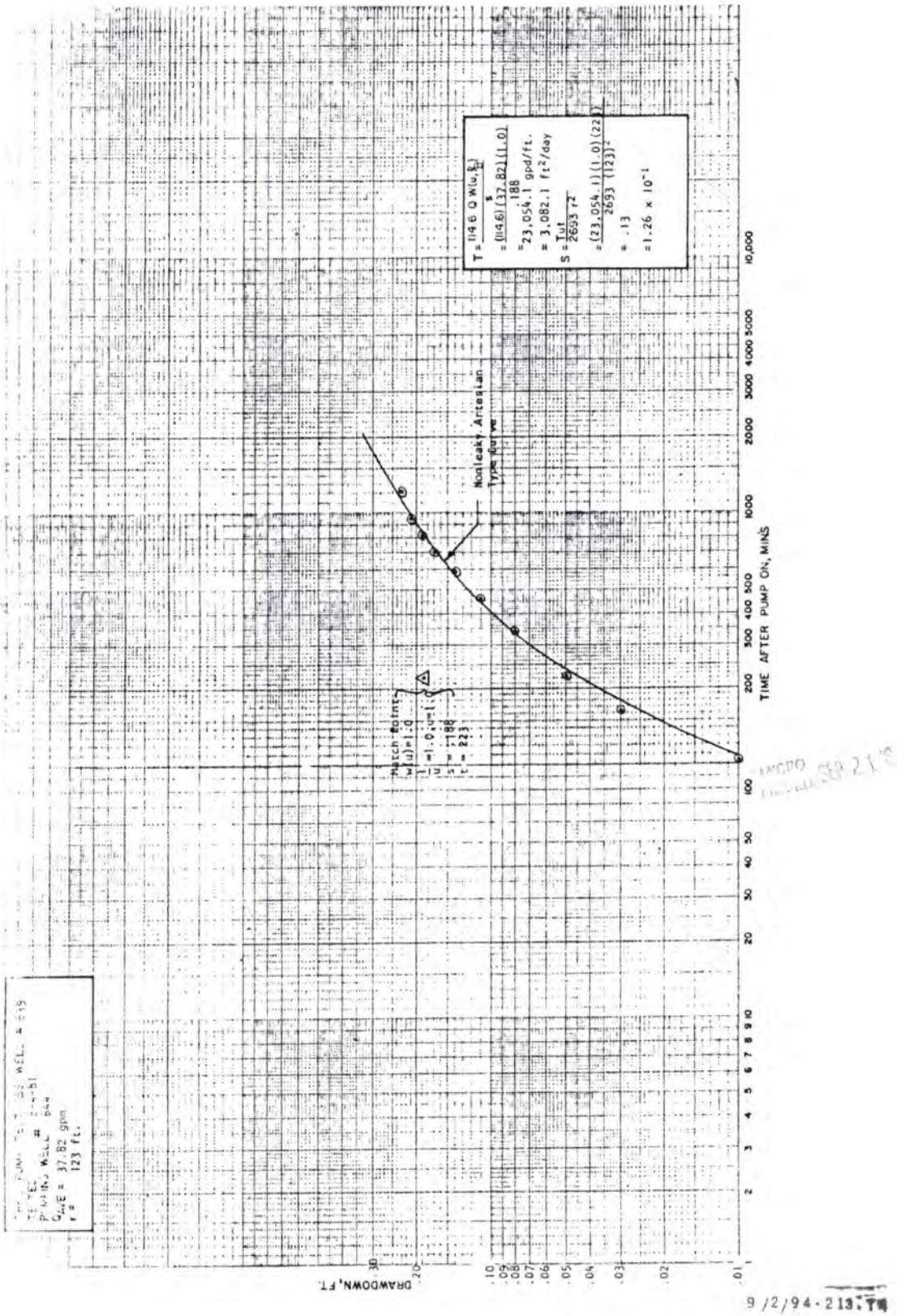
DEQ Ex. 3-1760



DEQ Ex. 3-1761

D11-466
TFN 6 2/025
RECD 10-25-10

Scanned, 02/26/2020

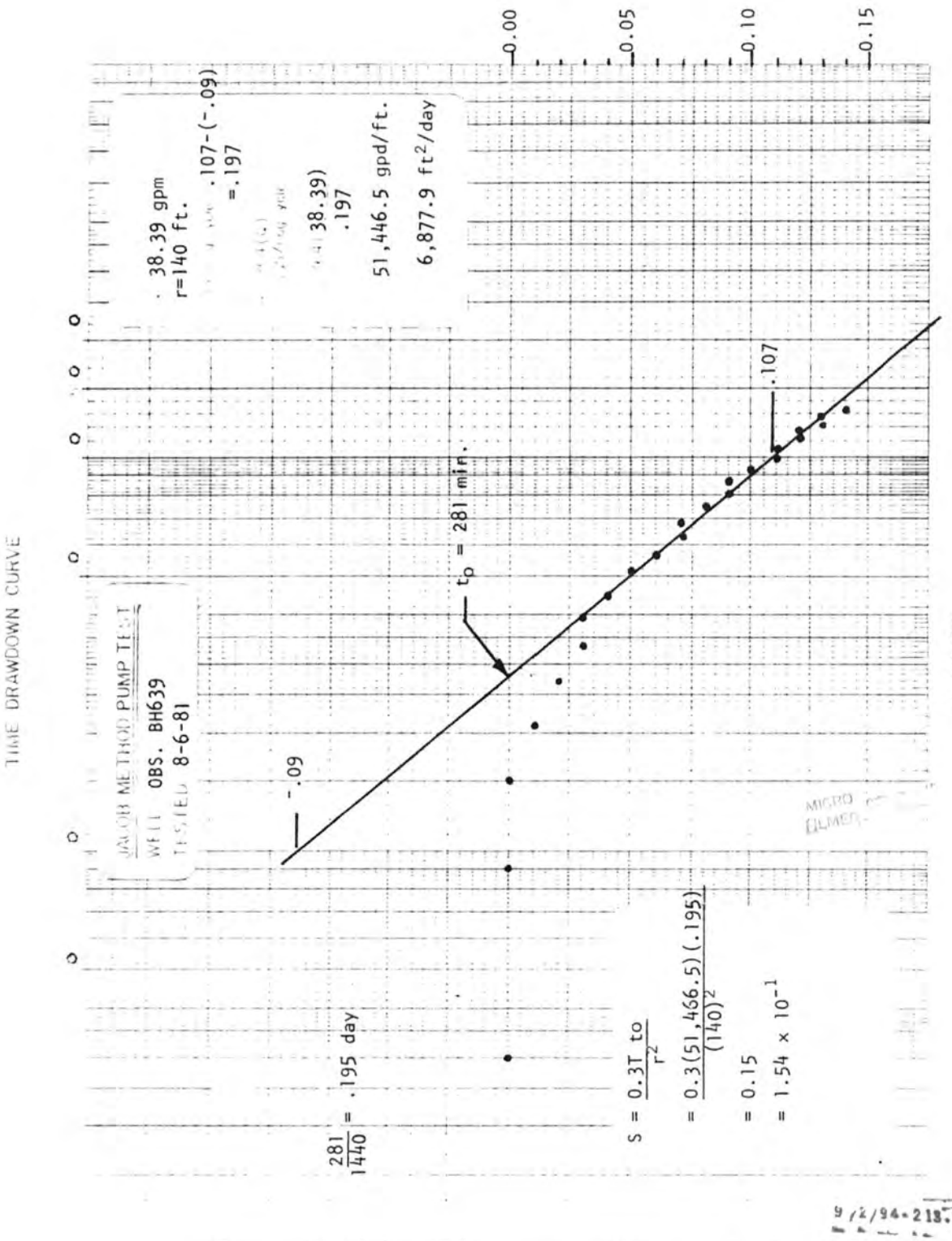


LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT

D11-467

TFR-8 2/025
RECD 10-25-18

DEQ Ex. 3-1762

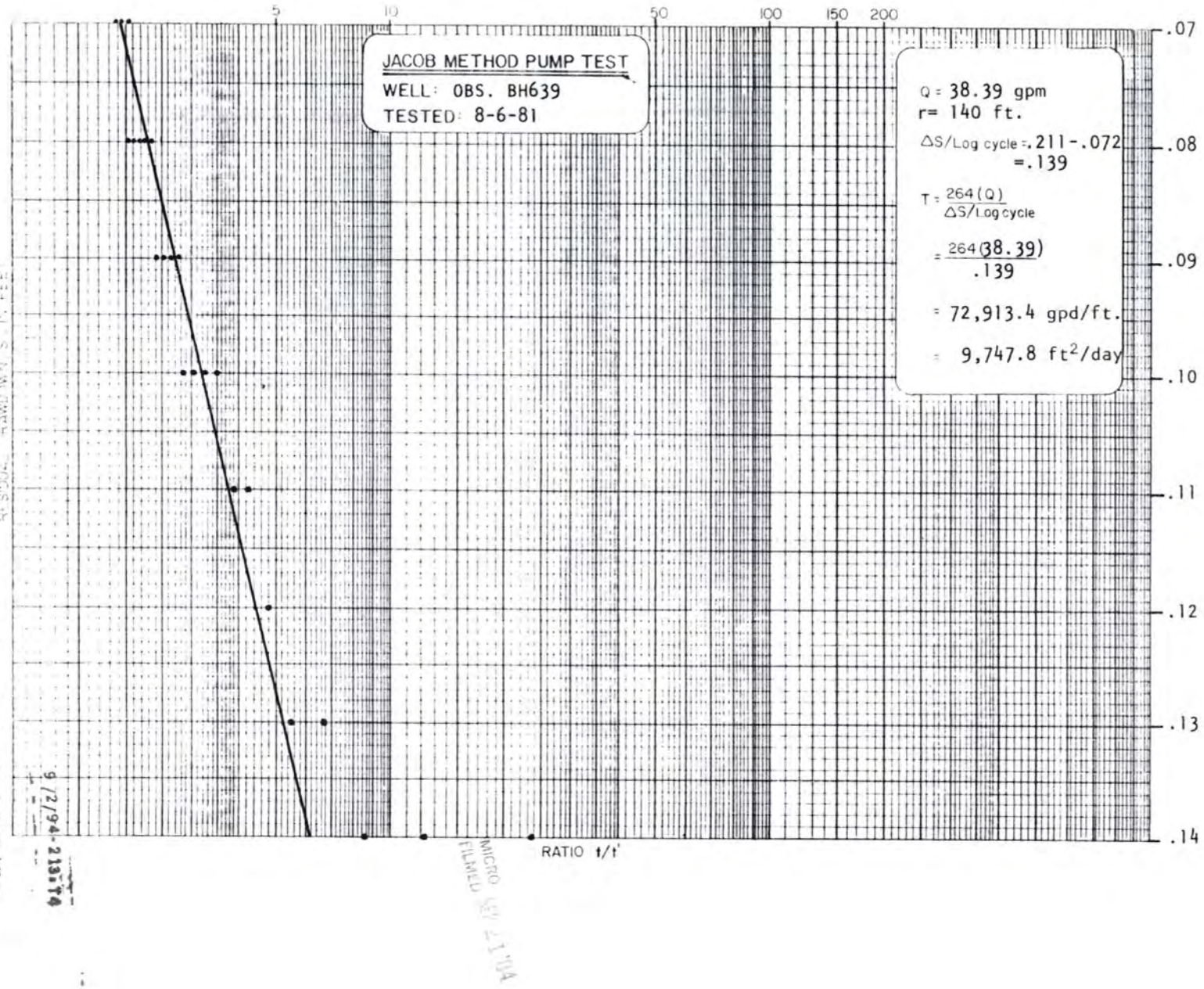


MICRO FILMED
9/2/94-218.T4
MINE QUALITY DIVISION
RECEIVED
TFN 2 5/203 PERMIT
7/31/89-218-T3
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1763

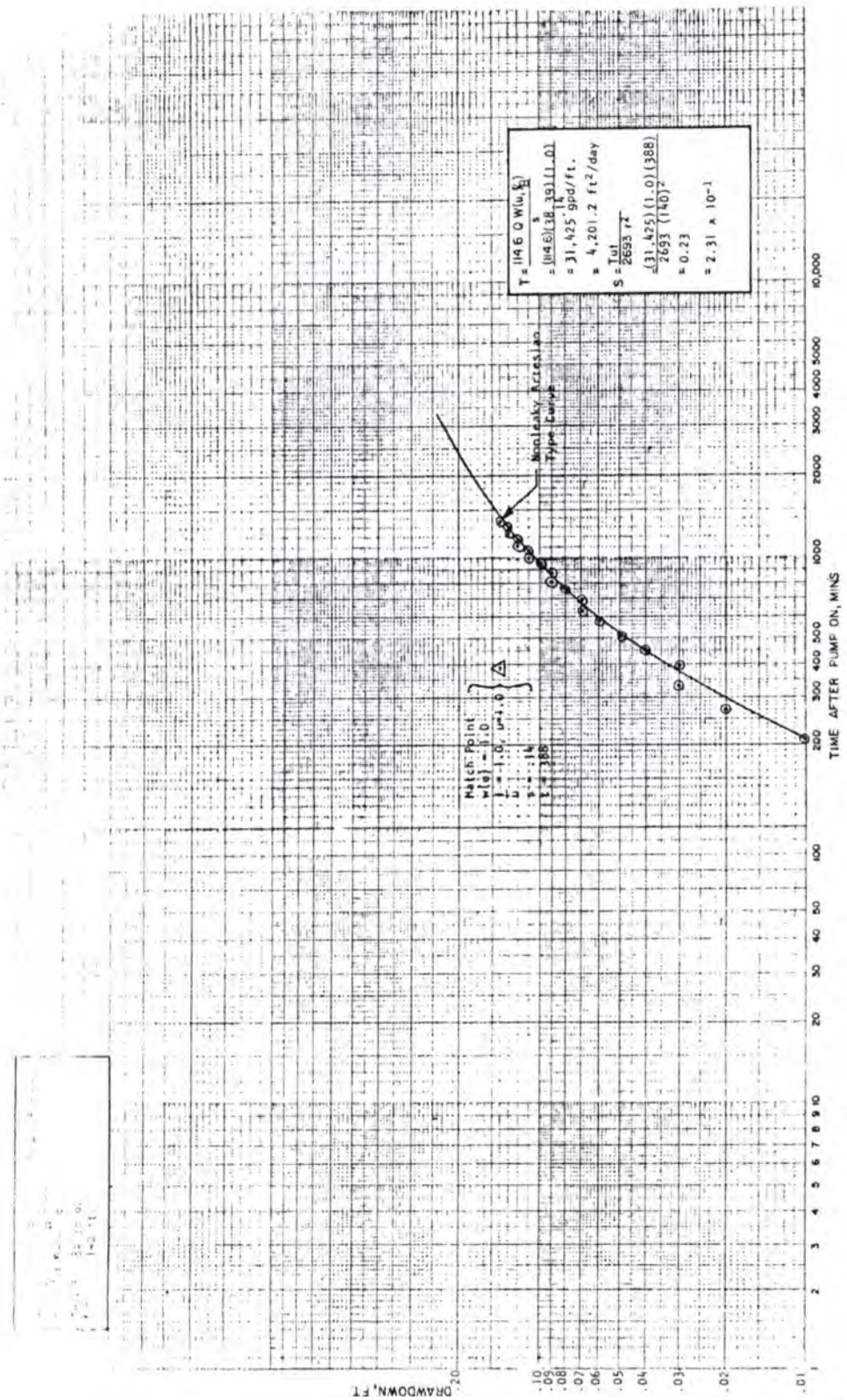
Scanned, 02/26/2020

TIME RECOVERY CURVE



SEE U.S. NAVIGABLE WATERS
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT
D11-469
MICRO FILMED SEP 2 1 '04
9/2/94-213:14
RECD 10-25-18

DEQ Ex. 3-1764



DEQ Ex. 3-1765

MICRO FILMED
9/2/94-21
LAND QUALITY
RECEIVED
213-T2
D11-470
TFN 6 2/025
RECD 10-25-18

Scanned, 02/26/2020

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. BH 640

Personnel D. Wolf Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ress Sheridan, WY Driller R. Reed

ethod drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 26 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 6' - 21'

Pump hp & type 2 hp Gould Pump depth 25 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3576.4

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 10.49 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7-24-81	0800	10.49	0			0
	0801	15.00	1			4.51
	0802	14.32	2			3.83
	0804	14.32	4			3.83
	0806	14.30	6			3.81
	0809	14.60	9			4.11
	0812	14.20	12			3.71
	0816	14.66	16			4.17
	0820	14.98	20			4.49
	0825	14.56	25			4.07
	0830	14.30	30			3.81
	0840	14.57	40			4.08
	0850	14.63	50			4.14
	0910	14.55	70			4.06
	0930	14.47	90			3.98
	1000	14.66	120			4.17
	1030	14.64	150			4.15
	1100	14.67	180			4.18
	1130	14.95	210			4.46
	1200	14.95	240			4.46
	1230	14.98	270			4.49

MICRO FILMED OCT 21 '84

9/2/94-21a.14

D11-471

TFN 6 2/025

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. BH 640

Personnel D. Wolf Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well

Well Owner PKS 5. Other (Specify)

'ress Sheridan, WY Driller R. Reed

chod drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 26 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 6' - 21'

Pump hp & type 2hp Gould Pump depth 25 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3576.4

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 10.49 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1300	15.03	300			4.54
OFF	1315		315	0		
	1316	10.90	316	1	316.0	0.41
	1317	10.88	317	2	158.5	0.39
	1318	10.94	318	3	106.0	0.45
	1320	10.94	320	5	64.0	0.45
	1325	10.92	325	10	32.5	0.43
	1330	10.89	330	15	22.0	0.40
	1345	10.84	345	30	11.5	0.35
	1400	10.80	360	60	6.0	0.31
	1430	10.76	390	90	4.3	0.27
	1500	10.74	420	120	3.5	0.25

MICRO FILMED

9/2/94-213-T4

LAND QUALITY DIVISION

RECEIVED DEC 29 1982

D11-472

TFN 6 2/025 5/293 PERMIT

DEQD 10-25-18

Scanned, 02/26/2020

WATER WELL BH 640

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	TEST DURATIONS PER MIN.	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7-24-81	0800	8.0	39.75	5.3	1	39.75
	0801	8.0	39.75	5.3	3	119.25
	0804	8.0	39.75	5.3	12	516.75
	0816	9.0	35.33	5.3	14	494.62
	0830	8.5	37.41	5.3	10	374.10
	0840	8.0	39.75	5.3	30	1192.50
	0910	8.0	39.75	5.3	20	795.00
	0930	8.0	39.75	5.3	30	1192.50
	1000	8.0	39.75	5.3	60	2385.00
	1200	8.0	39.75	5.3	60	2385.00
	1300	8.0	39.75	5.3	15	596.25
OFF	1315					
				TOTALS	255	10,090.72
			$\bar{Q} = \frac{10,090.72}{255} =$	39.57 gpm		
			Specfic Capacity =	$\frac{39.57 \text{ gpm}}{4.54 \text{ ft.}} = 8.72$ gpm/ft.		

MICRO FILMED SEP 21 '84

9/2/94-213.T4

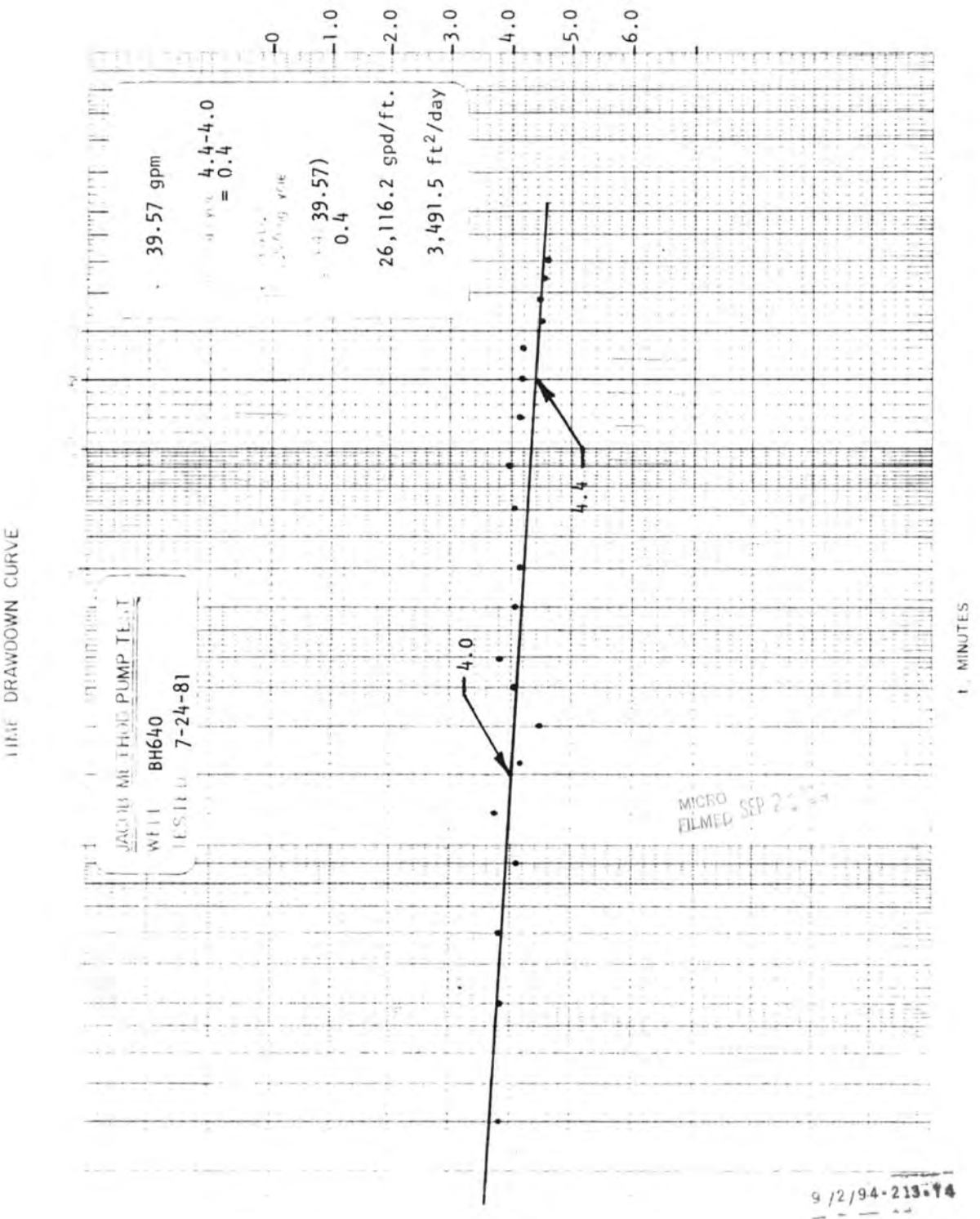
LAND QUALITY DIVISION

D11-473

7/31/89 213.T3

TFR & 2/025

TFR 1 5/2.05 PERMIT



TIME DRAWDOWN CURVE

9/2/94-213-14

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT

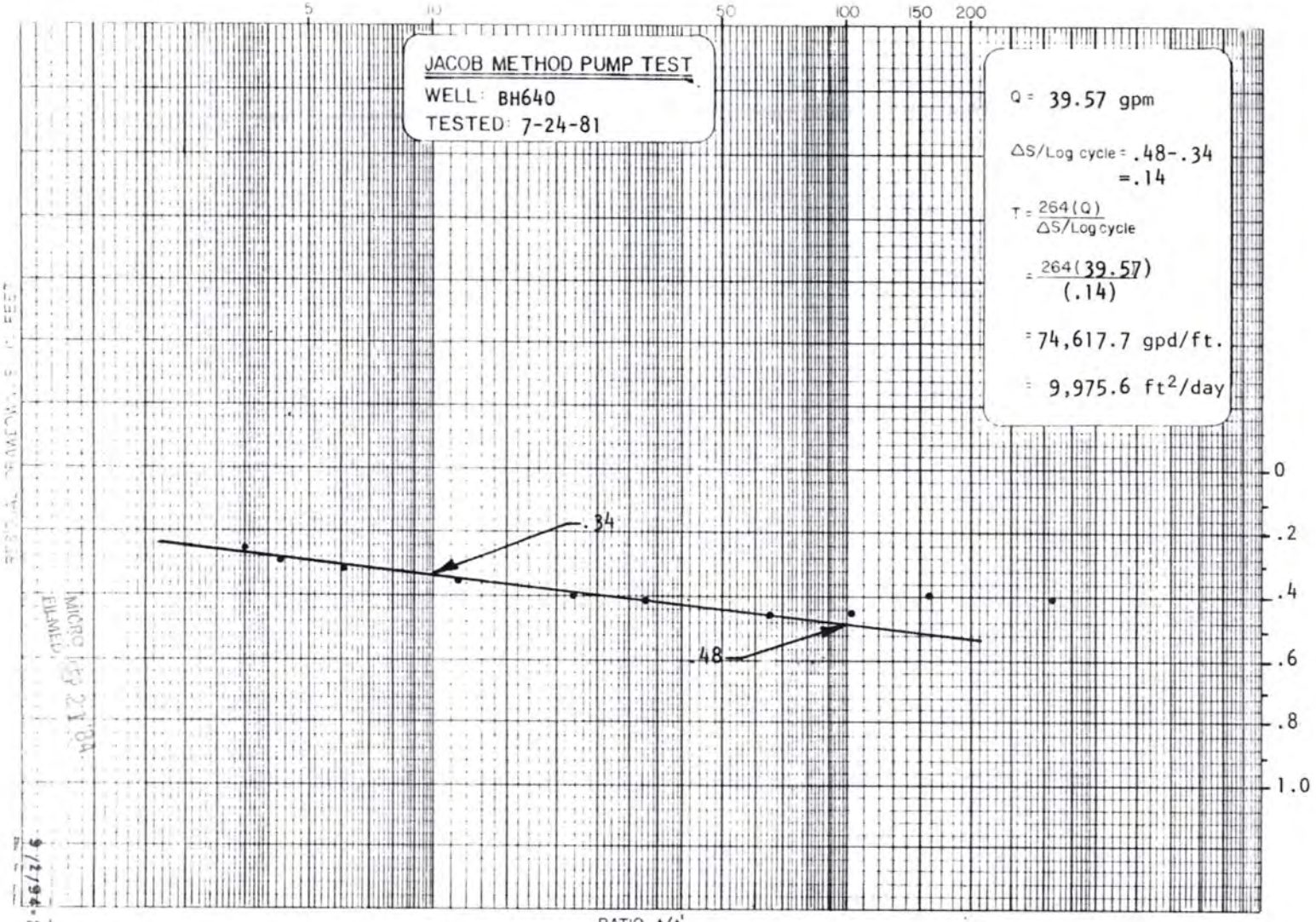
D11-474

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1769

Scanned, 02/26/2020

TIME RECOVERY CURVE



D11-475
TFN 6 2/025
RECD 10-25-13
9/1/94 213.14
LAND QUALITY DIVISION
TFN 6 2/025 213.72

DEQ Ex. 3-1770

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 11 WELL NO. 644

Personnel Bondar and Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY

Driller R. Reed

...od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 16.5 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 5' - 15'

Pump hp & type 3hp Gould Pump depth 15.0 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3566.2

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 8.23 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-4-81	1415	8.23				0
	1416	10.05	1			1.82
	1418	10.16	3			1.93
	1421	10.31	6			2.08
	1425	10.37	10			2.14
	1430	10.48	15			2.25
	1440	10.63	25			2.40
	1450	10.71	35			2.48
	1500	10.91	45			2.68
	1520	11.12	65			2.89
	1540	11.25	85			3.02
	1600	11.58	105			3.35
	1630	11.94	135			3.71
	1700	12.66	165			4.43
	1800	14.00	225			4.77
	1900	13.30	285			5.07
	2000	13.22	345			4.99
	2100	13.20	405			4.97
	2200	13.30	465			5.07
	2300	13.30	525			5.07
	2400	13.35	585			5.12

MICRO FILMED DEC 21 84
9/2/94.213.TA
LAND QUALITY DIVISION
RECEIVED DEC 28 1984
TFN 1 57293 PERMIT
TFN 6 2/025
RECD 10-25-18

D11-476

Scanned, 02/26/2020

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., Sec. 11 WELL NO. 644

Personnel Bondar and Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY

Driller R. Reed

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 16.5 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 5' - 15'

Pump hp & type 3hp Gould Pump depth 15.0 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3566.2

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 8.23 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-5-81	0100	13.38	645			5.15
	0200	13.32	705			5.09
	0400	13.33	825			5.10
	0600	13.35	945			5.12
OFF	0743	13.35	1048			5.12
	0745	9.03	1050	2	525	0.80
	0747	8.92	1052	4	263	0.69
	0750	8.86	1055	7	150.71	0.63
	0755	8.80	1060	12	88.33	0.57
	0800	8.75	1065	17	62.65	0.52
	0810	8.70	1075	27	39.81	0.47
	0830	8.64	1095	47	23.30	0.41
	0900	8.56	1125	77	14.61	0.33
	0930	8.52	1155	107	10.79	0.29
	1000	8.50	1185	137	8.65	0.27
	1030	8.48	1215	167	7.28	0.25
	1100	8.48	1245	197	6.32	0.23
	1200	8.43	1305	257	5.08	0.20
	1245	8.42	1350	302	~~4.47~~	0.19

MICRO FILMED SEP 21 84

9/2/94-213.14

LAND QUALITY DIVISION

D11-477

TFR 5 2/025

RECD 10-25-13

WATER WELL 644

PUMPING RATE DATA

DATE	TIME TEST TAKEN	TEST DURATION SEC.	GALS. PER MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
8-4-81	1416	8.9	35.7	5.3	5	178.5
	1421	8.2	38.8	5.3	4	155.2
	1425	8.3	38.3	5.3	5	191.5
	1440	8.2	38.8	5.3	15	582.0
	1500	8.2	38.8	5.3	20	776.0
	1520	8.2	38.8	5.3	20	776.0
	1540	8.2	38.8	5.3	20	776.0
	1600	8.2	38.8	5.3	30	1164.0
	1630	8.2	38.8	5.3	30	1164.0
	1700	8.5	37.4	5.3	60	2244.0
	1800	8.5	37.4	5.3	60	2244.0
	1900	8.2	38.8	5.3	60	2328.0
	2000	8.3	38.3	5.3	60	2298.0
	2100	8.5	37.4	5.3	60	2244.0
	2200	8.3	38.3	5.3	60	2298.0
	2300	8.3	38.3	5.3	60	2298.0
	2400	8.5	37.4	5.3	60	2244.0
8-5-81	0100	8.5	37.4	5.3	60	2244.0
	0200	8.5	37.4	5.3	120	4488.0
	0400	8.5	37.4	5.3	120	4488.0
	0600	8.5	37.4	5.3	103	3852.2
				TOTALS	1032	39033.4

$\overline{Q} = \frac{39033.4}{1032}$ = 37.82 gpm

specific capacity = $\frac{37.82 \text{ gpm}}{5.15 \text{ ft}}$ = 7.34 gpm/ft

MICRO FILMED SEP 21 '82

LAND QUALITY DIVISION

RECEIVED DEC 20 1982

D11-478

TFN 1 5/293 PERMIT

TFN 6 2/025

REC'D 10-25-18

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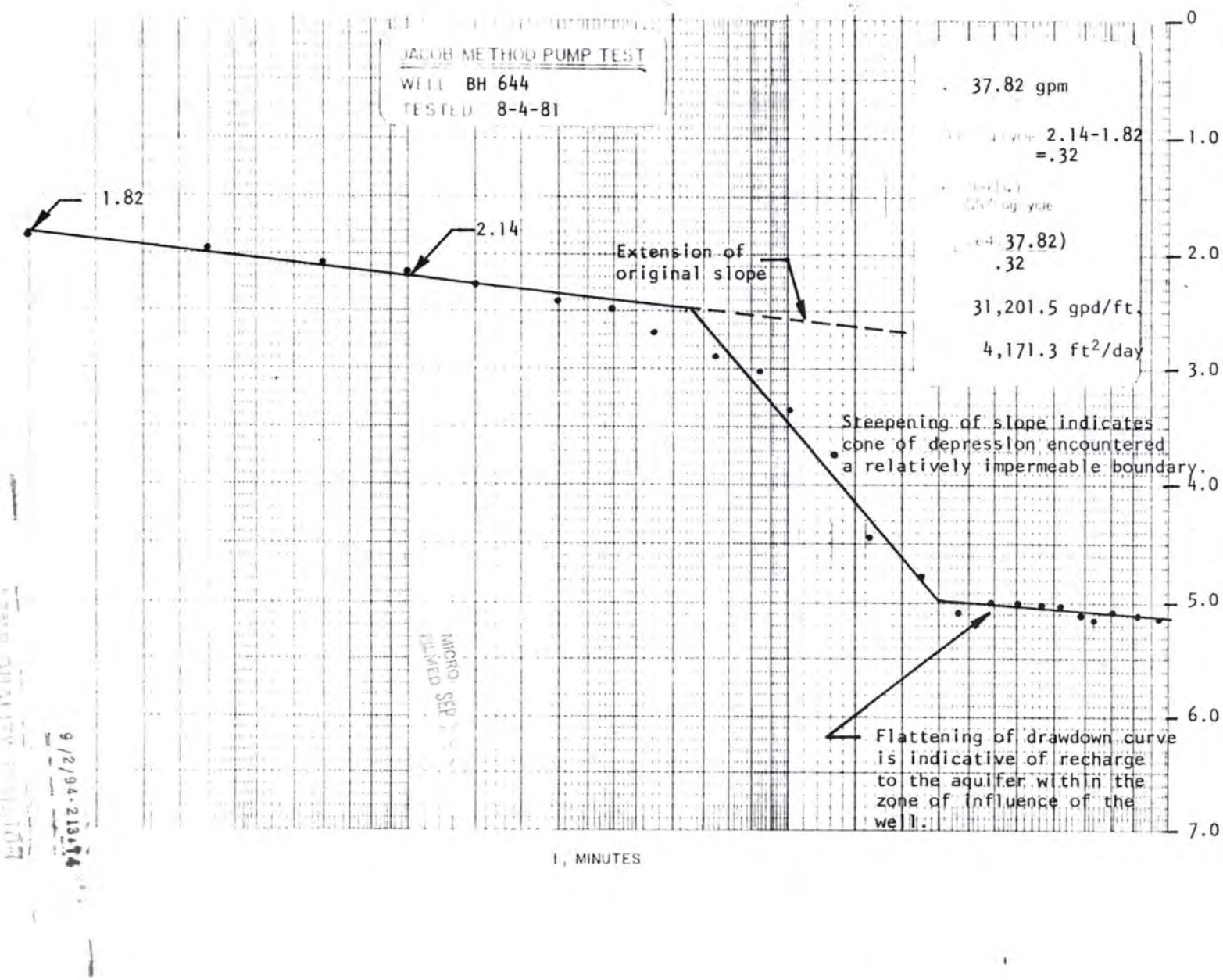
TIME DRAWDOWN CURVE



MICROFILMED SEP

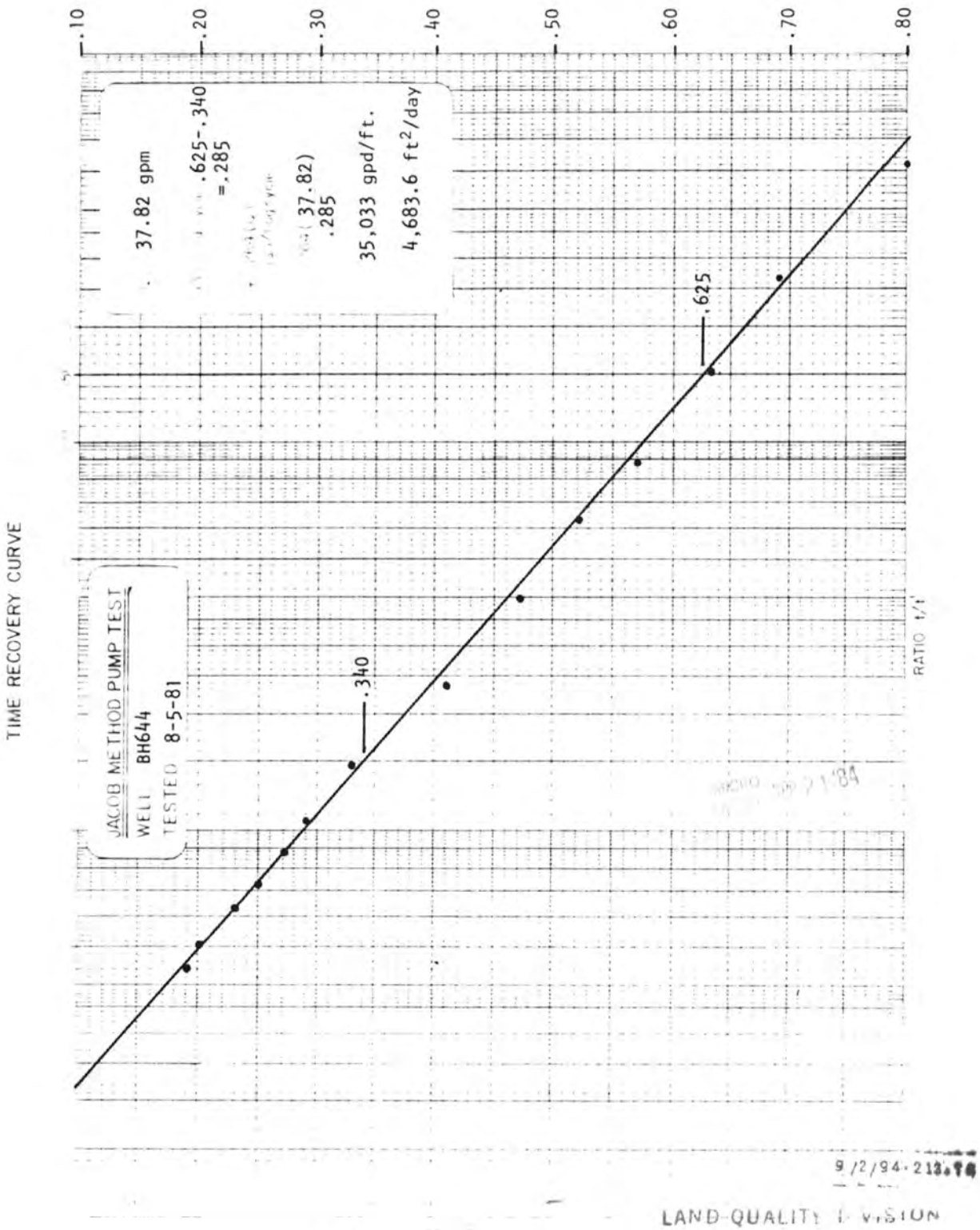
9/2/94-213-14

TFN 6 2/025

RECD 10-25-18

D11-479

DEQ Ex. 3-1774


.10
.20
.30
.40
.50
.60
.70
.80
37.82 gpm
.625-.340
=.285
(37.82)
.285
35,033 gpd/ft.
4,683.6 ft²/day
.625
.340
JACOB METHOD PUMP TEST
WELL BH644
TESTED 8-5-81
TIME RECOVERY CURVE
RATIO t/t'
9/2/94-213.16
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT
D11-480
TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1775

Scanned, 02/26/2020

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. R. 84 E. Sec. 11 WELL NO. 636
Personnel Bondar, Tittle
Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)
Well Owner PKS
ss Sheridan, WY Driller R. Reed
d drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other
Total well depth 18 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC
Type of screen or perforation saw slots Interval of screen or perforation 0' - 18'
Pump hp & type N/A Pump depth ft. Aquifer Alluvium
Aquifer lithology sands and gravels Altitude of land surface 3565.4
How determined surveyed MP Above Below LSD Altitude MP
WL from MP 8.84 How measured galvanometer/Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-4-81	1415	8.84	0			0
	1430	8.86	15			.02
	1445	8.88	30			.04
	1500	8.89	45			.05
	1530	8.90	75			.06
	1600	8.92	105			.08
	1700	8.94	165			.10
	1800	8.96	225			.12
	2000	8.99	345			.15
	2200	9.03	465			.19
	2400	9.05	585			.21
8-5-81	0200	9.07	705			.23
	0400	9.08	825			.24
	0600	9.09	945			.25
OFF	0743	9.10	1048			.26
	0800	9.09	1065	17	62.65	.25
	0830	9.08	1095	47	23.30	.24
	0934	9.07	1159	111	10.44	.23
	1000	9.06	1185	137	8.65	.22
	1100	9.05	1245	197	6.32	.21
	1200	9.04	1305	257	5.08	.20

MICRO FILMED SEP 21 '84
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT 218-72
D11-481
TFN 6 2/025
DEQD 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 11 WELL NO. 636

Personnel Bondar, Tittle Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY Driller R. Reed

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 18 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 0' - 18'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3565.4

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 8.84 How measured galvanometer/Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1300	9.04	1365	317	4.31	.20
	1400	9.03	1425	377	3.78	.19
	1500	9.02	1485	437	3.40	.18
	1700	9.01	1605	557	2.88	.17
	1900	9.00	1725	677	2.55	.16
	2300	8.98	1965	917	2.14	.14
8-6-81	0200	8.97	2145	1097	1.96	.13
	0500	8.96	2325	1277	1.82	.12
	0800	8.95	2505	1457	1.72	.11

MICRO FILMED

9/2/94-213,14

LAND QUALITY DIVISION

RECEIVED DEC. 28 1982

TFN 1 5/293 PERMIT

D11-482

TFN 6 2/025

RECD 10-25-18

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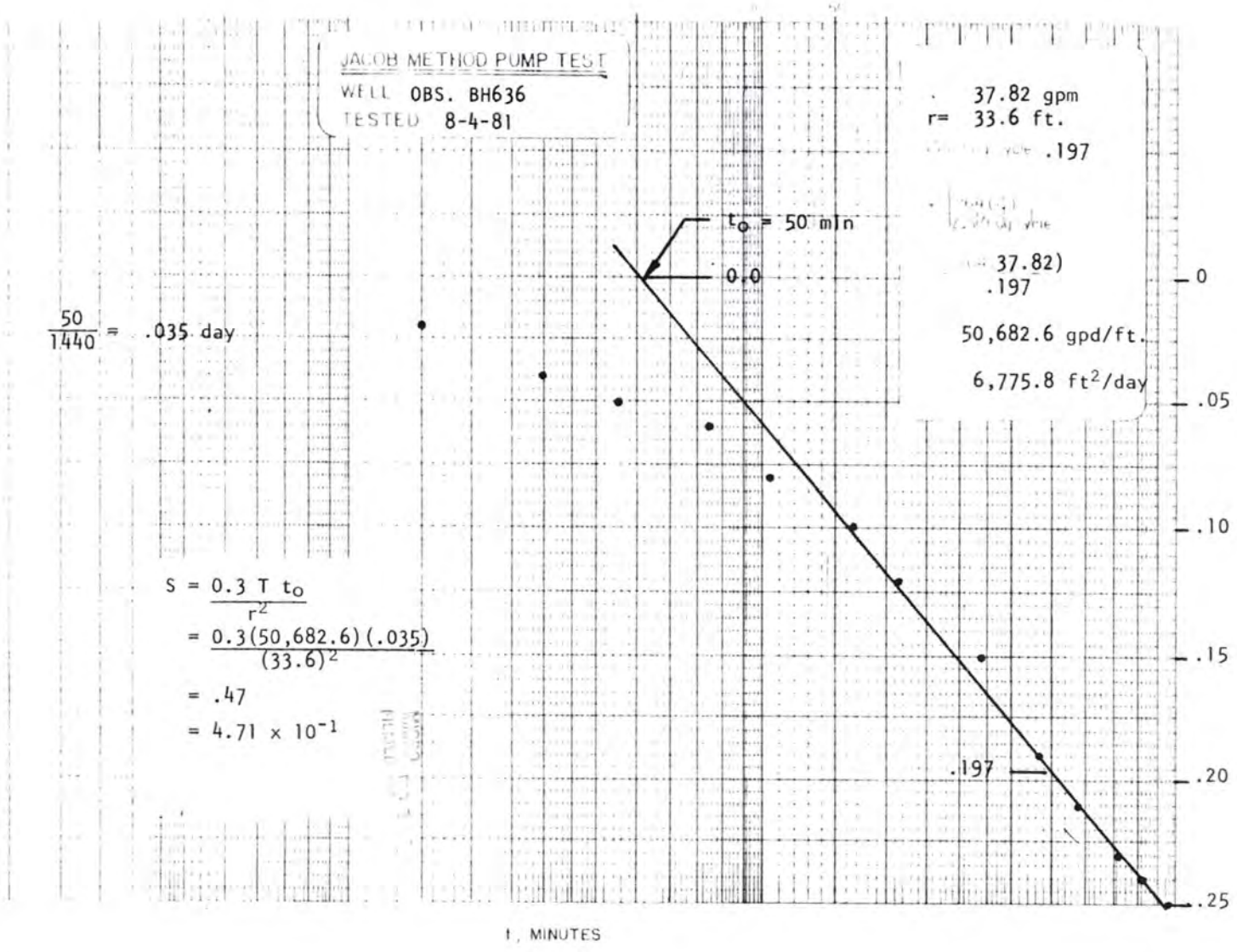
TIME DRAWDOWN CURVE

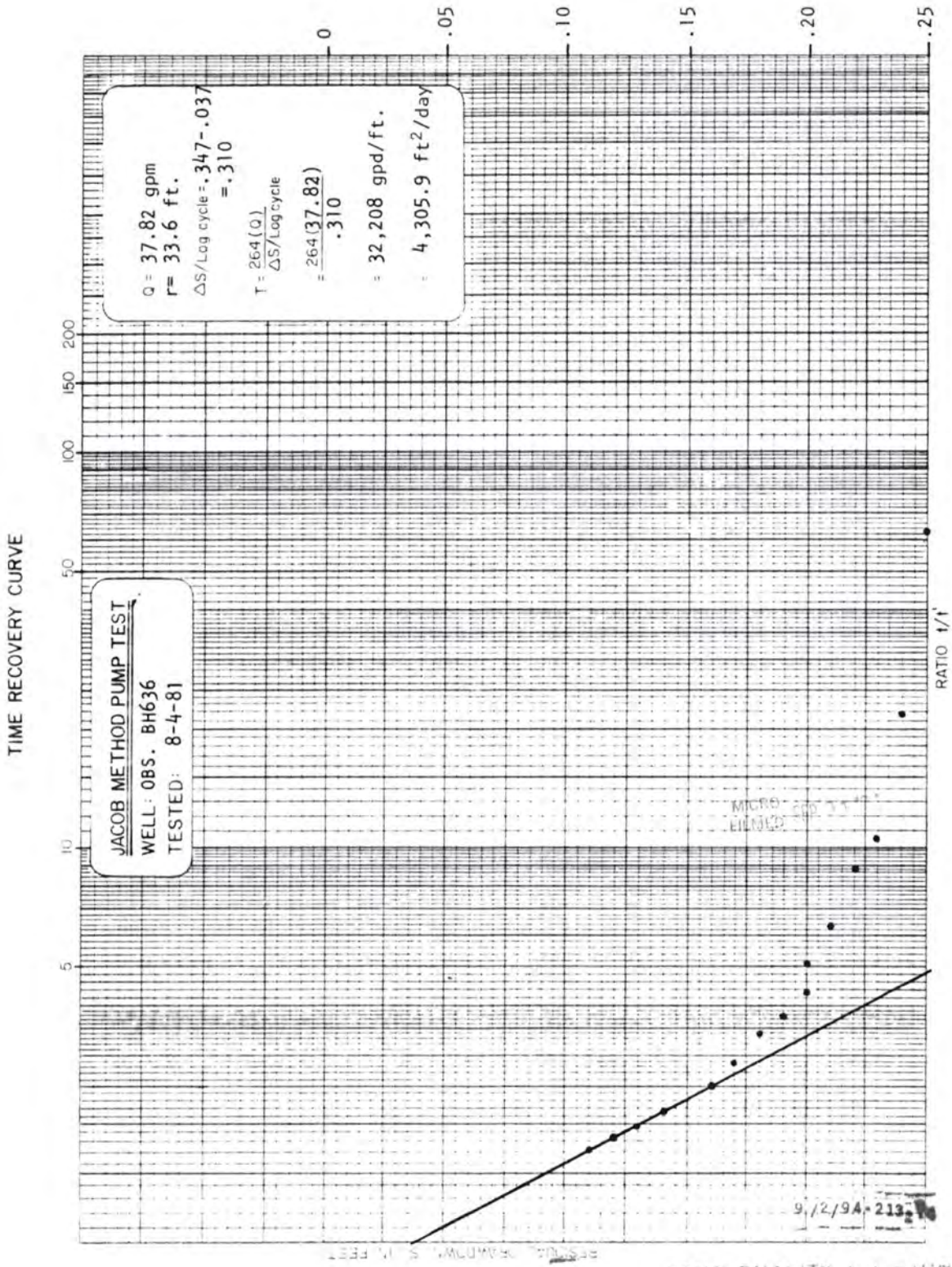


9/2/94 213714

RECEIVED SEP 28 1982
DEC 2/025
RECD 10-25-18

D11-483

DEQ Ex. 3-1778



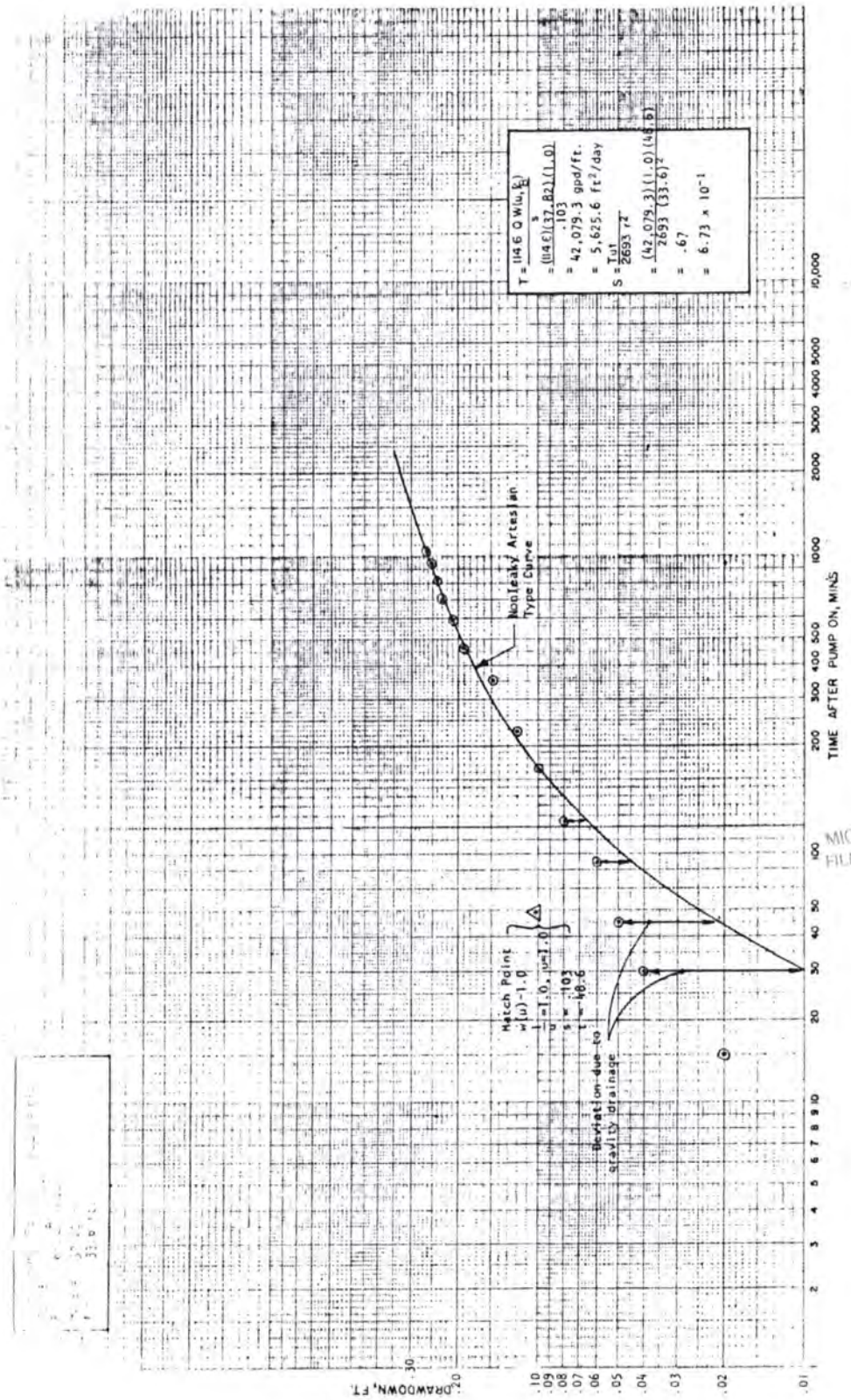
LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT

D11-484

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1779

Scanned, 02/26/2020



MICRO FILMED

9/2/94-213-F4

213-72

D11-485

TFN 6 2/025

RECD 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. R. 84 E. Sec. 11 WELL NO. 637

Personnel Bondar Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 18 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 0' - 18'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3565.9

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 6.64 How measured galvanometer/Steven's recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-4-81	1415	6.64	0			0
	1430	6.77	15			.13
	1445	6.83	30			.19
	1500	6.87	45			.23
	1530	6.92	75			.28
	1600	6.97	105			.33
	1700	7.03	165			.39
	1800	7.08	225			.44
	2000	7.15	345			.51
	2200	7.19	465			.55
	2400	7.23	585			.59
8-5-81	0200	7.26	705			.62
	0400	7.28	825			.64
	0600	7.30	945			.66
OFF	0743	7.32	1048			.68
	0800	7.20	1065	17	62.65	.56
	0815	7.14	1080	32	33.75	.50
	0830	7.10	1095	47	23.30	.46
	0900	7.05	1125	77	14.61	.41
	0933	7.00	1158	110	10.53	.36
	1000	6.98	1185	137	8.65	.34

MICRO FILMED SEP 21 '84

9/12/94 213.T

LAND QUALITY DIVISION

TFN 6 2/025

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 11 WELL NO. 637

Personnel Bondar Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan, WY Driller R. Reed

...hod drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 18 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 0' - 18'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3565.9

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 6.64 How measured galvanometer/Steven's recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1100	6.94	1245	197	6.32	.30
	1200	6.91	1305	257	5.08	.27
	1300	6.90	1365	317	4.31	.26
	1400	6.89	1425	377	3.78	.25
	1500	6.88	1485	437	3.40	.24
	1700	6.86	1605	557	2.88	.22
8-6-81	2000	6.84	1785	737	2.42	.20
	2400	6.82	2025	977	2.07	.18
	0400	6.80	2265	1217	1.86	.16
	0800	6.79	2505	1457	1.72	.15

MICRO FILMED SEP 21 '84

LAND ... RECEIVED ... 1982

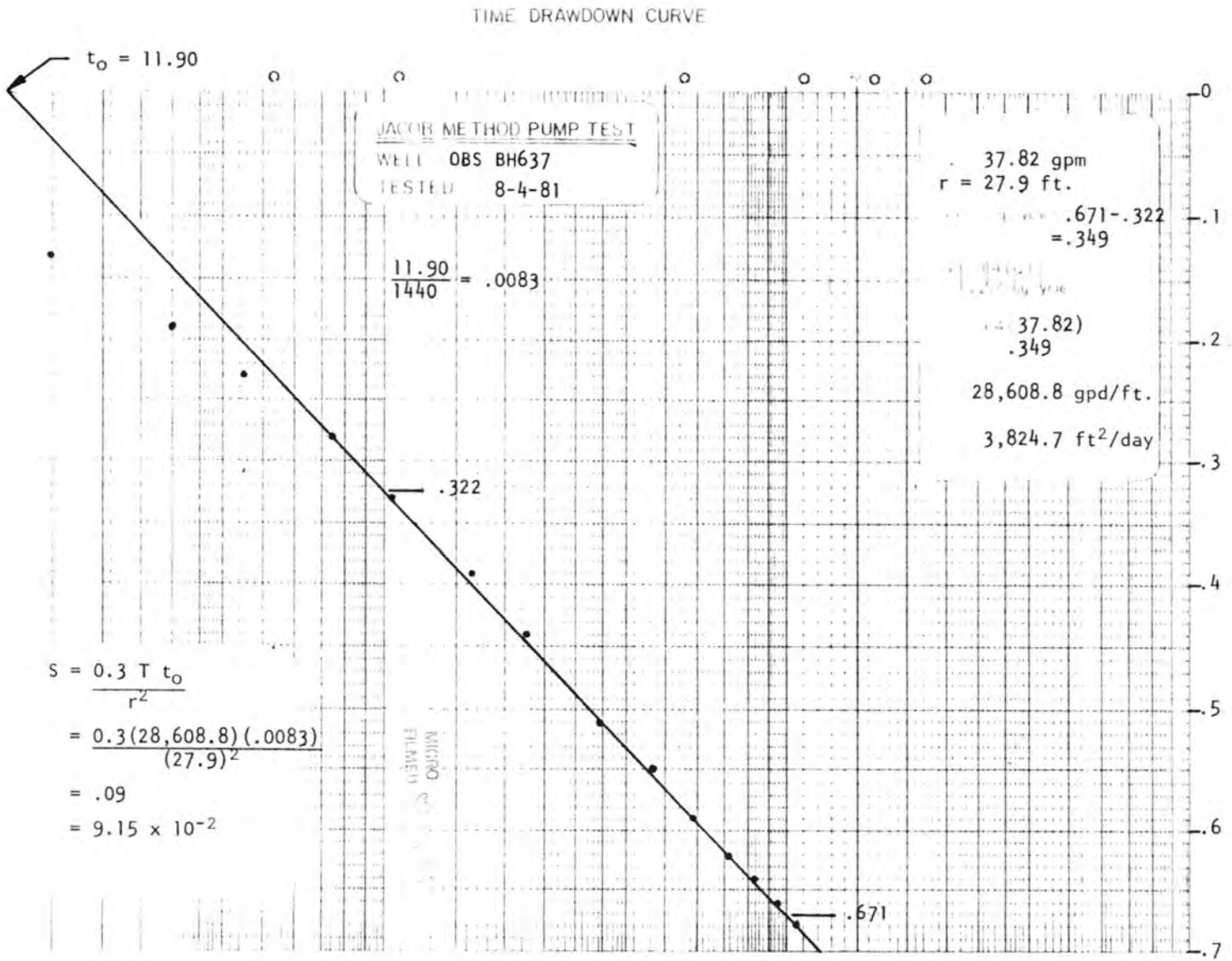
TFN 1 5/293 PERMIT

9/2/94-211.74

D11-487

TFN 6 27025

RECD 10-25-18

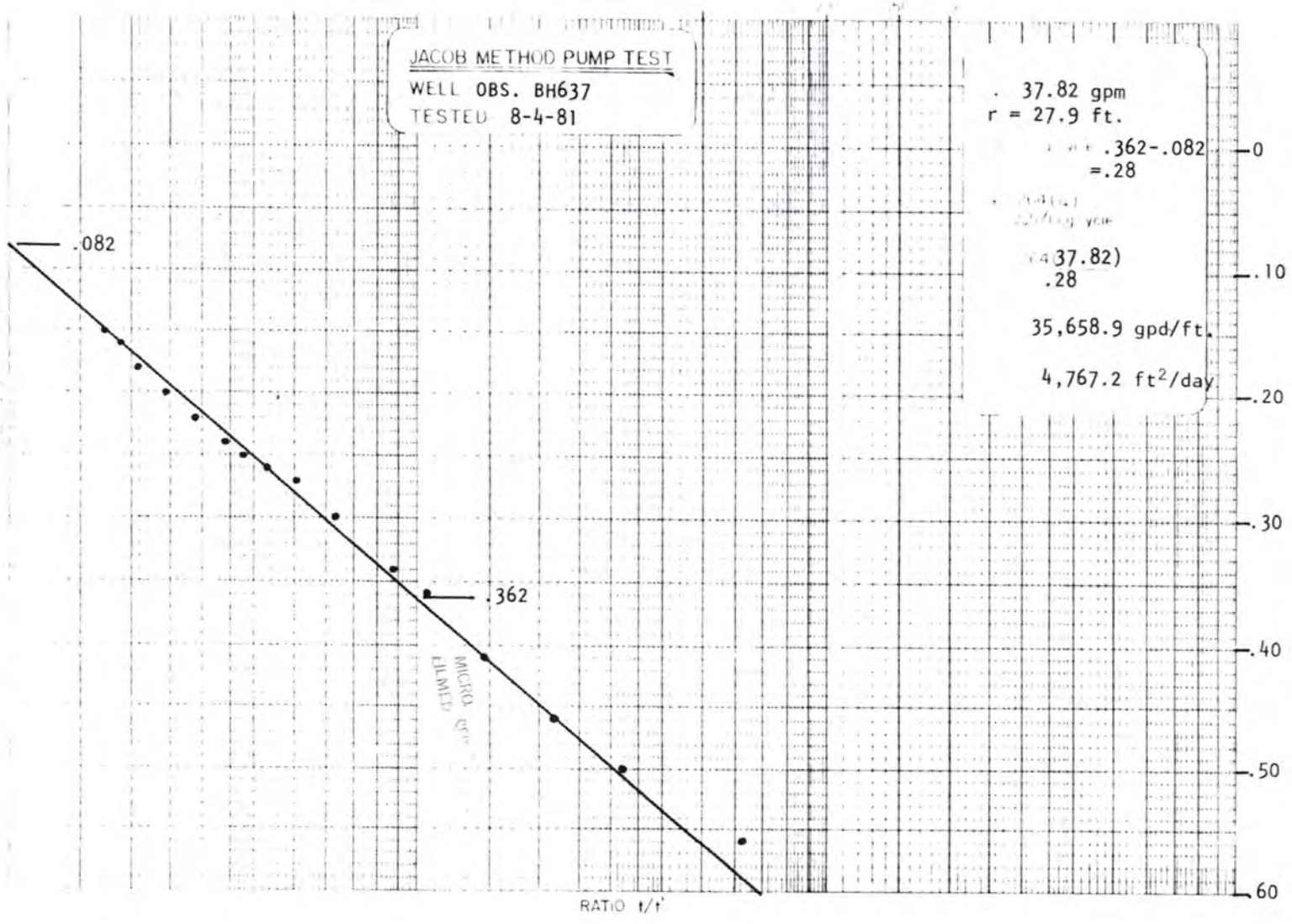


LAND QUALITY DIVISION
RECEIVED DEC 23 1982
D11-488
TFN 1 5/293 PERMIT
TFN 6 2/025
RECD 10-25-10
9/2/94-213.T4

DEQ Ex. 3-1783

Scanned, 02/26/2020

TIME RECOVERY CURVE



MICRO FILMED
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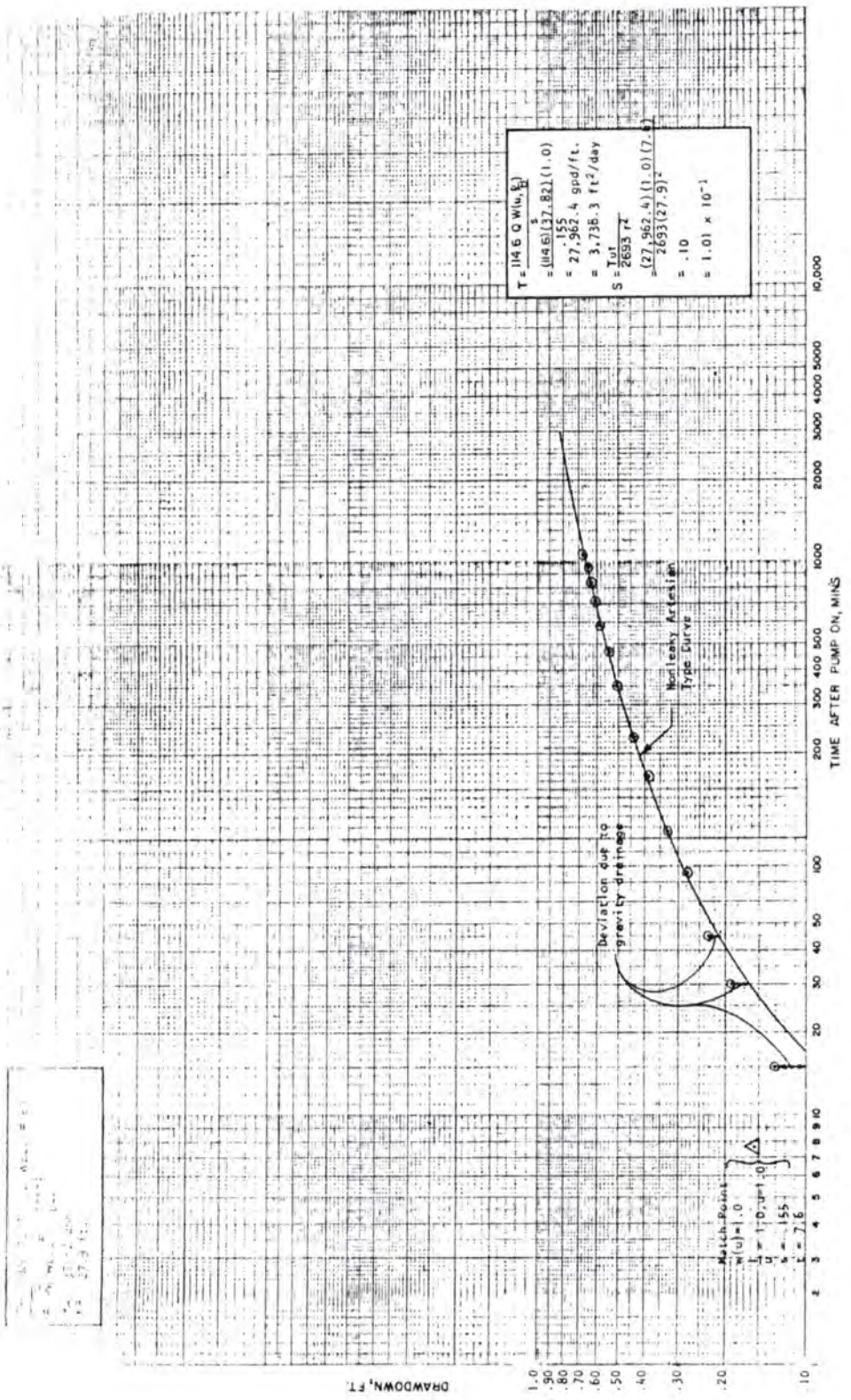
JUN 1 5/95 PERMIT 212-T2
TFN 6 2/025
RECD 10-25-18
D11-489
9/2/94-213.14

DEQ Ex. 3-1784



MICRO FILMED

LAND QUALITY DIVISION
RECEIVED DEC 28 1982

D11-490 TFN 1 5/293 PERMIT
TFN 6 2/825
RECD 10-25-10

9/2/94 · 213.74

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 11 WELL NO. 638

Personnel Bondar Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ess Sheridan WY Driller R. Reed

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 21 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 0' - 20'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3569.5

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 11.06 How measured galvanometer/Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-4-81	1415	11.06	0			0
	1430	11.08	15			.02
	1445	11.10	30			.04
	1500	11.12	45			.06
	1530	11.16	75			.10
	1600	11.18	105			.12
	1700	11.22	165			.16
	1800	11.25	225			.19
	2000	11.31	345			.25
	2200	11.35	465			.29
	2400	11.37	585			.31
8-5-81	0200	11.41	705			.35
	0400	11.43	825			.37
	0600	11.45	945			.39
OFF	0743	11.47	1048			.41
	0800	11.45	1065	17	62.65	.39
	0830	11.42	1095	47	23.30	.36
	0900	11.39	1125	77	14.61	.33
	1000	11.36	1185	137	8.65	.30
	1100	11.33	1245	197	6.32	.27
	1200	11.31	1305	257	5.08	.25

MICRO FILMED SEP 21 94

9/2/94-213-T4

TFN 6 2/025
RECD 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 11 WELL NO. 638

Personnel Bondar Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

ss Sheridan WY Driller R. Reed

od drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 21 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 0' - 20'

Pump hp & type N/A Pump depth ____ ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3569.5

How determined surveyed MP Above Below LSD ____ Altitude MP ____

WL from MP 11.06 How measured galvanometer/Steven's Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1400	11.27	1425	377	3.78	.21
	1600	11.25	1545	437	3.40	.19
	1900	11.23	1725	677	2.55	.17
	2100	11.22	1845	797	2.31	.16
	2330	11.21	1995	947	2.11	.15
	0200	11.20	2145	1097	1.96	.14
8-6-81	0600	11.19	2385	1337	1.78	.13

MICRO FILMED 2 1 '84

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT

9/2/94-213.14

TFN 6 2/025
RECD 10-25-18

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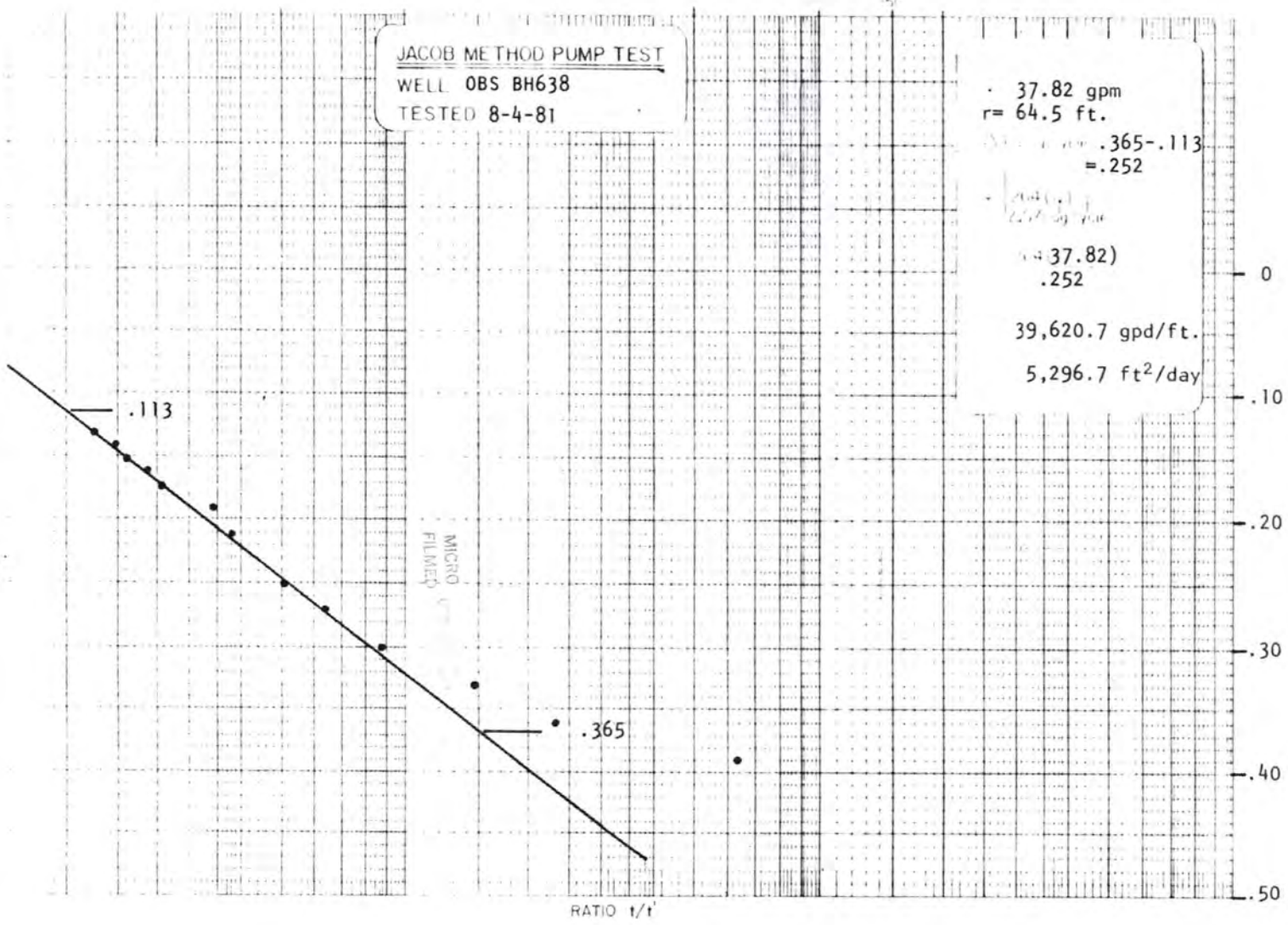
TIME RECOVERY CURVE



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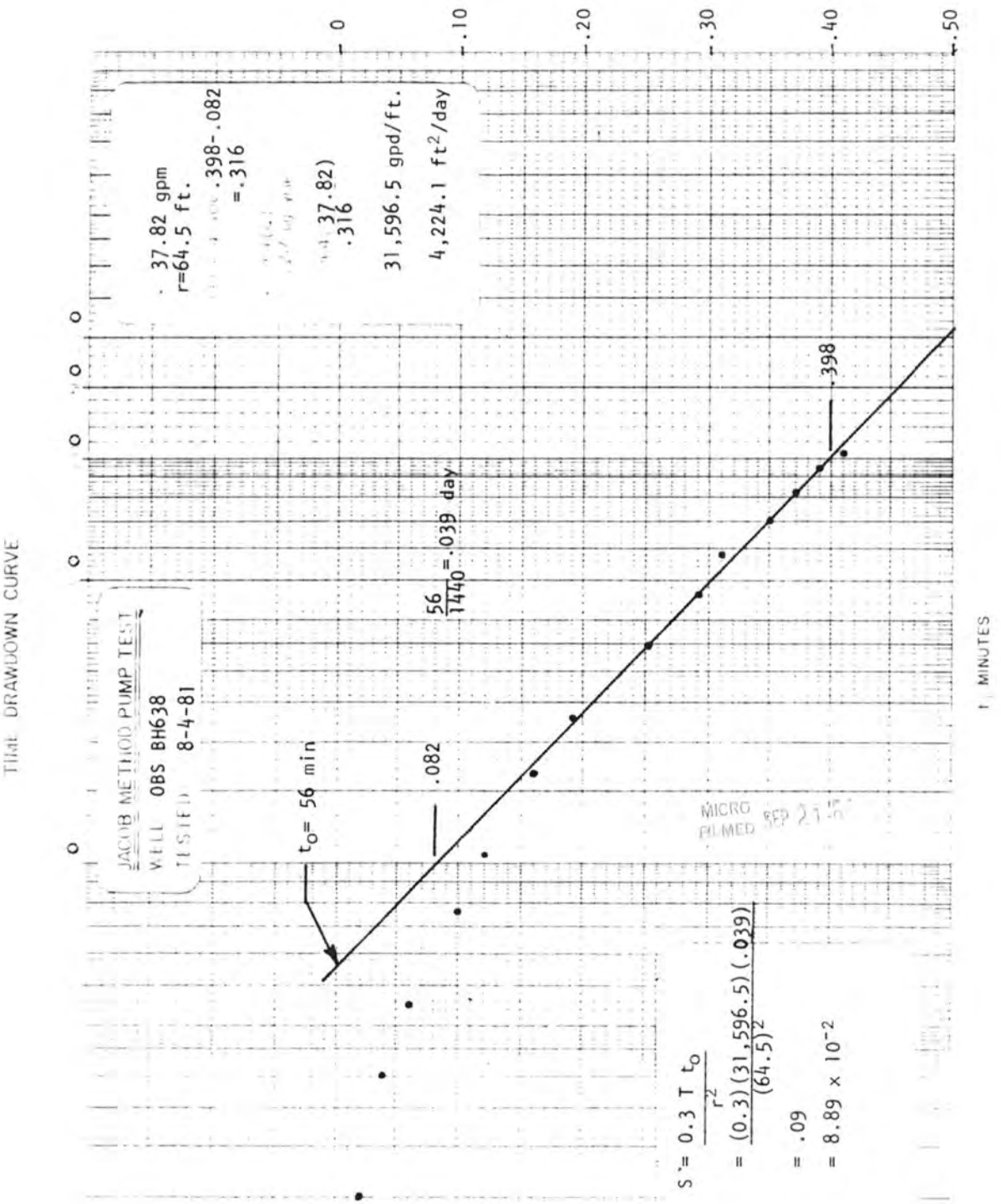
D11-493
TFN 6 2/0 25
RECD 10-25-18
9/2/94-213.14

DEQ Ex. 3-1788



LAND QUALITY DIVISION
RECEIVED DEC 28 1982

D11-494 TEN 1 5/293 PERMIT

TEN B 2/025
RECD 10-25-18

9/2/94-213.TE

DEQ Ex. 3-1789

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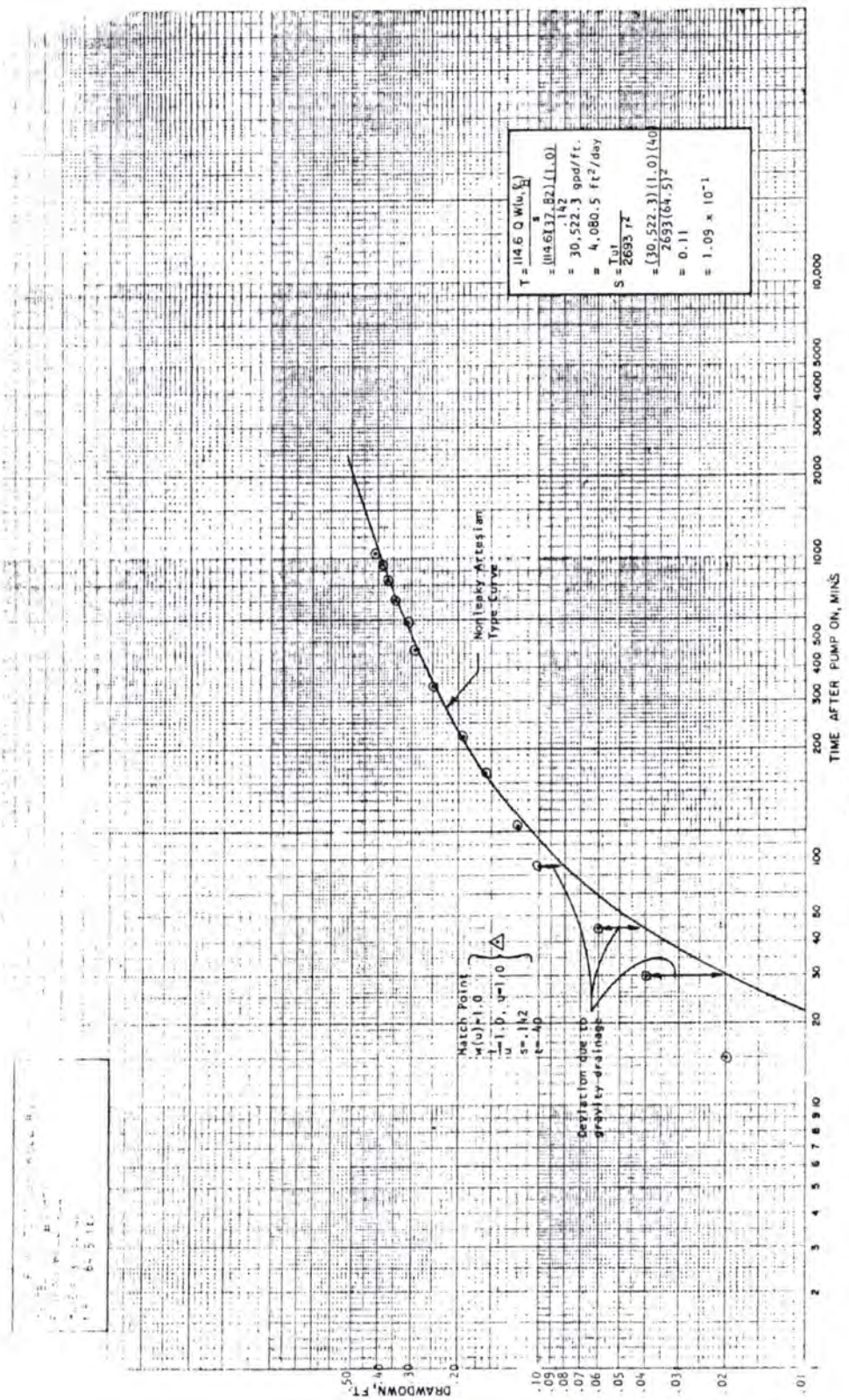

MICRO FILMED

DEQ Ex. 3-1790

9/2/94-213-T4

TFN 6 27025
RECD 10-25-18

'KS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., Sec. 11 WELL NO. 639

Personnel Bondar-Jones-Tittle
BHC

Test Type: 1. Single well drawdown 2. Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

Well Owner

Address Sheridan, WY Driller D. Fudge

Type drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 22 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slotted Interval of screen or perforation 0 - 20'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3569.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.21 How measured F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
8-6-81	0930	12.21	0			0
	1000	12.21	30			0
	1100	12.21	90			0
	1200	12.21	150			0
	1300	12.22	210			.01
	1400	12.23	270			.02
	1500	12.24	330			.03
	1600	12.24	390			.03
	1700	12.25	450			.04
	1800	12.26	510			.05
	1900	12.27	570			.06
	2000	12.28	630			.07
	2100	12.28	690			.07
	2200	12.29	750			.08
	2300	12.30	810			.09
	2400	12.30	870			.09
8-7-81	0100	12.31	930			.10
	0200	12.32	990			.11
	0300	12.32	1050			.11
	0400	12.33	1110			.12
	0500	12.33	1170			.12

MICRO FILMED DEC 1 84

LAND QUALITY DIVISION
RECEIVED DEC 28, 1982
TFN 1 5/293 PERMIT

D11-496

TFN 6 2/025
RECD 10-25-18

9/12/94-213-T4

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KS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., W., Sec. 11 WELL NO. 639

Personnel Bondar-Jones-Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner BHC

Sheridan Driller D. Fudge

How drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 22 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation slotted Interval of screen or perforation 0 - 20'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3569.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 12.21 How measured E-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT RESIDUAL DRAWDOWN
	0600	12.34	1230			.13
	0700	12.34	1290			.13
OFF	0800	12.35	1350			.14
3-7-81	0800	12.35	1350			.14
	0900	12.35	1410	60	23.50	.14
	1000	12.35	1470	120	12.25	.14
	1100	12.35	1530	180	8.50	.14
	1200	12.34	1590	240	6.63	.13
	1300	12.34	1650	300	5.50	.13
	1400	12.33	1710	360	4.75	.12
	1500	12.32	1770	420	4.21	.11
	1600	12.32	1830	480	3.81	.11
	1700	12.31	1890	540	3.50	.10
	1800	12.31	1950	600	3.25	.10
	1900	12.31	2010	660	3.05	.10
	2000	12.31	2070	720	2.88	.10
	2100	12.30	2130	780	2.73	.09
	2200	12.30	2190	840	2.61	.09
	2300	12.30	2250	900	2.50	.09
	2400	12.30	2310	960	2.41	.09
8-8-81	0100	12.29	2370	1020	2.32	.08

D11-497

TFN 0 2/025

RECD 10-25-13

KS GEOLOGY AND EXPLORATION

tate Wyoming County Sheridan T. 57 N., R. 84 E., Sec. 11 WELL NO. 639

ersonnel Bondar-Jones-Tittle

Test Type: 1. Single well drawdown 2. Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well
5. Other (Specify)

ell Owner BHC

d Sheridan, WY

Driller D. Fudge

e Drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

otal well depth 22 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

ype of screen or perforation slotted Interval of screen or perforation 0 - 20'

ump hp & type N/A Pump depth ____ ft. Aquifer Alluvium

quifer lithology sands and gravels Altitude of land surface 3569.7

ow determined surveyed MP Above / Below LSD ____ Altitude MP ____

WL from MP 12.21 How measured F-68 Recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	0200	12.29	2430	1080	2.25	.08
	0300	12.29	2490	1140	2.18	.08
	0400	12.29	2550	1200	2.13	.08
	0500	12.29	2610	1260	2.07	.08
	0600	12.28	2670	1320	2.02	.07
	0700	12.28	2730	1380	1.98	.07
	0800	12.28	2790	1440	1.94	.07

MICRO FILMED

LAND QUALITY DIVISION

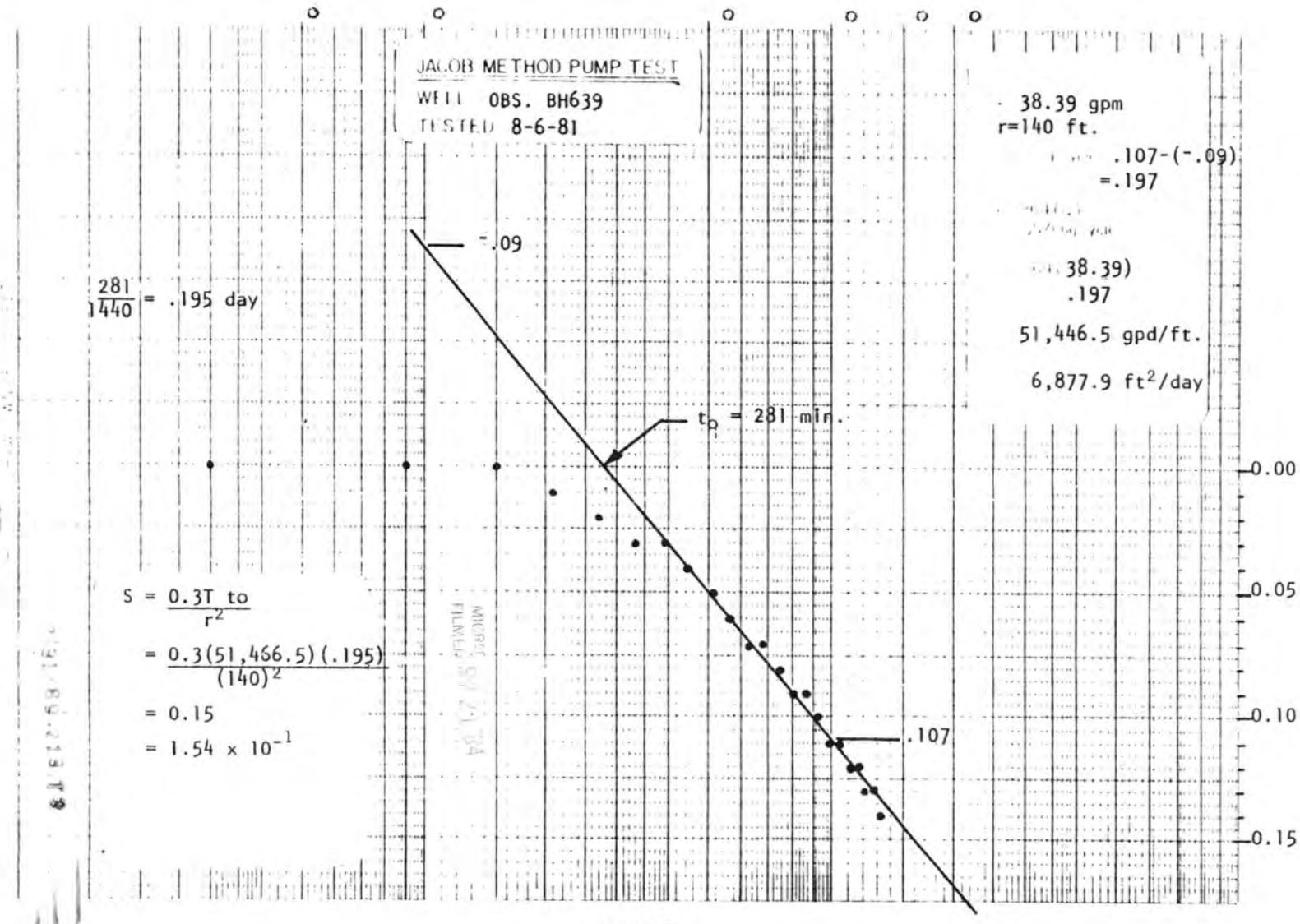
D11-498 RECEIVED, DEC 28 1982

TFR 6 2/025

DEQ 10-25-18

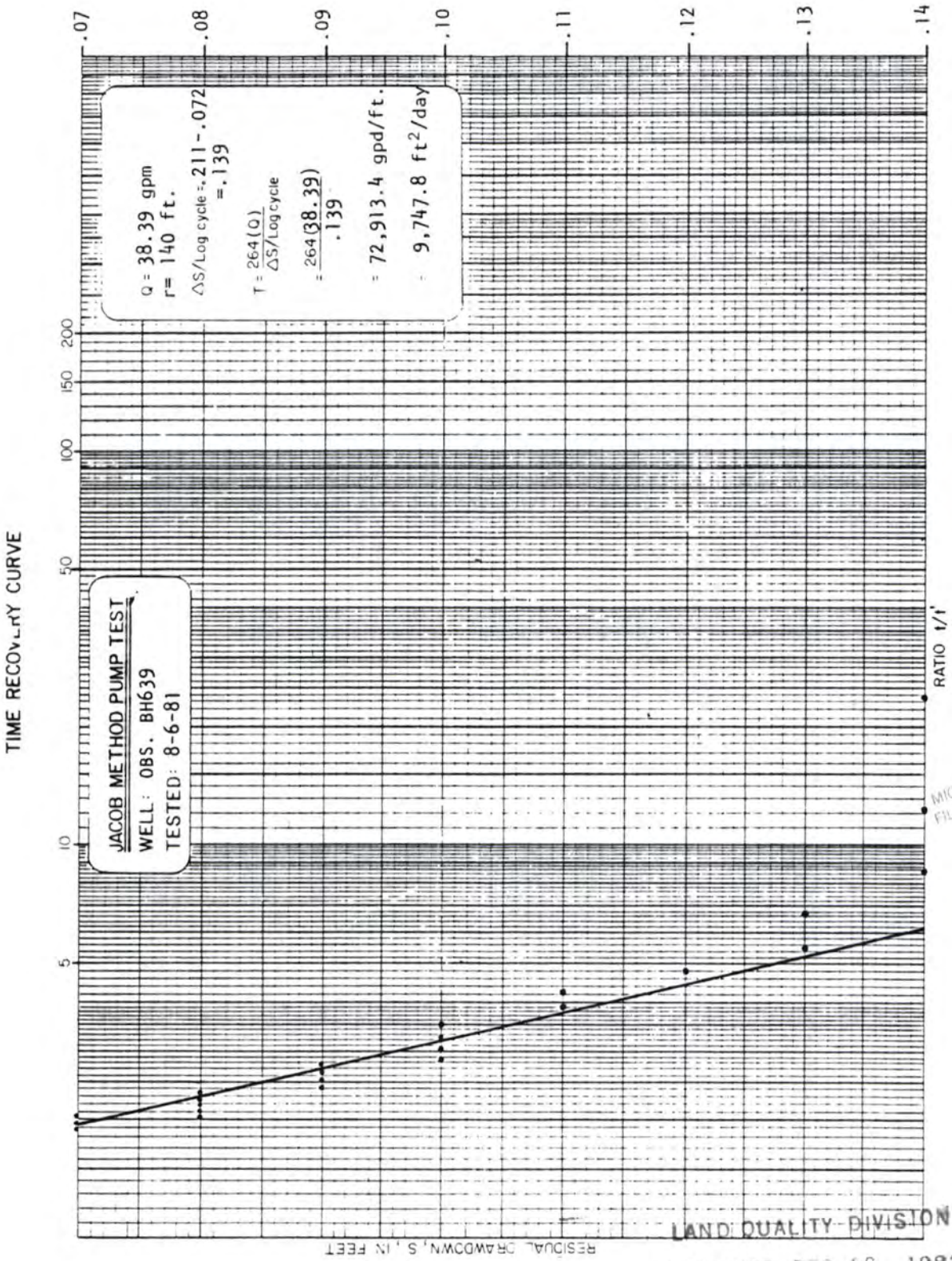
Scanned, 02/26/2020

TIME DRAW. .N CURVE



D11-499
TFN 6 2/025
RECD 10-25-13
9/2/94-213.T4

DEQ Ex. 3-1794



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D11-500
TFN G 2/025
RECD 10-25-18

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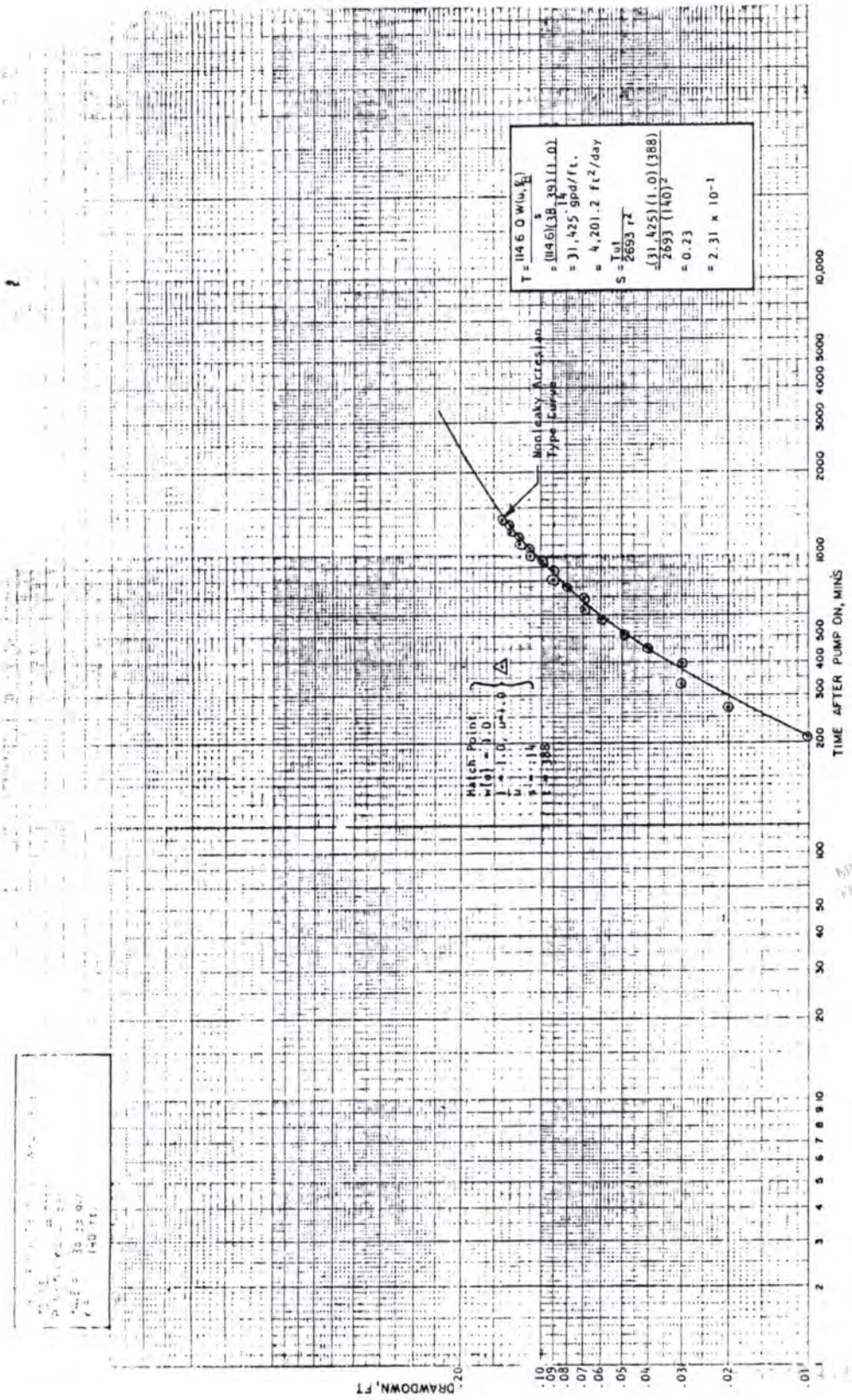

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. 645

Personnel Bondar, Andersen, Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

l Owner Big Horn Coal

dress Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 23 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 10' - 20'

Pump hp & type 3h.p. Gould Pump depth 22 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3579.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 7.83 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7-29-81	0822	7.83	0			0
	0823	10.00	1			2.17
	0825	10.10	3			2.27
	0830	10.21	8			2.38
	0840	10.30	18			2.47
	0900	10.42	38			2.59
	0920	10.50	58			2.67
	0940	10.59	78			2.76
	1000	10.61	98			2.78
	1030	10.67	128			2.84
	1100	10.72	158			2.89
	1130	10.72	188			2.89
	1200	10.74	218			2.91
	1300	10.83	278			3.00
	1400	10.87	338			3.04
	1500	10.95	398			3.12
	1600	10.98	458			3.15
	1700	11.07	518			3.24
	1800	11.09	578			3.26
	1900	11.14	638			3.31
	2000	11.17	698			3.34

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D11-502

TFR C 27025 RECD 10-25-18

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. 645 (cont)

Personnel Bondar, Andersen, Tittle

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

11 Owner Big Horn Coal

ress Sheridan WY

Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 23 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 10' - 20'

Pump hp & type 3 h.p. Gould Pump depth 22 ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3579.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 7.83 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	2100	11.26	758			3.43
	2200	11.33	818			3.50
	2300	11.34	878			3.51
	2400	11.43	938			3.60
7-30-81	0100	11.51	998			3.68
	0200	11.52	1058			3.69
	0300	11.68	1118			3.85
	0400	11.65	1178			3.82
	0500	11.59	1238			3.76
	0600	11.62	1298			3.79
	0700	11.66	1358			3.83
	0800	11.61	1418			3.78
OFF	0803	11.61	1421	0		3.78
	0804	9.07	1422	1	1422	1.24
	0805	8.88	1423	2	711.5	1.05
	0808	8.80	1426	3	475.3	0.97
	0811	8.70	1429	6	238.2	0.87
	0815	8.62	1433	10	143.3	0.79
	0820	8.57	1438	15	95.9	0.74
	0830	8.51	1448	25	57.9	0.68
	0845	8.43	1463	40	36.6	0.60

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D11-503
TFN 6 2/025
DEQ 10-25-13

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. 645 cont.

Personnel Bondar, Andersen, Tittle Test Type: 1. Single well drawdown 2. Single well recover
3. Drawdown with obs. well 4. Recovery with obs. well

Well Owner Big Horn Coal 5. Other (Specify)

Address Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 23 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 10' - 20'

Pump hp & type 3h.p. Gould Pump depth 22 ft. Aquifer Alluvium

Aquifer lithology sands ang gravels Altitude of land surface 3579.7

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 7.83 How measured galvanometer

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	0900	8.39	1478	55	26.9	0.56
	0920	8.34	1498	75	20.0	0.51
	0940	8.30	1518	95	16.0	0.47
	1000	8.27	1538	115	13.4	0.44
	1030	8.25	1568	145	10.8	0.42
	1100	8.23	1598	175	9.1	0.40
	1200	8.18	1658	235	7.1	0.35
	1300	8.16	1718	295	5.8	0.33
	1400	8.16	1778	355	5.0	0.33

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LAND QUALITY DIVISION

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TFN 1 5/293 PERMIT

D11-504

TFN 6 2/025

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WATER WELL #645

PUMPING RATE DATA

			TOTALS	1421		56342.63

DATE	TIME TEST TAKEN	TEST DURATION SEC.	MINUTE	VOLUME OF DISCHARGE, GALS.	TIME WEIGHTED DURATION	WEIGHTED AVERAGE DISCHARGE Q
7-29-81	0825	8.5	37.41	5.30	3	112.23
	0830	8.5	37.41	5.30	5	187.05
	0840	8.5	37.41	5.30	10	374.10
	0900	8.1	39.26	5.30	20	785.20
	0920	8.0	39.75	5.30	20	795.00
	0940	8.1	39.26	5.30	20	785.20
	1000	8.5	37.41	5.30	20	748.20
	1030	8.5	37.41	5.30	30	1122.30
	1100	8.5	37.41	5.30	30	1122.30
	1130	8.0	39.75	5.30	30	1192.50
	1200	8.5	37.41	5.30	30	1122.30
	1300	8.0	39.75	5.30	60	2385.00
	1400	8.0	39.75	5.30	60	2385.00
	1500	8.0	39.75	5.30	60	2385.00
	1600	8.0	39.75	5.30	60	2385.00
	1700	8.0	39.75	5.30	60	2385.00
	1800	8.0	39.75	5.30	60	2385.00
	1900	8.0	39.75	5.30	60	2385.00
	2000	8.0	39.75	5.30	60	2385.00
	2100	8.1	39.26	5.30	60	2355.60
	2200	8.0	39.75	5.30	60	2385.00
	2300	8.0	39.75	5.30	60	2385.00
	2400	8.0	39.75	5.30	60	2385.00
	0100	8.1	39.26	5.30	60	2355.60
	0200	7.2	44.17	5.30	60	2650.20
	0300	8.0	39.75	5.30	60	2385.00
	0400	8.0	39.75	5.30	60	2385.00
	0500	8.1	39.26	5.30	60	2355.60
	0800	8.0	39.75	5.30	183	7274.25

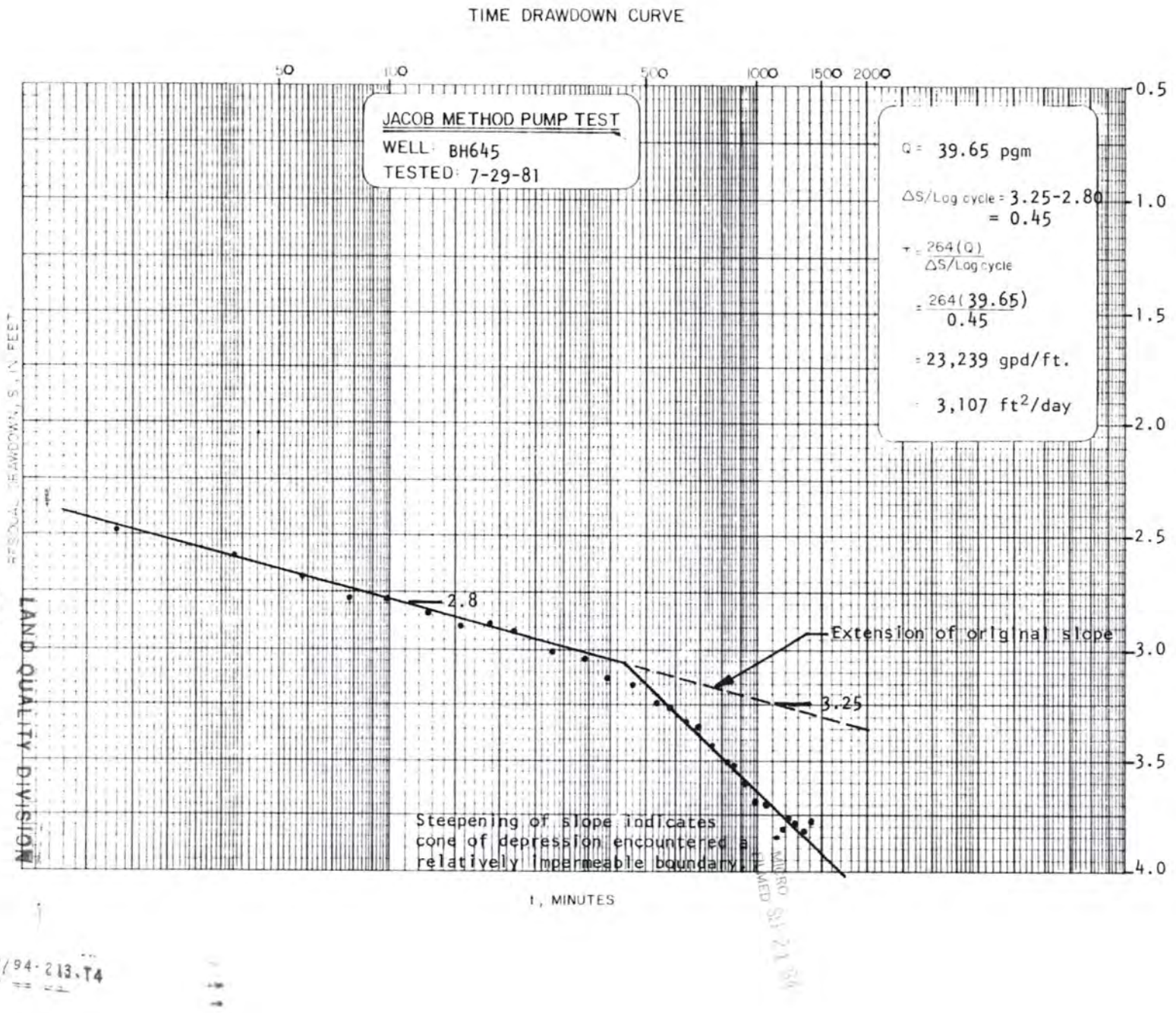
D11-505

TFN 1-5/293 PERMIT 213.T2

TFN 6 2/025

REC'D 10-25-13

8/2/94 213.T4


TIME DRAWDOWN CURVE
50
100
500
1000
1500
2000
JACOB METHOD PUMP TEST
WELL: BH645
TESTED: 7-29-81
Q = 39.65 pgm
ΔS/Log cycle = 3.25-2.80
= 0.45
T = 264(Q) / ΔS/Log cycle
= 264(39.65) / 0.45
= 23,239 gpd/ft.
= 3,107 ft²/day
2.8
Extension of original slope
3.25
Steepening of slope indicates cone of depression encountered a relatively impermeable boundary
t, MINUTES
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
RECEIVED FEB 28 1982
LAND QUALITY DIVISION
TFN 5/293 PERMIT
9/2/94-213.T4

DEQ Ex. 3-1801

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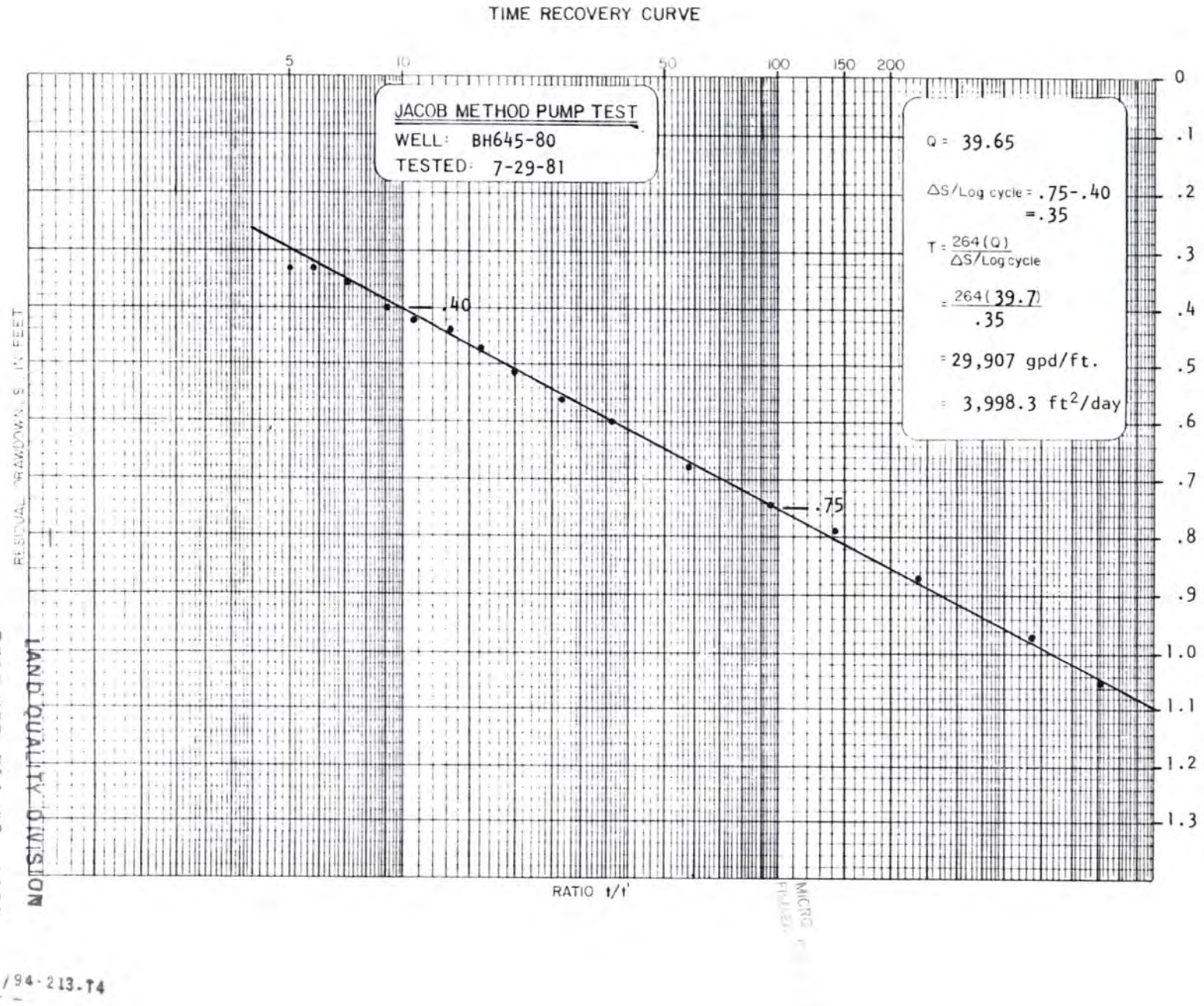

LAND QUALITY DIVISION
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JFN 1 5/293 PERMIT
D11-507
TFN 6 2/025
RECD 10-25-10
9/2/94-213.T4

DEQ Ex. 3-1802

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N., R. 84 E., Sec. 13 WELL NO. OB Well 623

Personnel Bondar Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

Address Sheridan Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 26 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 6' - 26'

Pump hp & type N/A Pump depth ____ ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3581.0'

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 9.60 How measured galvanometer/stevens recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7-29-81	0822	9.60	0			0
	0830	9.70	8			0.1
	0900	9.80	38			0.2
	0930	9.85	68			0.25
	1000	9.89	98			0.29
	1100	9.95	158			0.35
	1200	9.99	218			0.39
	1300	10.03	278			0.43
	1500	10.10	398			0.50
	1700	10.16	518			0.56
	1900	10.20	638			0.60
	2100	10.23	758			0.63
	2300	10.26	878			0.66
7-30-81	0100	10.29	998			0.69
	0300	10.30	1118			0.70
	0500	10.32	1238			0.72
	0700	10.34	1358			0.74
OFF	0800	10.34	1418	0	1418	0.74
	0815	10.16	1433	15	95.53	0.56
	0830	10.12	1448	30	48.27	0.52
	0845	10.08	1463	45	32.51	0.48

D11-508

TFR 6 2/025

RECD 10-25-13

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PKS GEOLOGY AND EXPLORATION cont.

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. OB Well 623

Personnel Bondar Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

11 Owner PKS

ress Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 26 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 6' - 26'

Pump hp & type N/A Pump depth ____ ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3581.0'

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 9.60 How measured galvanometer/stevens recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	0900	10.06	1478	60	24.63	0.46
	1000	9.99	1538	120	12.82	0.39
	1100	9.95	1598	180	8.88	0.35
	1200	9.93	1658	240	6.91	0.33
	1300	9.91	1718	300	5.73	0.31
	1400	9.90	1778	360	4.94	0.30
	1600	9.88	1898	480	3.95	0.28
	1800	9.87	2018	600	3.36	0.27
	2000	9.86	2138	720	2.97	0.26
	2200	9.85	2258	840	2.69	0.25
	2400	9.83	2378	960	2.48	0.23
7-31-81	0200	9.82	2498	1080	2.31	0.22
	0400	9.81	2618	1200	2.18	0.21
	0600	9.80	2738	1320	2.07	0.20
	0800	9.80	2858	1440	1.98	0.20

MICHAEL MINES P.E. 11-84

LAND QUALITY DIVISION.
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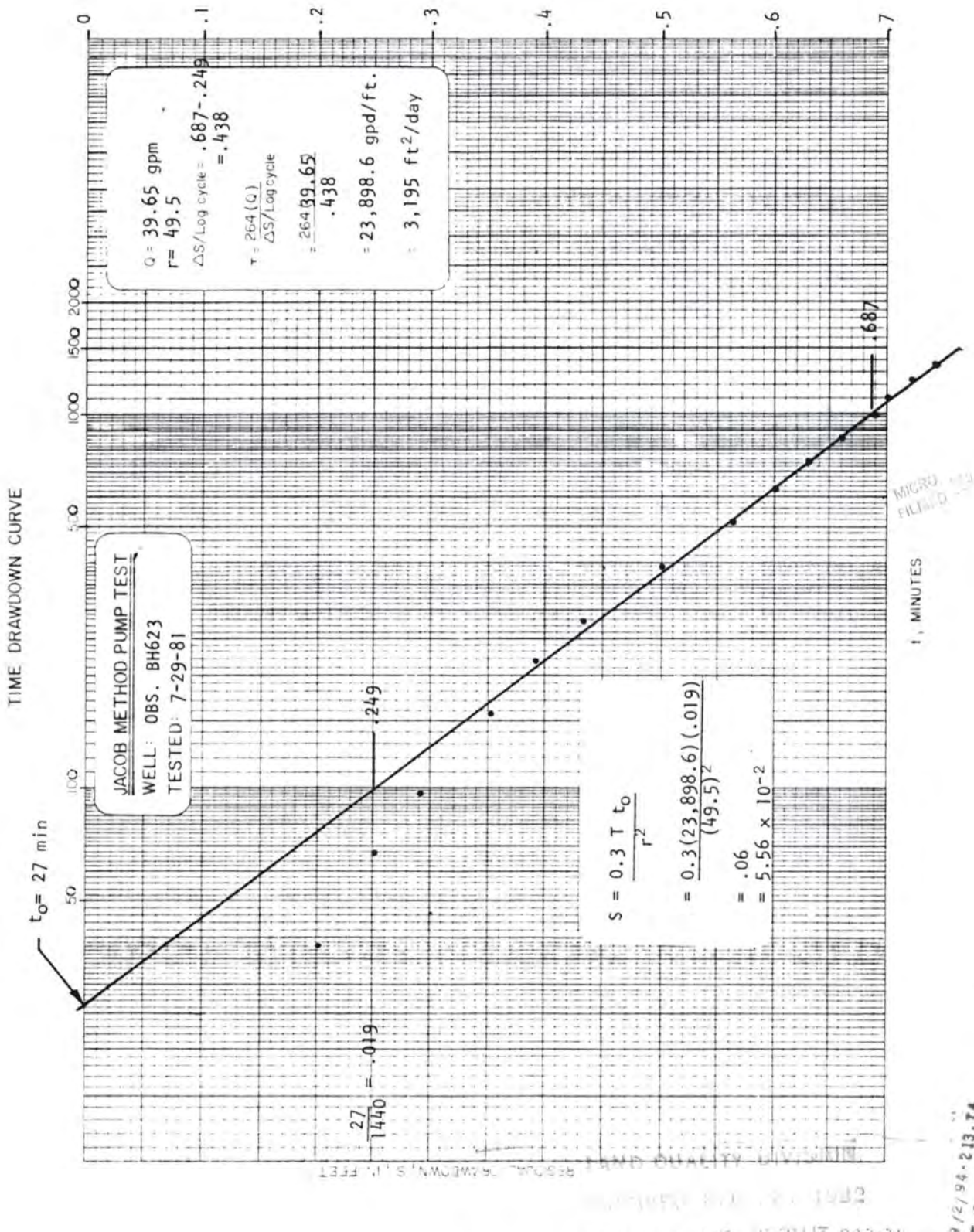
D11-509

TFN 6 2/025
REC'D 10-25-13



D11-510

TFN 6 2/025
RECD 10-25-18

DEQ Ex. 3-1805

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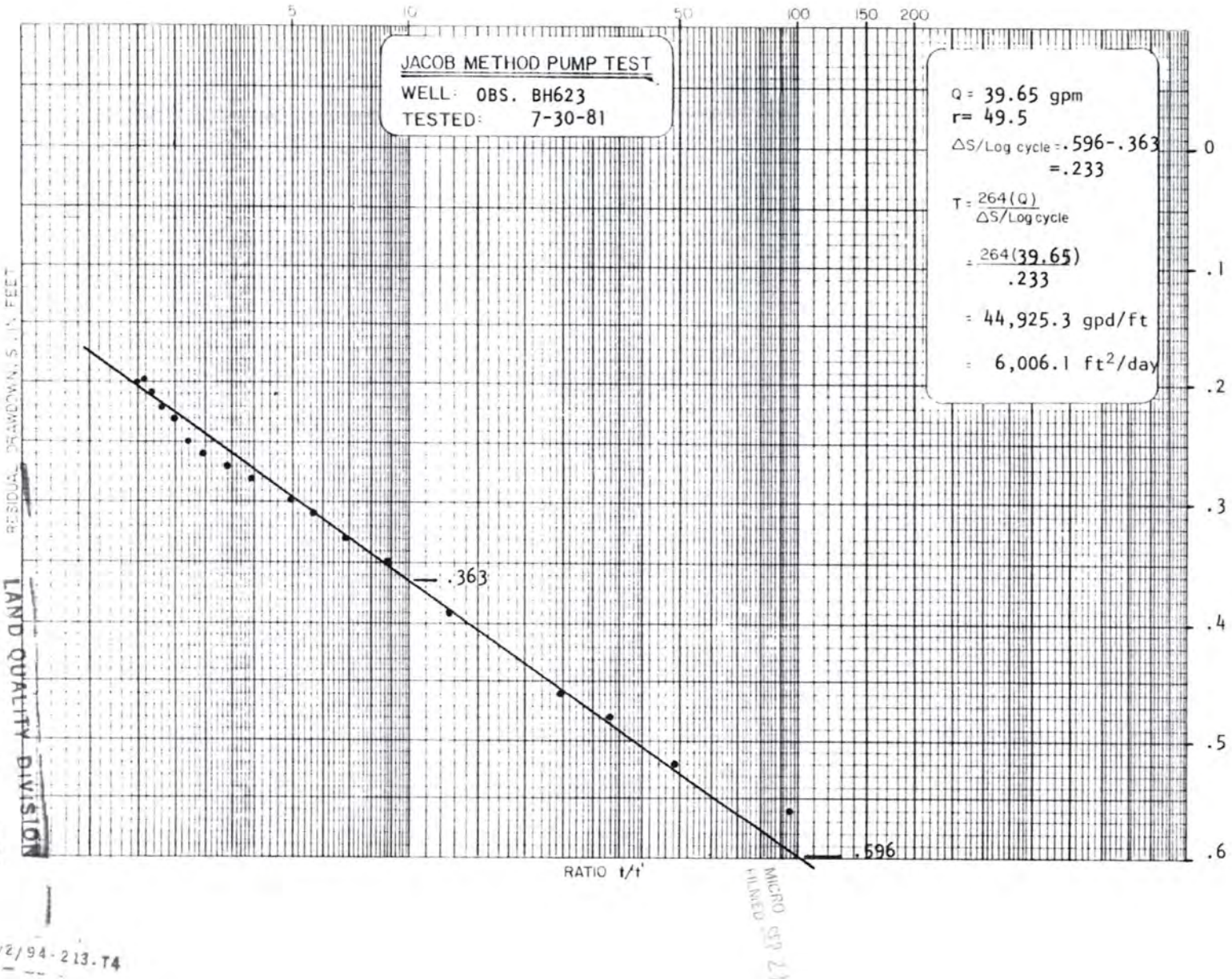
TIME RECOVERY CURVE



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TFN 1 5/293 PERMIT
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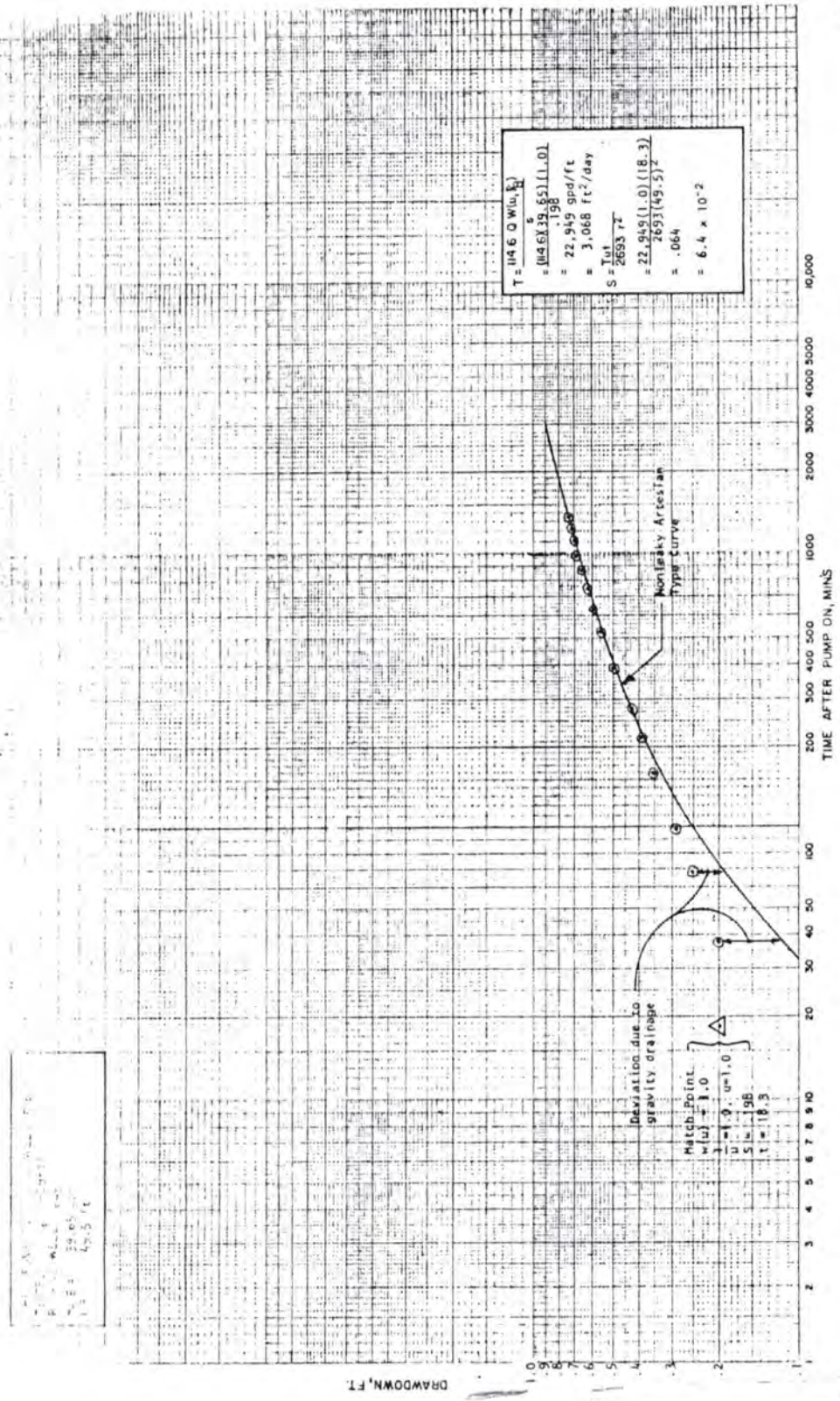
TFN 6 2/025
10-25-18
D11-511

DEQ Ex. 3-1806



TFN 6 2/025
RECD 10-25-18

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. 624

Personnel Bondar

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

1 Owner PKS

.dress Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 25.5 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 55' - 25.5'

Pump hp & type N/A Pump depth ____ ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3580.2'

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 8.09 How measured galvanometer/stevens recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7-29-81	0822	8.09	0			0
	0830	8.35	8			
	0845	8.44	23			0.26
	0900	8.49	38			0.40
	0930	8.57	68			0.48
	1000	8.62	98			0.53
	1030	8.65	128			0.56
	1100	8.69	158			0.60
	1130	8.72	188			0.63
	1200	8.74	218			0.65
	1300	8.78	278			0.69
	1400	8.81	338			0.72
	1500	8.85	398			0.76
	1600	8.88	458			0.79
	1800	8.93	578			0.84
	2000	8.97	698			0.88
	2200	9.00	818			0.91
	2400	9.03	938			0.94
7-30-81	0200	9.05	1058			0.96
	0400	9.07	1178			0.98
	0600	9.09	1298			1.00

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UNDERGROUND INJECTION CONTROL PERMIT 213-T4

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RECD 10-25-18

PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. 624

Personnel Bondar

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

Address Sheridan

Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 25.5 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 55' - 25.5'

Pump hp & type N/A Pump depth ____ ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3580.2'

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 8.09 How measured galvanometer/stevens recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
OFF	0800	9.11	1418	0	1418	1.02
	0815	8.80	1433	15	95.53	0.71
	0830	8.74	1448	30	48.27	0.65
	0845	8.69	1463	45	32.51	0.60
	0900	8.66	1478	60	24.63	0.57
	0930	8.60	1508	90	16.76	0.51
	1000	8.56	1538	120	12.82	0.47
	1030	8.53	1568	150	10.45	0.44
	1100	8.50	1598	180	8.88	0.41
	1200	8.47	1658	240	6.91	0.38
	1300	8.44	1718	300	5.73	0.35
	1400	8.42	1778	360	4.94	0.33
	1500	8.41	1838	420	4.38	0.32
	1600	8.40	1898	480	3.95	0.31
	1800	8.39	2018	500	3.36	0.30
	2000	8.38	2138	720	2.97	0.29
	2200	8.36	2258	840	2.69	0.27
	2400	8.35	2378	960	2.48	0.26
31-81	0200	8.34	2498	1080	2.31	0.25
	0400	8.33	2618	1200	2.18	0.24
	0600	8.32	2738	1320	2.07	0.23

LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT

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TFN 6 2/025
RECD 10-25-18

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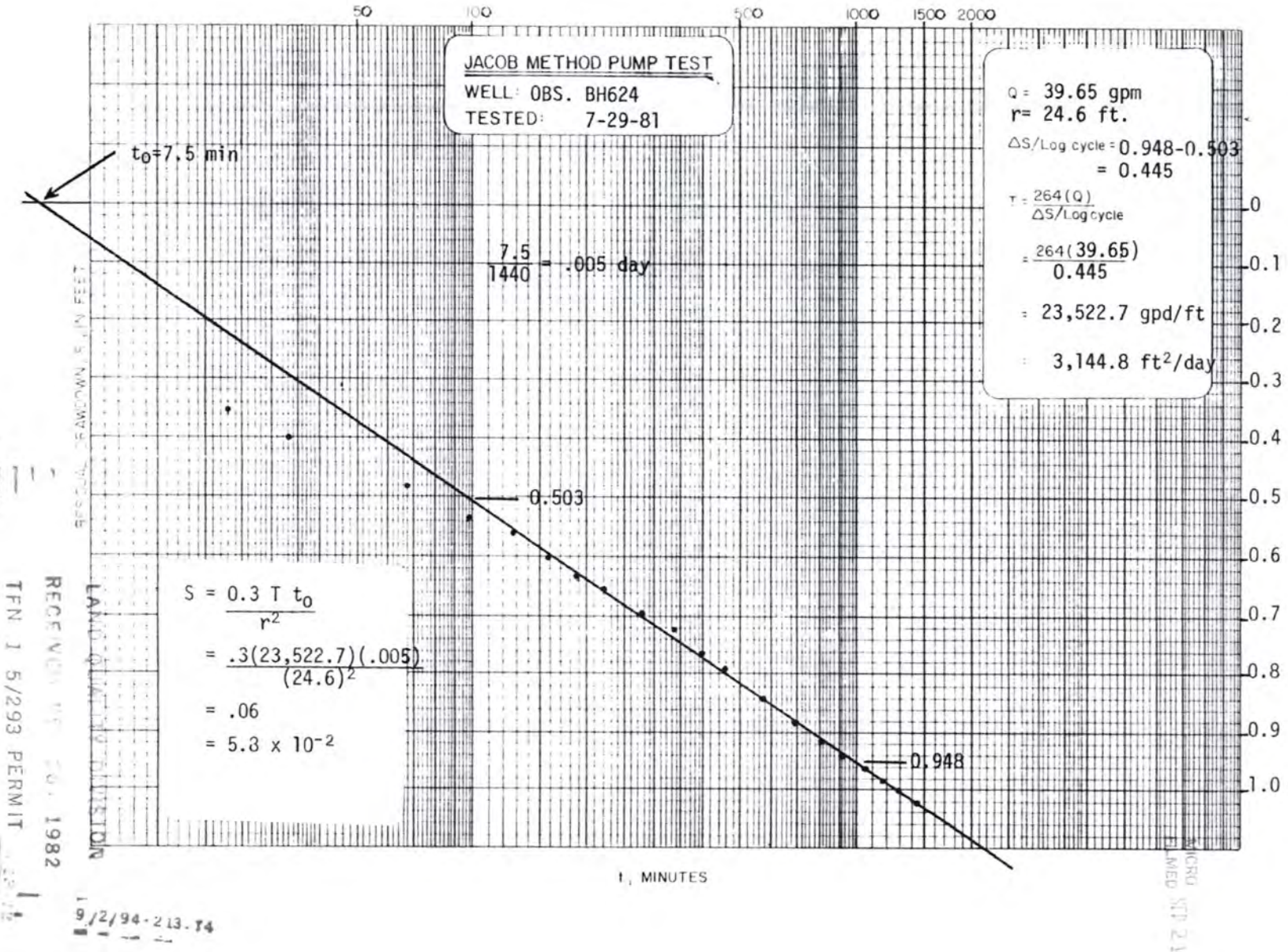
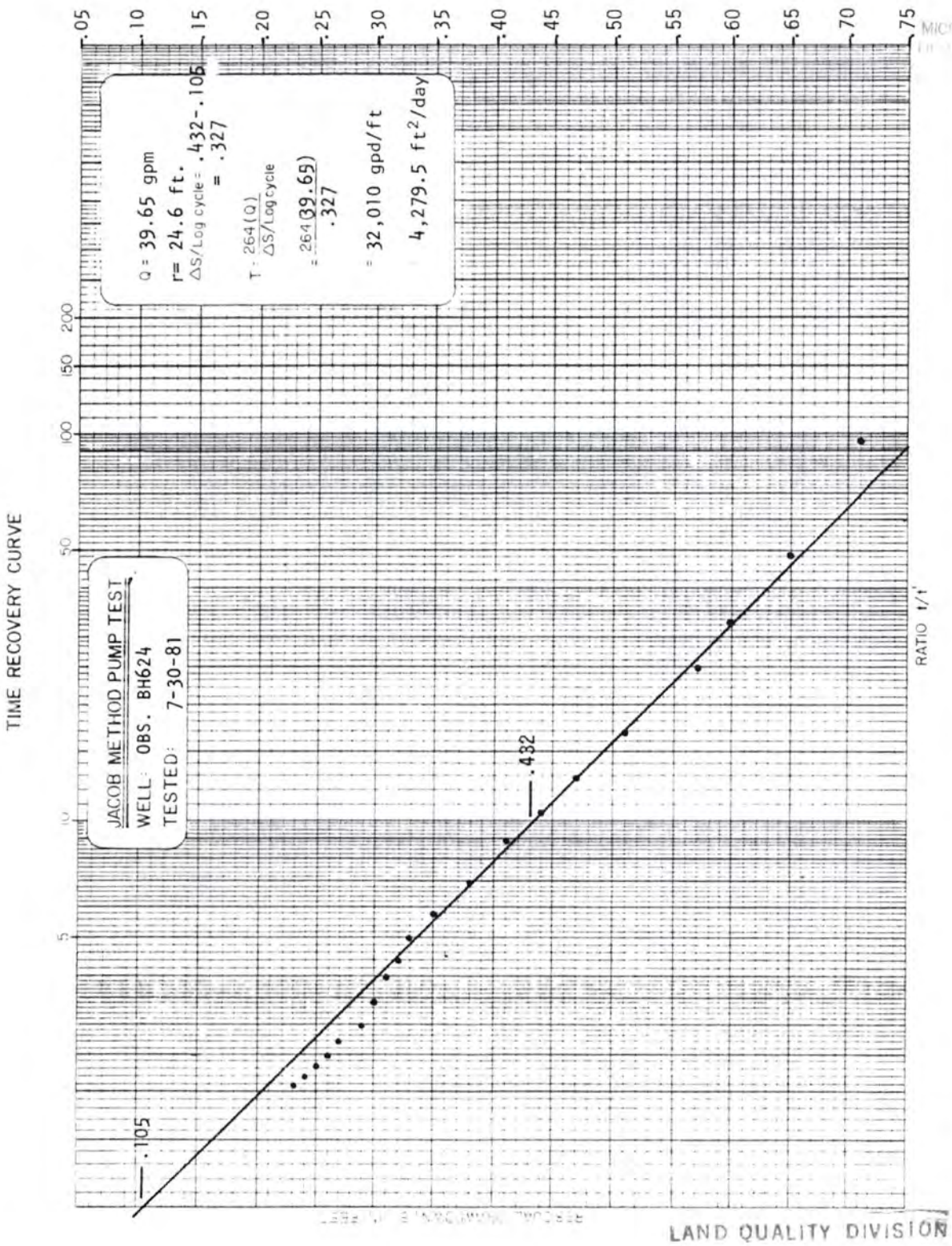
TIME DRAWDOWN CURVE



RECEIVED OCT 25 1982
TFN 5 2/025
TFN 1 5/293 PERMIT
RECD 10-25-13
D11-515
9/2/94-213.14

DEQ Ex. 3-1810



LAND QUALITY DIVISION
RECEIVED DEC 28 1982
TFN 1 5/293 PERMIT
D11-516
TFN 6 2/025
RECD 10-25-18
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DEQ Ex. 3-1811

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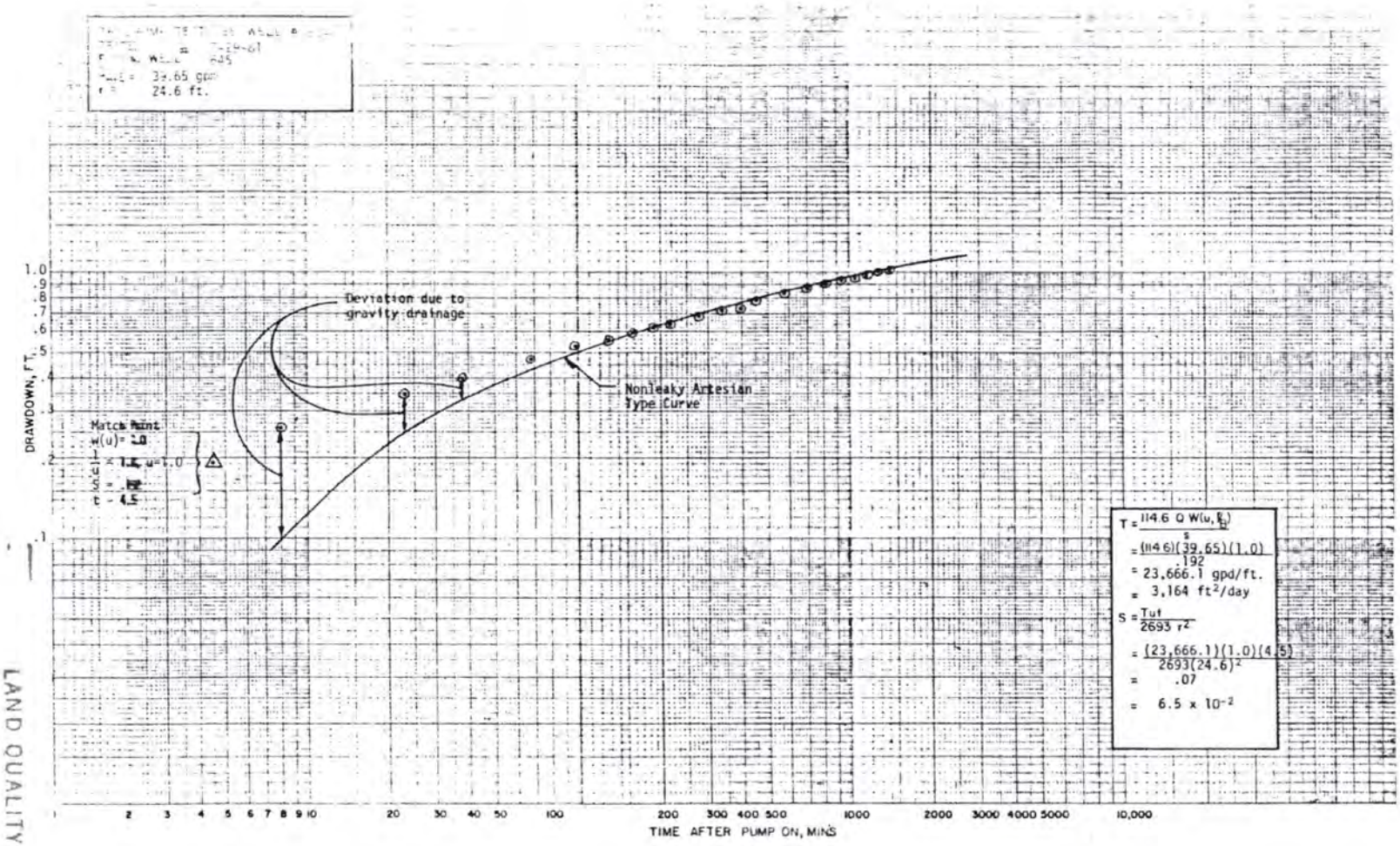

LAND QUALITY DIVISION
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JAN 0 2/025
RECD 10-25-13

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. R. 84 E. Sec. 13 WELL NO. OB Well #625

Personnel Bondar

Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well 5. Other (Specify)

Well Owner PKS

Address Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 26 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 6' - 26'

Pump hp & type N/A Pump depth ____ ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3582.8

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 10.60 How measured galvanometer/stevens recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7-29-81	0822	10.60	0			0
	0830	10.66	8			0.06
	0900	10.69	38			0.09
	1000	10.72	98			0.12
	1100	10.74	158			0.14
	1200	10.76	218			0.16
	1400	10.79	338			0.19
	1600	10.82	458			0.22
	1800	10.85	578			0.25
	2000	10.88	698			0.28
	2200	10.90	818			0.30
	2400	10.92	938			0.32
7-30-81	0200	10.94	1058			0.34
	0400	10.95	1178			0.35
	0600	10.97	1298			0.37
OFF	0800	10.98	1418	0	1418	0.38
	0815	10.90	1433	15	95.53	0.30
	0830	10.89	1448	30	48.27	0.29
	0900	10.88	1478	60	24.63	0.28
	1000	10.86	1538	120	12.82	0.26
	1200	10.84	1658	240	6.91	0.24

LAND QUALITY DIVISION
RECEIVED DEC 28 1982

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DEQ 10-25-18

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PKS GEOLOGY AND EXPLORATION (cont.)

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. OB Well #625

Personnel Bondar Test Type: 1. Single well drawdown 2. Single well recovery 3. Drawdown with obs. well 4. Recovery with obs. well

11 Owner PKS 5. Other (Specify)

ress Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary D. Dug P. Air-percussion V. Driven
B. Bored or augered H. Hyd-rotary R. Rev-rotary W. Drive-wash
C. Cable-tool J. Jetted T. Trenching Z. Other

Total well depth 26 Ft. Well Diameter 7 7/8 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 6' - 26'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3582.8

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 10.60 How measured galvanometer/stevens recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
	1400	10.82	1778	360	4.94	0.22
	1600	10.80	1898	480	3.95	0.20
	1800	10.79	2018	600	3.36	0.19
	2000	10.79	2138	720	2.97	0.19
	2200	10.78	2258	840	2.69	0.18
	2400	10.77	2378	960	2.48	0.17
7-31-81	0200	10.76	2498	1080	2.31	0.16
	0400	10.76	2618	1200	2.18	0.16
	0600	10.75	2738	1320	2.07	0.15
	0800	10.75	2858	1440	1.98	0.15

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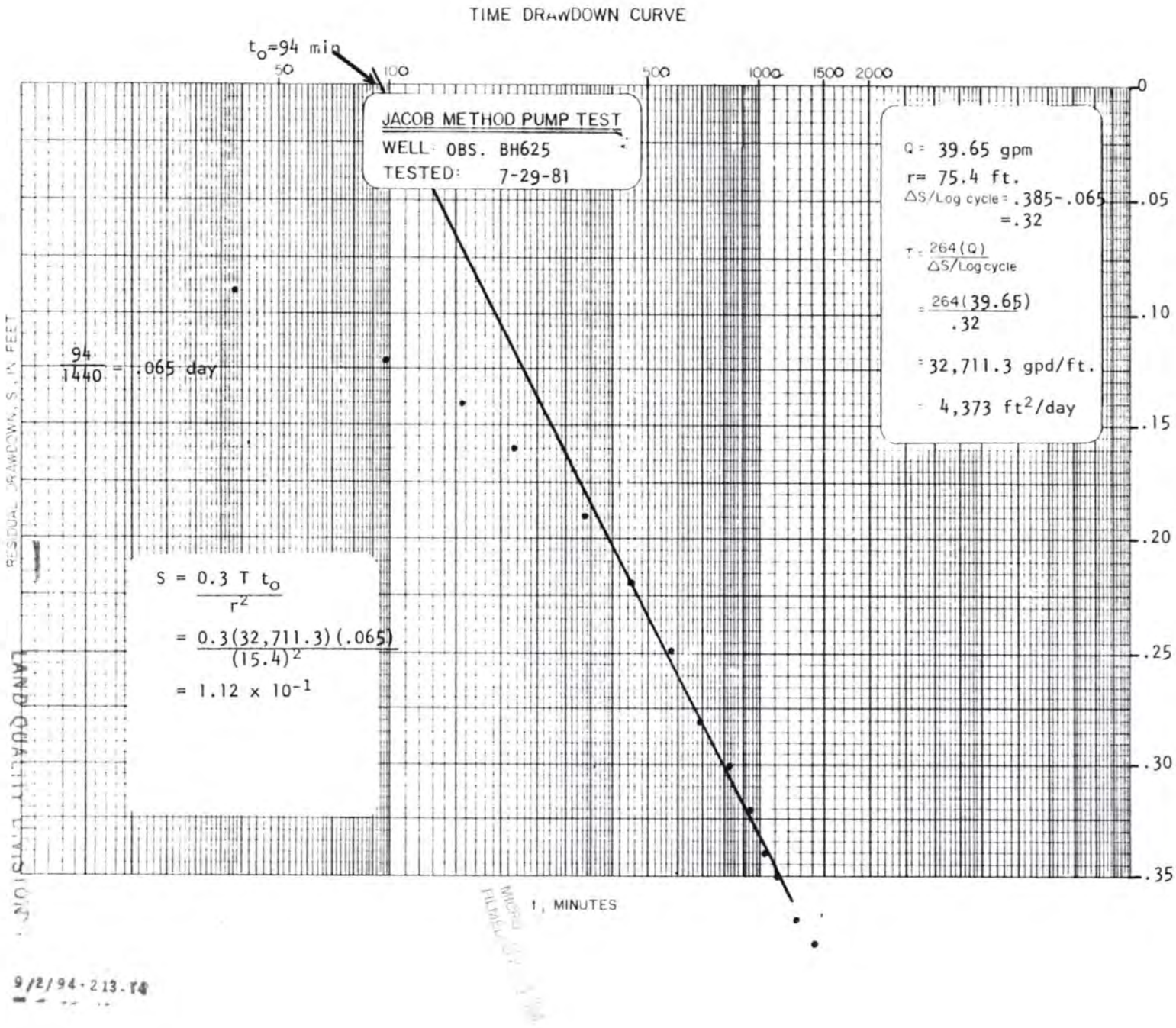

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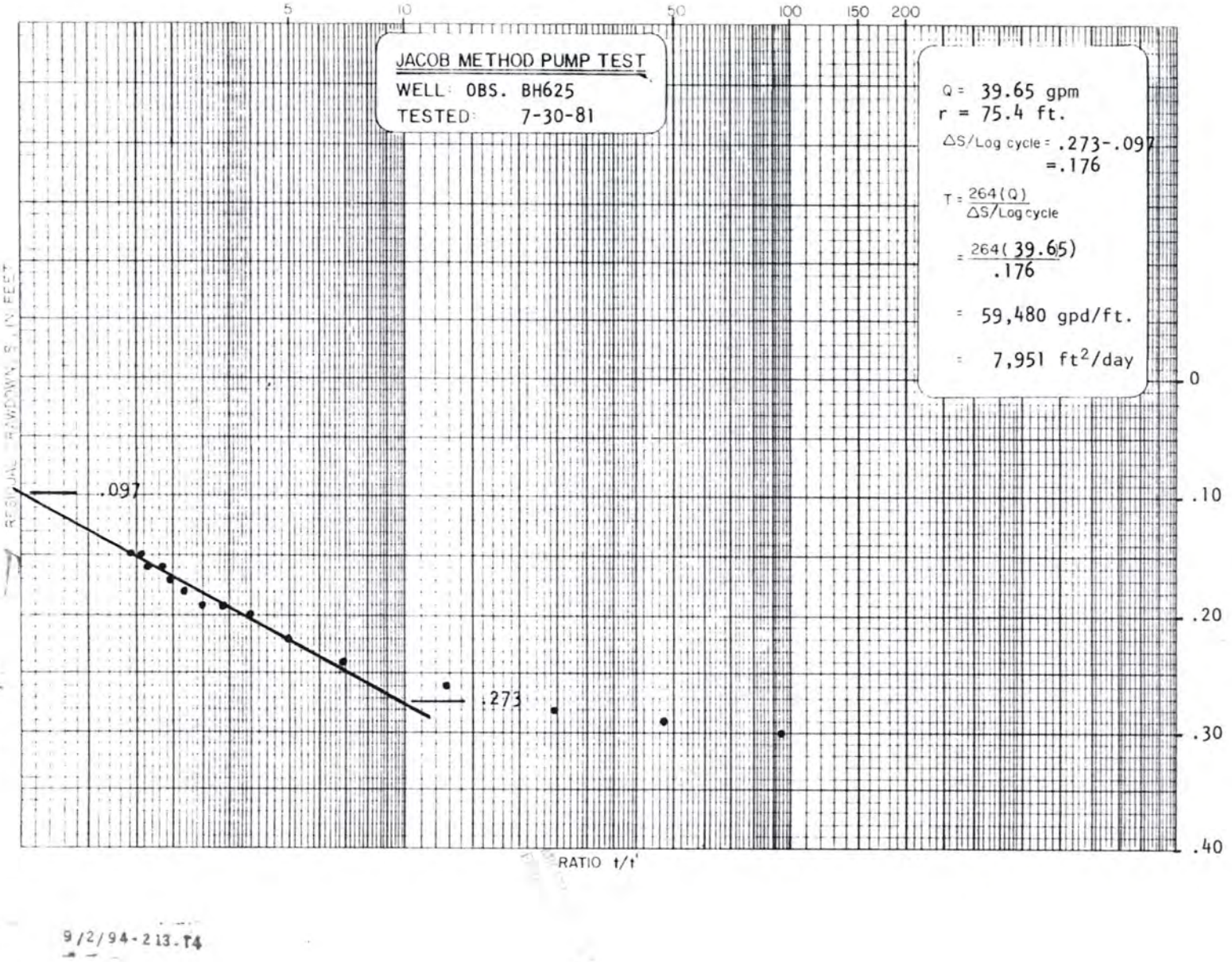
TIME RECOVERY CURVE



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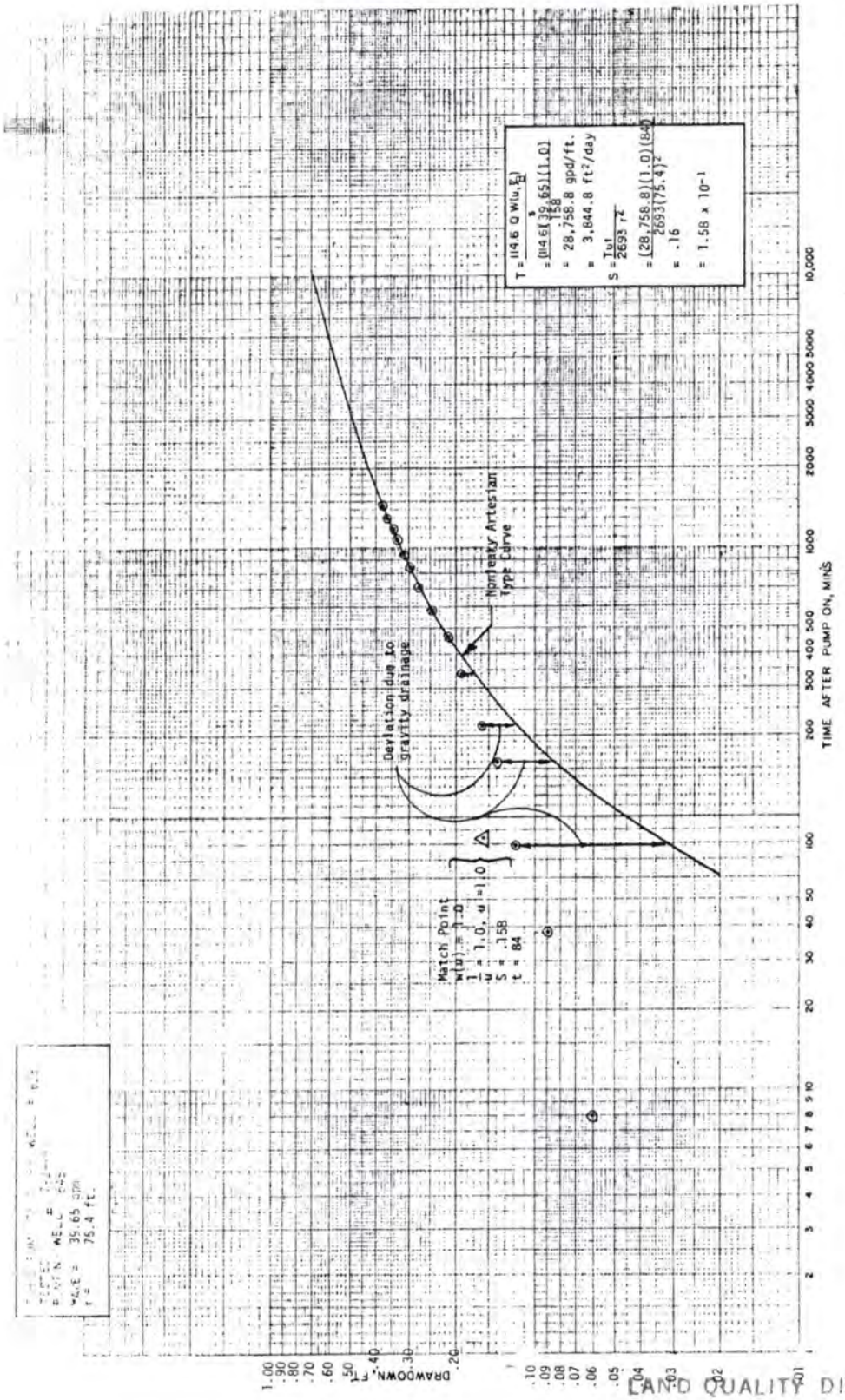

LAND QUALITY DIVISION
RECEIVED DEC 28, 1982
TFN 1 5/293 PERMIT

D11-522

TFN 6 2/025
RECD 10-25-13

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PKS GEOLOGY AND EXPLORATION

State Wyoming County Sheridan T. 57 N. S., R. 84 E. W., Sec. 13 WELL NO. OB Well #626

Personnel Bondar Test Type: 1. Single well drawdown 2. Single well recovery
3. Drawdown with obs. well 4. Recovery with obs. well

Owner PKS 5. Other (Specify)

ress Sheridan, WY Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd-rotary J. Jetted P. Air-percussion R. Rev-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 26.5' Ft. Well Diameter 7/78 in. Casing diameter 5 in. Casing type PVC

Type of screen or perforation saw slots Interval of screen or perforation 6.5' - 26.5'

Pump hp & type N/A Pump depth ft. Aquifer Alluvium

Aquifer lithology sands and gravels Altitude of land surface 3583.0'

How determined surveyed MP Above Below LSD Altitude MP

WL from MP 10.87 How measured galvanometer/stevens recorder

DATE	TIME	DEPTH TO WATER LEVEL	TIME SINCE PUMP ON t, MIN.	TIME SINCE PUMP OFF t', MIN.	t/t'	S, FT. RESIDUAL DRAWDOWN
7-29-81	0822	10.87	0			0
	0830	10.88	8			0.01
	0900	10.89	38			0.02
	1000	10.90	98			0.03
	1100	10.91	158			0.04
	1200	10.92	218			0.05
	1400	10.93	338			0.06
	1600	10.95	458			0.08
	1800	10.97	578			0.10
	2000	10.98	698			0.11
	2200	10.99	818			0.12
	2400	11.00	938			0.13
7-30-81	0200	11.01	1058			0.14
	0400	11.02	1178			0.15
	0600	11.03	1278			0.16
OFF	0800	11.04	1418	0	1418	0.17
	0815	10.03	1433	15	95.53	0.16
	0900	11.03	1478	60	24.63	0.16
	1000	11.02	1538	120	12.82	0.15
	1100	11.02	1598	180	8.88	0.15
	1200	11.01	1658	240	6.91	0.14

D11-523

TFN 6 2/025

TFN 5/283 PERMIT 213.T2

PKS GEOLOGY AND EXPLORATION

AQUIFER TEST DATA

State Wyoming County Sheridan T. 57 N. S. R. 84 E. W. Sec. 13 WELL NO. OB Well #626 cont.

Personnel Bondar

Test type: 1. Single well drawdown 3. Drawdown with obs. well 5. Other (specify) 2. Single well recovery 4. Recovery with obs. well

Owner PKS Address Sheridan, WY

Driller R. Reed

Method drilled: A. Air-rotary B. Bored or augered C. Cable-tool D. Dug H. Hyd.-rotary J. Jetted P. Air-percussion R. Rev.-rotary T. Trenching V. Driven W. Drive-wash Z. Other

Total well depth 26.5' ft. Well diameter 7/78 in.

Casing diameter 5 in. Casing type PVC

Type of screen or perforation Saw Slots Interval of screen or perforation 6.5' - 26.5'

Pump hp. & type N/A Pump depth ____ ft.

Aquifer Alluvium Aquifer lithology sands and gravels

Altitude of land surface 3583.0' How determined surveyed MP Above Below LSD ____ Altitude MP ____

SWL from MP 10.87 How measured galvanometer/stevens recorder

Date and hour	Time (minutes)	depth to water level		time since pump on t, min.		time since pump off t,' min.		t/t'	s,FT. Residual drawdown
	1400	11.00		1778		360		4.94	0.13
	1800	11.00		2018		600		3.36	0.13
	2200	10.99		2258		840		2.69	0.12
7-13-81	0200	10.98		2498		1080		2.31	0.11
	0600	10.98		2738		1320		2.07	0.11

D11-524

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TFN 6 2/025
REC'D 10-25-13
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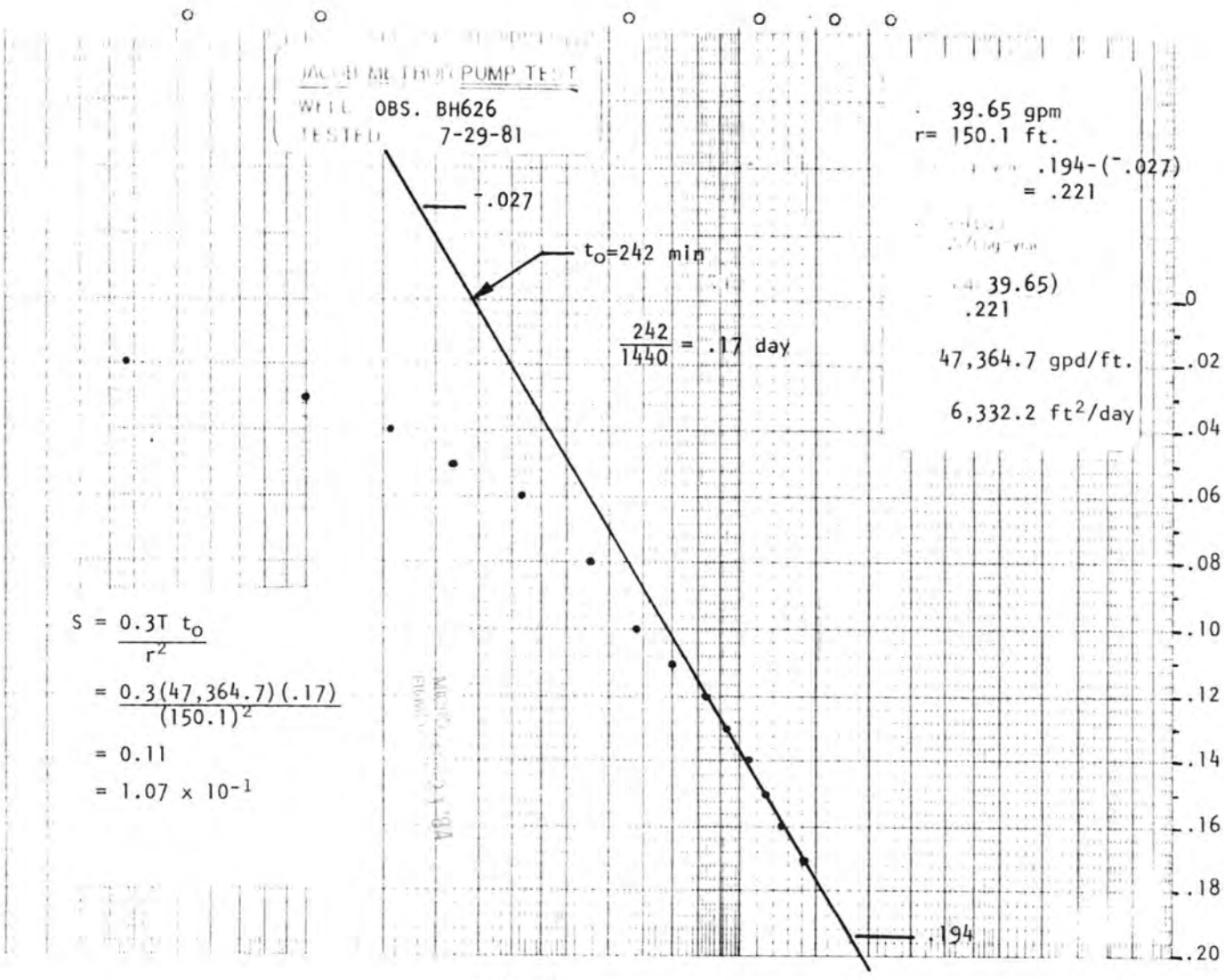
TIME DRAWDOWN CURVE



$$S = \frac{0.3T\ t_o}{r^2}$$

$$= \frac{0.3(47,364.7)(.17)}{(150.1)^2}$$

$$= 0.11$$

$$= 1.07 \times 10^{-1}$$

LAND QUALITY DIVISION
RECEIVED DEC 28 1982

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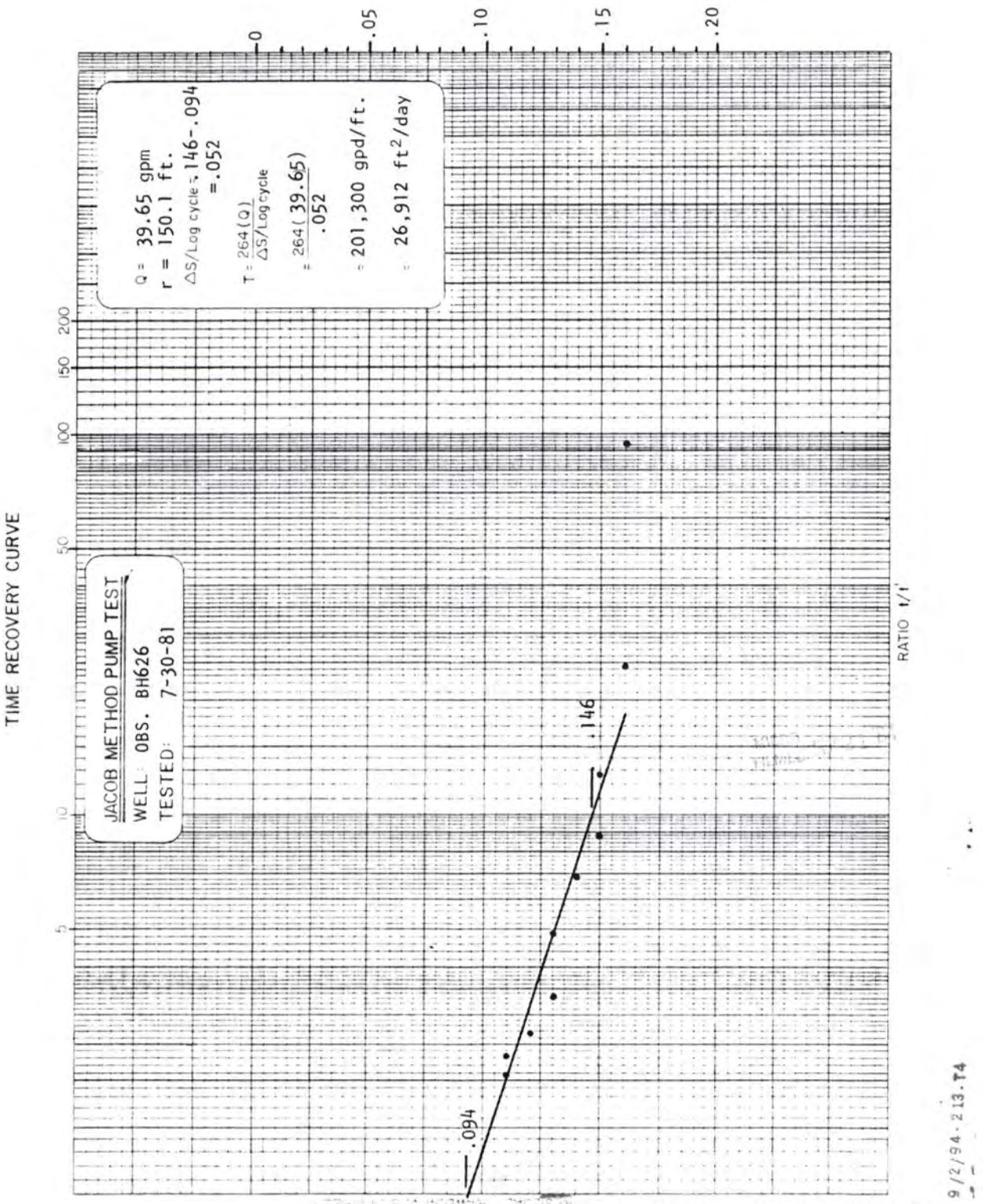
7/31 89-213-13
TFN 6 2/025
RECD 10-25-18

9/2/94-213-T4



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LAND QUALITY DIVISION
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TFN 1 5/293 PERMIT
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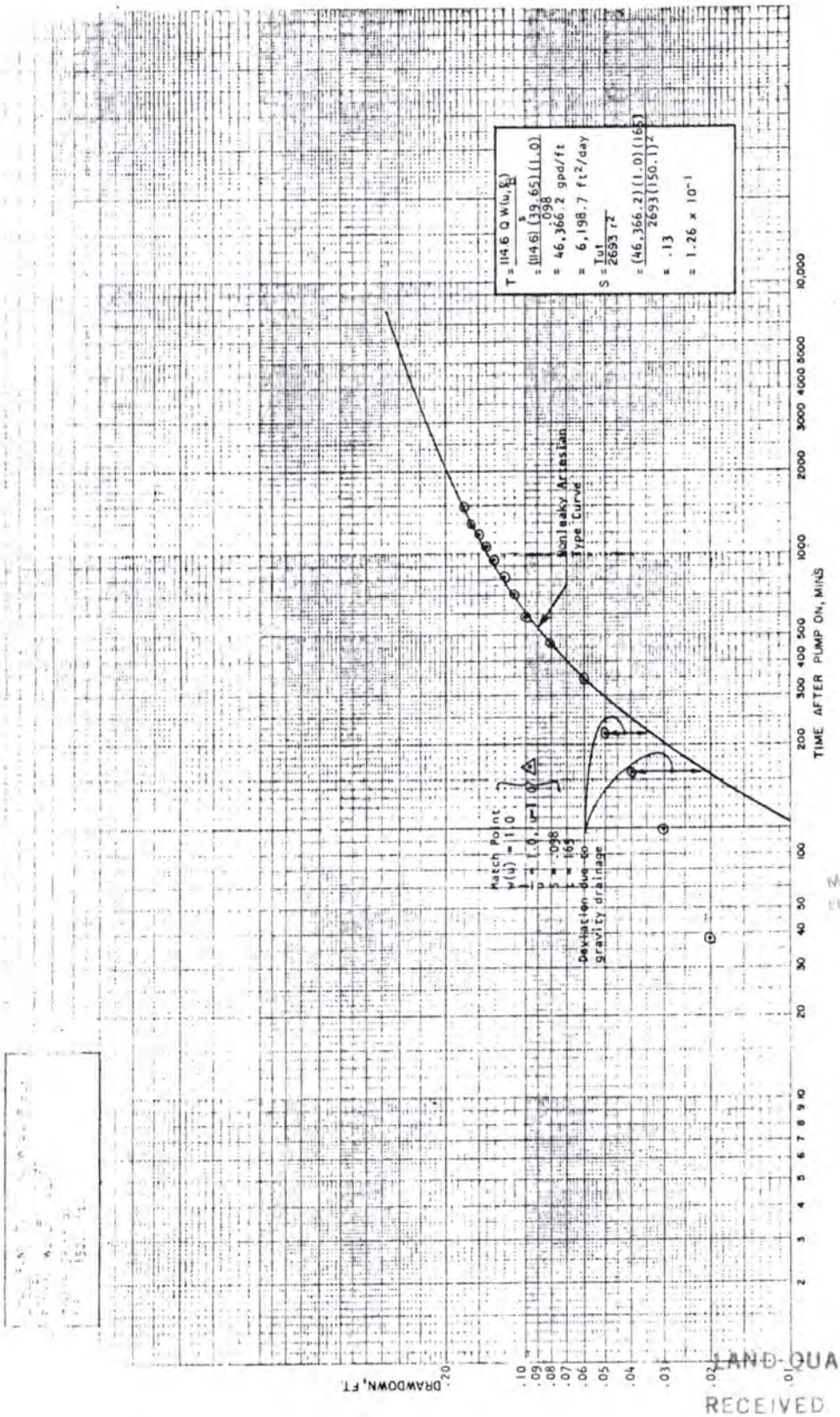

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ADDENDUM D6-15

Brook Mine
2018 Aquifer Tests

TFNS 2/825
RECD MAY 23,2019

Scanned, 02/26/2020

MEMORANDUM

WWC ENGINEERING

1849 Terra Avenue Sheridan, Wyoming 82801
PHONE: (307) 672-0761 FAX: (307) 674-4265 WEBSITE: www.wwcengineering.com

TO: **RAMACO**

FROM: **Ray Moores, P.E.**

DATE: **July 16, 2018**

SUBJECT: **Pumping Test Summary and Results for 578524-CRN and 578524-AL-1 Wells.**

WWC Engineering (WWC) conducted an aquifer test on the 578524-CRN well completed in the Carney Coal on June 7 and 8, 2018. During the aquifer test a nearby alluvial well 578524-AL-1 was also monitored. The objectives of the test were to measure the aquifer properties in the Carney Coal and evaluate whether there is a hydraulic connection between the Carney Coal and the alluvial aquifer. The well was pumped for 24 hours and obtained a maximum drawdown of 37 feet at an average discharge of 4 gallons per minute (gpm). WWC analyzed the aquifer test data with the Cooper and Jacob (1946) solution to obtain an aquifer transmissivity of 15.4 square feet per day. The Cooper and Jacob solution is a linear regression analysis that involves matching a straight line to drawdown data plotted as a function of the logarithm of time since pumping began. The slope of the line is then used to estimate the transmissivity. The Cooper and Jacob analysis as well as hydrographs for the pumped well and the observation well are attached to this memorandum. Using the calculated transmissivity, WWC utilized the drawdowns predicted by the Theis (1935) equation to evaluate the zone of influence of the aquifer test.

578524-CRN well was just over 70 feet deep with 5-inch diameter PVC casing installed to approximately 55 feet. Below 55 feet, 15 feet of 0.032" PCV slotted casing was installed. The Carney coal is approximately 10 feet thick at this location and the screen was installed 2.5 feet above and below the coal. The strata immediately adjacent to the coal was a very fine-grained bedrock clay. As such, the coal is the only contributing aquifer to the well. Well 578524-AL-1 is approximately 100 feet from the pumping well and is completed in the overlying alluvial aquifer. The alluvial aquifer is separated from the Carney coal by approximately 31 feet of clay. Using the Theis equation it is estimated that the radius of influence in the Carney coal seam extended approximately 120 feet from the pumping well during the test. As such, if the Carney coal is in communication with the overlying alluvium water level fluctuations would have been observed in the alluvial well.

During the aquifer test, water levels in Well 578524-AL-1 were continuously monitored using a transducer placed in the well. The attached hydrograph produced from the transducer readings shows that during the test water levels in the well fluctuated by about 0.1 feet. However, the pattern of water level fluctuations was consistent with natural changes in the barometric pressure and not consistent with those that would have been observed had there been a hydrologic connection between the Carney Coal and alluvium. During the first part of the test, a thunderstorm went through the area which would have dropped the barometric pressure and resulted in an observed rise in the water levels in the transducer. Once the storm moved on, the barometric pressures increased which would have translated to an observed drop in the water

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TFNS 2/025
RECD MAY 23, 2019

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levels in the transducer readings. The attached hydrograph demonstrates this expected pattern of water level fluctuations. Due to equipment limitations the transducer in the alluvial well was removed immediately after the test. To better understand the natural variation in the well another transducer was installed for a 2 week period following the aquifer test. The attached hydrograph from the 2 week monitoring period shows natural variation in the water levels in the alluvial well up to about 0.8 feet. As such, the water level fluctuation observed during the aquifer test is well within the expected range of natural variation.

In conclusion this test demonstrated:

- That there is no direct hydraulic connection between the Carney Coal and the alluvial aquifer.
- That the transmissivity of the Carney coal in the vicinity of the well is approximately 15.4 square feet per day. Assuming the thickness of the contributing coal aquifer is 10 feet the hydraulic conductivity is estimated at 1.5 feet per day.

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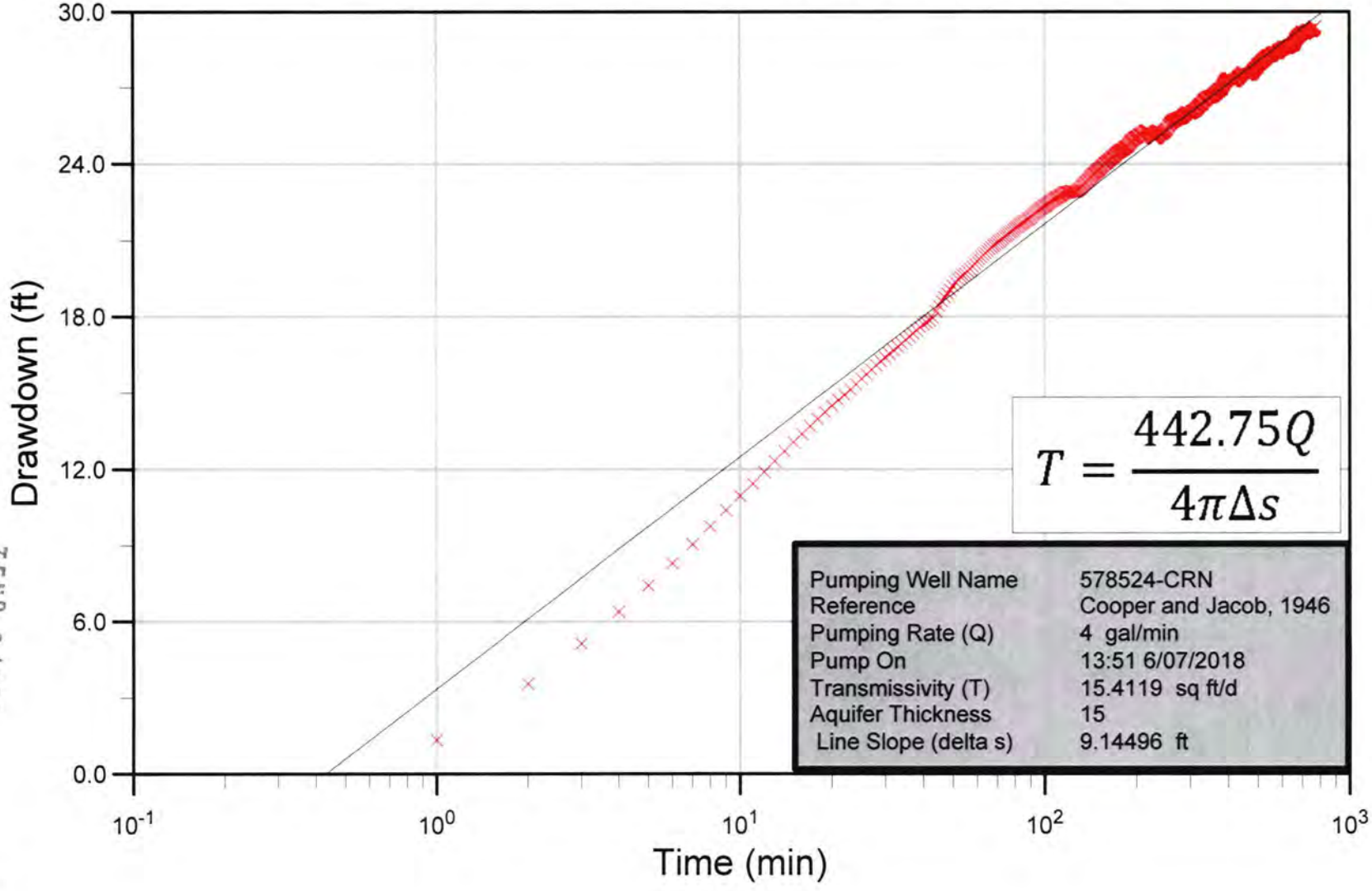
Cooper and Jacob Analysis for 578524-CRN well



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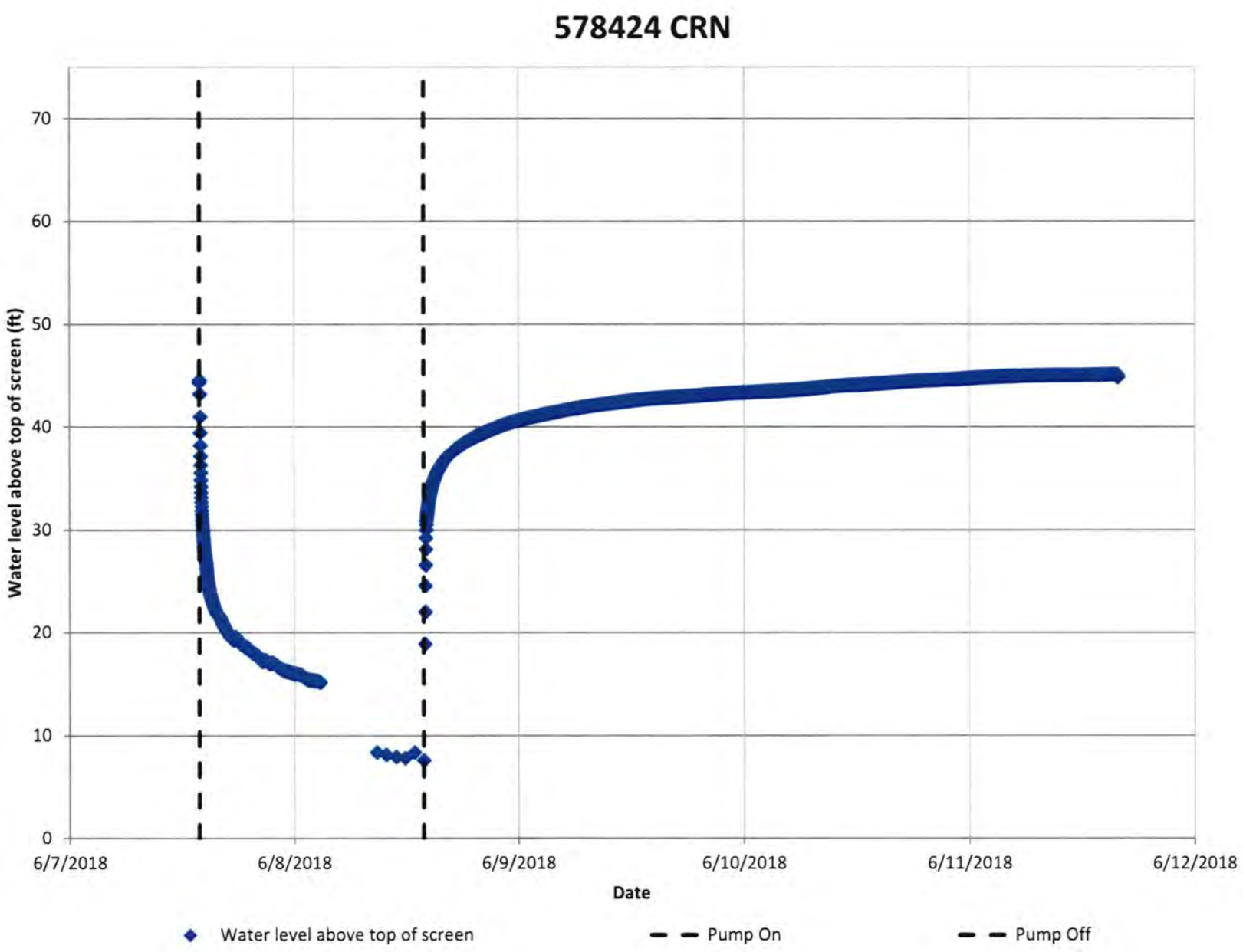

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RECD MAY 29, 2019

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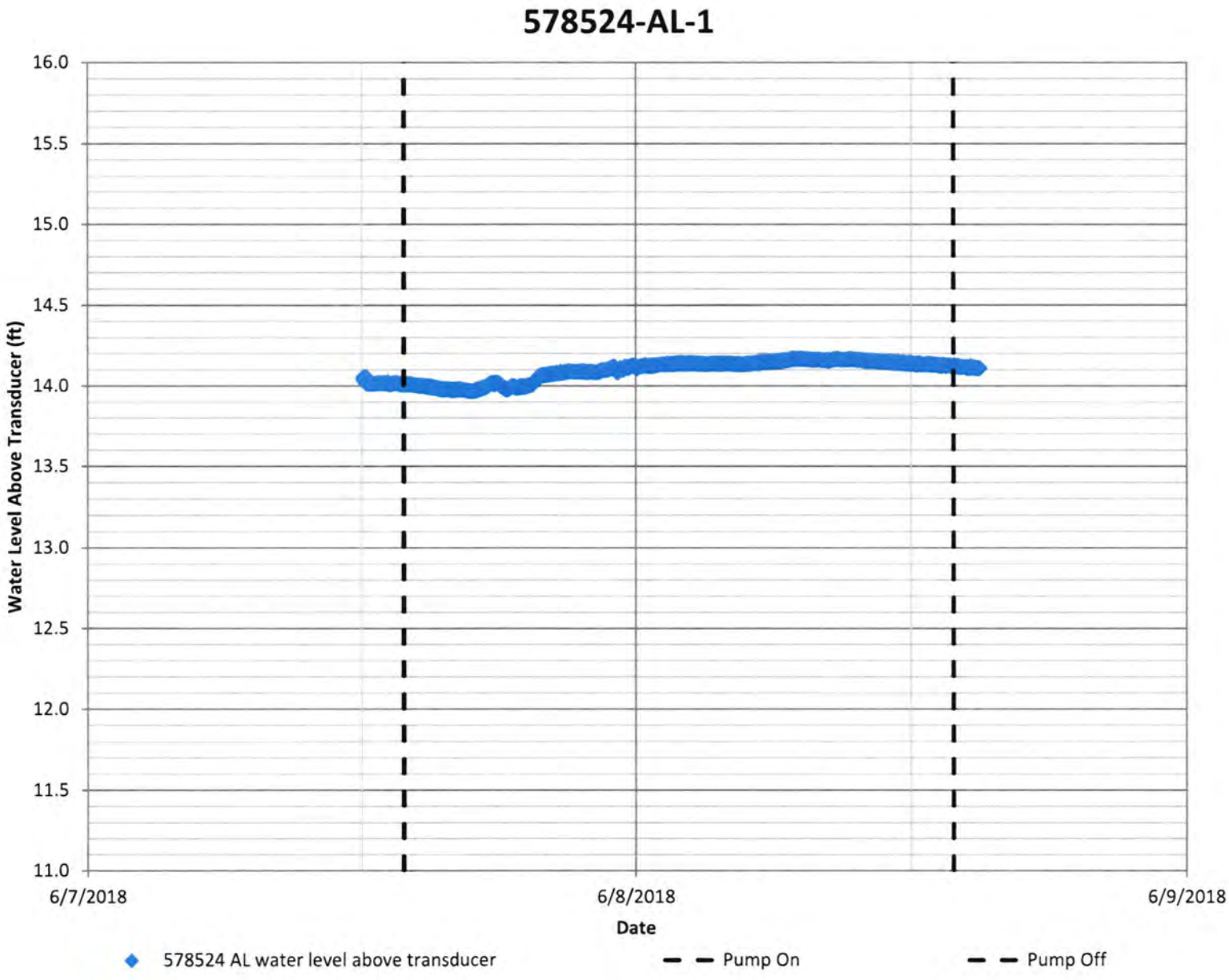

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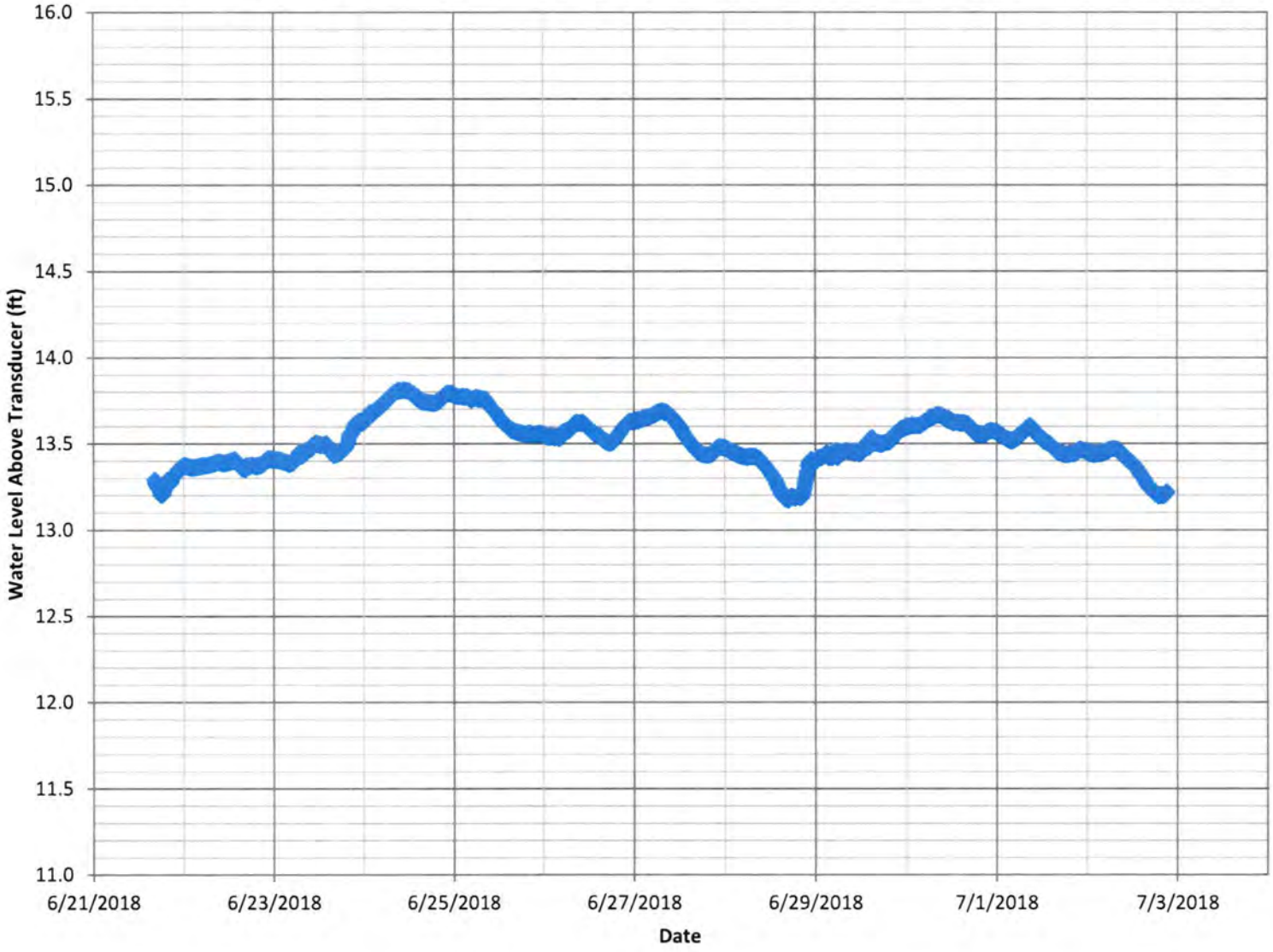
578524-AL-1 Post Aquifer Test Observation Period Water Fluctuations



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EEQ MAY 23, 2019

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MEMORANDUM

WWC ENGINEERING

1849 Terra Avenue Sheridan, Wyoming 82801
PHONE: (307) 672-0761 FAX: (307) 674-4265 WEBSITE: www.wwcengineering.com

TO: **RAMACO**

FROM: **Ray Moores, P.E.**

DATE: **July 20, 2018**

SUBJECT: **Pumping Test Summary and Results for 578420-CRN and 578420-AL-1 Wells.**

WWC Engineering (WWC) conducted an aquifer test on the 578420-CRN well completed in the Carney Coal on June 21, 2018. During the aquifer test a nearby alluvial well 578420-AL-1 was also monitored. The objectives of the test were to measure the aquifer properties in the Carney Coal and evaluate whether there is a hydraulic connection between the Carney Coal and the alluvial aquifer. The well was pumped for 38 minutes and obtained a maximum drawdown of 15.6 feet at an average discharge of 0.5 gallons per minute (gpm). WWC analyzed the aquifer test data with the Theis Recovery (1935) solution to obtain an aquifer transmissivity of 0.07 square feet per day. The Theis Recovery analysis as well as hydrographs for the pumped well and the observation well are attached to this memorandum.

578420-CRN well is approximately 30 feet deep. The Carney coal is about 5 feet thick and starts at about 18 feet below the surface. The strata immediately above and below to the coal is a very fine-grained bedrock claystone. As such, the coal is the only contributing unit to the well. Well 578420-AL-1 is approximately 155 feet from the pumping well and is completed in the overlying alluvial aquifer. The alluvial aquifer is separated from the Carney coal by approximately 3 feet of claystone.

Despite the relatively low pumping rate (0.5 gpm) during the aquifer test, the water level in well 578420-CRN dropped to the level of the pump after 38 minutes. The amount of water in storage within the wellbore and filter pack around the wellbore is approximately equivalent to the total volume of water pumped during the test. Since the aquifer test didn't pull the majority of water from the formation, the test is less than ideal. Never-the-less, for a radius very close to the wellbore the transmissivity calculated by the Theis recovery solution is a reasonable approximation.

Given the low transmissivity of the Carney coal in this vicinity and the short duration of the aquifer test, the alluvial well was too far away to show any impacts from pumping in 578420-CRN. The hydrograph from 578420-AL-1 confirms that the alluvial water level was not affected during the test.

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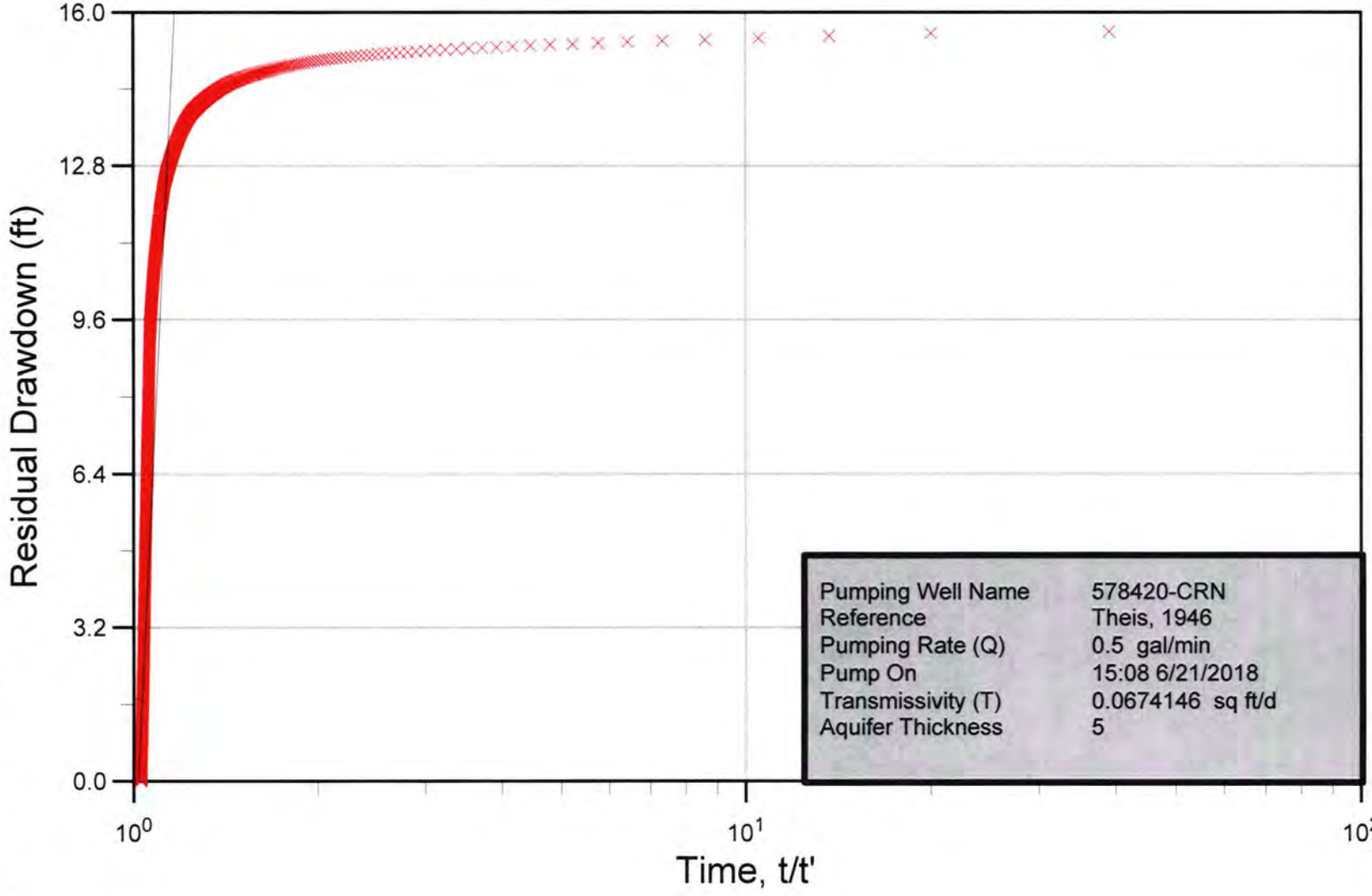
Theis Recovery 578420-CRN



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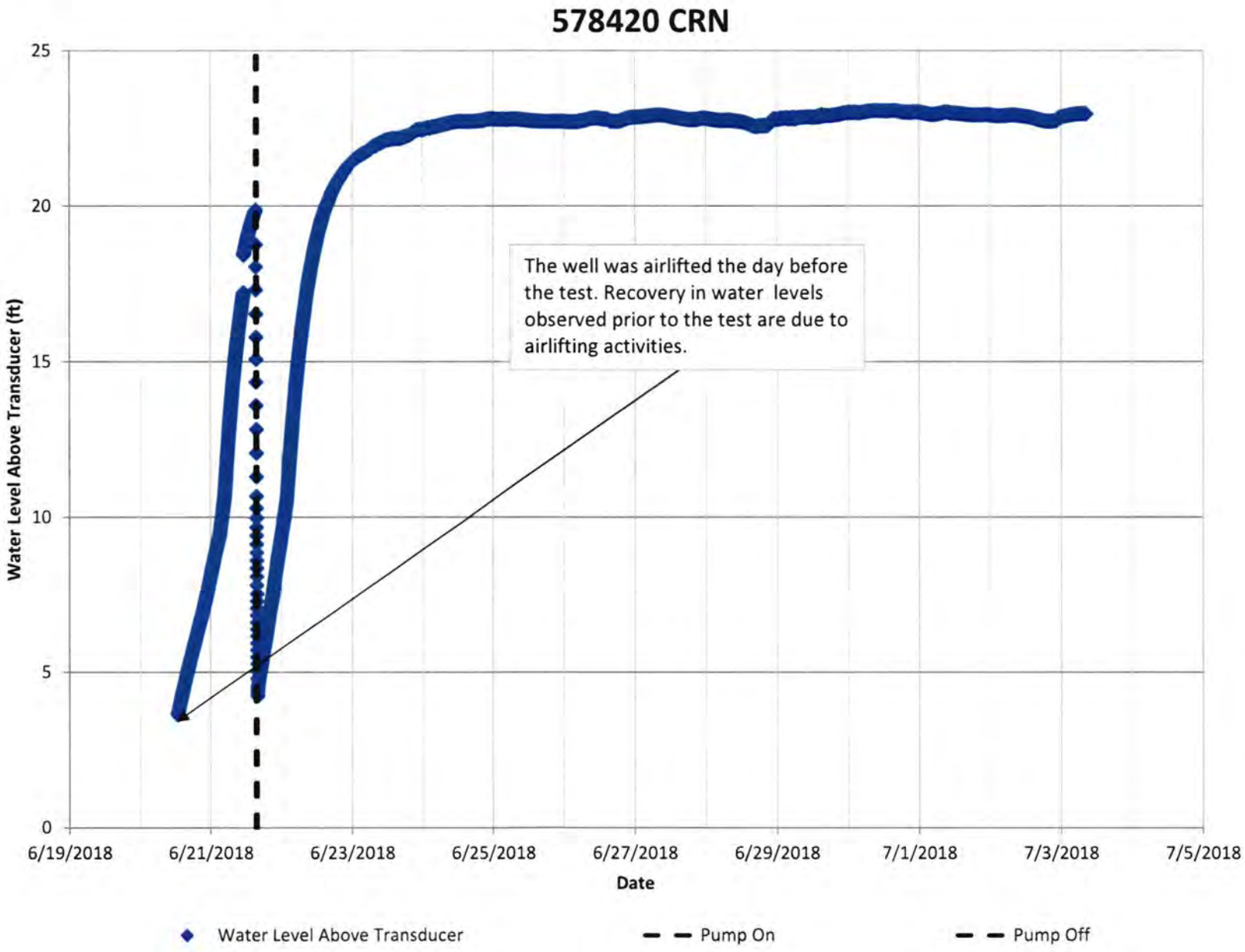

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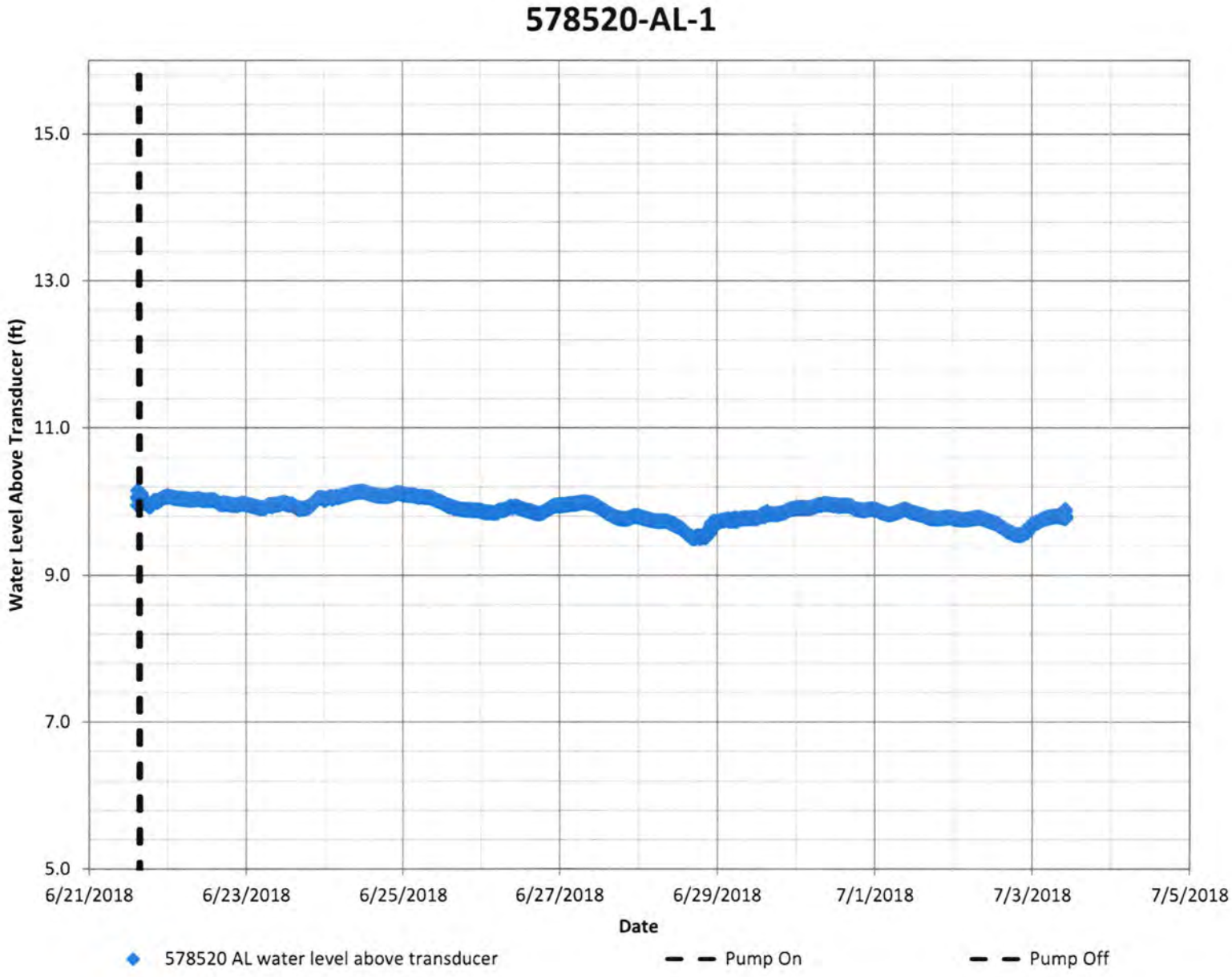

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RECD MAY 23, 2019

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SLUG TESTS

Slug testing was performed in aquifers to estimate the aquifer's hydraulic conductivity. The type of test was a slug out test. For each slug test, the following was documented: date of slug test, time of slug test, personnel present, weather conditions, equipment used, and water level measurements. The transducer was set in the well and the groundwater was stabilized for a time period suitable for the transducer. The water level in the well was measured with a pressure transducer prior to starting the test. The water level was rapidly lowered and then measurements of the rising water level in the well were taken. After the well has had a sufficient time to recover to equilibrium, the water level readings were ceased, and the transducer was withdrawn from the well.

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OCT 23, 2019

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2018 Slug Test Summary

Well	Aquifer thickness (ft)	Well Diameter (ft)	Screen Length (ft)	Top of screen at (ft)	Confined?	K (Hvorslev) (ft/d)	K (Bouwer/Rice) (ft/d)	Transmissivity (ft2/day)
578417-MST	6	0.167	5	156	No	NA	0.016	0.10
578417-CRN	16	0.167	22	118	No	NA	0.022	0.35
578408-MST	5	0.167	5	113	Yes	1.417	NA	7.09
578408-CRN	11	0.167	10	86	No	NA	0.097	1.07
578409-MST	5	0.417	5	115	No	NA	0.510	2.55
578409-CRN	18	0.417	20	88	No	NA	0.313	5.63
578418-CRN	20	0.417	20	132	No	NA	0.975	19.50
578512-MST	5	0.417	5	109	No	NA	1.205	6.03
578512-AL-1	18.5	0.417	15	5	No	NA	23.038	426.20
578513-MST	5	0.417	5	137	Yes	55.677	NA	278.38
578513-AL-1	19	0.417	15	5	No	NA	39.34	747.5
578418-AL-1	24	0.417	20	5	No	NA	0.229	5.50
578511-MST	4	0.417	5	152	Yes	0.135	NA	0.54
578511-CRN	8	0.417	8	119	No	NA	0.379	3.03
578433-AL-1	12	0.167	10	6	No	NA	6.72	80.6
578434-AL-1	9	0.167	10	6	No	NA	18.25	164.25
578434-AL-2	10	0.167	10	NA	No	NA	28.858	288.58
578420-AL-1	10	0.167	10	6	No	NA	18.984	189.84
578421-3-MAS	3	0.417	6	118	Yes	0.232	NA	0.70

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WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578417-MST

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☐ electric tape ☒ pressure transducer

Slug Type: ☐ solid ☒ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 5 1/8" = 0.43', 2" PVC casing inches

Screen/Perforation Top Depth (below land surface) 156' - 161' feet

Screen Length 5' feet

Aquifer Thickness 26' feet

Depth of Static Water Level (from measurement point) 160.41', TD = 163.80' feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 7 / 18 Time 10:28 (AM)/PM

Tranducer Off Date 3 / 8 / 18 Time 13:08 AM/(PM)

Weather Conditions

Test Performed by Loren Ruttinger, Rod Fuller

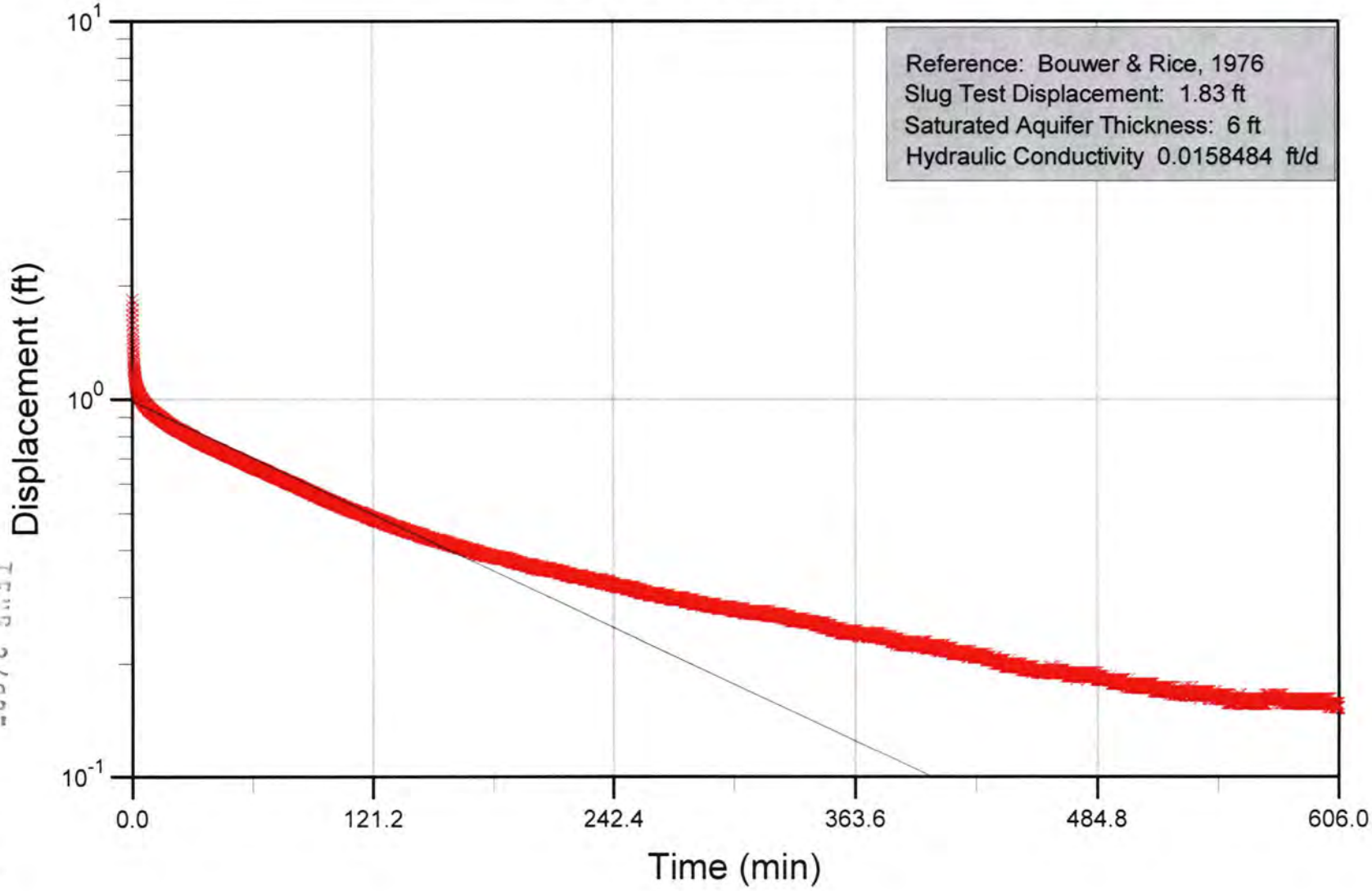
TFNS 2/625

D6-15-14

RECD MAY 23, 2019

Scanned, 02/26/2020

578417-MST



TFRD 2/825
RECD MAY 23, 2019

Scanned, 02/26/2020

RAMACO

Brook Mine
Page 1 of 1

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578417-CRN

Type of Slug Test: ☐ Slug In ☒ Slug Out

Water Level Measurements by: ☐ electric tape ☒ pressure transducer

Slug Type: ☒ solid ☒ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 5 5/8" = 0.47', 2" PVC casing inches

Screen/Perforation Top Depth (below land surface) 118' - 140' = 22' feet

Screen Length 22' feet

Aquifer Thickness 124' - 140' = 16' feet

Depth of Static Water Level (from measurement point) NA, TD = 142.43' feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 7 / 18 Time 11:50 (AM)/PM

Tranducer Off Date 3 / 8 / 18 Time 10:08 (AM)/PM

Weather Conditions

Test Performed by Rod Fuller, LOREN Ruttinger

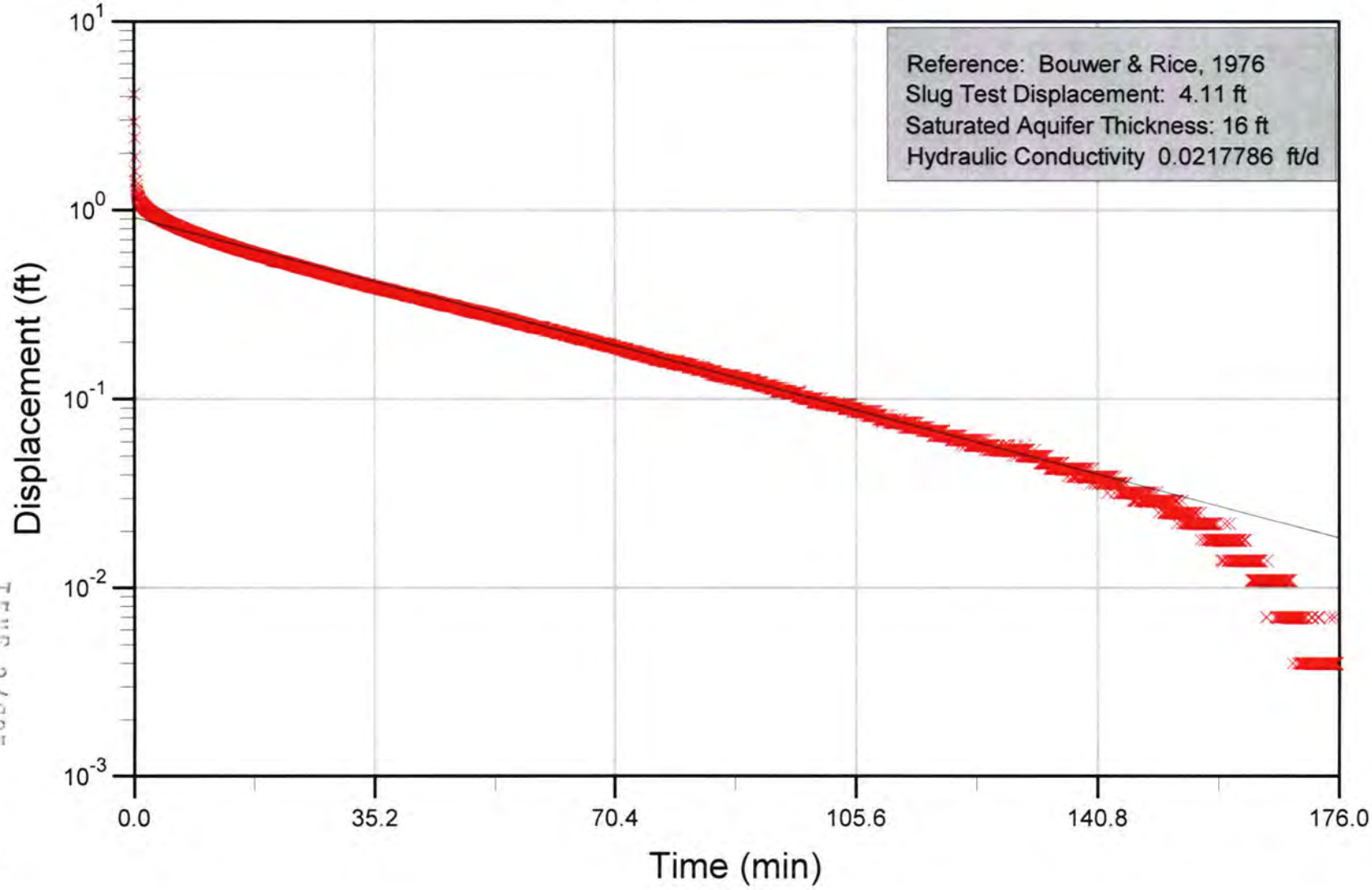
April 2019

TFNS 2/825
RECD MAY 23, 2019

D6-15-16

Scanned, 02/26/2020

578417-CRN



TFWS 2/823
RECD MAY 23, 2018

Scanned, 02/26/2020

RAMACO

Brook Mine
Page 1 of 1

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578408-MST

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☑ ~~electric tape~~ ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole ~~NA~~ 5 5/8" = 0.47', 2" SCH 40 Casing inches

Screen/Perforation Top Depth (below land surface) 113' - 118' = 5' feet

Screen Length 5' feet

Aquifer Thickness ~5' feet

Depth of Static Water Level (from measurement point) DTW 104.07' / TD 120.20 feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point 3,887.9' feet a.m.s.l.

Transducer On Date 3 / 9 / 18 Time 0950 AM/PM

Tranducer Off Date 3 / 9 / 18 Time 1404 AM/PM

Weather Conditions Clear and sunny 40°F ish

Test Performed by Rod Fuller

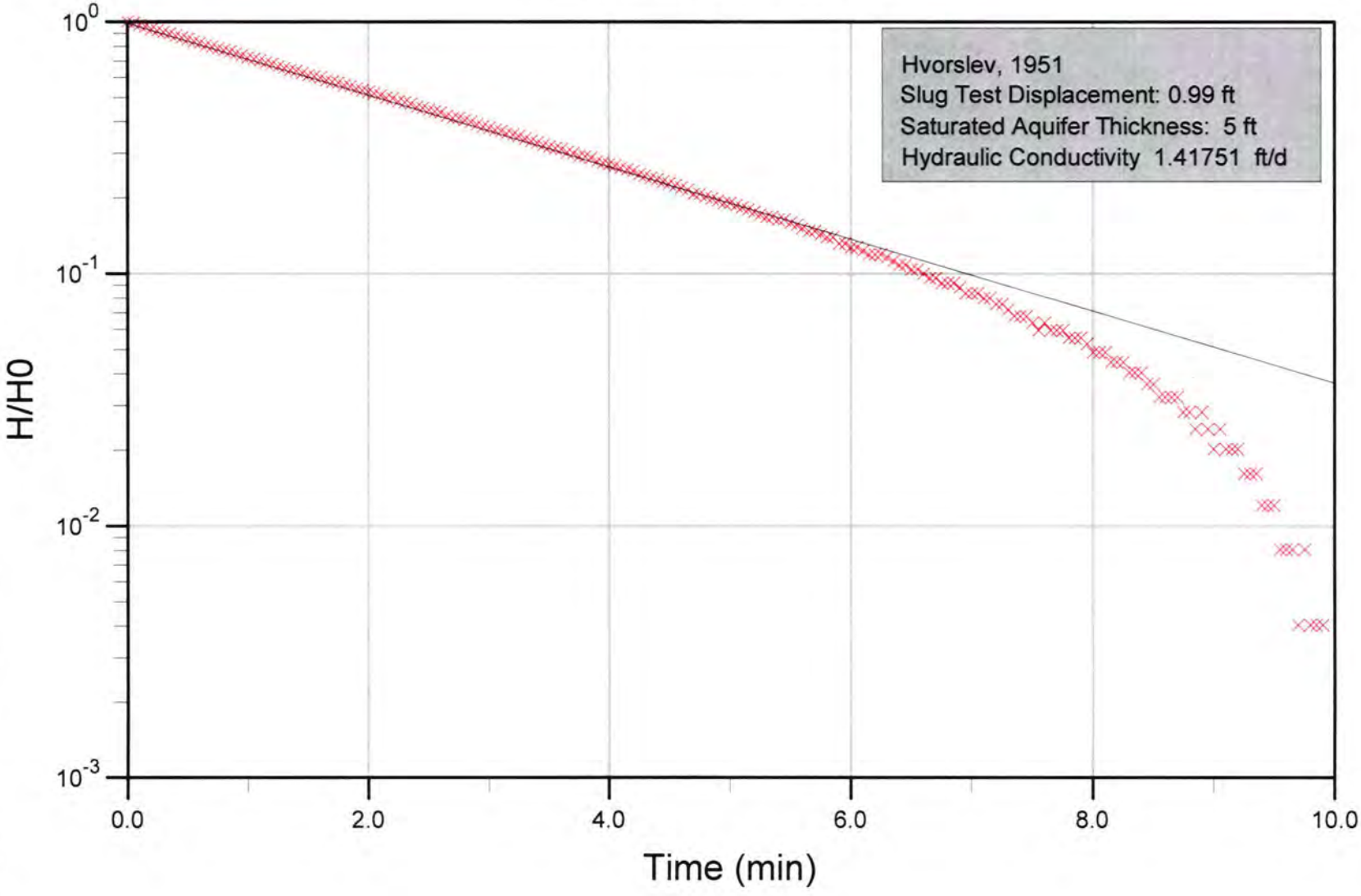
April 2019

TENS 2/625
RECD MAY 23, 2019

D6-15-18

Scanned, 02/26/2020

578408-MST



TFNS 2/525
RECD MAY 29, 2019

DEQ Ex. 3-1841

Scanned, 02/26/2020

RAMACO

Brook Mine
Page 1 of 1

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578408-CRN

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☑ ~~electric tape~~ ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet (11.33')

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 5⅛" = 0.43', 2" Well casing inches

Screen/Perforation Top Depth (below land surface) 86-96' feet

Screen Length 10' feet

Aquifer Thickness ~11' feet

Depth of Static Water Level (from measurement point) 87.39' / TD = 98.27' feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point 3,887.7' feet a.m.s.l.

Transducer On Date 3 / 9 / 18 Time 1018 AM/PM

Tranducer Off Date 3 / 9 / 18 Time 1352 AM/PM

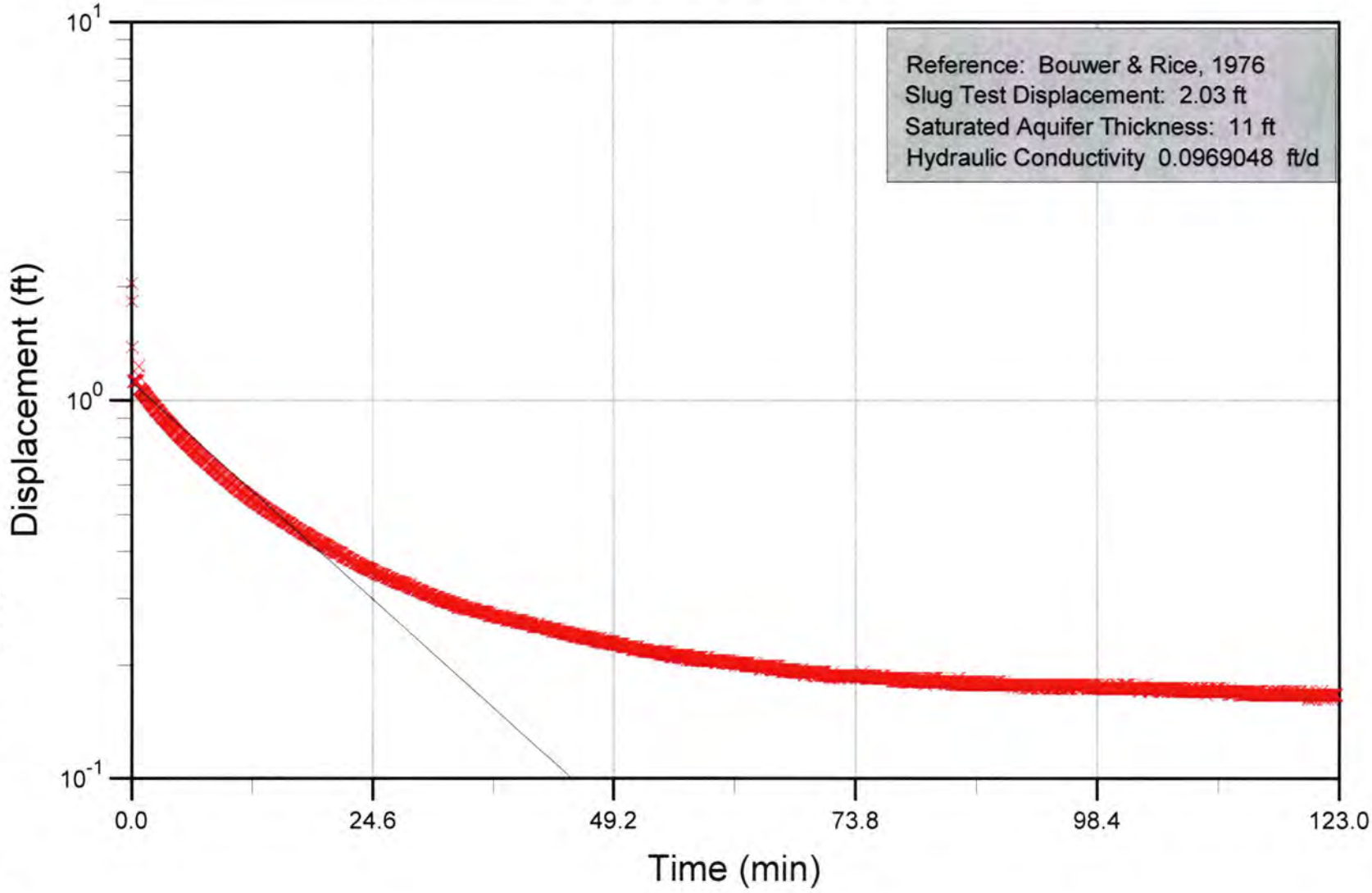
Weather Conditions Clear and sunny, 40°F 15h

Test Performed by Rod Fuller

TFNS 2/025
RECD MAY 23, 2019

Scanned, 02/26/2020

578408-CRN



TFNS 2/6/25
RECD MAY 23, 2019

DEQ Ex. 3-1843

Scanned, 02/26/2020

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco - 2013139-98

Observation Well No. 578409 - MST

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☑ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: 1.56 feet

Cased Well Casing ID 4.75" (5") inches

Diameter of Drilled Hole 9 7/8" inches

Screen/Perforation Top Depth (below land surface) 115' feet

Screen Length 115'-120' → 5' feet

Aquifer Thickness 5' feet

Depth of Static Water Level (from measurement point) 96.00 / TD = 122.80 feet

Height of Measurement Point (above land surface) ___ feet

Elevation of Measurement Point 3712.4 feet a.m.s.l.

Transducer On Date 3 / 26 / 19 Time 1058 (AM)/PM

Tranducer Off Date 3 / 27 / 19 Time 0444 (AM)/PM

Weather Conditions ___

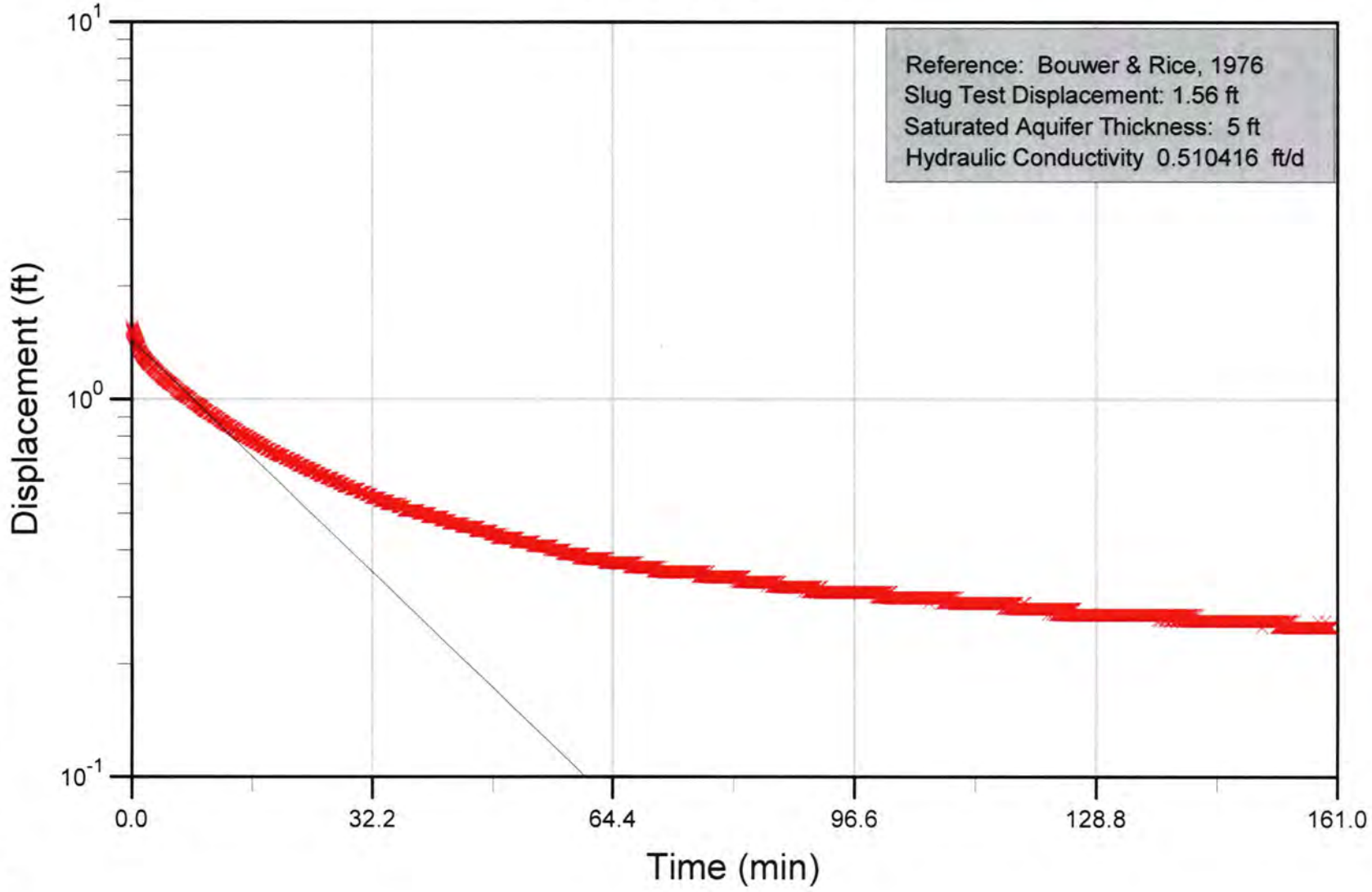
Test Performed by Rod Fuller

DEQ Ex. 3-1844

TFNS 2/025
RECD MAY 23, 2019

Scanned, 02/26/2020

578409-MST



TFNS 2/2/25
RECD MAY 29, 2018

DEQ Ex. 3-1845

Scanned, 02/26/2020

RAMACO

Brook Mine

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco - 2013139-98

Observation Well No. 578409-CRN

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☑ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: 1.41' feet

Cased Well Casing ID 4.75" (5") inches

Diameter of Drilled Hole 9 7/8" inches

Screen/Perforation Top Depth (below land surface) 88' feet

Screen Length 20' feet

Aquifer Thickness 88' to 108' → 20' feet

Depth of Static Water Level (from measurement point) 88.71 / TD = 110.45 feet

Height of Measurement Point (above land surface) _____ feet

Elevation of Measurement Point 3712.7 feet a.m.s.l.

Transducer On Date 3 / 26 / 19 Time 1144 (AM)/PM

Tranducer Off Date 3 / 27 / 19 Time 9:59 AM/PM

Weather Conditions _____

Test Performed by Rod Fuller

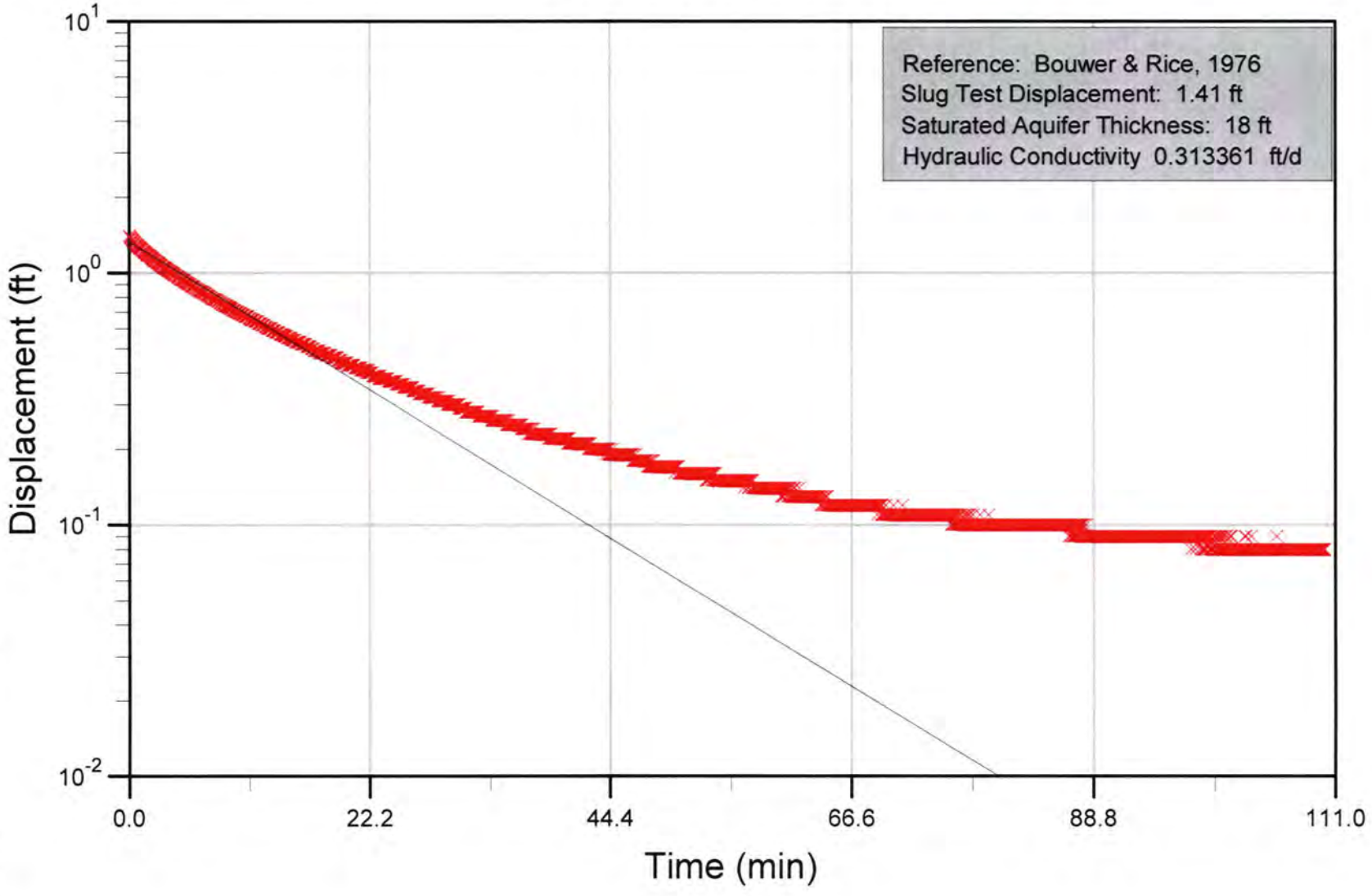
April 2019

D6-15-24

TENS 2/025
RECD MAY 23, 2019

Scanned, 02/26/2020

578409-CRN



TFNS 2/825
SEED MAY 28, 2015

Scanned, 02/26/2020

RAMACO

Brook Mine
Page 1 of 1

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578418 - CRN

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☐ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole ~~NA~~ 9 7/8" 5" Casing (SDR-17) inches

Screen/Perforation Top Depth (below land surface) 132' - 152' feet

Screen Length 20' feet

Aquifer Thickness ≥ 20' feet

Depth of Static Water Level (from measurement point) TD 153.75 feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 9 / 18 Time 1454 AM/PM

Tranducer Off Date 3 / 10 / 18 Time 1734 AM/PM

Weather Conditions

Test Performed by Rod Fulks

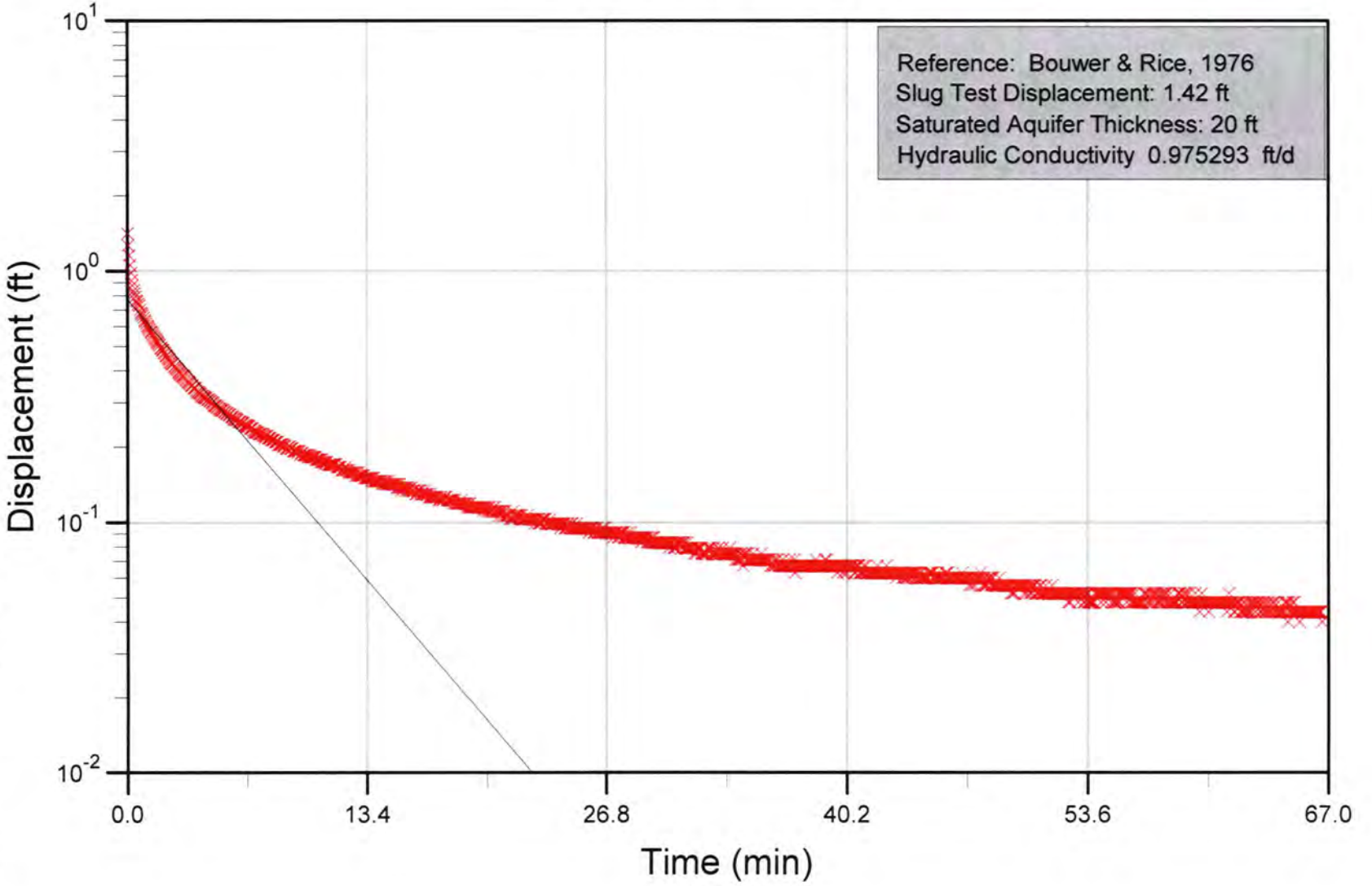
April 2019

TFNS 2/825
RECD MAY 23, 2019

D6-15-26

Scanned, 02/26/2020

578418-CRN



TFNS 2/825
RECD MAY 23, 2019

Scanned, 02/26/2020

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578512-MST

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ~~☑ electric tape~~ ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet 3.33'

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 9 7/8" = 0.82', 5" Casing (SDR-17) inches

Screen/Perforation Top Depth (below land surface) 109 - 114 feet

Screen Length 5' feet

Aquifer Thickness 109 - 114 = 5' feet

Depth of Static Water Level (from measurement point) 111.92', TD = 114.92' feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 12 / 18 Time 11:21 (AM)/PM

Tranducer Off Date 3 / 12 / 18 Time 14.02 AM/(PM)

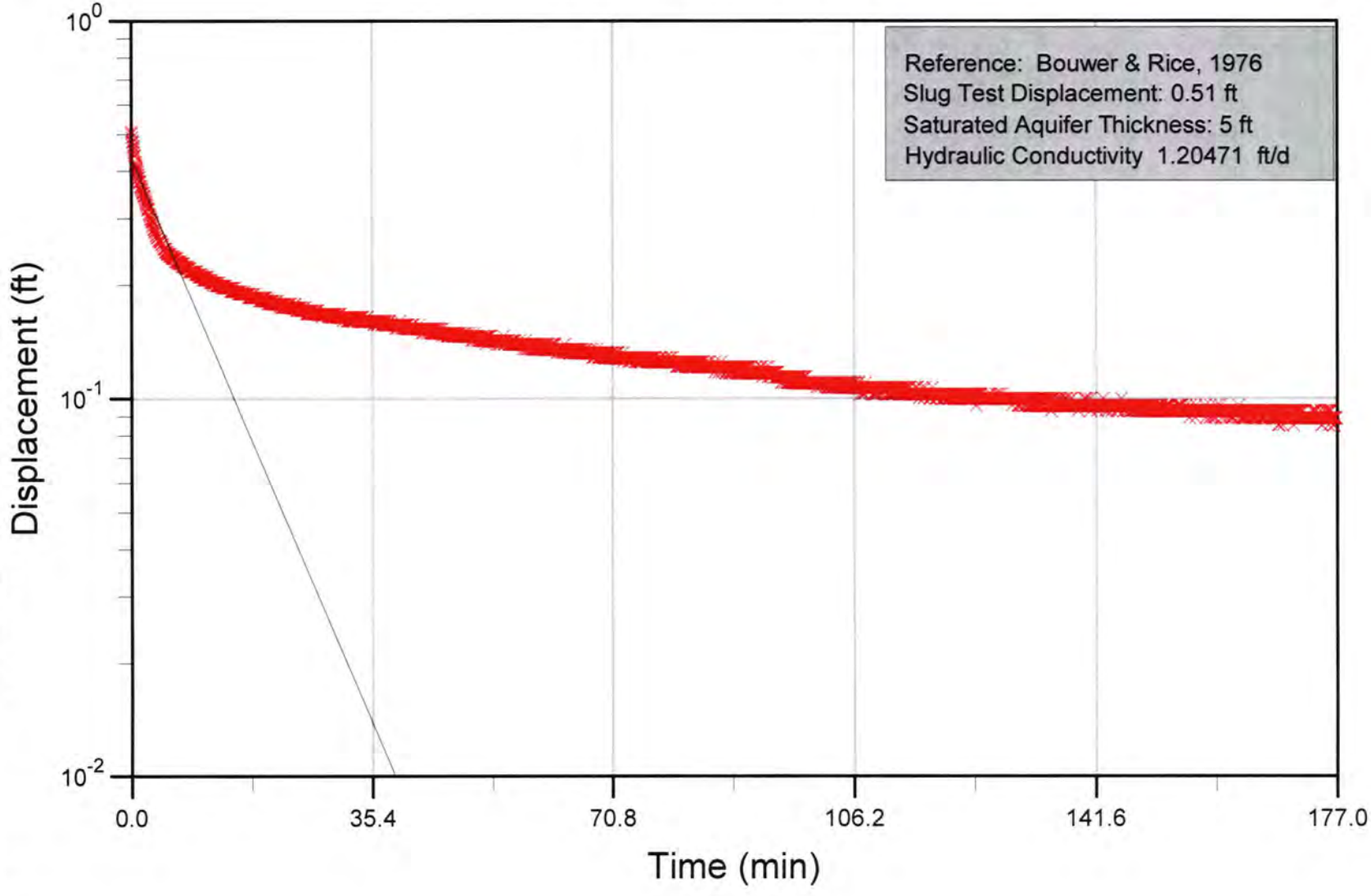
Weather Conditions

Test Performed by Rod Fuller

TENS 2/825
RECD MAY 23, 2018

Scanned, 02/26/2020

578512-MST



TFNS 2/025
RECD MAY 28, 2019

Scanned, 02/26/2020

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578512-AL

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☐ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 9 7/8" = 0.82', 5" casing (SDR-17) inches

Screen/Perforation Top Depth (below land surface) 5'-20' feet

Screen Length 5'-20' = 15' feet

Aquifer Thickness 1'-19.5' = 18.5' feet

Depth of Static Water Level (from measurement point) 3.71', TD = 21.35' feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 10 / 12 / 18 Time 1215 AM/PM

Tranducer Off Date 10 / 12 / 18 Time 1434 AM/PM

Weather Conditions

Test Performed by Rod Fuller

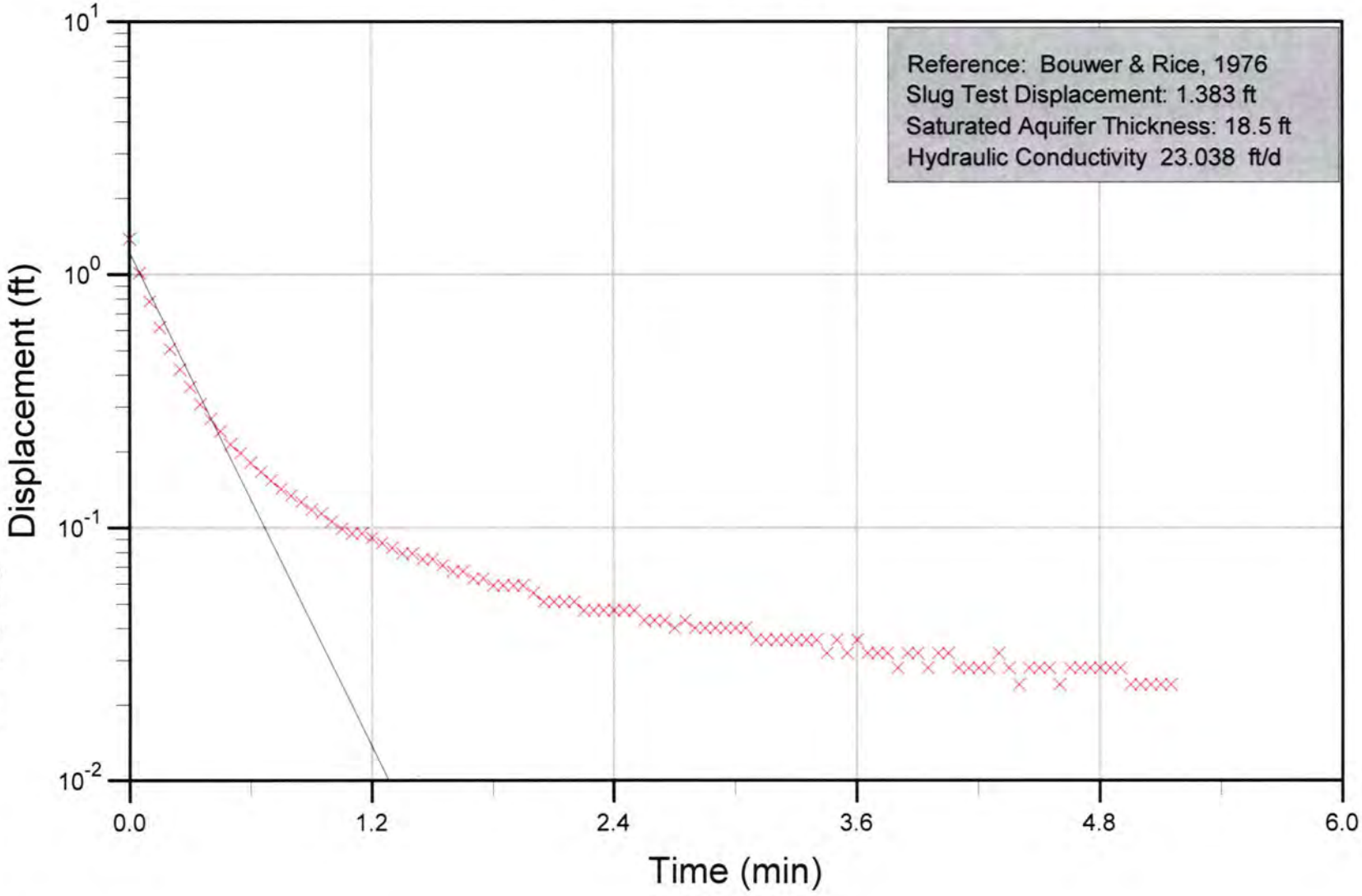
April 2019

TFNS 2/825
RECD MAY 23, 2019

D6-15-30

Scanned, 02/26/2020

578512-AL-1



TFNS 2/625
RECD MAY 23, 2019

Scanned, 02/26/2020

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578513 - MST

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☑ ~~electric tape~~ ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet

30.03
30.08

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 9 7/8" = 0.82', 5" Casing (SDR-17) inches

Screen/Perforation Top Depth (below land surface) 137' - 142' = 5' feet

Screen Length 5' feet

Aquifer Thickness 137-142' = 5' feet

Depth of Static Water Level (from measurement point) 105.77 / TD = 144.10 feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 12 / 18 Time 1513 AM/PM

Tranducer Off Date 3 / 12 / 18 Time 1551 AM/PM

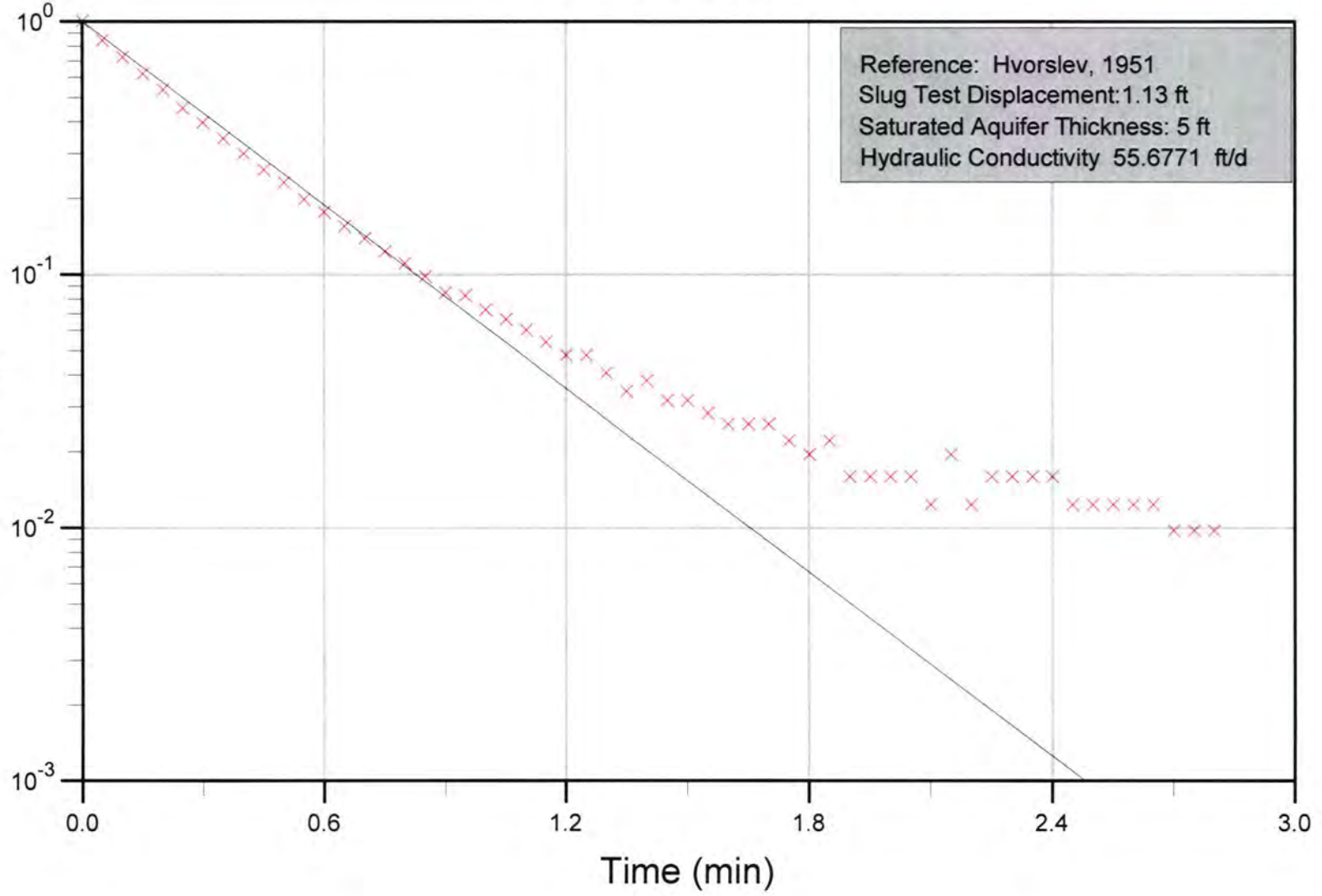
Weather Conditions

Test Performed by Rod Fuller

TFNS 2/825
RECD MAY 23, 2019

Scanned, 02/26/2020

578513-MST



TFNS 2/025

DEQ Ex. 3-1855

Scanned, 02/26/2020

RAMACO

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578513-AL

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ~~☑ electric tape~~ ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 9 7/8" = 0.82', 5" PVC Casing inches

Screen/Perforation Top Depth (below land surface) 5' - 20' = 15' feet

Screen Length 15' feet

Aquifer Thickness 1 - 20 = 19' feet

Depth of Static Water Level (from measurement point) 6.51' / TD = 20.90 feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 13 / 18 Time 1021 (AM)/PM

Tranducer Off Date 3 / 13 / 18 Time 11:51 (AM)/PM

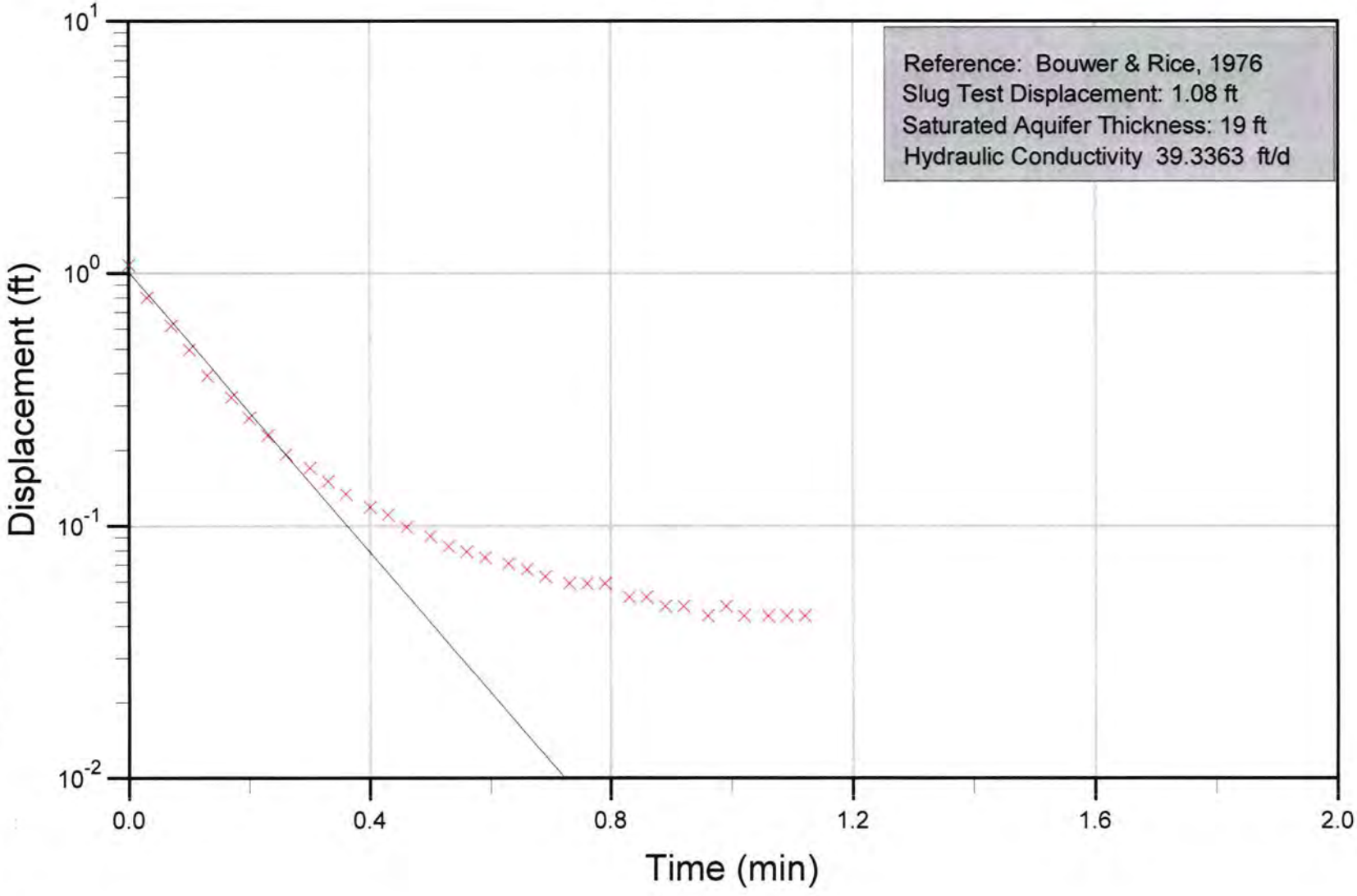
Weather Conditions Clear and sunny 25°F ish

Test Performed by Rod Fuller

TFNS 2/825
RECEIVED MAY 23, 2019

Scanned, 02/26/2020

578513-AL-1



TENS 2/625
RECEIVED MAY 29, 2019

Scanned, 02/26/2020

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578418-AL-1

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☑ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet (4.03)

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 9 7/8" = 0.82', 5" casing (PVC) inches

Screen/Perforation Top Depth (below land surface) 5' - 25' feet

Screen Length 20' feet

Aquifer Thickness 1' - 25' = 24' feet

Depth of Static Water Level (from measurement point) 20.72', TD = 24.67' feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 13 / 18 Time 1145 (AM)/PM

Tranducer Off Date 3 / 14 / 18 Time 1008 (AM)/PM

Weather Conditions Clear and sunny 35°F 15h

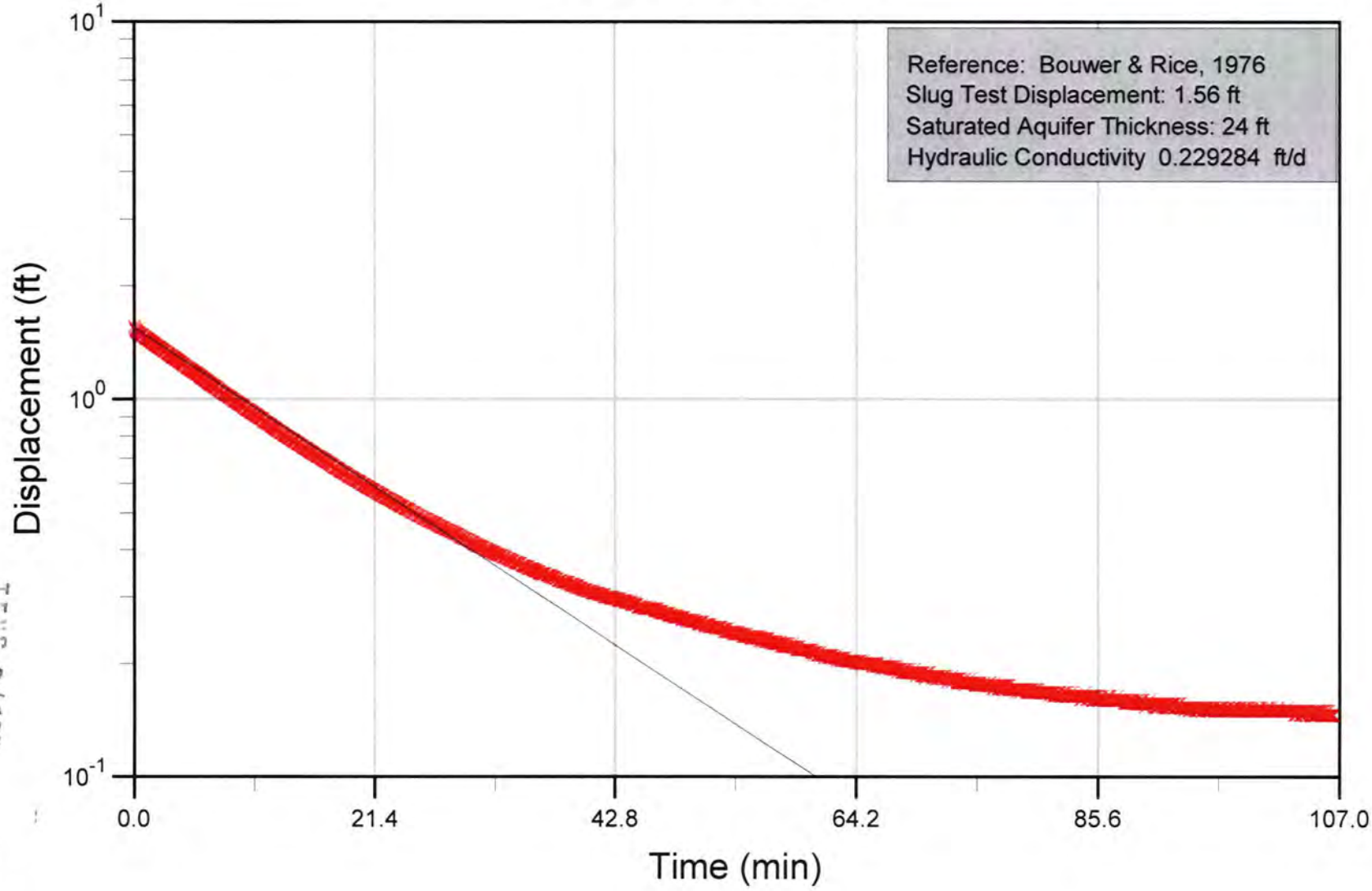
Test Performed by Rod Fuller

DEQ Ex. 3-1858

TFWS 2/825
RECD MAY 23, 2019

Scanned, 02/26/2020

578418-AL-1



TFNS 2/025

Scanned, 02/26/2020

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578511 - MST

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ~~☑ electric tape~~ ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 9 7/8 = 0.82', 5" casing (SDR-17) inches

Screen/Perforation Top Depth (below land surface) 152'-157' = 5' feet

Screen Length 5' feet

Aquifer Thickness 152-156 = 4.0' feet

Depth of Static Water Level (from measurement point) 149.71' / TD = 158.70' feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

* Pulled up slug and also pulled up ~~P.T.~~, which was tangled with slug line. Cleared P.T. and reset. Used more weight

Transducer On Date 3 / 14 / 18 Time ~~1044~~ 1420 AM/PM

Tranducer Off Date 3 / 15 / 18 Time 1003 AM/PM

Weather Conditions clear and sunny 50°F +

Test Performed by Rod Fuller

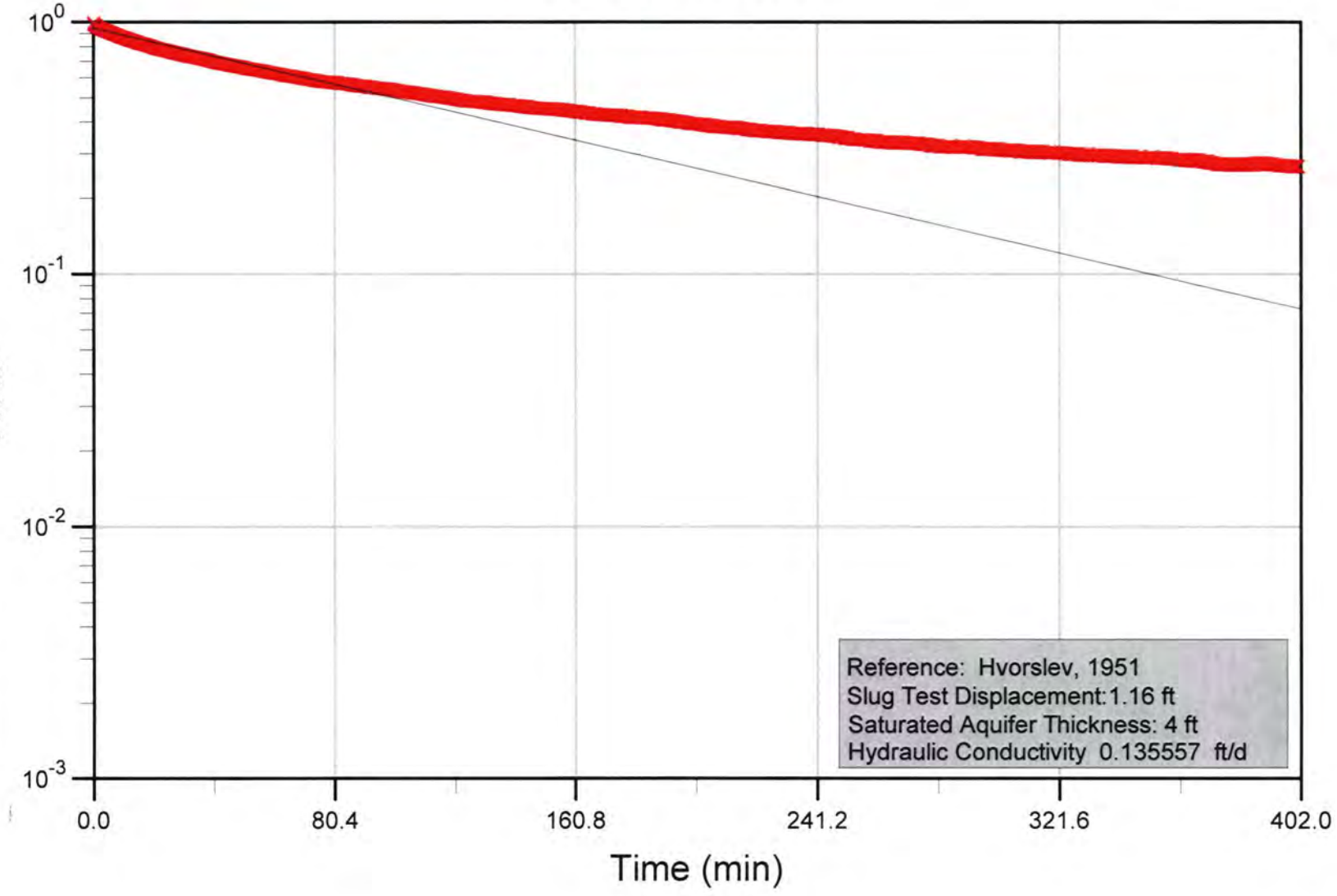
April 2019

TFNS 2/825
RECD MAY 23, 2019

D6-15-38

Scanned, 02/26/2020

578511-MST



TFWS 2/625

DEQ Ex. 3-1861

Scanned, 02/26/2020

RAMACO

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578511-CRN

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☑ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

8.87

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole 9 7/8 = 0.82', 5" Casing (SDR-17) inches

Screen/Perforation Top Depth (below land surface) 119' - 127' = 8' feet

Screen Length 8' feet

Aquifer Thickness 119' - 127' = 8' feet

Depth of Static Water Level (from measurement point) 119.42' / TD = 128.80 feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 14 / 18 Time 11:16 (AM)/PM

Tranducer Off Date 3 / 15 / 18 Time 9:29 (AM)/PM

Weather Conditions Clear and sunny 50°F +

Test Performed by Rod Fuller

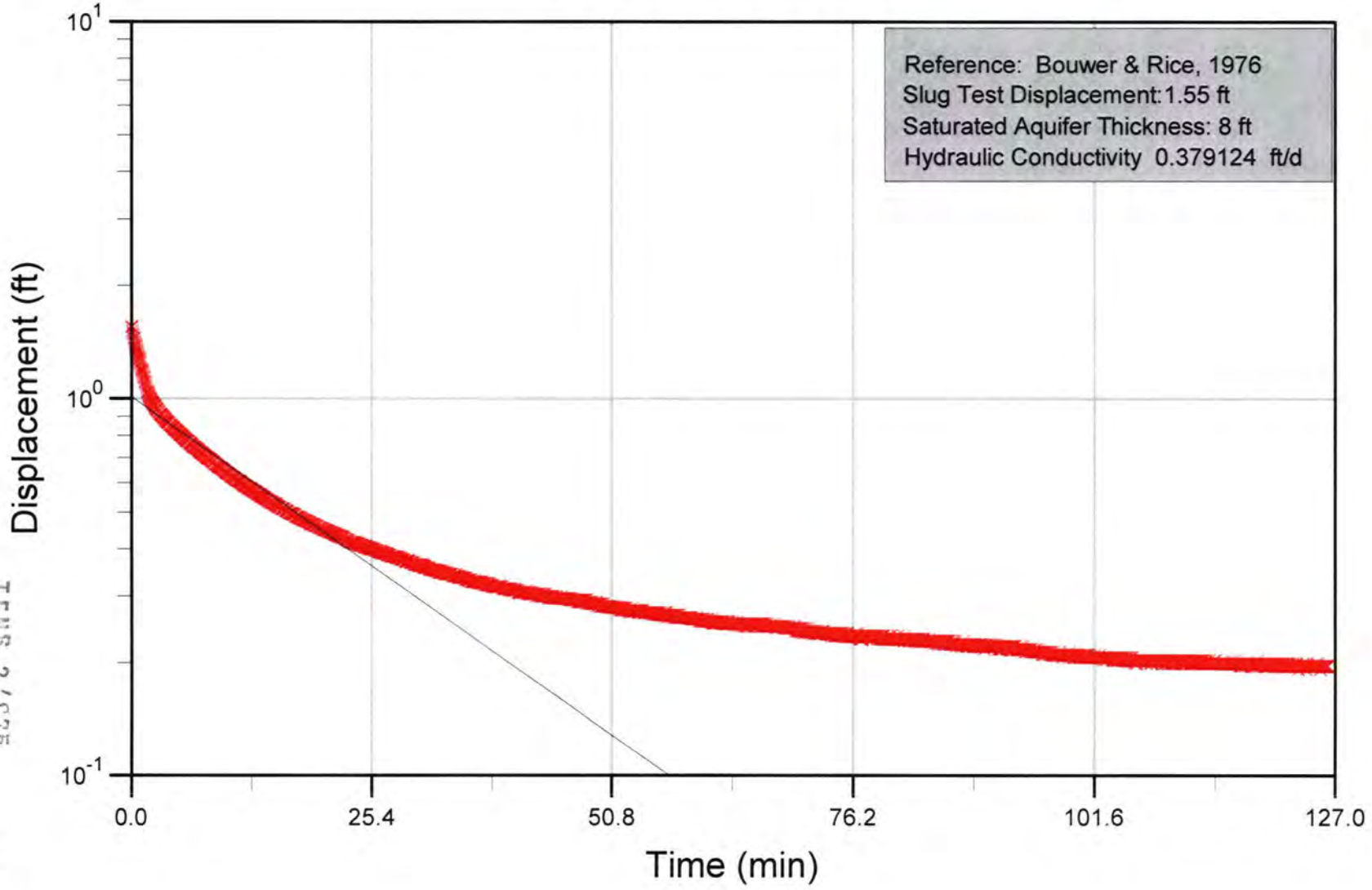
TFNS 2/825

D6-15-40

DEC... ...ry 23, 2019

Scanned, 02/26/2020

578511-CRN



TFNS 2/825
RECD MAY 23, 2019

DEQ Ex. 3-1863

Scanned, 02/26/2020

RAMACO

Brook Mine
Page 1 of 1

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578433-AL-1

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☑ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole Geoprobe 2" core (2" casing) inches

Screen/Perforation Top Depth (below land surface) 6 feet feet

Screen Length 10 feet feet

Aquifer Thickness 12' - 16' feet

Depth of Static Water Level (from measurement point) TD = 16.16 feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 15 / 18 Time 1047 (AM)/PM

Tranducer Off Date 3 / 15 / 18 Time 1223 AM/(PM)

Weather Conditions

Test Performed by Rod Fuller

TFNS 2/825

RECD MAY 23, 2019

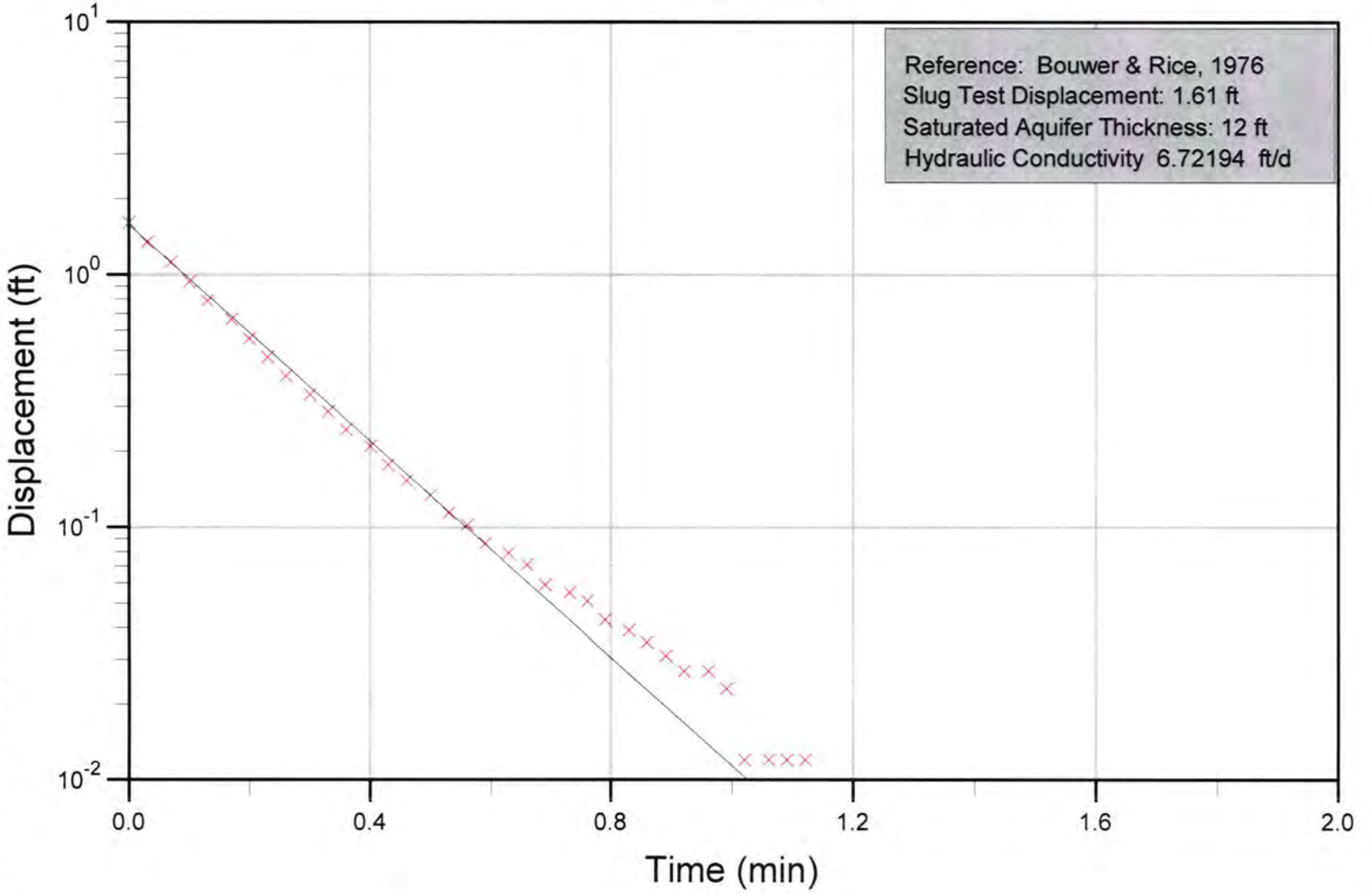
April 2019

D6-15-42

DEQ Ex. 3-1864

Scanned, 02/26/2020

578433-AL-1



TFNS 2/825
RECD MAY 23, 2019

Scanned, 02/26/2020

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco

Observation Well No. 578434-AL-1

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☐ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: NA feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole Geoprobe 2" core (2" casing) inches

Screen/Perforation Top Depth (below land surface) 10' feet

Screen Length 2" PVC 10' of perforated screen feet

Aquifer Thickness 4-13 feet feet

Depth of Static Water Level (from measurement point) TD = 13.25 feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 3 / 15 / 18 Time 1232 AM/PM

Tranducer Off Date 3 / 15 / 18 Time 13:21 AM/PM

Weather Conditions

Test Performed by Rod Fuehrer

April 2019

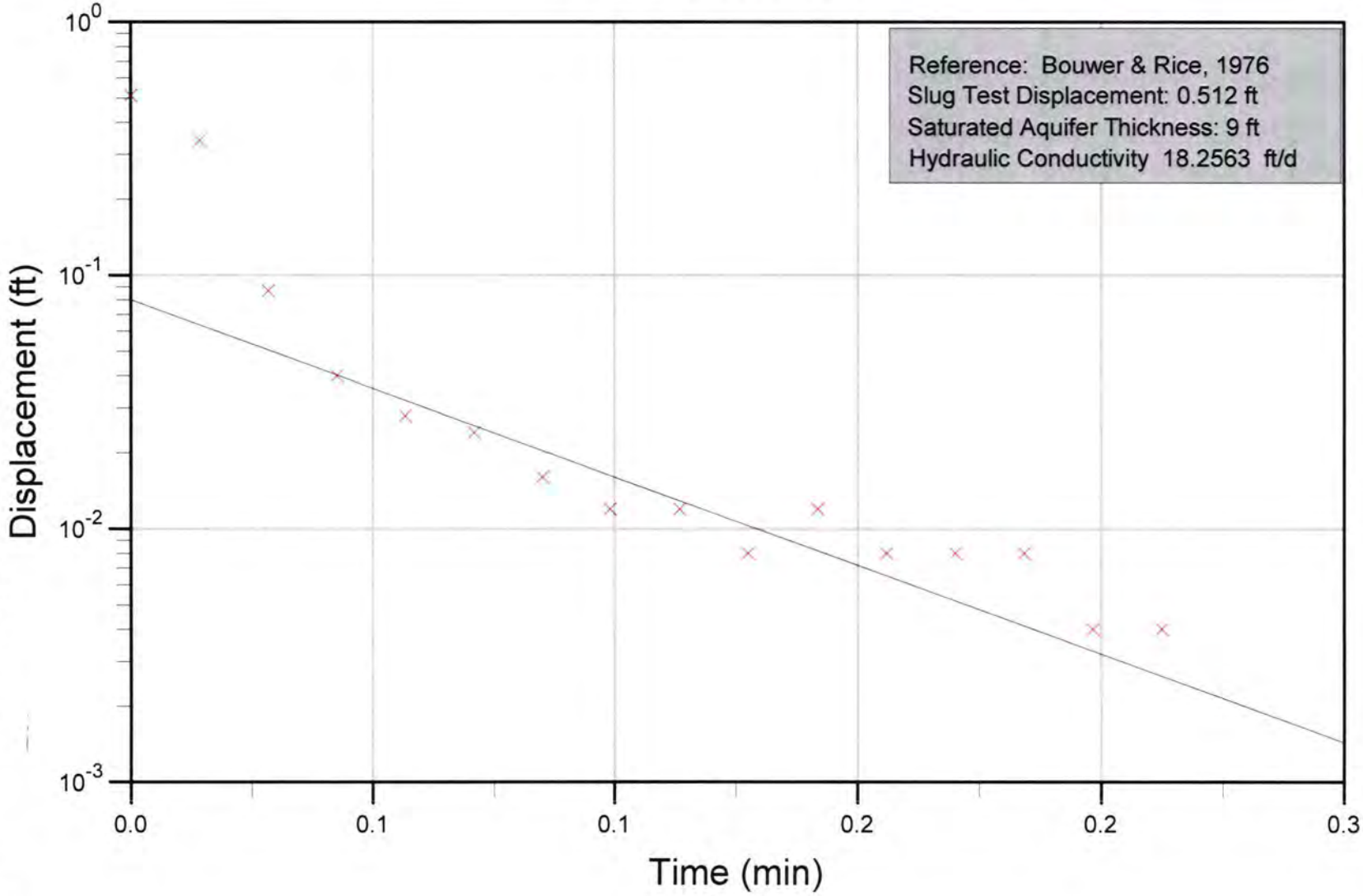
TENS 2/825

D6-15-44

DEBOrAH 23, 2019

Scanned, 02/26/2020

578434-AL-1



DEQ Ex. 3-1867

Scanned, 02/26/2020

RAMACO

Brook Mine
Page ___ of ___

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco - 2013139

Observation Well No. 578434-AL-2

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☐ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: 1.22 feet

Pumped Well Casing ID NA inches

Diameter of Drilled Hole Geoprobe 2" core (2" Casing) inches

Screen/Perforation Top Depth (below land surface) _____ feet

Screen Length 2" PVC 10' of perforated screen feet

Aquifer Thickness 4'-14' = 10' feet

Depth of Static Water Level (from measurement point) 5.05' / TD = 16.81 feet

Height of Measurement Point (above land surface) NA feet

Elevation of Measurement Point NA feet a.m.s.l.

Transducer On Date 4 / 19 / 18 Time 13:36 AM/PM

Tranducer Off Date 4 / 19 / 18 Time 14:13 AM/PM

Weather Conditions Clear but windy 50°F

Test Performed by Rod Fuller

April 2019

D6-15-46

DEQ Ex. 3-1868

TFNS 2/825
RECD MAY 23, 2019

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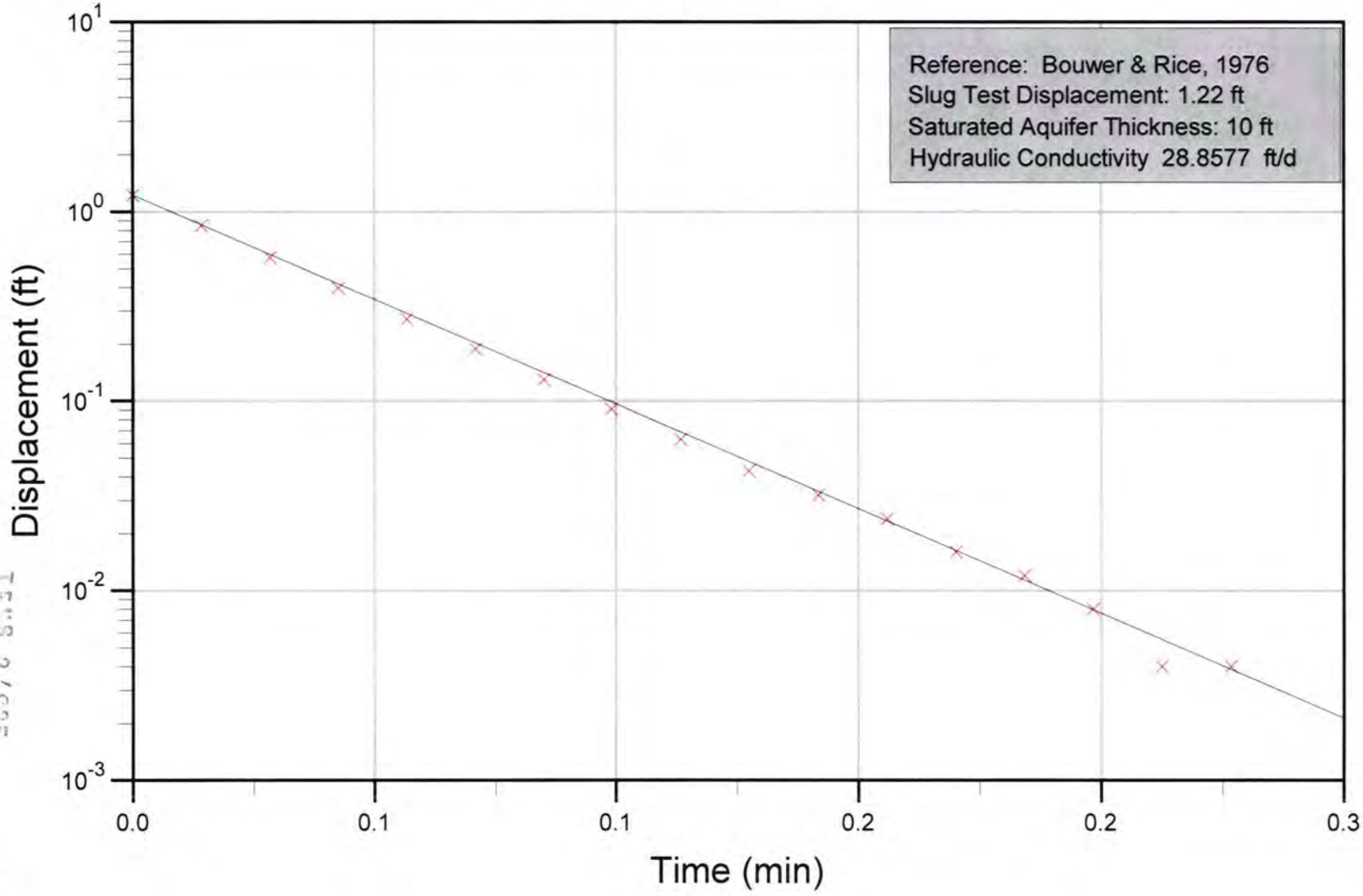
578434-AL-2



TFMS 2/525
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WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco - 2014163-01

Observation Well No. 578420-AL-1 (20AL-1)

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☐ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: 0.99' (9.79) feet

Pumped Well Casing ID _____ inches

Diameter of Drilled Hole 2" PVC / 5 1/2" hole dia. inches

Screen/Perforation Top Depth (below land surface) 5.6 to 15.6 feet

Screen Length 10' feet

Aquifer Thickness 15' feet

Depth of Static Water Level (from measurement point) DTW = 7.88 from mp / TD = 17.45 from mp feet

Height of Measurement Point (above land surface) _____ feet

Elevation of Measurement Point Stick up = 2.0' feet a.m.s.l.

Transducer On Date 7 / 3 / 18 Time 1028 (AM)/PM

Tranducer Off Date 7 / 3 / 18 Time 1042 (AM)/PM

Weather Conditions Sunny and 80°F 14 minutes

Test Performed by Rod Fuller

April 2019

TENS 2/825

D6-15-48

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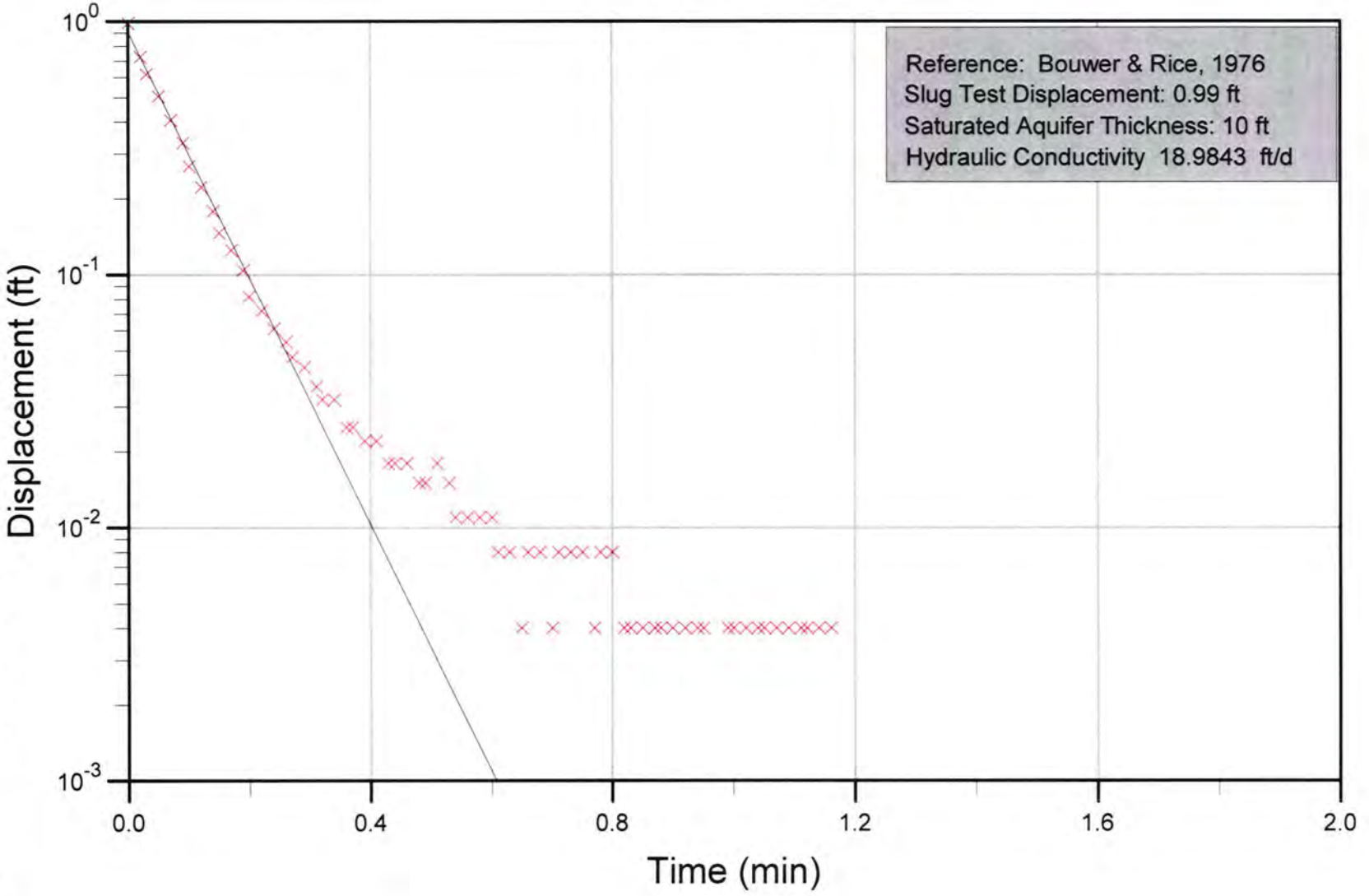
578420-AL-1



TFWS 2/625
[illegible] 23, 2019

DEQ Ex. 3-1871

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RAMACO

Brook Mine
Page ___ of ___

WWC ENGINEERING

SLUG TEST FIELD DATA

Project/Client Ramaco - 2014163-98 27.51 27.64

Observation Well No. 578421-3-MAS

Type of Slug Test: ☐ Slug In ☑ Slug Out

Water Level Measurements by: ☐ electric tape ☑ pressure transducer

Slug Type: ☐ solid ☑ water

Initial Displacement Due to Slug: _____ feet

Pumped Well Casing ID _____ inches

Diameter of Drilled Hole 5" casing (0.417') 8 3/4" (0.729') inches

Screen/Perforation Top Depth (below land surface) 118' - 124' feet

Screen Length 6' feet

Aquifer Thickness 121' to 124' = 3' feet

Depth of Static Water Level (from measurement point) DTW = 55.60 / TD = 134.10 feet

Height of Measurement Point (above land surface) _____ feet

Elevation of Measurement Point _____ feet a.m.s.l.

Transducer On Date 6 / 6 / 18 Time 12:39 AM/PM

Tranducer Off Date 6 / 7 / 18 Time 10:57 AM/PM

Weather Conditions Clear & sunny 80°F 1,338 minutes

Test Performed by Rod Fuller

TENS 2/825
RECD MAY 23, 2019

April 2019 D6-15-50

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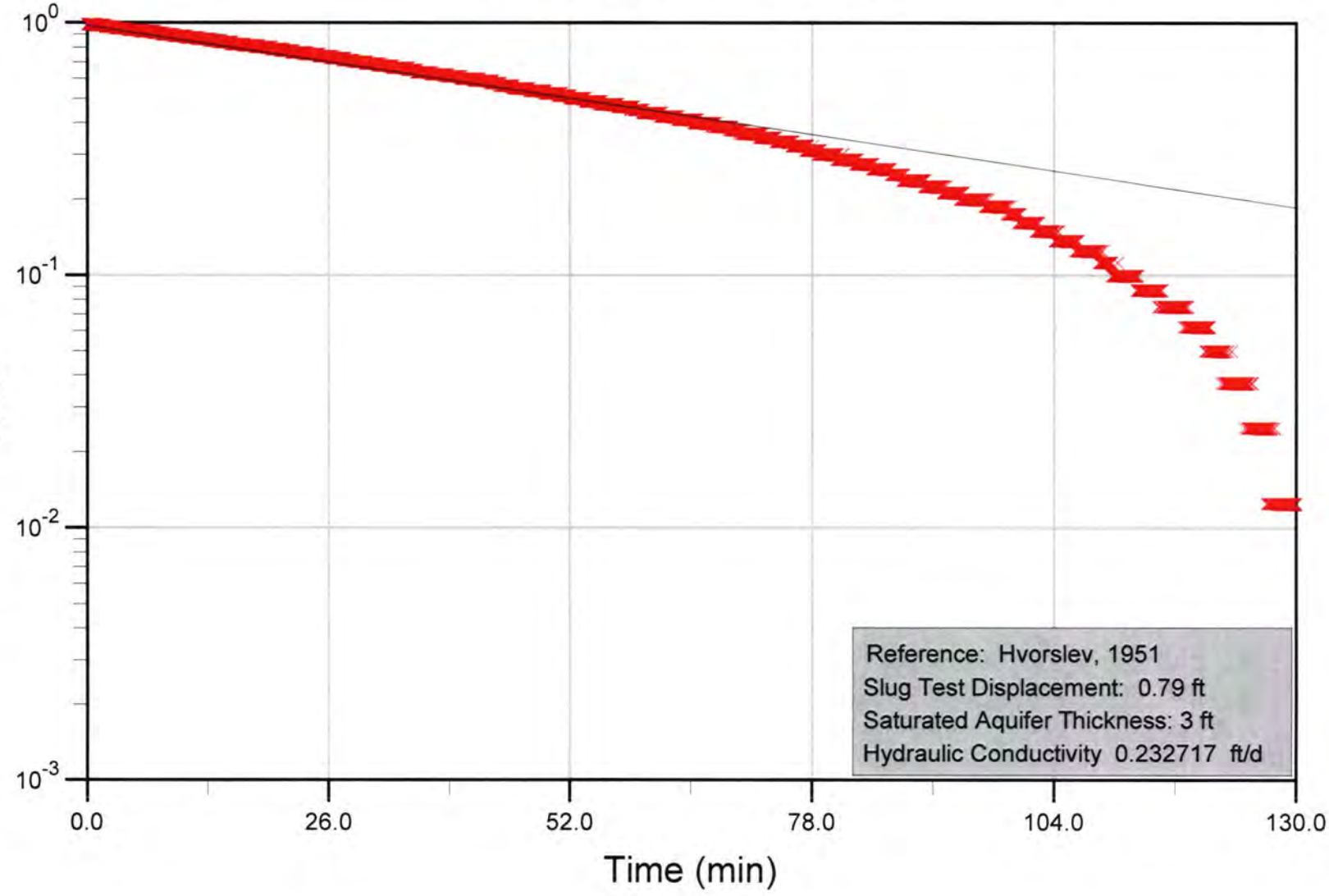
578421-3-MAS



IFNS 2/825
RECD MAY 23, 2019

DEQ Ex. 3-1873

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ADDENDUM D6-16

Core Permeability Results

TFN 6 2/025
RECD 10-25-18

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Summary of Permeability Results

Tester	Sample ID	Depth (ft)	Strata	Description	Average Permeability (ft/day)
AET	578513-5	68-69	Upper Carney Upper Confining Interval	Silty clay, brown (CL-ML)	0.0000607
AET	578513-5	91.5-92.5	Upper Carney Lower Confining Interval	Silty clay, gray (CL-ML)	0.0000275
AET	578513-5	99-100	Lower Carney Upper Confining Interval	Silty clay, gray (CL-ML)	0.0000788
AET	R13-023	140-141	Lower Carney Lower Confining Interval	Silty clay, gray (CL-ML)	0.000197
Strata	R13-019	147.5	Carney Upper Confining Interval	Grey Claystone	0.000108
Strata	R13-019	170.5	Carney Lower Confining Interval	Grey Clayey Sandstone	0.00000595
Strata	R13-023	160.8	Masters Upper Confining Interval	Grey Claystone	0.00000139
Strata	R13-023	168.9	Masters Lower Confining Interval	Grey Sandstone	0.252

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Hydraulic Conductivity/Permeability

Flexible-Wall and Rigid-Wall Constant Head Permeability Test as per ASTM D 5084

AET Project No.: 19-00725 Project Name: Ramaco - Brook Mine

Project Location: Northwest of Sheridan, Wyoming Engineer: Loren Ruttinger, WWC

Date Submitted: 11/2/2017 Received By: LM Date Tested: 11/2/2017 Tested By: LM

Sample Description: Silty clay brown (CL-ML)

Test Number: 4 Sample No.: 578513-5 Depth: 68-69'

Sample Location: 578513-5 (68-69') Sample Type (In-Situ or Remolded in the Lab): In-Situ

Test Type: X Flexible Wall (ASTM D-5084) _____ Rigid Wall (ASTM D-5856)

Initial Sample		Final Sample		Various Sample & Test Parameters	
Sample Wt: (g)	823.70	Sample Wt: (g)	932.10	Specific Gravity:	2.65
Length: (in)	3.623	Length: (in)	3.761	Spec. Grav. Assumed/Tested:	Assumed
Diameter: (in)	2.997	Diameter: (in)	3.028	Proctor MDD & OMC:	Pcf and
Area: (in^2)	7.054	Area: (in^2)	7.201	%MDD & %above / below OMC:	and
Volume: (cf)	0.0148	Volume:(cu.ft)	0.0157	Permeant Liquid:	Tap Water
MC: (%)	7.51%	MC: (%)	21.66	Cell Pressure: (psi)	80.0
Dry Unit Wt: (pcf)	114.28	Dry Unit Wt (pcf)	107.79	Consolidation Stress(psi):	4.0
Saturation: (%)	44.52	Saturation: (%)	107.46	Burette Area (cm):	1.00

Time	Inflow Reading (cm)	Outflow Reading (cm)	Inflow Pressure (psi)	Outflow Pressure (psi)	Gradient	Temp (°C)	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity @ 20°C (cm/sec)	Include in Ave. (y/n)
11/9/17 6:00 AM	10.40	21.40	77.0	75.0	15.3	20.0	2.22E-08	2.22E-08	Y
11/10/17 6:00 AM	12.00	20.00	77.0	75.0	15.3	20.0	2.34E-08	2.34E-08	Y
11/11/17 6:00 AM	13.40	18.80	77.0	75.0	15.3	20.0	2.07E-08	2.07E-08	Y
11/12/17 6:00 AM	14.70	17.60	77.0	75.0	15.3	20.0	2.02E-08	2.02E-08	Y
11/13/17 6:00 AM	16.00	16.40	77.0	75.0	15.3	20.0	2.06E-08	2.06E-08	Y

Average Hydraulic Conductivity at 20 °C: 2.14E-08 cm/sec 6.07E-05 ft/day

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Hydraulic Conductivity/Permeability

Flexible-Wall and Rigid-Wall Constant Head Permeability Test as per ASTM D 5084

AET Project No.: 19-00725 Project Name: Ramaco, Brook Mine

Project Location: Northwest of Sheridan, Wyoming Engineer: Loren Ruttinger, WWC

Date Submitted: 11/2/2017 Received By: LM Date Tested: 11/2/2017 Tested By: LM

Sample Description: Silty clay, gray (CL-ML)

Test Number: 3 Sample No.: 578513-5 Depth: 91.5-92.5'

Sample Location: 578513-5 (91.5-92.5') Sample Type (In-Situ or Remolded in the Lab): In-Situ

Test Type: X Flexible Wall (ASTM D-5084) _____ Rigid Wall (ASTM D-5856)

Initial Sample		Final Sample		Various Sample & Test Parameters	
Sample Wt: (g)	504.30	Sample Wt: (g)	572.50	Specific Gravity:	2.65
Length: (in)	2.081	Length: (in)	2.089	Spec. Grav. Assumed/Tested:	Assumed
Diameter: (in)	3.000	Diameter: (in)	3.130	Proctor MDD & OMC:	Pcf and
Area: (in^2)	7.069	Area: (in^2)	7.694	%MDD & %above / below OMC:	and
Volume: (cf)	0.0085	Volume:(cu.ft)	0.0093	Permeant Liquid:	Tap Water
MC: (%)	3.66%	MC: (%)	17.67	Cell Pressure: (psi)	80.0
Dry Unit Wt: (pcf)	126.09	Dry Unit Wt (pcf)	115.33	Consolidation Stress(psi):	4.0
Saturation: (%)	31.11	Saturation: (%)	107.97	Burette Area (cm):	1.00

Time	Inflow Reading (cm)	Outflow Reading (cm)	Inflow Pressure (psi)	Outflow Pressure (psi)	Gradient	Temp (°C)	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity @ 20°C (cm/sec)	Include in Ave. (y/n)
11/10/17 6:00 AM	11.40	18.20	76.0	75.0	13.3	20.0	1.04E-08	1.04E-08	Y
11/11/17 6:00 AM	12.00	17.60	76.0	75.0	13.3	20.0	1.05E-08	1.05E-08	Y
11/12/17 6:00 AM	12.50	17.10	76.0	75.0	13.3	20.0	8.89E-09	8.90E-09	Y
11/13/17 6:00 AM	13.00	16.60	76.0	75.0	13.3	20.0	9.01E-09	9.02E-09	Y

Average Hydraulic Conductivity at 20 °C: 9.70E-09 cm/sec 2.75E-05 ft/day

TFR 6 2/025
RECD 10-25-13

Reviewed By: Lu McLaughlin

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Hydraulic Conductivity/Permeability

Flexible-Wall and Rigid-Wall Constant Head Permeability Test as per ASTM D 5084

AET Project No.: 19-00725 Project Name: Ramaco - Brook Mine

Project Location: Northwest of Sheridan, Wyoming Engineer: Loren Ruttinger, WWC

Date Submitted: 11/2/2017 Received By: LM Date Tested: 11/2/2017 Tested By: LM

Sample Description: Silty clay, Gray, (CL-ML)

Test Number: 2 Sample No.: 2 578513-5 Depth: 99-100'

Sample Location: 578513-5 (99-100') Sample Type (In-Situ or Remolded in the Lab): In-Situ

Test Type: X Flexible Wall (ASTM D-5084) _____ Rigid Wall (ASTM D-5856)

Initial Sample		Final Sample		Various Sample & Test Parameters	
Sample Wt: (g)	915.70	Sample Wt: (g)	1012.80	Specific Gravity:	2.65
Length: (in)	3.518	Length: (in)	3.650	Spec. Grav. Assumed/Tested:	Assumed
Diameter: (in)	3.001	Diameter: (in)	3.090	Proctor MDD & OMC:	Pcf and
Area: (in^2)	7.073	Area: (in^2)	7.499	%MDD & %above / below OMC:	and
Volume: (cf)	0.0144	Volume:(cu.ft)	0.0158	Permeant Liquid:	Tap Water
MC: (%)	20.40%	MC: (%)	33.17	Cell Pressure: (psi)	80.0
Dry Unit Wt: (pcf)	116.52	Dry Unit Wt (pcf)	105.87	Consolidation Stress(psi):	4.0
Saturation: (%)	128.97	Saturation: (%)	156.44	Burette Area (cm):	1.00

Time	Inflow Reading (cm)	Outflow Reading (cm)	Inflow Pressure (psi)	Outflow Pressure (psi)	Gradient	Temp (°C)	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity @ 20°C (cm/sec)	Include in Ave. (y/n)
11/9/17 6:00 AM	10.30	19.10	77.0	75.0	15.7	20.0	2.92E-08	2.92E-08	Y
11/10/17 6:00 AM	12.40	17.50	77.0	75.0	15.7	20.0	2.84E-08	2.84E-08	Y
11/11/17 6:00 AM	14.30	16.00	77.0	75.0	15.7	20.0	2.68E-08	2.68E-08	Y
11/12/17 6:00 AM	16.10	14.50	77.0	75.0	15.7	20.0	2.66E-08	2.66E-08	Y
11/13/17 6:00 AM	18.00	13.00	77.0	75.0	15.7	20.0	2.81E-08	2.81E-08	Y

Average Hydraulic Conductivity at 20 °C: 2.78E-08 cm/sec 7.88E-05 ft/day

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RECD 10-25-18

Reviewed By: Lu McLaughlin

DEQ Ex. 3-1878

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Hydraulic Conductivity/Permeability

Flexible-Wall and Rigid-Wall Constant Head Permeability Test as per ASTM D 5084

AET Project No.: 19-00725 Project Name: Ramaco - Brook Mine

Project Location: Northwest of Sheridan, Wyoming Engineer: Loren Ruttinger, WWC

Date Submitted: 11/2/2017 Received By: LM Date Tested: 11/2/2017 Tested By: LM

Sample Description: Silty clay, gray (CL-ML)

Test Number: 1 Sample No.: R13-023 Depth: 140-141'

Sample Location: R13-023, Depth 140-141' Sample Type (In-Situ or Remolded in the Lab): In-Situ

Test Type: X Flexible Wall (ASTM D-5084) _____ Rigid Wall (ASTM D-5856)

Initial Sample		Final Sample		Various Sample & Test Parameters	
Sample Wt: (g)	1116.30	Sample Wt: (g)	1149.90	Specific Gravity:	2.65
Length: (in)	4.237	Length: (in)	4.249	Spec. Grav. Assumed/Tested:	Assumed
Diameter: (in)	2.970	Diameter: (in)	3.010	Proctor MDD & OMC:	Pcf and
Area: (in^2)	6.928	Area: (in^2)	7.116	%MDD & %above / below OMC:	and
Volume: (cf)	0.0170	Volume:(cu.ft)	0.0175	Permeant Liquid:	Tap Water
MC: (%)	18.53%	MC: (%)	22.10	Cell Pressure: (psi)	80.0
Dry Unit Wt: (pcf)	122.31	Dry Unit Wt (pcf)	118.69	Consolidation Stress(psi):	4.0
Saturation: (%)	139.53	Saturation: (%)	148.92	Burette Area (cm):	1.00

Time	Inflow Reading (cm)	Outflow Reading (cm)	Inflow Pressure (psi)	Outflow Pressure (psi)	Gradient	Temp (°C)	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity @ 20°C (cm/sec)	Include in Ave. (y/n)
11/10/17 6:00 AM	5.20	20.20	76.0	75.0	6.5	20.0	7.01E-08	7.01E-08	Y
11/11/17 6:00 AM	7.20	18.20	76.0	75.0	6.5	20.0	6.69E-08	6.69E-08	Y
11/12/17 6:00 AM	9.20	16.20	76.0	75.0	6.5	20.0	7.03E-08	7.03E-08	Y
11/13/17 6:00 AM	11.10	14.30	76.0	75.0	6.5	20.0	7.02E-08	7.02E-08	Y

Average Hydraulic Conductivity at 20 °C: 6.94E-08 cm/sec 1.97E-04 ft/day

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RECD 10-25-18

Reviewed By: Lu McLaughlin

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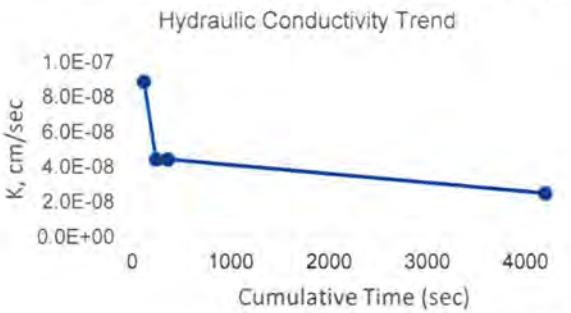
STRATA

FLEXWALL PERMEABILITY TEST

ASTM D5084 (Method C)

(permeation of sample)



Project No.: WY17374A
Sample ID: R13-019 at 147.5'
Tested by: JF

Date Tested: 11/7/2017

Client: WWC Engineering
Project: Brook Mine Permeability Testing
Sample Description: Grey CLAYSTONE

Initial Dry Density: 140
Initial Moisture Content: 8%
Final Moisture Content: 9%

Remolded
x Undisturbed

Hydraulic Gradient 89.5
System Constant, C 0.440 (cm^2)

Chamber 120 (psi)
Upper 28.5 (psi)
Lower 35 (psi)

$a_{influent\ burette}$ 0.88 cm^2
Final Length, L_f 5.113 cm
Final Area, A_f 43.738 cm^2

Date	Time (s)	Temperature °C	Temperature R_T	Burette Readings Lower V_U (t) (cc)	Burette Readings Upper V_L (t) (cc)	Incremental Flow Inflow (lower) (cc)	Incremental Flow Outflow (upper) (cc)	Incremental Flow Ratio In/Out	Head Difference[1] h (t)	Preliminary[2] kA/L (cm^2/sec)	Final[3] k_{20} (x10⁻) (cm/sec)	ASTM D5084 Method C k_{20} (cm/sec)
11/10/2017	0	21.2	0.975	1.50	18.80							
11/10/2017	60	21.2	0.975	1.55	18.75	0.05	0.05	1.0	465.6			
11/10/2017	120	21.2	0.975	1.60	18.70	0.05	0.05	1.0	465.6	7.8E-07	8.9E-08	8.9E-08
11/10/2017	240	21.2	0.975	1.65	18.65	0.05	0.05	1.0	465.5	3.9E-07	4.4E-08	4.4E-08
11/10/2017	360	21.2	0.975	1.70	18.60	0.05	0.05	1.0	465.5	3.9E-07	4.4E-08	4.4E-08
11/16/2017	4200	21.2	0.975	2.60	17.70	0.90	0.90	1.0	464.6	2.2E-07	2.5E-08	2.5E-08

Permeant liquid: standard water

kavg = 3.8E-08 cm/s

Reviewed by:

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RECD 10-25-18

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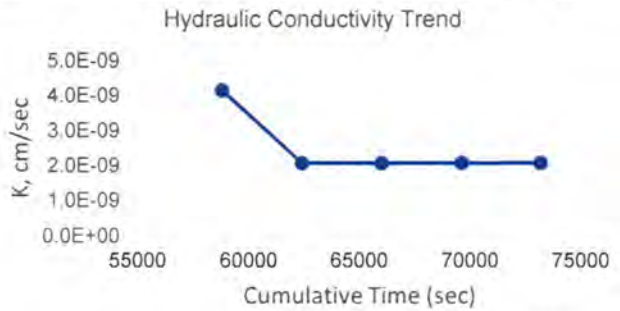
STRATA

FLEXWALL PERMEABILITY TEST

ASTM D5084 (Method C)

(permeation of sample)



Project No.: WY17374A
Sample ID: R13-019 at 170.5'
Tested by: JF

Client: WWC Engineering
Project: Brook Mine Permeability Testing
Sample Description: Grey CLAYEY SANDSTONE

Remolded
x Undisturbed

Date Tested: 11/15/2017

Initial Dry Density: 138
Initial Moisture Content: 7%
Final Moisture Content: 19%

Hydraulic Gradient 126.6
System Constant, C 0.440 (cm^2)

Chamber 120 (psi)
Upper 30 (psi)
Lower 40 (psi)

$a_{influent\ burette}$ 0.88 cm^2
Final Length, L_f 5.56 cm
Final Area, A_f 44.49 cm^2

Date	Time (s)	Temperature °C	Temperature R_T	Burette Readings Lower V_U (t) (cc)	Burette Readings Upper V_L (t) (cc)	Incremental Flow Inflow (lower) (cc)	Incremental Flow Outflow (upper) (cc)	Incremental Flow Ratio In/Out	Head Difference[1] h (t)	Preliminary[2] kA/L (cm^2/sec)	Final[3] k_{20} (x10$^-$) (cm/sec)	**ASTM D5084 Method C k_{20} (cm/sec)**
11/9/2017	0	21.1	0.978	4.30	17.20							
11/9/2017	58800	21.1	0.978	5.30	16.20	1.00	1.00	1.0	708.8			
11/9/2017	62400	21.1	0.978	5.50	16.00	0.20	0.20	1.0	708.6	3.4E-08	4.2E-09	4.2E-09
11/9/2017	66000	21.1	0.978	5.60	15.90	0.10	0.10	1.0	708.5	1.7E-08	2.1E-09	2.1E-09
11/10/2017	69600	21.1	0.978	5.70	15.80	0.10	0.10	1.0	708.4	1.7E-08	2.1E-09	2.1E-09
11/11/2017	73200	21.1	0.978	5.80	15.70	0.10	0.10	1.0	708.3	1.7E-08	2.1E-09	2.1E-09
11/13/2017	76800	21.1	0.978	5.90	15.60	0.10	0.10	1.0	708.2	1.7E-08	2.1E-09	2.1E-09

Permeant liquid: standard water

kavg = 2.1E-09 cm/s

Reviewed by:

TFN 6 2/025
RECD 10-25-13

V:\PROJECTS\W\WWC Engineering\WY17374A Brook Mine Perm Testing\Lab Summaries\R13-019 at 170.5 Peremeability.xlk.xlsR13-019 at 170.5 Peremeability.xlk.xls

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STRATA

FLEXWALL PERMEABILITY TEST

ASTM D5084 (Method C)

(permeation of sample)

Project No.: WY17374A
Sample ID: R13-023 at 160.8
Tested by: JF

Client: WWC Engineering
Project: Brook Mine Permeability Testing
Sample Description: Grey Claystone

Remolded
x Undisturbed

Date Tested: 11/21/2017

Initial Dry Density: 128.2 pcf
Initial Moisture Content: 10%
Final Moisture Content: 19%

Hydraulic Gradient: 131.6
System Constant, C: 0.440 (cm^2)

Chamber: 125 (psi)
Upper: 24 (psi)
Lower: 35 (psi)

$a_{influent\ burette}$: 0.88 cm^2
Final Length, L_f: 5.88 cm
Final Area, A_f: 44.46 cm^2

Date	Time (s)	Temperature °C	Temperature R_T	Burette Readings Lower V_U (t) (cc)	Burette Readings Upper V_L (t) (cc)	Incremental Flow Inflow (lower) (cc)	Incremental Flow Outflow (upper) (cc)	Incremental Flow Ratio In/Out	Head Difference[1] h (t)	Preliminary[2] kA/L (cm^2/sec)	Final[3] k_{20} (x10^{-}) (cm/sec)	**ASTM D5084 Method C k_{20} (cm/sec)**
11/22/2017	0	21.5	0.968	1.90	14.00							
11/22/2017	3600	21.5	0.968	1.95	13.95	0.05	0.05	1.0	779.8			
11/22/2017	7200	21.5	0.968	2.00	13.90	0.05	0.05	1.0	779.7	7.8E-09	9.9E-10	9.9E-10
11/22/2017	10800	21.5	0.968	2.05	13.85	0.05	0.05	1.0	779.7	7.8E-09	9.9E-10	9.9E-10
11/22/2017	14400	21.5	0.968	2.10	13.80	0.05	0.05	1.0	779.6	7.8E-09	9.9E-10	9.9E-10
11/22/2017	104400	21.5	0.968	2.70	13.20	0.60	0.60	1.0	779.0	3.7E-09	4.8E-10	4.8E-10
11/22/2017	111600	21.5	0.968	2.75	13.15	0.05	0.05	1.0	779.0	3.9E-09	5.0E-10	5.0E-10
11/22/2017	118800	21.5	0.968	2.80	13.10	0.05	0.05	1.0	778.9	7.8E-09	9.9E-10	5.0E-10

Permeant liquid: standard water

kavg = 4.9E-10 cm/s

Reviewed by:

TFN 6 2/025

RECD 12-25-19

V:\PROJECTS\WWWC Engineering\WY17374A Brook Mine Perm Testing\Lab Summaries\R13-023 at 160.8 Peremeability.xlk.xlsR13-023 at 160.8 Peremeability.xlk.xls

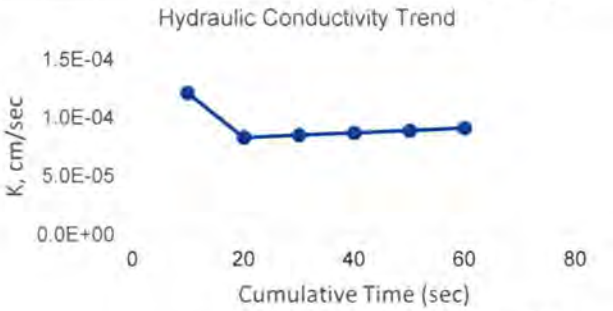
Scanned, 02/26/2020

STRATA

FLEXWALL PERMEABILITY TEST

ASTM D5084 (Method C)

(permeation of sample)



Project No.: WY17374A
Sample ID: R13-023 at 168.9'
Tested by: JF

Date Tested: 11/28/2017

Client: WWC Engineering
Project: Brook Mine Permeability Testing
Sample Description: Grey SANDSTONE

Initial Dry Density: 194.1 pcf
Initial Moisture Content: 2%
Final Moisture Content: 4%

Remolded
x Undisturbed

Hydraulic Gradient 3.6
System Constant, C 0.440 (cm^2)

Chamber 125 (psi)
Upper 34.9 (psi)
Lower 35.1 (psi)

$a_{influent\ burette}$ 0.88 cm^2
Final Length, L_f 3.894 cm
Final Area, A_f 45.19 cm^2

Date	Time (s)	Temperature		Burette Readings		Incremental Flow			Head Difference[1] h (t)	Preliminary[2] kA/L (cm^2/sec)	Final[3] k_{20} (x10$^-$) (cm/sec)	ASTM D5084 Method C k_{20} (cm/sec)
		°C	R_T	Lower V_U (t) (cc)	Upper V_L (t) (cc)	Inflow (lower) (cc)	Outflow (upper) (cc)	Ratio In/Out				
11/22/2017	0	20.9	0.983	16.30	7.70							
11/22/2017	10	20.9	0.983	16.50	7.50	0.20	0.20	1.0	9.3			
11/22/2017	20	20.9	0.983	16.80	7.20	0.30	0.30	1.0	9.0	1.4E-03	1.2E-04	1.2E-04
11/22/2017	30	20.9	0.983	17.00	7.00	0.20	0.20	1.0	8.8	9.8E-04	8.3E-05	8.3E-05
11/22/2017	40	20.9	0.983	17.20	6.80	0.20	0.20	1.0	8.6	1.0E-03	8.5E-05	8.5E-05
11/22/2017	50	20.9	0.983	17.40	6.60	0.20	0.20	1.0	8.4	1.0E-03	8.7E-05	8.7E-05
11/22/2017	60	20.9	0.983	17.60	6.40	0.20	0.20	1.0	8.2	1.1E-03	8.9E-05	8.9E-05
11/22/2017	70	20.9	0.983	17.80	6.20	0.20	0.20	1.0	8.0	2.1E-03	1.8E-04	9.1E-05

Permeant liquid: standard water

kavg = 8.9E-05 cm/s

Reviewed by:

TFN 6 2/025

DEQ-10-25-13

DEQ Ex. 3-1883

Statistical Summary of Permeability (ft/day)

	Upper Carney Upper Confining Interval	Upper Carney Lower Confining Interval	Lower Carney Upper Confining Interval	Lower Carney Lower Confining Interval	Carney Upper Confining Interval	Carney Lower Confining Interval	Masters Upper Confining Interval	Masters Lower Confining Interval
Minimum	5.73E-05	2.52E-05	7.54E-05	1.90E-04	7.09E-05	5.95E-06	1.36E-06	2.35E-01
Maximum	6.63E-05	2.98E-05	8.28E-05	1.99E-04	2.52E-04	1.19E-05	2.81E-06	3.40E-01
Mean	6.07E-05	2.75E-05	7.89E-05	1.97E-04	1.43E-04	7.14E-06	2.10E-06	2.62E-01
Median	5.87E-05	2.75E-05	7.97E-05	1.99E-04	1.25E-04	5.95E-06	2.11E-06	2.49E-01

TFN3 2/626 NOV 23, 2019

DEQ Ex. 3-1884

Scanned, 02/26/2020

New Groundwater Level Data

WELL_NAME	MEAS_DATE	GW_ELEV	GASSY	COMMENTS
578415-SPL-1	1/10/19	3585.43		
578415-SPL-2	1/10/19	3540.88		
578420-AL-1	1/10/19	3624.33		
578420-CRN-PUMP-1	1/10/19	3624.14		
578513-OVB-1	1/11/19	DRY		DRY

New Field Groundwater Quality Data

MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578415-SPL-1	1/10/19	FIELD PH	6.71	Field	
Brook Mine	578415-SPL-1	1/10/19	FIELD SP CONDUCTANCE AT 25 C	5060	Field	
Brook Mine	578415-SPL-1	1/10/19	FIELD TURBIDITY NTU	37.5	Field	
Brook Mine	578415-SPL-1	1/10/19	FIELD WATER TEMP	9.6	Field	
Brook Mine	578415-SPL-2	1/10/19	FIELD PH	7.68	Field	
Brook Mine	578415-SPL-2	1/10/19	FIELD SP CONDUCTANCE AT 25 C	1848	Field	
Brook Mine	578415-SPL-2	1/10/19	FIELD TURBIDITY NTU	31.5	Field	
Brook Mine	578415-SPL-2	1/10/19	FIELD WATER TEMP	9.90	Field	
Brook Mine	578420-AL-1	1/10/19	FIELD PH	7.44	Field	
Brook Mine	578420-AL-1	1/10/19	FIELD SP CONDUCTANCE AT 25 C	852	Field	
Brook Mine	578420-AL-1	1/10/19	FIELD TURBIDITY NTU	111	Field	
Brook Mine	578420-AL-1	1/10/19	FIELD WATER TEMP	8.50	Field	
Brook Mine	578420-CRN-PUMP	1/10/19	FIELD PH	7.76	Field	
Brook Mine	578420-CRN-PUMP	1/10/19	FIELD SP CONDUCTANCE AT 25 C	1099	Field	
Brook Mine	578420-CRN-PUMP	1/10/19	FIELD TURBIDITY NTU	4.0	Field	
Brook Mine	578420-CRN-PUMP	1/10/19	FIELD WATER TEMP	9.10	Field	
Brook Mine	LAYA #1	4/9/19	FIELD PH	7.95	Field	
Brook Mine	LAYA #1	4/9/19	FIELD SP CONDUCTANCE AT 25 C	1954.00	Field	
Brook Mine	LAYA #1	4/9/19	FIELD TURBIDITY NTU	3.02	Field	
Brook Mine	LAYA #1	4/9/19	FIELD WATER TEMP	7.20	Field	
Brook Mine	578420-CRN-PUMP	4/9/19	FIELD PH	7.81	Field	
Brook Mine	578420-CRN-PUMP	4/9/19	FIELD SP CONDUCTANCE AT 25 C	1098.00	Field	
Brook Mine	578420-CRN-PUMP	4/9/19	FIELD TURBIDITY NTU	20.70	Field	
Brook Mine	578420-CRN-PUMP	4/9/19	FIELD WATER TEMP	12.80	Field	
Brook Mine	TDAW-01	7/11/19	FIELD PH	7.47	Field	
Brook Mine	TDAW-01	7/11/19	FIELD SP CONDUCTANCE AT 25 C	1093	Field	
Brook Mine	TDAW-01	7/11/19	FIELD TURBIDITY NTU	0.65	Field	
Brook Mine	TDAW-01	7/11/19	FIELD WATER TEMP	11.5	Field	
Brook Mine	LAYA #2	7/26/19	FIELD PH	7.28	Field	
Brook Mine	LAYA #2	7/26/19	FIELD SP CONDUCTANCE AT 25 C	3670	Field	
Brook Mine	LAYA #2	7/26/19	FIELD TURBIDITY NTU	47.8	Field	
Brook Mine	LAYA #2	7/26/19	FIELD WATER TEMP	10.7	Field	
Brook Mine	LAYA #3	7/26/19	FIELD PH	7.57	Field	
Brook Mine	LAYA #3	7/26/19	FIELD SP CONDUCTANCE AT 25 C	1071	Field	
Brook Mine	LAYA #3	7/26/19	FIELD TURBIDITY NTU	1.71	Field	
Brook Mine	LAYA #3	7/26/19	FIELD WATER TEMP	11	Field	

DEQ Ex. 3-1886

New Field Groundwater Quality Data

MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578415-AL-1	7/26/19	FIELD PH	7.1	Field	
Brook Mine	578415-AL-1	7/26/19	FIELD SP CONDUCTANCE AT 25 C	2270	Field	
Brook Mine	578415-AL-1	7/26/19	FIELD TURBIDITY NTU	Over Limit	Field	
Brook Mine	578415-AL-1	7/26/19	FIELD WATER TEMP	12.6	Field	

DEQ Ex. 3-1887

New Lab Groundwater Quality Data

MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578415-SPL-1	1/10/19	PH	7.9	IML	S1901113-001A	1/11/19	SM 4500 H B	
Brook Mine	578415-SPL-1	1/10/19	SP CONDUCTANCE AT 25 C	4140	IML	S1901113-001A	1/11/19	SM 2510B	
Brook Mine	578415-SPL-1	1/10/19	TDS DRIED AT 180 C	4800	IML	S1901113-001A	1/11/19	SM 2540	
Brook Mine	578415-SPL-1	1/10/19	TDS CALCULATED	4320	IML	S1901113-001A	1/25/19	SM 1030E	
Brook Mine	578415-SPL-1	1/10/19	TOTAL ALKALINITY AS CACO3	1000	IML	S1901113-001A	1/11/19	SM 2320B	
Brook Mine	578415-SPL-1	1/10/19	HARDNESS CA/MG AS CACO3	2480	IML	S1901113-001A	1/25/19	SM 2340B	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED NH3 AS N	7.6	IML	S1901113-001B	1/15/19	EPA 350.1	
Brook Mine	578415-SPL-1	1/10/19	SAR	3.2	IML	S1901113-001A	1/25/19	Calculation	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED HCO3 AS HCO3	1220	IML	S1901113-001A	1/11/19	SM 2320B	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED CO3 AS CO3	-5	IML	S1901113-001A	1/11/19	SM 2320B	
Brook Mine	578415-SPL-1	1/10/19	OH AS OH	-5	IML	S1901113-001A	1/11/19	SM 2320B	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED CL	24	IML	S1901113-001A	1/11/19	EPA 300.0	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED F	0.4	IML	S1901113-001A	1/11/19	SM 4500FC	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1901113-001B	1/14/19	EPA 353.2	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED SO4	2510	IML	S1901113-001A	1/11/19	EPA 300.0	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED CA	422	IML	S1901113-001A	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED MG	347	IML	S1901113-001A	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED K	52	IML	S1901113-001A	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED NA	364	IML	S1901113-001A	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	CATIONS	67.31	IML	S1901113-001A	1/25/19	SM 1030E	
Brook Mine	578415-SPL-1	1/10/19	ANIONS	72.93	IML	S1901113-001A	1/25/19	SM 1030E	
Brook Mine	578415-SPL-1	1/10/19	CATION ANION BALANCE	4.01	IML	S1901113-001A	1/25/19	SM 1030E	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED AL	-0.1	IML	S1901113-001C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED AS	-0.005	IML	S1901113-001C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED BA	-0.1	IML	S1901113-001C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED B	0.1	IML	S1901113-001C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED CD	-0.001	IML	S1901113-001C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED CR	-0.01	IML	S1901113-001C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED CU	-0.01	IML	S1901113-001C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED FE	2.43	IML	S1901113-001C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED PB	-0.02	IML	S1901113-001C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED MN	1.12	IML	S1901113-001C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED HG	-0.001	IML	S1901113-001C	1/16/19	EPA 245.1	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED MO	-0.02	IML	S1901113-001C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED NI	0.04	IML	S1901113-001C	1/11/19	EPA 200.7	

DEQ Ex. 3-1888

New Lab Groundwater Quality Data

MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED SE	-0.005	IML	S1901113-001C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-1	1/10/19	DISSOLVED ZN	-0.01	IML	S1901113-001C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	TOTAL FE	3.09	IML	S1901113-001D	1/16/19	EPA 200.7	
Brook Mine	578415-SPL-1	1/10/19	TOTAL MN	1.18	IML	S1901113-001D	1/16/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	PH	8.5	IML	S1901113-002A	1/12/19	SM 4500 H B	
Brook Mine	578415-SPL-2	1/10/19	SP CONDUCTANCE AT 25 C	1750	IML	S1901113-002A	1/12/19	SM 2510B	
Brook Mine	578415-SPL-2	1/10/19	TDS DRIED AT 180 C	1190	IML	S1901113-002A	1/11/19	SM 2540	
Brook Mine	578415-SPL-2	1/10/19	TDS CALCULATED	1190	IML	S1901113-002A	1/25/19	SM 1030E	
Brook Mine	578415-SPL-2	1/10/19	TOTAL ALKALINITY AS CACO3	1120	IML	S1901113-002A	1/12/19	SM 2320B	
Brook Mine	578415-SPL-2	1/10/19	HARDNESS CA/MG AS CACO3	80	IML	S1901113-002A	1/25/19	SM 2340B	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED NH3 AS N	5.6	IML	S1901113-002B	1/15/19	EPA 350.1	
Brook Mine	578415-SPL-2	1/10/19	SAR	22.2	IML	S1901113-002A	1/25/19	Calculation	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED HCO3 AS HCO3	1260	IML	S1901113-002A	1/12/19	SM 2320B	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED CO3 AS CO3	49	IML	S1901113-002A	1/12/19	SM 2320B	
Brook Mine	578415-SPL-2	1/10/19	OH AS OH	-5	IML	S1901113-002A	1/12/19	SM 2320B	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED CL	16	IML	S1901113-002A	1/11/19	EPA 300.0	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED F	1.5	IML	S1901113-002A	1/12/19	SM 4500FC	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1901113-002B	1/14/19	EPA 353.2	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED SO4	2	IML	S1901113-002A	1/11/19	EPA 300.0	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED CA	16	IML	S1901113-002A	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED MG	10	IML	S1901113-002A	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED K	16	IML	S1901113-002A	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED NA	456	IML	S1901113-002A	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	CATIONS	22.22	IML	S1901113-002A	1/25/19	SM 1030E	
Brook Mine	578415-SPL-2	1/10/19	ANIONS	22.91	IML	S1901113-002A	1/25/19	SM 1030E	
Brook Mine	578415-SPL-2	1/10/19	CATION ANION BALANCE	1.51	IML	S1901113-002A	1/25/19	SM 1030E	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED AL	-0.1	IML	S1901113-002C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED AS	-0.005	IML	S1901113-002C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED BA	0.3	IML	S1901113-002C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED B	-0.1	IML	S1901113-002C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED CD	-0.001	IML	S1901113-002C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED CR	-0.01	IML	S1901113-002C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED CU	-0.01	IML	S1901113-002C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED FE	0.07	IML	S1901113-002C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED PB	-0.02	IML	S1901113-002C	1/11/19	EPA 200.8	

DEQ Ex. 3-1889

New Lab Groundwater Quality Data

MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED MN	-0.02	IML	S1901113-002C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED HG	-0.001	IML	S1901113-002C	1/16/19	EPA 245.1	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED MO	-0.02	IML	S1901113-002C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED NI	-0.01	IML	S1901113-002C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED SE	-0.005	IML	S1901113-002C	1/11/19	EPA 200.8	
Brook Mine	578415-SPL-2	1/10/19	DISSOLVED ZN	-0.01	IML	S1901113-002C	1/11/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	TOTAL FE	0.67	IML	S1901113-002D	1/16/19	EPA 200.7	
Brook Mine	578415-SPL-2	1/10/19	TOTAL MN	0.03	IML	S1901113-002D	1/16/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	PH	8.2	IML	S1901113-003A	1/14/19	SM 4500 H B	
Brook Mine	578420-AL-1	1/10/19	SP CONDUCTANCE AT 25 C	760	IML	S1901113-003A	1/12/19	SM 2510B	
Brook Mine	578420-AL-1	1/10/19	TDS DRIED AT 180 C	540	IML	S1901113-003A	1/11/19	SM 2540	
Brook Mine	578420-AL-1	1/10/19	TDS CALCULATED	500	IML	S1901113-003A	1/25/19	SM 1030E	
Brook Mine	578420-AL-1	1/10/19	TOTAL ALKALINITY AS CACO3	328	IML	S1901113-003A	1/14/19	SM 2320B	
Brook Mine	578420-AL-1	1/10/19	HARDNESS CA/MG AS CACO3	377	IML	S1901113-003A	1/25/19	SM 2340B	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED NH3 AS N	-0.1	IML	S1901113-003B	1/15/19	EPA 350.1	
Brook Mine	578420-AL-1	1/10/19	SAR	0.8	IML	S1901113-003A	1/25/19	Calculation	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED HCO3 AS HCO3	401	IML	S1901113-003A	1/14/19	SM 2320B	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED CO3 AS CO3	-5	IML	S1901113-003A	1/14/19	SM 2320B	
Brook Mine	578420-AL-1	1/10/19	OH AS OH	-5	IML	S1901113-003A	1/14/19	SM 2320B	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED CL	3	IML	S1901113-003A	1/11/19	EPA 300.0	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED F	0.3	IML	S1901113-003A	1/12/19	SM 4500FC	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1901113-003B	1/14/19	EPA 353.2	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED SO4	128	IML	S1901113-003A	1/11/19	EPA 300.0	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED CA	90	IML	S1901113-003A	1/16/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED MG	37	IML	S1901113-003A	1/16/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED K	3	IML	S1901113-003A	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED NA	37	IML	S1901113-003A	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	CATIONS	9.23	IML	S1901113-003A	1/25/19	SM 1030E	
Brook Mine	578420-AL-1	1/10/19	ANIONS	9.33	IML	S1901113-003A	1/25/19	SM 1030E	
Brook Mine	578420-AL-1	1/10/19	CATION ANION BALANCE	0.54	IML	S1901113-003A	1/25/19	SM 1030E	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED AL	-0.1	IML	S1901113-003C	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED AS	-0.005	IML	S1901113-003C	1/11/19	EPA 200.8	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED BA	0.2	IML	S1901113-003C	1/11/19	EPA 200.8	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED B	-0.1	IML	S1901113-003C	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED CD	-0.001	IML	S1901113-003C	1/11/19	EPA 200.8	

New Lab Groundwater Quality Data

MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578420-AL-1	1/10/19	DISSOLVED CR	-0.01	IML	S1901113-003C	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED CU	-0.01	IML	S1901113-003C	1/11/19	EPA 200.8	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED FE	-0.05	IML	S1901113-003C	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED PB	-0.02	IML	S1901113-003C	1/11/19	EPA 200.8	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED MN	0.17	IML	S1901113-003C	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED HG	-0.001	IML	S1901113-003C	1/16/19	EPA 245.1	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED MO	-0.02	IML	S1901113-003C	1/11/19	EPA 200.8	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED NI	-0.01	IML	S1901113-003C	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED SE	-0.005	IML	S1901113-003C	1/11/19	EPA 200.8	
Brook Mine	578420-AL-1	1/10/19	DISSOLVED ZN	-0.01	IML	S1901113-003C	1/11/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	TOTAL FE	2.3	IML	S1901113-003D	1/16/19	EPA 200.7	
Brook Mine	578420-AL-1	1/10/19	TOTAL MN	0.58	IML	S1901113-003D	1/16/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	PH	8.4	IML	S1901113-004A	1/12/19	SM 4500 H B	
Brook Mine	578420-CRN-PUMP	1/10/19	SP CONDUCTANCE AT 25 C	996	IML	S1901113-004A	1/12/19	SM 2510B	
Brook Mine	578420-CRN-PUMP	1/10/19	TDS DRIED AT 180 C	700	IML	S1901113-004A	1/11/19	SM 2540	
Brook Mine	578420-CRN-PUMP	1/10/19	TDS CALCULATED	660	IML	S1901113-004A	1/25/19	SM 1030E	
Brook Mine	578420-CRN-PUMP	1/10/19	TOTAL ALKALINITY AS CACO3	424	IML	S1901113-004A	1/12/19	SM 2320B	
Brook Mine	578420-CRN-PUMP	1/10/19	HARDNESS CA/MG AS CACO3	234	IML	S1901113-004A	1/25/19	SM 2340B	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED NH3 AS N	2.5	IML	S1901113-004B	1/15/19	EPA 350.1	
Brook Mine	578420-CRN-PUMP	1/10/19	SAR	4.1	IML	S1901113-004A	1/25/19	Calculation	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED HCO3 AS HCO3	490	IML	S1901113-004A	1/12/19	SM 2320B	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED CO3 AS CO3	13	IML	S1901113-004A	1/12/19	SM 2320B	
Brook Mine	578420-CRN-PUMP	1/10/19	OH AS OH	-5	IML	S1901113-004A	1/12/19	SM 2320B	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED CL	4	IML	S1901113-004A	1/11/19	EPA 300.0	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED F	0.9	IML	S1901113-004A	1/12/19	SM 4500FC	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1901113-004B	1/14/19	EPA 353.2	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED SO4	166	IML	S1901113-004A	1/11/19	EPA 300.0	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED CA	43	IML	S1901113-004A	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED MG	31	IML	S1901113-004A	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED K	13	IML	S1901113-004A	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED NA	145	IML	S1901113-004A	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	CATIONS	11.49	IML	S1901113-004A	1/25/19	SM 1030E	
Brook Mine	578420-CRN-PUMP	1/10/19	ANIONS	12.08	IML	S1901113-004A	1/25/19	SM 1030E	
Brook Mine	578420-CRN-PUMP	1/10/19	CATION ANION BALANCE	2.49	IML	S1901113-004A	1/25/19	SM 1030E	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED AL	-0.1	IML	S1901113-004C	1/11/19	EPA 200.7	

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MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED AS	-0.005	IML	S1901113-004C	1/11/19	EPA 200.8	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED BA	0.1	IML	S1901113-004C	1/11/19	EPA 200.8	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED B	-0.1	IML	S1901113-004C	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED CD	-0.001	IML	S1901113-004C	1/11/19	EPA 200.8	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED CR	-0.01	IML	S1901113-004C	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED CU	-0.01	IML	S1901113-004C	1/11/19	EPA 200.8	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED FE	-0.05	IML	S1901113-004C	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED PB	-0.02	IML	S1901113-004C	1/11/19	EPA 200.8	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED MN	0.49	IML	S1901113-004C	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED HG	-0.001	IML	S1901113-004C	1/16/19	EPA 245.1	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED MO	-0.02	IML	S1901113-004C	1/11/19	EPA 200.8	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED NI	-0.01	IML	S1901113-004C	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED SE	-0.005	IML	S1901113-004C	1/11/19	EPA 200.8	
Brook Mine	578420-CRN-PUMP	1/10/19	DISSOLVED ZN	-0.01	IML	S1901113-004C	1/11/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	TOTAL FE	0.35	IML	S1901113-004D	1/16/19	EPA 200.7	
Brook Mine	578420-CRN-PUMP	1/10/19	TOTAL MN	0.50	IML	S1901113-004D	1/16/19	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	PH	8.4	IML	S1904165-001A	43565.68	SM 4500 H B	
Brook Mine	LAYA #1	4/9/19	SP CONDUCTANCE AT 25 C	1840	IML	S1904165-001A	43565.68	SM 2510B	
Brook Mine	LAYA #1	4/9/19	TDS DRIED AT 180 C	1270	IML	S1904165-001A	43565.53	SM 2540	
Brook Mine	LAYA #1	4/9/19	TDS CALCULATED	1260	IML	S1904165-001A	43570.49	SM 1030E	
Brook Mine	LAYA #1	4/9/19	TOTAL ALKALINITY AS CACO3	1140	IML	S1904165-001A	43565.68	SM 2320B	
Brook Mine	LAYA #1	4/9/19	HARDNESS CA/MG AS CACO3	90	IML	S1904165-001A	43570.49	SM 2340B	
Brook Mine	LAYA #1	4/9/19	DISSOLVED NH3 AS N	4.7	IML	S1904165-001B	43567.45	EPA 350.1	
Brook Mine	LAYA #1	4/9/19	SAR	22.5	IML	S1904165-001A	43570.49	Calculation	
Brook Mine	LAYA #1	4/9/19	DISSOLVED HCO3 AS HCO3	1350	IML	S1904165-001A	43565.68	SM 2320B	
Brook Mine	LAYA #1	4/9/19	DISSOLVED CO3 AS CO3	24	IML	S1904165-001A	43565.68	SM 2320B	
Brook Mine	LAYA #1	4/9/19	OH AS OH	-5	IML	S1904165-001A	43565.68	SM 2320B	
Brook Mine	LAYA #1	4/9/19	DISSOLVED CL	36	IML	S1904165-001A	43566.95	EPA 300.0	
Brook Mine	LAYA #1	4/9/19	DISSOLVED F	2	IML	S1904165-001A	43565.68	SM 4500FC	
Brook Mine	LAYA #1	4/9/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1904165-001B	43566.43	EPA 353.2	
Brook Mine	LAYA #1	4/9/19	DISSOLVED SO4	-1	IML	S1904165-001A	43565.67	EPA 300.0	
Brook Mine	LAYA #1	4/9/19	DISSOLVED CA	13	IML	S1904165-001A	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED MG	14	IML	S1904165-001A	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED K	19	IML	S1904165-001A	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED NA	491	IML	S1904165-001A	43565.8	EPA 200.7	

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MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	LAYA #1	4/9/19	CATIONS	23.94	IML	S1904165-001A	43570.49	SM 1030E	
Brook Mine	LAYA #1	4/9/19	ANIONS	23.96	IML	S1904165-001A	43570.49	SM 1030E	
Brook Mine	LAYA #1	4/9/19	CATION ANION BALANCE	0.04	IML	S1904165-001A	43570.49	SM 1030E	
Brook Mine	LAYA #1	4/9/19	DISSOLVED AL	-0.1	IML	S1904165-001C	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED AS	-0.005	IML	S1904165-001C	43566.27	EPA 200.8	
Brook Mine	LAYA #1	4/9/19	DISSOLVED BA	0.4	IML	S1904165-001C	43566.27	EPA 200.8	
Brook Mine	LAYA #1	4/9/19	DISSOLVED B	0.1	IML	S1904165-001C	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED CD	-0.001	IML	S1904165-001C	43566.27	EPA 200.8	
Brook Mine	LAYA #1	4/9/19	DISSOLVED CR	-0.01	IML	S1904165-001C	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED CU	-0.01	IML	S1904165-001C	43566.27	EPA 200.8	
Brook Mine	LAYA #1	4/9/19	DISSOLVED FE	-0.05	IML	S1904165-001C	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED PB	-0.02	IML	S1904165-001C	43566.27	EPA 200.8	
Brook Mine	LAYA #1	4/9/19	DISSOLVED MN	0.03	IML	S1904165-001C	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED HG	-0.001	IML	S1904165-001C	43567.43	EPA 245.1	
Brook Mine	LAYA #1	4/9/19	DISSOLVED MO	-0.02	IML	S1904165-001C	43566.27	EPA 200.8	
Brook Mine	LAYA #1	4/9/19	DISSOLVED NI	-0.01	IML	S1904165-001C	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	DISSOLVED SE	-0.005	IML	S1904165-001C	43566.27	EPA 200.8	
Brook Mine	LAYA #1	4/9/19	DISSOLVED ZN	-0.01	IML	S1904165-001C	43565.8	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	TOTAL FE	0.15	IML	S1904165-001D	43566.79	EPA 200.7	
Brook Mine	LAYA #1	4/9/19	TOTAL MN	0.03	IML	S1904165-001D	43566.79	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	PH	8.3	IML	S1904165-002A	43565.68	SM 4500 H B	
Brook Mine	578420-CRN-PUMP	4/9/19	SP CONDUCTANCE AT 25 C	1040	IML	S1904165-002A	43565.68	SM 2510B	
Brook Mine	578420-CRN-PUMP	4/9/19	TDS DRIED AT 180 C	690	IML	S1904165-002A	43565.53	SM 2540	
Brook Mine	578420-CRN-PUMP	4/9/19	TDS CALCULATED	680	IML	S1904165-002A	43570.49	SM 1030E	
Brook Mine	578420-CRN-PUMP	4/9/19	TOTAL ALKALINITY AS CACO3	421	IML	S1904165-002A	43565.68	SM 2320B	
Brook Mine	578420-CRN-PUMP	4/9/19	HARDNESS CA/MG AS CACO3	220	IML	S1904165-002A	43570.49	SM 2340B	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED NH3 AS N	2.9	IML	S1904165-002B	43567.45	EPA 350.1	
Brook Mine	578420-CRN-PUMP	4/9/19	SAR	4.94	IML	S1904165-002A	43570.49	Calculation	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED HCO3 AS HCO3	510	IML	S1904165-002A	43565.68	SM 2320B	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED CO3 AS CO3	-5	IML	S1904165-002A	43565.68	SM 2320B	
Brook Mine	578420-CRN-PUMP	4/9/19	OH AS OH	-5	IML	S1904165-002A	43565.68	SM 2320B	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED CL	4	IML	S1904165-002A	43566.96	EPA 300.0	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED F	1.1	IML	S1904165-002A	43565.68	SM 4500FC	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1904165-002B	43566.43	EPA 353.2	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED SO4	168	IML	S1904165-002A	43565.68	EPA 300.0	

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MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED CA	38	IML	S1904165-002A	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED MG	30	IML	S1904165-002A	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED K	14	IML	S1904165-002A	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED NA	169	IML	S1904165-002A	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	CATIONS	12.29	IML	S1904165-002A	43570.49	SM 1030E	
Brook Mine	578420-CRN-PUMP	4/9/19	ANIONS	12.1	IML	S1904165-002A	43570.49	SM 1030E	
Brook Mine	578420-CRN-PUMP	4/9/19	CATION ANION BALANCE	0.79	IML	S1904165-002A	43570.49	SM 1030E	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED AL	-0.1	IML	S1904165-002C	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED AS	-0.005	IML	S1904165-002C	43566.29	EPA 200.8	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED BA	-0.1	IML	S1904165-002C	43566.29	EPA 200.8	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED B	-0.1	IML	S1904165-002C	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED CD	-0.001	IML	S1904165-002C	43566.29	EPA 200.8	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED CR	-0.01	IML	S1904165-002C	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED CU	-0.01	IML	S1904165-002C	43566.29	EPA 200.8	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED FE	-0.05	IML	S1904165-002C	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED PB	-0.02	IML	S1904165-002C	43566.29	EPA 200.8	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED MN	0.37	IML	S1904165-002C	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED HG	-0.001	IML	S1904165-002C	43567.44	EPA 245.1	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED MO	-0.02	IML	S1904165-002C	43566.29	EPA 200.8	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED NI	-0.01	IML	S1904165-002C	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED SE	-0.005	IML	S1904165-002C	43566.29	EPA 200.8	
Brook Mine	578420-CRN-PUMP	4/9/19	DISSOLVED ZN	-0.01	IML	S1904165-002C	43565.8	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	TOTAL FE	1.1	IML	S1904165-002D	43566.79	EPA 200.7	
Brook Mine	578420-CRN-PUMP	4/9/19	TOTAL MN	0.36	IML	S1904165-002D	43566.79	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	PH	8.2	IML	S1907203-001A	43659.02	SM 4500 H B	
Brook Mine	TDAW-01	7/11/19	SP CONDUCTANCE AT 25 C	1140	IML	S1907203-001A	43659.02	SM 2510B	
Brook Mine	TDAW-01	7/11/19	TDS DRIED AT 180 C	730	IML	S1907203-001A	43661.39	SM 2540	
Brook Mine	TDAW-01	7/11/19	TDS CALCULATED	660	IML	S1907203-001A	43671.4	SM 1030E	
Brook Mine	TDAW-01	7/11/19	TOTAL ALKALINITY AS CACO3	431	IML	S1907203-001A	43659.02	SM 2320B	
Brook Mine	TDAW-01	7/11/19	HARDNESS CA/MG AS CACO3	524	IML	S1907203-001A	43671.4	SM 2340B	
Brook Mine	TDAW-01	7/11/19	DISSOLVED NH3 AS N	-0.1	IML	S1907203-001B	43665.41	EPA 350.1	
Brook Mine	TDAW-01	7/11/19	SAR	0.85	IML	S1907203-001A	43671.4	Calculation	
Brook Mine	TDAW-01	7/11/19	DISSOLVED HCO3 AS HCO3	526	IML	S1907203-001A	43659.02	SM 2320B	
Brook Mine	TDAW-01	7/11/19	DISSOLVED CO3 AS CO3	-5	IML	S1907203-001A	43659.02	SM 2320B	
Brook Mine	TDAW-01	7/11/19	OH AS OH	-5	IML	S1907203-001A	43659.02	SM 2320B	

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MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	TDAW-01	7/11/19	DISSOLVED CL	5	IML	S1907203-001A	43658.83	EPA 300.0	
Brook Mine	TDAW-01	7/11/19	DISSOLVED F	0.3	IML	S1907203-001A	43659.02	SM 4500FC	
Brook Mine	TDAW-01	7/11/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1907203-001B	43661.44	EPA 353.2	
Brook Mine	TDAW-01	7/11/19	DISSOLVED SO4	178	IML	S1907203-001A	43658.83	EPA 300.0	
Brook Mine	TDAW-01	7/11/19	DISSOLVED CA	98	IML	S1907203-001A	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED MG	68	IML	S1907203-001A	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED K	4	IML	S1907203-001A	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED NA	45	IML	S1907203-001A	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	CATIONS	12.54	IML	S1907203-001A	43671.4	SM 1030E	
Brook Mine	TDAW-01	7/11/19	ANIONS	12.47	IML	S1907203-001A	43671.4	SM 1030E	
Brook Mine	TDAW-01	7/11/19	CATION ANION BALANCE	0.27	IML	S1907203-001A	43671.4	SM 1030E	
Brook Mine	TDAW-01	7/11/19	DISSOLVED AL	-0.1	IML	S1907203-001C	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED AS	-0.005	IML	S1907203-001C	43658.77	EPA 200.8	
Brook Mine	TDAW-01	7/11/19	DISSOLVED BA	-0.1	IML	S1907203-001C	43658.77	EPA 200.8	
Brook Mine	TDAW-01	7/11/19	DISSOLVED B	0.1	IML	S1907203-001C	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED CD	-0.001	IML	S1907203-001C	43658.77	EPA 200.8	
Brook Mine	TDAW-01	7/11/19	DISSOLVED CR	-0.01	IML	S1907203-001C	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED CU	-0.01	IML	S1907203-001C	43658.77	EPA 200.8	
Brook Mine	TDAW-01	7/11/19	DISSOLVED FE	-0.05	IML	S1907203-001C	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED PB	-0.02	IML	S1907203-001C	43658.77	EPA 200.8	
Brook Mine	TDAW-01	7/11/19	DISSOLVED MN	0.41	IML	S1907203-001C	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED HG	-0.001	IML	S1907203-001C	43665.61	EPA 245.1	
Brook Mine	TDAW-01	7/11/19	DISSOLVED MO	-0.02	IML	S1907203-001C	43658.77	EPA 200.8	
Brook Mine	TDAW-01	7/11/19	DISSOLVED NI	-0.01	IML	S1907203-001C	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	DISSOLVED SE	-0.005	IML	S1907203-001C	43658.77	EPA 200.8	
Brook Mine	TDAW-01	7/11/19	DISSOLVED ZN	0.04	IML	S1907203-001C	43662.7	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	TOTAL FE	0.07	IML	S1907203-001D	43662.87	EPA 200.7	
Brook Mine	TDAW-01	7/11/19	TOTAL MN	0.41	IML	S1907203-001D	43662.87	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	PH	7.9	IML	S1907400-001A	7/29/2019	SM 4500 H B	
Brook Mine	LAYA #2	7/26/19	SP CONDUCTANCE AT 25 C	3530	IML	S1907400-001A	7/29/2019	SM 2510B	
Brook Mine	LAYA #2	7/26/19	TDS DRIED AT 180 C	3480	IML	S1907400-001A	7/26/2019	SM 2540	
Brook Mine	LAYA #2	7/26/19	TDS CALCULATED	3020	IML	S1907400-001A	8/2/2019	SM 1030E	
Brook Mine	LAYA #2	7/26/19	TOTAL ALKALINITY AS CACO3	537	IML	S1907400-001A	7/29/2019	SM 2320B	
Brook Mine	LAYA #2	7/26/19	HARDNESS CA/MG AS CACO3	1800	IML	S1907400-001A	8/2/2019	SM 2340B	
Brook Mine	LAYA #2	7/26/19	DISSOLVED NH3 AS N	0.3	IML	S1907400-001B	7/29/2019	EPA 350.1	

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MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	LAYA #2	7/26/19	SAR	2.73	IML	S1907400-001A	8/2/2019	Calculation	
Brook Mine	LAYA #2	7/26/19	DISSOLVED HCO3 AS HCO3	655	IML	S1907400-001A	7/29/2019	SM 2320B	
Brook Mine	LAYA #2	7/26/19	DISSOLVED CO3 AS CO3	-5	IML	S1907400-001A	7/29/2019	SM 2320B	
Brook Mine	LAYA #2	7/26/19	OH AS OH	-5	IML	S1907400-001A	7/29/2019	SM 2320B	
Brook Mine	LAYA #2	7/26/19	DISSOLVED CL	18	IML	S1907400-001A	7/29/2019	EPA 300.0	
Brook Mine	LAYA #2	7/26/19	DISSOLVED F	0.8	IML	S1907400-001A	7/29/2019	SM 4500FC	
Brook Mine	LAYA #2	7/26/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1907400-001B	7/29/2019	EPA 353.2	
Brook Mine	LAYA #2	7/26/19	DISSOLVED SO4	1870	IML	S1907400-001A	7/29/2019	EPA 300.0	
Brook Mine	LAYA #2	7/26/19	DISSOLVED CA	248	IML	S1907400-001A	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED MG	288	IML	S1907400-001A	8/1/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED K	14	IML	S1907400-001A	8/1/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED NA	267	IML	S1907400-001A	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	CATIONS	48.03	IML	S1907400-001A	8/2/2019	SM 1030E	
Brook Mine	LAYA #2	7/26/19	ANIONS	50.17	IML	S1907400-001A	8/2/2019	SM 1030E	
Brook Mine	LAYA #2	7/26/19	CATION ANION BALANCE	2.17	IML	S1907400-001A	8/2/2019	SM 1030E	
Brook Mine	LAYA #2	7/26/19	DISSOLVED AL	-0.1	IML	S1907400-001C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED AS	-0.005	IML	S1907400-001C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #2	7/26/19	DISSOLVED BA	-0.1	IML	S1907400-001C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #2	7/26/19	DISSOLVED B	0.5	IML	S1907400-001C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED CD	-0.001	IML	S1907400-001C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #2	7/26/19	DISSOLVED CR	-0.01	IML	S1907400-001C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED CU	-0.01	IML	S1907400-001C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #2	7/26/19	DISSOLVED FE	-0.05	IML	S1907400-001C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED PB	-0.02	IML	S1907400-001C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #2	7/26/19	DISSOLVED MN	0.34	IML	S1907400-001C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED HG	-0.001	IML	S1907400-001C	7/30/2019	EPA 245.1	
Brook Mine	LAYA #2	7/26/19	DISSOLVED MO	-0.02	IML	S1907400-001C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #2	7/26/19	DISSOLVED NI	-0.01	IML	S1907400-001C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	DISSOLVED SE	-0.005	IML	S1907400-001C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #2	7/26/19	DISSOLVED ZN	-0.01	IML	S1907400-001C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	TOTAL FE	1.65	IML	S1907400-001E	7/30/2019	EPA 200.7	
Brook Mine	LAYA #2	7/26/19	TOTAL MN	0.49	IML	S1907400-001E	7/30/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	PH	8.2	IML	S1907400-002A	7/29/2019	SM 4500 H B	
Brook Mine	LAYA #3	7/26/19	SP CONDUCTANCE AT 25 C	1070	IML	S1907400-002A	7/29/2019	SM 2510B	
Brook Mine	LAYA #3	7/26/19	TDS DRIED AT 180 C	720	IML	S1907400-002A	7/26/2019	SM 2540	

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MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	LAYA #3	7/26/19	TDS CALCULATED	650	IML	S1907400-002A	8/2/2019	SM 1030E	
Brook Mine	LAYA #3	7/26/19	TOTAL ALKALINITY AS CACO3	418	IML	S1907400-002A	7/29/2019	SM 2320B	
Brook Mine	LAYA #3	7/26/19	HARDNESS CA/MG AS CACO3	516	IML	S1907400-002A	8/2/2019	SM 2340B	
Brook Mine	LAYA #3	7/26/19	DISSOLVED NH3 AS N	-0.1	IML	S1907400-002B	7/29/2019	EPA 350.1	
Brook Mine	LAYA #3	7/26/19	SAR	0.59	IML	S1907400-002A	8/2/2019	Calculation	
Brook Mine	LAYA #3	7/26/19	DISSOLVED HCO3 AS HCO3	510	IML	S1907400-002A	7/29/2019	SM 2320B	
Brook Mine	LAYA #3	7/26/19	DISSOLVED CO3 AS CO3	-5	IML	S1907400-002A	7/29/2019	SM 2320B	
Brook Mine	LAYA #3	7/26/19	OH AS OH	-5	IML	S1907400-002A	7/29/2019	SM 2320B	
Brook Mine	LAYA #3	7/26/19	DISSOLVED CL	4	IML	S1907400-002A	7/29/2019	EPA 300.0	
Brook Mine	LAYA #3	7/26/19	DISSOLVED F	0.7	IML	S1907400-002A	7/29/2019	SM 4500FC	
Brook Mine	LAYA #3	7/26/19	DISSOLVED NO2 + NO3 AS N	0.3	IML	S1907400-002B	7/29/2019	EPA 353.2	
Brook Mine	LAYA #3	7/26/19	DISSOLVED SO4	203	IML	S1907400-002A	7/29/2019	EPA 300.0	
Brook Mine	LAYA #3	7/26/19	DISSOLVED CA	92	IML	S1907400-002A	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED MG	70	IML	S1907400-002A	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED K	2	IML	S1907400-002A	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED NA	31	IML	S1907400-002A	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	CATIONS	11.72	IML	S1907400-002A	8/2/2019	SM 1030E	
Brook Mine	LAYA #3	7/26/19	ANIONS	12.76	IML	S1907400-002A	8/2/2019	SM 1030E	
Brook Mine	LAYA #3	7/26/19	CATION ANION BALANCE	4.26	IML	S1907400-002A	8/2/2019	SM 1030E	
Brook Mine	LAYA #3	7/26/19	DISSOLVED AL	-0.1	IML	S1907400-002C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED AS	-0.005	IML	S1907400-002C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #3	7/26/19	DISSOLVED BA	-0.1	IML	S1907400-002C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #3	7/26/19	DISSOLVED B	0.2	IML	S1907400-002C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED CD	-0.001	IML	S1907400-002C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #3	7/26/19	DISSOLVED CR	-0.01	IML	S1907400-002C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED CU	-0.01	IML	S1907400-002C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #3	7/26/19	DISSOLVED FE	-0.05	IML	S1907400-002C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED PB	-0.02	IML	S1907400-002C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #3	7/26/19	DISSOLVED MN	-0.02	IML	S1907400-002C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED HG	-0.001	IML	S1907400-002C	7/30/2019	EPA 245.1	
Brook Mine	LAYA #3	7/26/19	DISSOLVED MO	-0.02	IML	S1907400-002C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #3	7/26/19	DISSOLVED NI	-0.01	IML	S1907400-002C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	DISSOLVED SE	-0.005	IML	S1907400-002C	7/30/2019	EPA 200.8	
Brook Mine	LAYA #3	7/26/19	DISSOLVED ZN	-0.01	IML	S1907400-002C	7/29/2019	EPA 200.7	
Brook Mine	LAYA #3	7/26/19	TOTAL FE	-0.05	IML	S1907400-002E	7/30/2019	EPA 200.7	

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Brook Mine	LAYA #3	7/26/19	TOTAL MN	-0.02	IML	S1907400-002E	7/30/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	PH	7.9	IML	S1907400-003A	7/29/2019	SM 4500 H B	
Brook Mine	578415-AL-1	7/26/19	SP CONDUCTANCE AT 25 C	2430	IML	S1907400-003A	7/29/2019	SM 2510B	
Brook Mine	578415-AL-1	7/26/19	TDS DRIED AT 180 C	2030	IML	S1907400-003A	7/26/2019	SM 2540	
Brook Mine	578415-AL-1	7/26/19	TDS CALCULATED	1790	IML	S1907400-003A	8/2/2019	SM 1030E	
Brook Mine	578415-AL-1	7/26/19	TOTAL ALKALINITY AS CACO3	734	IML	S1907400-003A	7/29/2019	SM 2320B	
Brook Mine	578415-AL-1	7/26/19	HARDNESS CA/MG AS CACO3	1350	IML	S1907400-003A	8/2/2019	SM 2340B	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED NH3 AS N	0.2	IML	S1907400-003B	7/29/2019	EPA 350.1	
Brook Mine	578415-AL-1	7/26/19	SAR	0.8	IML	S1907400-003A	8/2/2019	Calculation	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED HCO3 AS HCO3	895	IML	S1907400-003A	7/29/2019	SM 2320B	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED CO3 AS CO3	-5	IML	S1907400-003A	7/29/2019	SM 2320B	
Brook Mine	578415-AL-1	7/26/19	OH AS OH	-5	IML	S1907400-003A	7/29/2019	SM 2320B	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED CL	10	IML	S1907400-003A	7/29/2019	EPA 300.0	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED F	0.3	IML	S1907400-003A	7/29/2019	SM 4500FC	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED NO2 + NO3 AS N	-0.1	IML	S1907400-003B	7/29/2019	EPA 353.2	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED SO4	845	IML	S1907400-003A	7/29/2019	EPA 300.0	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED CA	224	IML	S1907400-003A	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED MG	192	IML	S1907400-003A	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED K	16	IML	S1907400-003A	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED NA	68	IML	S1907400-003A	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	CATIONS	30.31	IML	S1907400-003A	8/2/2019	SM 1030E	
Brook Mine	578415-AL-1	7/26/19	ANIONS	32.54	IML	S1907400-003A	8/2/2019	SM 1030E	
Brook Mine	578415-AL-1	7/26/19	CATION ANION BALANCE	3.55	IML	S1907400-003A	8/2/2019	SM 1030E	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED AL	-0.1	IML	S1907400-003C	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED AS	-0.005	IML	S1907400-003C	7/30/2019	EPA 200.8	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED BA	-0.1	IML	S1907400-003C	7/30/2019	EPA 200.8	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED B	0.3	IML	S1907400-003C	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED CD	-0.001	IML	S1907400-003C	7/30/2019	EPA 200.8	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED CR	-0.01	IML	S1907400-003C	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED CU	-0.01	IML	S1907400-003C	7/30/2019	EPA 200.8	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED FE	-0.05	IML	S1907400-003C	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED PB	-0.02	IML	S1907400-003C	7/30/2019	EPA 200.8	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED MN	1.51	IML	S1907400-003C	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED HG	-0.001	IML	S1907400-003C	7/30/2019	EPA 245.1	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED MO	-0.02	IML	S1907400-003C	7/30/2019	EPA 200.8	

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New Lab Groundwater Quality Data

MINE_NAME	SAMP_STATION_NAME	SAMP_DATE	PARAMETER_NAME	PARAMETER_VALUE	LAB_COMP_NAME	LAB_BOTTLE_ID	ANALYSIS_DATE	ANALYTICAL_METHOD	COMMENTS
Brook Mine	578415-AL-1	7/26/19	DISSOLVED NI	0.01	IML	S1907400-003C	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED SE	-0.005	IML	S1907400-003C	7/30/2019	EPA 200.8	
Brook Mine	578415-AL-1	7/26/19	DISSOLVED ZN	-0.01	IML	S1907400-003C	7/29/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	TOTAL FE	111	IML	S1907400-003E	7/30/2019	EPA 200.7	
Brook Mine	578415-AL-1	7/26/19	TOTAL MN	3.95	IML	S1907400-003E	7/30/2019	EPA 200.7	