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Final Environmental Impact Statement and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project

Volume 1 of 4

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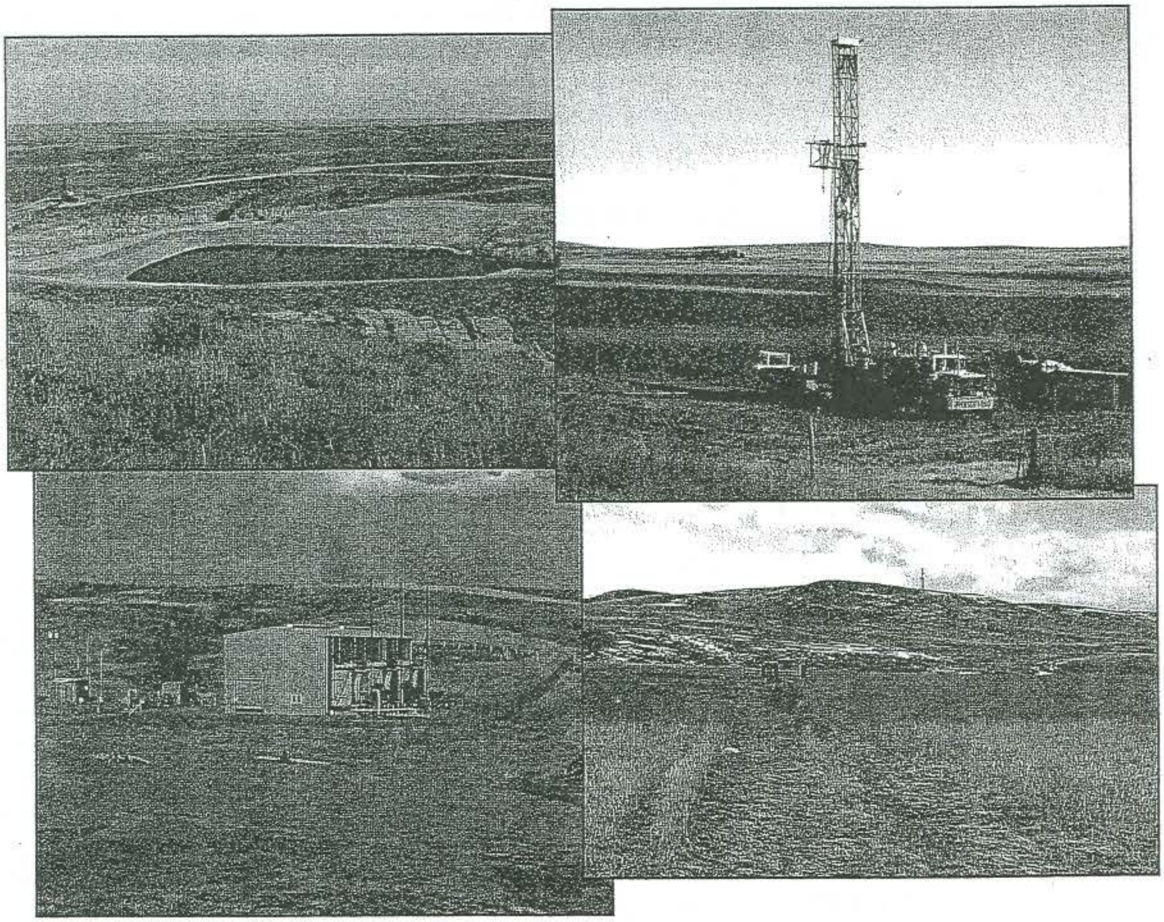

shrink-swell potential than does clay particle size. For example, the mudstones of the Wasatch and Fort Union formations contain montmorillonite (smectite or bentonite) and mixed-layer clays, which expand and contract depending on the introduction or deletion of oxygen and hydrogen (Devine 2002). Because of the absence of air and water and the difficulty of root growth, reclamation of a tightly compacted clay soil is extremely difficult without loosening the soil before seeding.

Shrink-swell potential is the potential for volume change in a soil with a gain or loss in moisture. Like compaction, a soil's shrink-swell potential is determined partially by its clay content. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. Montmorillonite clays are derived from the decomposition of shales and volcanic rock and can swell up to 15 times their dry-state volume when exposed to water. Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to capacity. A change of 3 percent is considered low, 3 to 6 percent is moderate, and a change of greater than 6 percent is classified as high. In soils with a high shrink-swell potential, Rapid changes in volume can damage structures and roads (NRCS 1986a, b, c). Appendix E identifies the soil series in the Project Area that exhibit a high clay composition and related high shrink-swell potential. Soils with a clay composition of 35 percent of greater are classified as high clay (NRCS 1971-1997). Soils classified as high shrink-swell potential in the county soil survey are marked as severe hazards in this section.

Severe shrink-swell potential soils occur along the northern and western borders of the Project Area and on either side of the Powder River, down the center of Sheridan and Johnson Counties and the eastern portion of Campbell County. The entire south half of Campbell County and small, widely separated portions of Converse County are dominated by these soils also.

Salinity and Sodicity

The SAR, or sodicity, of surface water and groundwater and salinity of soils are important chemical characteristics based on their effects on plant life and soils productivity. SAR is the ratio of the concentration of sodium ions relative to calcium and magnesium ions in water. Salinity in soil and water is commonly represented as a measurement of the amount of soluble salts in water, or TDS, measured in mg/L or parts per million (ppm). Measuring TDS in soils requires complete chemical analysis in a laboratory and can be time consuming and expensive. A more practical measurement of salinity in soils and water is electrical conductivity (EC), which is measured in deci-Siemens per centimeter (∂S/cm), or millimhos per centimeter (mmhos/centimeter) at 25 °C (Ayers and Westcot 1985). SAR can be measured only in water, whereas salinity can be measured in both soil and water. Salinity detracts from a plant's ability to take in water, whereas sodicity slows the movement of water through the soil.

Plant roots exclude salt from the water they extract from the soil. A plant must expend significant energy to take in water in highly saline water. This expenditure diverts energy from growth and reproduction, reducing the productivity of the plant. Soils with salinity levels from 0 to 8 mmhos/centimeters are considered slightly saline, soils with levels of 8 to 16 mmhos/centimeters are considered moderately saline, and soils with salinity levels above 16 mmhos/centimeters are considered strongly saline.

Soils with high clay content are most likely to experience adverse effects from high sodium. Sodicity is a more serious threat than salinity because it is much more difficult to reclaim sodic soils than saline soils. High sodium levels impair the permeability and infiltration rates of clay soils as a result of dispersion (Munn 2002a, b).

Catious such as calcium, magnesium, and sodium are attracted to negative charges on clay particles. Sodium can displace other catious on the clay exchange sites and cause the clay particles to disperse. This dispersion of the clay particles destroys soil structure, resulting in a reduction in water movement into and through the soil.

Salinity in soils can be affected by the SAR in and duration of exposure to surface water. Consequently, the salinity of soils can change rapidly over time and can differ greatly between similar soil types depending on the quality of the local water and the irrigation program. Additionally, any soil that is poorly drained, such as clay, has flat slopes, impermeable bedrocks, or is flooded frequently, could retain water and concentrate salts. These types of soils cover 40.6 percent of the Project Area.

Small sections of the Project Area concentrated near the confluence of the Powder River and the South Fork of the Powder River and along the Bell Fourche River, Black Thunder, and Little Black Thunder creeks are classified as high salinity. The saline soils in these areas most likely occupy toe slopes, alluvial fans, and stream terraces. Soils near or downstream from coal mines have also been found to be highly saline (Tidball and Ebens 1976). These statements are very general possible locations for saline soils. Chemical characteristics in soils can vary greatly over a large geographic area, regardless of soil type.

Poor Revegetation Potential

Soils with poor revegetation potential were identified using the land capability classification given in the county soil surveys. Soils are grouped according to their limitations for field crops, the risk of damage if used for agriculture, and response to management. Capability classes are divided into eight groups (Roman Numerals I–VIII), with Class I soils having few limitations and Class VII soils having multiple limitations that prevent commercial crop production. Class VII and Class VIII soils were determined have poor revegetation potential for this analysis.

Soils with poor revegetation potential occur throughout the Project Area, except the central portion of Campbell County.

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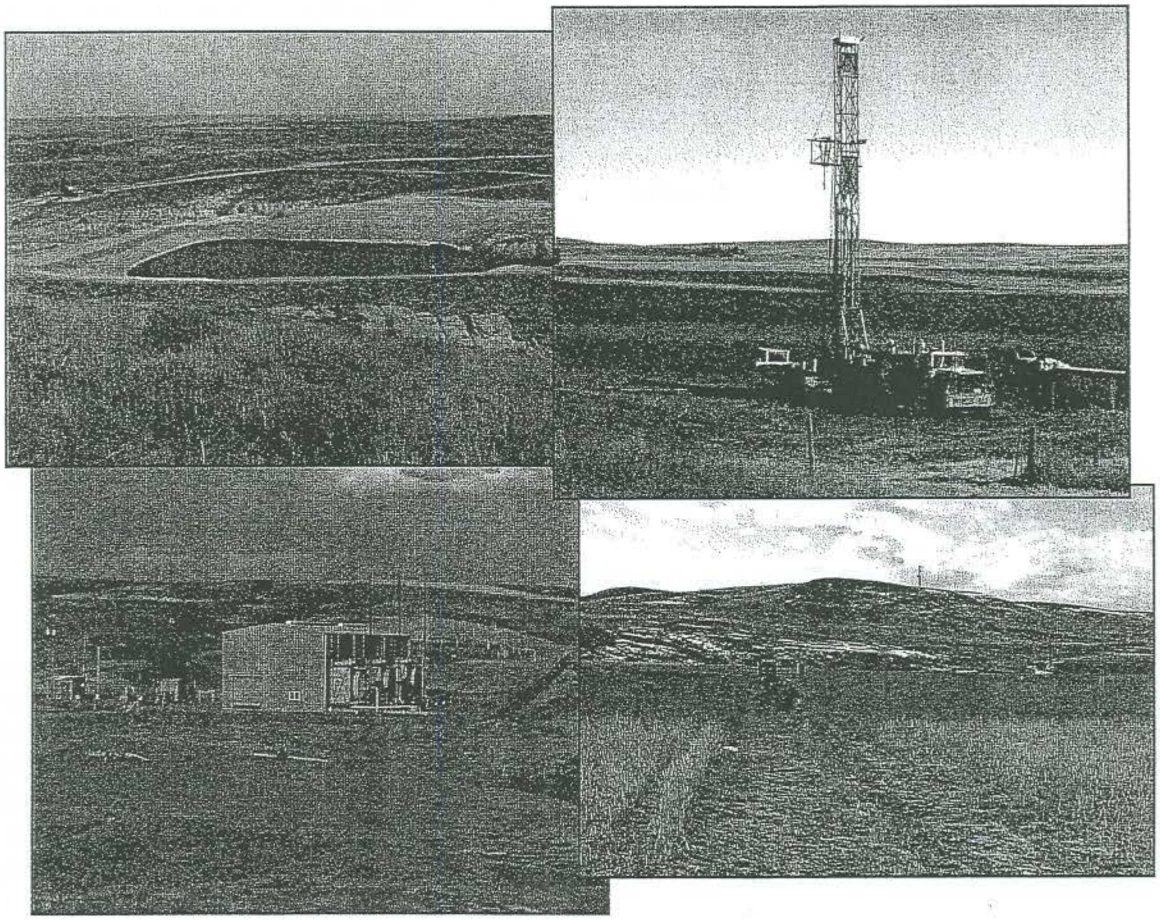

Produced water from CBM wells would be gathered for discharge at outfalls. Outfalls may feed into small stock reservoirs, constructed infiltration basins, or other facilities before the outflows reach surface drainages. No direct effects on wetlands and riparian areas would occur due to the containment reservoirs because they would be constructed in upland sites. Infiltration reservoirs would be constructed within floodplains or at upland sites. Infiltration reservoirs that are constructed within floodplains would affect the wetlands and riparian areas of the respective sub-watersheds, as previously described. The full extent of these direct disturbances cannot currently be quantified because the locations of the reservoirs have not been established.

No direct effects to wetlands and riparian areas would occur as a result of the creation of land application disposal sites or injection facilities. These sites would be located in upland areas away from drainages and floodplains. Water would be applied at agronomic rates at LAD sites so that there would be no runoff or infiltration of applied water that could reach surface drainages.

Discharges of produced water would decrease after the peak values (Table 4–13) are reached and would be terminated at the end of the project. Previously existing wetlands and floodplains that had expanded because of the increase in stream flows would experience vegetation dieback as the hydrology returned to normal conditions. Wildlife populations that depend on wetlands and riparian areas for food, cover, and water may decrease in abundance and wildlife species richness may be diminished. Salt scalds are accumulations of mineral salts in surface soil caused by evaporation that may appear within riparian corridors and along wetland edges. Salt scalds inhibit growth and recruitment of many wetland and upland plant species (DLWC 2000, Seelig 2000) and could perpetuate adverse saline conditions to wetlands via surface runoff of precipitation. New depressional wetlands or groundwater wetlands created by the increased stream flows during the life of the project would dry up after discharges of produced water cease and the hydrologic conditions return to normal. Associated wetland species communities could be eliminated in these locations and are not likely to be assimilated into the communities of remaining wetlands and riparian areas. Salt scalds could appear as the saline water and saline groundwater evaporates in the newly formed wetlands.

Impacts from Produced Water Quality

The water produced during extraction of CBM has been measured at 47 locations throughout the PRB for its mineral composition and other water quality parameters by the USGS (Rice et al. 2000). Details on water quality specific to the Project Area are included in the section on Surface Water Quality of Chapter 3. The USGS study reported that most concentrations of trace elements were at or below the analytical detection limits and no noticeable trends were apparent. This study and others cited in Chapter 3 indicate that the primary water quality parameters of interest regarding ecological impacts to wetlands and riparian areas from releases of produced water are salinity caused by high concentrations of sodium cation and sodicity caused by high concentrations of bicarbonate ions.

Average values are predicted for the proposed discharges of produced water in each of the sub-watersheds that would be affected by the project (Table 4–13) and are discussed in the section on Surface Water Quality. Substantial increases in the normal levels of salinity and sodicity in the surface waters of several of the Project Area's sub-watersheds by discharges of produced water would affect the ecosystem structure and functions of wetlands and riparian areas. The salinity and sodicity measures of the produced water discharges would not be ameliorated in the sub-watersheds where minimum mean flows are less than, and mean monthly flows are similar to, the rate of discharge for produced water that would reach the streams and rivers. Plant communities have been identified as the wetland biota most sensitive to increases in concentrations of salinity in water (Hart et al. 1991). The growth, vigor, and reproductive success of plant and animal species of aquatic and semi-aquatic systems, such as wetlands and riparian areas, depend on a range of tolerance to water quality parameters, including salinity, sodicity, pH, and others (Mitsch and Gosselink 1993). Additionally, increased salinity and longer periods of soil saturation or inundation can act synergistically to the detriment of many species of riparian plants (Hart et al. 1991). Above-normal concentrations of salinity cause stress to plants that can lead to dieback and changes in species community composition. The predicted range in the concentration of salinity of the produced water discharge for the project is greater than the threshold values for effects to plants (Horpestad 2001, James and Hart 1993, Nielsen and Brock 2001), indicating that adverse effects would affect vegetation in wetlands and riparian areas in the seven sub-watersheds with predicted average concentrations of salinity in the middle or high end of the range of values (Table 4–13). However, injury to vegetation communities of wetlands and riparian areas may be avoided if the narrative water quality standards developed for the protection of agriculture are coincidentally protective of native wetlands vegetation species.

Biota of wetlands and riparian areas other than plants would also be adversely affected by increases in salinity. Benthic and water column invertebrates of wetlands are also sensitive to increases in salinity, with adverse effects appearing in some taxa at 1,000 mg/L TDS. The most sensitive of the invertebrate taxa are benthic multicellular organisms and certain insects, such as stoneflies, mayflies, caddisflies, and dragonflies (Hart et al. 1991). Waterfowl and fish depend directly these invertebrate taxa for food.

Increased sodicity in the floodplains of the main stems of the Project Area sub-watersheds would affect wetlands and riparian areas through amplified sedimentation within riparian corridors, including floodplain terraces. SARs of 13 or more may cause potentially irreversible changes to soil structure that reduce percolation of rainfall and surface water flows, restrict root growth, limit permeability of gases and moisture, and make tillage difficult (Seelig 2000, U.S. Salinity Laboratory Staff 1954). At least some of the average SARs for the affected sub-watersheds may be greater than 13, with the highest values potentially occurring in the Clear Creek and the Upper Tongue River sub-watersheds (Tables 4–7 and 4–10). The effects of increased sedimentation have been previously discussed in this section in terms of the increase in the velocity and volume of surface water flow in stream channels. Reduced percolation and the formation of an impermeable soil surface in areas of high clay content over large expanses of floodplains would increase the contribution of surface runoff to in-channel stream flows that are already high. The establishment and maintenance of riparian grasses, shrubs, and trees within the riparian corridor and in wetlands would be limited by the degraded soil structure caused by the highly sodic discharges of produced water. Additional information on the effects of an increased sodium absorption ratio on soils, agricultural crops, and native upland vegetation can be found in the sections on Soils, Land Use, and Vegetation.

Alternatives 2A and 2B

The numbers of well pads and the miles of linear facilities, such as roads, pipelines, and power lines, that may affect wetlands and riparian areas are the same for Alternatives 1, 2A, and 2B. The effects to wetlands and riparian areas from these facilities would therefore be the same for these alternatives. Alternatives 2A and 2B would result in similar percentages and areal extent of short- and long-term direct disturbances to wetlands and riparian areas as Alternative 1, but would result in greater direct disturbances than Alternative 3. The lack of differences in direct disturbance to wetlands and riparian areas is a result of the planned avoidance of these environmentally sensitive areas. Additional details about direct disturbances are included in Chapter 2.

Most of the affected sub-watersheds, with the exception of the Upper Belle Fourche River sub-watershed, would receive more discharges of produced water to streams and rivers under Alternatives 1 and 3 than under Alternatives 2A and 2B (Table 4–3). Therefore, the effects to wetlands and riparian areas from predicted quantity and quality of produced water would be less for Alternatives 2A and 2B than for Alternatives 1 and 3.

Alternative 3

A smaller number of facilities related to the extraction of CBM in the Project Area would be constructed under Alternative 3 than for the other alternatives and, thus, the extent of effects to wetlands and riparian areas would be proportionally less. The predicted rates of discharge for produced water that would reach the main stems of the various affected sub-watersheds would be the same as for Alternative 1 (Table 2–8). The effects to wetlands and riparian areas from quantity and quality of produced water previously discussed would be the same for this alternative. Most of the affected sub-watersheds, with the exception of the Upper Belle Fourche River sub-watershed, would receive more discharges of produced water to streams and rivers under Alternatives 1 and 3 than under Alternatives 2A and 2B (Table 4–3). Therefore, the effects to wetlands and riparian areas from predicted quantity and quality of produced water previously discussed would be greater for Alternatives 1 and 3 than for Alternatives 2A and 2B.

Cumulative Effects

Implementation of the alternatives would contribute to other types of effects on wetlands and riparian areas in the Project Area. Oil and gas extraction, in general, attempts to avoid environmentally sensitive areas such as wetlands and riparian areas. However, these types of projects are on the increase in the PRB. Future projects of a similar nature would have similar levels of effects to wetlands and riparian areas within the sub-watersheds. Other types of natural resource extraction projects might have more or fewer effects to wetlands and riparian areas of