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SOIL AND WATER RESOURCE CONSULTANTS

February 15, 2007

Wyoming Environmental Quality Council
122 West 25th Street
Herschler Building, Room 1714
Cheyenne, Wyoming 82002

Subject: Written testimony pertaining to the proposed revisions to the Chapter 1 Water Quality Rules and Regulations – Section 20 Agricultural Use Protection Policy.

Dear Council Members:

I respectfully submit for your consideration the following comments regarding the draft Section 20 Agricultural Use Protection Policy as it pertains to the derivation of default effluent limits for electrical conductivity (EC) and sodium adsorption ratio (SAR) and the proposal to make it part of the Chapter 1 rules and regulations. On May 4, 2006, I submitted two letters to Mr. Bill DiRienzo of the Wyoming Department of Environmental Quality regarding the derivation of EC and SAR limits, respectively. I have attached them to this summary letter in the event you have not received them as part of the administrative record on this matter.

By way of introduction, I am a board-certified professional soil scientist having practiced as an environmental consultant in Montana and Wyoming, and throughout the world, for over 25 years. I have an M.S. degree in Land Rehabilitation (soil science emphasis) from Montana State University, and a B.S. in Resource Conservation (soil science emphasis) from the University of Montana. I am currently President of KC Harvey, Inc., a Wyoming corporation with nearly 20 employees specializing in the difficult problems associated with soil and water chemistry, water management and land reclamation. For the past eight years, my practice has focused on water management and soil and water salinity/sodicity issues associated with oil and gas development. I am credited as the first to research, develop, and apply managed irrigation techniques for the beneficial use of coalbed natural gas produced water in Wyoming. I have directed or participated in over 100 separate projects related to produced water management, WYPDES permitting, soil and water chemistry investigations, and reclamation for coalbed and conventional natural gas projects in Wyoming, Colorado, and Montana. Four years ago, I convinced the leading coalbed natural gas producer in Montana to fund an unprecedented soil, water and crop monitoring and landowner assistance program for the entire Tongue River drainage. I am an applied scientist; I use science, and the truth it yields, to prevent and solve problems, and alleviate fear.

I was invited by Mr. Bill DiRienzo of the WDEQ Water Quality Division to participate and contribute to the development of the Agricultural Use Protection policy over two years ago. Since then I have participated in committee meetings, draft review, public comment, and several hearings by the Water and Waste Advisory Board and others. My comments in this letter

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summarize my findings presented in the attached letters and to summarize what I have learned since submitting them last May.

I strongly urge you, and for you to urge your colleagues on the Council, to please read the attached letters that I submitted last May. I have been told that they are the most comprehensive science based comments to be submitted regarding the Agricultural Use Protection Policy. I spent over three months researching many dozens of research articles and other written material from the world-wide scientific literature. I interviewed leading scientists in the field. I compiled and analyzed actual soil, water and plant data collected by me and others in Wyoming to gain insight into the regional specific relationships between salinity, sodicity, soils, climate, crop production, hydrology, etc.

General Comments

Northeastern Wyoming is essentially a desert, or at most a semi-arid environment. This area is experiencing the worst long-term drought on record. Coalbed natural gas produced water is unaltered groundwater. It is not terribly salty; rather it is naturally enriched in sodium and low in calcium making it "soft." Similar and worse quality water is put to use around the world and in Wyoming to grow food for people and forage for livestock as well as livestock watering. We should view the availability of this water as a resource that has many opportunities for use and is, in fact, being used beneficially by many landowners in Wyoming. Somewhere along the line we allowed fear, not science, to dictate policy and management of this water. We should not be so afraid of this water. Because the interaction between soil and all water is complex, regulating discharges of produced water should be based on well-reasoned and scientifically supported information and not on a "one-size fits all" mentality. We should respect it and put it to beneficial use through flexible policies that recognize the complex interactions of soil and water through science- and risk-based mitigation, monitoring and, if necessary, remediation programs. Yes, it is a technical and complex set of issues; therefore, it is the obligation of us all to learn as much about them as possible before we regulate them.

While soil and water interactions are complex, we can make predictions regarding the outcome of these interactions based on the available information. Predictions regarding the potential impacts associated with soil and water salinity/sodicity and the potential for a measurable decrease in forage and livestock production can be separate; i.e., just because there is an incremental increase in soil salinity and/or sodicity, there will not necessarily be a measurable decrease in agricultural production. In addition, any potential decrease in forage production brought on by the presence of water in a watershed must be weighed against the potential increase in livestock production due to the availability of the same water for stock watering. This relationship has been left out of the WYPDES permitting and Section 20 evaluation process. Often, there are positive impacts to be considered.

Comments Regarding the Derivation of Effluent Limits for EC

The Water Quality Division has historically taken the position that the default effluent limits for EC should be based on the USDA Agricultural Research Service (ARS) Salt Tolerance Database (USDA ARS, 2006). The ARS Salt Tolerance Database relies on California-based salinity

thresholds developed to approximate the specific plant, soil and environmental variables associated with that region. Regional differences in soil chemistry, climate and agricultural practices have a profound influence on the effects of salinity on soil. Therefore, the applicability of California-based salinity threshold data to crops is questionable, at best, when attempting to apply them to crops growing in Wyoming. The extreme climate, lack of soil development, lack of moisture, lack of soil nutrients, high altitude and cropping practices, among other things, in Wyoming will limit a plant's ability to reach its 100 percent physiological yield potential before an incremental increase in soil salinity will. I confirmed this simple principle with leading soil and crop scientists from California. These are the same experts relied upon by the Water Quality Division and invited to Wyoming by Director Corra.

Because it focuses on soils more typical of Wyoming soils, I urge the Council to maintain the use of the USDA Bridger Plant Materials Center guidelines for plant salinity thresholds. These guidelines were developed by the USDA for use in Montana and Wyoming. They correspond to similar guidelines coming from Alberta and Saskatchewan, which are very similar with respect to climate, soils, etc. to that of northeastern Wyoming. These guidelines are confirmed every day in Wyoming where forage yields for plants such as alfalfa do not vary due to variations in soil salinity.

As an example of the difference between California soils versus Wyoming soils, I reviewed literature and evidence concerning the effects of salinity on alfalfa (considered the most salt sensitive plant irrigated in northeastern Wyoming). The California database lists alfalfa as having a 100 percent yield threshold due to soil EC of 2 dS/m (in other words, in California, if the average soil EC increases above 2 dS/m, then alfalfa yield will theoretically decrease). Sources of research and field guidance outside of California suggest alfalfa has a higher relative 100 percent yield threshold for soil EC, perhaps as high as 4 to 8 dS/m. In Wyoming, identical yields for alfalfa were reported in fields with soil EC values ranging from 1.8 dS/m to as high as 6.5 dS/m (see the attached letter to Bill DiRienzo regarding EC limits). In other words, under Wyoming conditions, I have reviewed publicly available data which demonstrate that no measurable decrease in alfalfa production occurred with soil salinities of up to 6.5 dS/m. In addition, I have reviewed data available to the public that demonstrates alfalfa yields from California and Wyoming were independent of soil salinity (i.e., the yield did not correlate with soil salinity). These findings demonstrate that the impact of the other Wyoming factors on crop and forage production (extreme climate, lack of soil development, lack of moisture, lack of soil nutrients, high altitude, and cropping practices), reduce the utility of the California database for Wyoming conditions.

Comments Regarding the Derivation of Effluent Limits for SAR

Plant growth problems associated with excess sodium adsorption are in response to negative changes in soil structure resulting in reduced air exchange, water infiltration and hydraulic conductivity. Excess sodium adsorption by the clay minerals in soils can lead to dispersion of soil particles, plugging of soil pores and sealing of the soil. SAR is a measure of the sodicity risk in irrigation water. The higher the salinity of irrigation water, the higher the SAR can be without impacting soil structure and impairing soil infiltration and permeability. Excess sodium adsorption is caused by the long-term application of water with a high SAR. The universally

applied sodic soil threshold is an exchangeable sodium percentage (ESP) greater than 15. This definition does not mean that degradation of soil structure will occur in all soils once the ESP exceeds 15. This phenomenon is dependent on a multitude of physical and chemical variables.

I agree that a cap on the Tier 1 default SAR limit should be established. In an effort to obtain the most credible data, rather than rely on SAR water quality thresholds based on dated information from another region with soils that are not representative of Wyoming soils, I looked at actual soil data from the Powder River Basin of Wyoming. This region-specific analysis is based on 382 soil samples. Based on the statistical relationship between ESP and SAR in the 382 soil samples, an SAR effluent limit of 16 would correspond to an ESP of 10 in the soil. On average, this would provide a 33% margin of safety against the formation of sodic soil conditions (i.e., that the SAR of the water would cause the ESP of the soil to exceed 15% leading to soil structure degradation and soil sealing). I would expect this relationship to be relatively the same throughout Wyoming based on field experience.

The Agricultural Use Protection Policy recommended by the Water and Waste Advisory Board (Board) sets forth default limits for SAR that are extrapolated from the Hanson et al. (1999) chart relating the established EC effluent limit to SAR, up to a maximum of 16. The Board's determination that the appropriate cap for SAR is 16 (and not 10, as argued by the WQD) is based on the fact that scientific research and evidence indicates that a higher cap is appropriate in Wyoming due to the difference in Wyoming soils versus California soils. The effluent limit for SAR will be determined in conjunction with EC so that the relationship of SAR to EC remains within the "no reduction in rate of infiltration" zone of the Hanson et al. (1999) diagram.

Based on the available science and when soil characteristics typically found in Wyoming are taken into account, if Appendix H is to be adopted, the Tier 1 default effluent limitation for SAR should be capped at 16, not 10 as recommended by the Water Quality Division. This corresponds to an EC effluent limitation of 2.7 dS/m based on the widely-accepted Hansen diagram. Interestingly, based on the USDA Bridger Plant Materials Center guidelines, an EC of 2.7 dS/m is also the proposed EC limit when protection of alfalfa is the goal.

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Thank you very much for your time and consideration of these comments. If I can be of service to the EQC in any way, or if you have any questions, please do not hesitate to contact me.

Sincerely,

Kevin C. Harvey, M.Sc., CPSSc.

Principal Soil Scientist