

IN RE: PETITION TO AMEND WYOMING)
WATER QUALITY RULE, CHAPTER 2)
APPENDIX H)

Docket No. 05-312

Terri A. Lorenzon, Director
Environmental Quality Council

RESPONSE OF MARATHON OIL COMPANY
TO PETITIONERS' FIRST STATUS REPORT

Introduction and Summary

Marathon Oil Company ("Marathon") has joined in Respondents' joint response being filed in this matter. Marathon is submitting this individual response to amplify five points that are made in the joint response.

First, Petitioners' suggestion in their "First Status Report" that the Council could at this stage proceed on the original petition for amendment of Appendix H is without merit. That original petition, submitted December 7, 2005, is no longer before the Council, having been withdrawn when Petitioners filed their second petition on March 2, 2006. As explained in the Joint Motion to Deny and Terminate Proceedings, filed May 5, 2006, which is incorporated herein by reference, Petitioners effectively withdrew that petition by filing a new petition on March 2, 2006 (and withdrew that petition in favor of a third petition on May 8, 2006).

Second, under the Environmental Quality Act ("EQA"), Petitioners' pending May 8 petition set forth in their "status report" cannot be the subject of rulemaking except after review by Department of Environmental Quality ("DEQ") and the Water Quality Advisory Board. The Environmental Quality Council ("EQC") does not have statutory authority to engage in unilateral rulemaking in response to Petitioners' petition.

Third, stripped of its unlawful “burden of proof” and “credible evidence” requirements, the operative May 8 petition merely restates the procedure by which DEQ currently issues WYPDES discharge permits under the EQA and the Department’s Agricultural Use Policy. No rulemaking is required to ensure that DEQ permit writers issue permits for CBM produced water discharges that protect water quality in Wyoming.

Fourth, Petitioners’ proposed ban on any discharge of naturally-occurring CBM water as “pollution” would be even more injurious to Wyoming water-users than were their original and first substitute petitions. The new petition would prevent new discharges of produced water that could and would be used by ranchers and farmers. This highly desirable water would never even be produced under Petitioners’ new approach.

Fifth, the May 8 petition’s proposed limits on sulfates, total dissolved solids (“TDS”) and barium in CBM produced water in the Powder River Basin are unjustified in light of the evidence demonstrating the long-term successful use of produced water for livestock and irrigation throughout Wyoming. Moreover, it would be premature to establish new limits for these constituents before University of Wyoming scientists complete work on a new study. The purpose of the study is to enable regulation of these constituents to be based on a sound scientific footing instead of on anecdotal and hearsay claims of harm to livestock from drinking produced water in Wyoming. No regulatory action should be taken until this scientific work is finished.

Discussion

1. Petitioner’s Original Petition Is Not Before the Council.

As explained in Respondents’ letter to the Council dated March 10, 2006, which is incorporated by reference herein and in the Joint Motion to Deny and Terminate Proceedings, filed May 5, 2006, Petitioners clearly and unequivocally withdrew their original

petition when they filed a new petition on March 2, 2006. Under the new petition, Appendix H would not be amended (except to make it inapplicable to CBM produced water) and a new Appendix I imposing “beneficial use” requirements on CBM produced water discharges would instead be adopted.

Petitioners’ March 2 petition reflected a strategic retreat for Petitioners in the face of evidence presented at the February 16, 2006 hearing, which demonstrated that produced water from conventional oil and gas operations is crucial to Wyoming ranching operations. Petitioners clearly intended as of March 2 that the new petition – not the original one – would be the operative petition that the Council should notice for rulemaking. As counsel for Petitioners explained in her March 2 cover letter:

As you know, my clients feel strongly that people who wish to make use of produced water are entitled to do so. We have therefore followed up on the suggestions made by Councilman Moore, and drafted a new Appendix I which is specific to CBM. . . . I wanted to put this before the Council and the DEQ prior to public notice of the hearing on the rule.

Letter from Kate M. Fox to Terri Lorenzon (Mar. 2, 2006) at 1.

Even had Petitioners not clearly expressed their intent to substitute the March 2 petition for the December 7 petition, EQC rules do not contemplate that more than one petition from a petitioner on a given subject could be before the Council at any given time. Under Chapter III, Section 2(a) of EQC’s rules, “each petition” to promulgate, amend or repeal a rule must be submitted to the Council. Under Section 2(c), “After filing of *the petition*, the Council may hold a prehearing conference to review *the petition* and *its* persuasiveness.” (emphasis added). Under Section 2(d): “As soon as practicable, the Council shall deny *the petition* in writing (stating its reasons for the denial) or initiate rule-making procedures.” (emphasis added)

Under the Council's rules, a petition must be sufficiently defined to enable the Council to carry out its procedural obligations to evaluate that petition – not some other petition or group of petitions. Petitioners elected on March 2 to change “the petition” before the Council and abandoned the original petition. Then, on May 8 – after the Attorney General opined that both the original petition and its March 2 replacement were beyond the Council's legal authority, and after Respondents moved on that basis to terminate the proceedings --Petitioners undertook another strategic retreat, withdrew their March 2 petition, and put forth a third, unrelated petition. That May 8 petition, with all the infirmities discussed below and in Respondents' Joint Response, is now “the petition” before the Council.

2. EQC Is Not Authorized to Conduct This Unilateral Rulemaking.

As explained in detail in Petitioners' Joint Response, neither Petitioners' pending May 8 petition, set forth in their “status report,” nor their prior petitions can be the subject of rulemaking except after review by the Water Quality Advisory Board and DEQ. If the EQC does not simply dismiss the Petition in accordance with Respondents' May 5 motion, then the Petition must be referred to the DEQ for review and comment by the Water Quality Advisory Board, the Water Quality Division Administrator and the Director. Those entities must make recommendations on the proposed rule before the EQC could continue with further rulemaking. Thus, should the EQC determine it wants to proceed with a rulemaking, the matter must be referred to the DEQ to formulate recommendations, with input from the Water Quality Advisory Board, before the EQC proceeds. EQC may not proceed unilaterally.

3. Petitioners' New Proposal, Stripped of Its Discriminatory and Unlawful "Burden of Proof," Simply Restates DEQ's Current Water Quality-Based Permitting.

The Attorney General has confirmed that EQC cannot regulate the quantity of CBM water discharges unless the quantity directly relates to the quality of the discharge. "The EQA allows regulation of the quantity of water if the quantity has an unacceptable effect on the *quality* of the water." Letter from Attorney General Patrick Crank to Gov. Dave Freudenthal, April 12, 2006 at 1 (emphasis added). As the Attorney General observed, "There is no express authority, nor is there any implied authority, in the EQA for regulation of water quantity in the absence of a direct tie to water quality." *Id.* at 6.

Petitioners cannot seriously dispute that their first two petitions asked the Council to go beyond its authority. Indeed, Petitioners stated that the purpose of the original petition was to require DEQ to take into account in WYPDES permitting decisions "impacts to land and water that result from quantity *rather than quality* of discharged water." December 7, 2005 Petition at 9 (emphasis added).

Petitioners attempt to take issue with the Attorney General's opinion in their "Status Report," but seek to salvage their position by asking the Council to proceed on an entirely new petition in the form of a different Appendix I that would require applicants for permits to discharge CBM water to establish by "credible evidence" that the "quantity of produced water shall not cause or have the potential to cause, unacceptable water quality." Status Report at 5.

As explained in detail in Respondents' Joint Response, Petitioners improperly invoke the "credible evidence" standard, which the legislature intended DEQ to use only in setting water quality standards and designating uses, not in establishing effluent limitations in WYPDES permits. Moreover, Petitioners seek to place on CBM produced water

dischargers a “burden of proof” that no other WYPDES permit applicant must carry. Marathon respectfully submits that, while the EQA may allow different effluent limitations in WYPDES permits for different types of discharges, this discriminatory imposition of a unique procedural burden on a particular class of WYPDES dischargers when they seek permits is arbitrary and capricious and would not survive judicial scrutiny.

If these unlawful elements are removed from Petitioners’ May 8 petition, then it is clear that Petitioners’ request simply restates how WYPDES permits are issued today for CBM discharges. That is, DEQ already requires permit applicants to provide information about the quality of their discharges and the projected quantity, so that the impact on water quality in receiving waters can be predicted. DEQ then places limits on the pollutant concentration of the discharge, and sometimes on the flow rates at that concentration, in order to preserve water quality in the receiving waters in accordance with the State’s water quality standards. Where water quality standards may be exceeded, DEQ requires the discharger to demonstrate through a Use Attainability Analysis that the discharge will not harm the environment and imposed permit limits accordingly. Thus, WYPDES permits are currently written to prevent “unacceptable” water quality, i.e., water quality that, as a result of a given discharge, does not meet the relevant water quality standard or will harm the environment. No new Appendix I is required to establish protection for water quality in receiving streams, which already is provided under existing DEQ procedures.

Moreover, Petitioners’ proposed ban on “pollution,” and thus on discharges, is contrary to DEQ’s Agricultural Use Policy, under which DEQ regulates “pollution” so as to

protect water quality. The Agricultural Use Policy, as it currently exists and as proposed to be revised,¹ provides in pertinent part:

Section 20. **Agricultural Water Supply.** All Wyoming surface waters which have the natural water quality potential for use as an agricultural water supply shall be maintained at a quality which allows continued use of such waters for agricultural purposes.

Degradation of such waters shall not be of such an extent to cause a measurable decrease in crop or livestock production.

Unless otherwise demonstrated, all Wyoming surface waters have the natural water quality potential for use as an agricultural water supply.

As DEQ explained in its proposed revision to the Agricultural Use Policy, a key purpose of water quality standards is “to provide a basis for establishing permit limits on regulated activities (WYPDES . . . permits).” DEQ is considering revisions to the Agricultural Use Policy, not to ban “pollution,” but “to provide guidelines to be used by the Water Quality Division when translating the narrative goals expressed in the Section 20 standard into appropriate WYPDES permit limits where maintaining agricultural use of the receiving waters is an issue.”² That statement aptly describes the proper role of DEQ in regulating “pollution” in discharges to waters of the state. A ban on “pollution” would improperly curtail DEQ’s regulation of “pollution” through the WYPDES system.

¹ The Water Quality Division of DEQ has proposed the revision in response to a recommendation from the Water Quality Advisory Board. See deq.state.wy.us/wqd/events/AG_policy/AG_POLICY_4TH_DRAFT.pdf.

² As DEQ observes in the proposed revised Agricultural Use Policy: “[T]he implementation of the narrative criteria [regarding no decrease in crop or livestock production] through WYPDES permits will always involve making reasonable judgments and assumptions.” Petitioners’ third petition, shorn of its discriminatory burden-of-proof provisions, calls for nothing more than DEQ permit writers already are doing.

4. Petitioners' New Proposal to Ban "Pollution" In CBM Produced Water Discharges Would Be Even More Injurious to Wyoming Agriculture Than Their Previous Petitions.

Petitioners apparently seek to reintroduce their impossible-to-satisfy "beneficial use" requirement for produced water discharges in the guise of requiring a permit applicant to show "that the produced water would not constitute 'pollution' as defined in the EQA." Status Report at 5. The EQA defines "pollution" to include, among other things, "alteration of the physical, chemical or biological properties of any waters of the state." W.S. 35-11-103(c).³ The definition is broad precisely because the legislature intended that DEQ would apply it on a discharge-by-discharge basis and establish effluent limits in discharge permits to regulate "pollution" in order to protect the *quality* of receiving waters.

The definition of "pollution" does not work as an effluent limitation, whether for CBM produced water or any other discharge. For example, as applied to CBM produced water, unless the receiving water into which the produced water is discharged is of a quality identical in all respects to the discharge, that produced water would effect some change in the properties of the receiving water and thus would arguably be "pollution." The conclusion that produced water is "pollution" could be advanced even though the produced water is in a completely natural state, i.e., is in the same condition in which it emerges from the ground.⁴ Even treated CBM produced water would not be chemically identical to the receiving waters and arguably could be considered "pollution" under the statutory definition.

³ The term also includes "any discharge of . . . wastes . . . into any waters of the state . . . which creates a nuisance or renders any waters harmful, detrimental or injurious to public health, safety or welfare . . . or which degrades the water for its intended use or adversely affects the environment." This alternate definition of "pollution" contemplates some evaluation of the impact of discharge, but appears superfluous because any discharge that causes an alteration of receiving water quality or composition is arguably "pollution."

⁴ Petitioners' approach is incoherent. On the one hand, as discussed above, their petition would allow DEQ to issue a WYPDES permit if the discharge, though "pollution," will not adversely

Counsel for Petitioners represented to the Council in her March 2 letter that “my clients feel strongly that people who wish to make use of produced water are entitled to do so.” However, Petitioners’ proposed new Appendix I would achieve the opposite result – no rancher or farmer could obtain produced water because the discharge of produced water apparently would be banned as a “pollutant.” Based on Marathon’s experiences with extensive utilization of produced water from conventional oil and gas production over many years, Petitioners’ proposed ban on all discharges of CBM produced water could have a devastating prospective effect on Wyoming agriculture. As discussed in Marathon’s March 10 comments, in 2002 and 2003 the ranching community strongly supported the renewal of Marathon’s WYPDES permits to discharge produced water from Marathon’s Pitchfork, Gebo, North Sunshine and Steamboat fields because the water is important to them economically, especially during drought years. In the current proceeding, Marathon provided for the record statements of numerous ranchers as to how highly they value their supplies of produced water. Many ranchers echoed these comments at the Council’s February 16, 2006 hearing.

There is no evidence to suggest that produced water from CBM operations will not also be highly valuable to ranchers and farmers. Experience strongly suggests that the Council should avoid any disruption or curtailment of CBM produced water discharges. Not having the benefit of these perennial water sources would hurt many agricultural operators in Wyoming.

impact water quality. And, the proposal also prescribes effluent limitations for permissible concentrations of some constituents – e.g., sulfates and barium -- in discharges of CBM produced water. Yet, no discharge of “pollution” ostensibly could be permitted.

5. Available Scientific Data Do Not Support Petitioners' Proposed Effluent Limits For CBM Produced Water.

The May 8 petition's proposed reductions in limits on sulfates and TDS, and new limit on barium, in CBM produced water in the Powder River Basin are hold-overs from the earlier petitions. These revised limits are unjustified in light of the evidence demonstrating the long-term successful use of produced water for livestock and irrigation throughout Wyoming. On this point, Marathon incorporates by reference its comments to the Council dated February 10, 2006.

As DEQ recently noted, "The basic concept in protecting a livestock watering use is to ensure that water quality is not acutely toxic to livestock or does not contain pollutants in concentrations that would affect growth or reproduction." Agricultural Use Policy (Fourth Draft) at 2. In other words, even water whose quality may not be optimal for livestock watering under controlled laboratory conditions (where alternative water is available) is preferable in the real world to no water at all for livestock. According to DEQ, the existing limits that appear in Appendix H (5000 mg/L TDS; 3000 mg/L Sulfate; 2000 mg/L Chloride) "are intended to ensure that the water is safe for livestock to drink." *Id.* Plainly, produced water meeting these criteria has been used for decades in Wyoming to water stock without toxic effects and without interfering with reproduction. Petitioners have provided no data to even call into question this real-world experience, much less justify drastically reduced effluent limits that could not feasibly be met and which would result in significant curtailment of future discharges of CBM produced water that could have been used to water stock.

Because there are many scientific questions about the exact relationship of TDS and salinity levels in livestock water supplies to animal health, DEQ has indicated that it intends

to proceed with a program of research recently proposed by scientists at the University of Wyoming. These scientists (Merl Raisbeck D.V.M., Ph.D, DABVT; K. J. Reddy, Ph.D; and Michael Smith Ph.D) will conduct a two-year “Critical Review of the Scientific Literature Relating to Water Quality for Wyoming Livestock and Wildlife.” (“UW Proposal”) See Exhibit A attached hereto. The fact that a critical review of the existing scientific literature is needed demonstrates the current degree of uncertainty. In the proposal, Dr. Raisbeck and his colleagues summarize the current state of scientific uncertainty:

Water quality standards, as enumerated in “appendix H” governing surface discharges are based upon science that is several decades old and have been challenged. That *the challenges are themselves based upon dubious information* is, in itself, a reflection of the state of current water quality recommendations by various land grant institutions and governmental agencies. In many cases, newer, presumably better, data is available. It just hasn’t trickled down to a useful level. CBM technology itself has created questions (e.g. Ba) that never had to be answered before. We propose updating current recommendations where adequate information is available. This will be accomplished by assembling and critically reviewing existing data then assembling it into a coherent set of recommendations. Areas where existing data is insufficient will be identified as future research needs.

UW Proposal at 1 (emphasis added). The University of Wyoming researchers expressly cite Petitioners’ challenge to existing effluent limits as an example of a scientifically unfounded “hearsay” assertion about the supposed deficiencies in the current standard:

A case in point involves the recent challenge to existing standards for sulfate (SO₄), Ba and total dissolved solids (TDS) (Fox, 2005). Several ranchers and the Powder River Basin Resource Council challenged current Wyoming Water Quality Rules, alleging that they were insufficient to protect livestock health. In support of their claim, they cited extension service websites at Utah State, the Wyoming State Chemist and Colorado State University, which purportedly demonstrated that existing standards for these elements would endanger livestock and wildlife (Fox, 2005). After spending several days, many phone calls and repeated searches of the (semi) scientific literature we determined that the numbers cited as hazardous SO₄ concentrations were based upon possible transient diarrhea in baby pigs in the Midwest and not supported by controlled experiments nor well documented case reports in any species. We were unable to backtrack to any scientific source for the other recommendations.

UW Proposal at 1-2 (emphasis added). It would be premature and irrational for EQC or DEQ to impose the limits proposed by Petitioners on sulfates, TDS or barium in CBM produced water until the pending scientific review is completed and it is determined scientifically what, if any, reductions should be made in applying the current Appendix H standards to CBM produced water.

Conclusion

For the foregoing reasons, Marathon respectfully urges the EQC to take no further action on either of Petitioners' first two petitions, deny Petitioners' third petition and terminate these proceedings. In the alternative, should the EQC believe it may lawfully proceed with rulemaking effort, Respondents request that the issue be referred to the DEQ and the Water Quality Advisory Board for appropriate review and recommendation under the proper procedures and following the statutory requirements for rulemaking under the EQA.

Respectfully submitted,



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Dated: June 16, 2006

EXHIBIT A

**Critical Review of the Scientific Literature Relating to
Water Quality for Wyoming Livestock and Wildlife**

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Project length: 2 years
Proposed cost: \$102,197 (DOE), \$35,048 (Match), \$137,244 (Total)

Abstract

Water is an essential nutrient, arguably the most essential nutrient. Livestock and big game in the arid areas of Wyoming currently impacted by Coal Bed Methane (CBM) development have few choices when it comes to sources of this essential nutrient; often there is no recourse but produced water that may be of dubious quality. Water quality standards, as enumerated in “appendix H” governing surface discharges are based upon science that is several decades old and have been challenged. That the challenges are themselves based upon dubious information is, in itself, a reflection of the state of current water quality recommendations by various land grant institutions and governmental agencies. In many cases, newer, presumably better, data is available. It just hasn’t trickled down to a useful level. CBM technology itself has created questions (e.g. Ba) that never had to be answered before. We propose updating current recommendations where adequate information is available. This will be accomplished by assembling and critically reviewing existing data then assembling it into a coherent set of recommendations. Areas where existing data is insufficient will be identified as future research needs.

Justification and Scope

Water is a simple compound, yet it is arguably the nutrient most essential to life. Water accounts for 50-75% of the body weight of most terrestrial animals. It is *the* solvent responsible for movement of nutrients, metabolites and waste products between body compartments and into/out of the body as a whole. It plays a central role in mammalian thermoregulation. Loss of between 10-20% of the body’s water content is fatal in most higher animals. Although there are a few exceptions, most mammals (including those economically important in Wyoming) derive the vast majority of their water by drinking. The amount of water that any particular animal requires on a given day is influenced by a variety of physiological and environmental parameters, however none of our livestock or game species can survive more than a few days without access to some form of water. In an arid state like Wyoming animals often don’t have much choice about the water they drink. As noted by a WGF biologist in the Red Desert “...its wet ain’t it? That’s a damn sight better than the alternative.” However, because water is also an excellent solvent for minerals, it represents a potential source of excess minerals and other toxicants.

Fairly conservative water quality standards exist for human consumption. A somewhat looser set of standards and effluent limits has been adopted for livestock (and by inference, wildlife) consumption (e.g., WYDEQ) based largely upon a review published in 1974 (NRC, 1974). While there is some good science underlying some of the standards, the simple fact is that many of today’s standards are based upon science that is at least 30 years old - or upon the best guess of the nearest expert available when they were written. In addition, the advent of the Internet has also resulted in a volume of hearsay and urban legend that would have been impossible 20 years ago. The latter, especially, lends itself to constant challenges of any regulation and can only be countered by solid data.

A case in point involves the recent challenge to existing standards for sulfate (SO₄), Ba and total dissolved solids (TDS) (Fox, 2005). Several ranchers and the Powder River Basin Resource Council challenged current Wyoming Water Quality Rules, alleging that they were insufficient

to protect livestock health. In support of their claim, they cited extension service websites at Utah State, the Wyoming State Chemist and Colorado State University, which purportedly demonstrated that existing standards for these elements would endanger livestock and wildlife (Fox, 2005). After spending several days, many phone calls and repeated searches of the (semi) scientific literature we determined that the numbers cited as hazardous SO₄ concentrations were based upon possible transient diarrhea in baby pigs in the Midwest and not supported by controlled experiments nor well documented case reports in any species. We were unable to backtrack to any scientific source for the other recommendations.

Objectives

The objective of this project is a *thorough review of the scientific knowledge base re: water quality for the classes of livestock and economically important wildlife species endemic to Wyoming*. Special emphasis will be placed upon contaminants that are common in Coal Bed Methane produced waters. It is *not* an attempt to re-write existing standards as doing so is more properly the province of the political and/or regulatory communities. It is rather to provide a sound scientific basis for decisions by these authorities. The data will also provide a better foundation for outreach via the university's traditional outlets such as the Cooperative Extension Service.

Significance

Current regulatory standards and outreach recommendations in virtually all of the western states are all too often based upon anecdotal information, extrapolation from dissimilar species and different environmental conditions, and just plain SWAG's of various authorities at the time of compilation. Most haven't been updated since the 1970's. A compilation of the scientific literature, both experimental and clinical, with an emphasis on more recent work will provide 1) a solid scientific foundation for any revision of standards or 2) reinforce existing standards and 3) identify gaps in the knowledge base that should be addressed by future research. This data is sorely needed, as evidenced by numerous conversations with landowners and ranchers, information requests to the WSVL and the letter of support from the director of WYDEQ Water Quality Division.

Methods

Although this project resembles a thesis literature review, the diversity and breadth of the topic and the fragmentary nature of the knowledge base require an approach that is simultaneously more extensive and more intensive than the typical such review. Although minor variations will undoubtedly be required, the basic strategy is as follows:

Dr. Reddy will prioritize a list of contaminants based upon what is commonly found in CBM waters. His extensive experience with CBM water over the last 5 years makes him uniquely qualified for this task. His database of water quality is the most extensive in the PRB. Although the project will not be limited to this list, the importance of CBM produced waters to the state's economy make it a logical starting point for the effort. The priority list will be amended according to the current state of the art in toxicology and animal physiology (Dr. Raisbeck), the

livestock production environment (Dr. Smith) and the big game environment (Dr. Tate).

An initial screening of the literature will be accomplished for each of the major water components identified above via the usual computerized databases (Medline, Toxline, CAB, Biosis, CAS) and references assigned keywords reflecting the nature of the publication (e.g. primary or secondary source, clinical or experimental data), species involved (the intent is to focus economically important species such as sheep, cattle, elk, deer or pronghorn), the nature of toxic effects, if any, and then stored in a bibliographic database (e.g. Papyrus). A sub-set of these papers will be winnowed out for reverse searching via citation links (e.g. Citation Index) and the process repeated. Bibliographies of the collected papers will be screened for primary citations not already in the database. *The objective of this process is to wind up with an extensive collection of reliable, first-hand reports of intoxication and/or NOELs, not secondary citations.*

A second, simultaneous, search for data will be based upon "networking", i.e. making direct contact with regulators and animal health experts in other Rocky Mountain states to solicit input that may not have made it into the computerized bibliographic databases. Examples of this category might include, but are not limited to, unpublished theses, industrial or governmental reports and searches of diagnostic lab databases. It also includes first hand reports of poisoning by diagnosticians, wildlife biologists, etc., so long as the story can be corroborated by ancillary data (lab reports, etc.) and fits good diagnostic practices (e.g. Koch's Postulates). Finally, we will attempt to interview the authors of various extension bulletins relating to water quality for animals about their sources of information. Hard copy will be obtained where available and included in the above database with an additional flag indicating its non-peer-reviewed status.

Obviously, the latter category of information is going to require very careful scrutiny *vis-a-vis* its reliability and accuracy, but it is a resource that should not be ignored. Non-academic agencies often commission or conduct relatively well funded and rigorous research projects to address specific issues, but the investigators have little incentive to publish anything beyond technical reports to the funding organization - and the sponsor may not want embarrassing information broadcast to the world at large, even if it is technically public. For example, the first experimental confirmation of the discovery that SO₄ causes polioencephalomalacia in ruminants (Raisbeck, 1981) was completed by Dr. John Mahoney of Ralston Purina in ca. 1983 (John Mahoney DVM, *personal communication*). The study involved over 200 animals, extensive controls and rigorous (GLP) quality control. The first *published* experiment involved 9 animals, no controls and was published in 1991 (Gould et al., 1991). The PI has seen the former report several years ago and, without casting any aspersions on Gould et al., it is a superior study. It was just never been published in the peer-reviewed literature.

A final source of material to be gleaned during the search (initial) phase are historical established standards such as the NRC's *Nutrients and Toxic Substances in Water for Livestock and Poultry* (NRC, 1974). Again, the intent is to validate the accuracy and relevance of the original sources, then update recommendations in light of more recent information.

Once the bibliographic database is built it will be digested and reduced to simple recommendations appropriate to large mammals in an environment typical of Wyoming and the northern Great Plains. This is where the expertise of the investigators and collaborators really

comes into play. For example: S has been demonstrated to be toxic to ruminants both experimentally and under field conditions. Various papers describe poisoning in cattle and sheep, but attribute it to water SO₄ concentrations anywhere from 1000 mg/L (Beke and Hironaka, 1991) to over 3000 mg/L (Haydock, 2003) while others indicate NOEL greater than 5000 mg/L (Digesti and Weeth, 1976). The validity of the reported lethal dose needs to be determined in light of the basic design of the report and any analysis done (toxicology and chemistry, Raisbeck and Reddy) and ancillary factors such as other dietary components (toxicology and management, Raisbeck and Smith). Interactions with other dietary components, common to Wyoming environments, which potentiate or inhibit toxicity, need to be evaluated (toxicology and chemistry, Raisbeck and Reddy). Since virtually nothing is known about the toxicology of S in antelope, deer, etc. extrapolation of dose from (e.g. cattle) represents a combined effort of wildlife physiology and toxicology (Raisbeck and Tate). S is known to inhibit the uptake of essential trace elements such as Cu. The question arises as to whether state government agencies are interested in regulating water quality to allow for nutrient interactions or only concern themselves with overt toxicity? If so, how detailed should such regulations be? (DEQ, Zygmont)

Once the final compilation has been accomplished and recommendations are finalized, the various components, and their rationale, will be submitted to other authorities in the field for comment. The short time available for preparation of this proposal precludes getting written agreement from outside authorities but the PI is confident that he can get input from veterinary toxicologists and chemists re: all of the major contaminants as he has significant "networking" links (e.g. moderator for the veterinary toxicology - "VETTOX" - listserv for the last 10 years) with a variety of experts in the field.

The final products of this research will be: 1) a set of guidelines re: water quality for animals to be promulgated via the UWCES; 2) a review paper in one of the livestock production or wildlife journals (e.g. *J Anim Sci* or *J Wildlife Dis*); and 3) a set of recommendations, with supporting documentation, for the WYDEQ. The final report to EPSCOR will also include a recommendation for research needed to address gaps in the current knowledge base.

Time Schedule

June, 2006 - Sept, 2006	Recruit a MS level graduate student with a strong background in wildlife biology, environmental toxicology or livestock production and organic/inorganic chemistry.
Sept, 2006 - June, 2007	Collect data
June, 2007 - Sept, 2007	Compile data, solicit review from outside authorities
Sept, 2007 - June 2008	Incorporate outside reviews, compose recommendations, finalize and publish results, finish thesis.

References

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NRC (1974) *Nutrients and Toxic Substances in Water for Livestock and Poultry*. National Academy Press, Washington, DC.

WYDEQ Wyoming Water Quality Rules, Chapter 2, Appendix H, Section b.vii.

ORGANIZATION				Year 1		
University of Wyoming						
PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR						
M. F. Raisbeck						
	CAL	ACAD	SUMR	FUNDS REQUESTED FROM AGENCY	NON-FEDERAL MATCHING FUNDS	TOTAL PROJECT COSTS
1 M. A. Smith	0.				\$4,200	\$4,200
2 K.J. Reddy	0.			\$8,611		\$8,611
3 M. F. Raisbeck	0.			\$4,700	\$4,700	\$9,400
4.						\$0
5. () OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)						\$0
6. () TOTAL SENIOR PERSONNEL (1-5)	0.25	0.00	0.00	\$13,311	\$8,900	\$22,211
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. () POST DOCTORAL ASSOCIATES						\$0
2. () OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)						\$0
3. () GRADUATE STUDENTS				\$13,416		\$13,416
4. GRADUATE STUDENT HEALTH INSURANCE				\$809		
5. () UNDERGRADUATE STUDENTS						\$0
6. () SECRETARIAL-CLERICAL						\$0
7. () OTHER						\$0
TOTAL SALARIES AND WAGES (A+B)				\$27,536	\$8,900	\$36,436
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS) 40%						
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				\$33,184	\$12,460	\$45,644
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$1,000)						
TOTAL PERMANENT EQUIPMENT						\$0
E. TRAVEL						
1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)						\$0
2. FOREIGN						\$0
F. PARTICIPANT SUPPORT COSTS						
1. Workshop STIPENDS \$						
2. TRAVEL						
3. SUBSISTENCE						
4. OTHER including TUITION						
TOTAL PARTICIPANT COSTS					\$35	\$35
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						\$0
2. PUBLICATION COSTS/PAGE CHARGES						\$0
3. CONSULTANT SERVICES						\$0
4. COMPUTER (ADPE) SERVICES				\$1,200		\$1,200
5. SUBCONTRACTS						\$0
6. OTHER Tuition and fees				\$4,386		\$4,386
TOTAL OTHER DIRECT COSTS				\$5,586	\$0	\$5,586
H. TOTAL DIRECT COSTS (A THROUGH G)				\$38,770	\$12,495	\$51,265
I. INDIRECT COSTS (SPECIFY)						
TOTAL INDIRECT COSTS Approved rate of 40.5%				\$15,702	\$5,046	\$20,748
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				\$54,471	\$17,541	\$72,012
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				\$54,471	\$17,541	\$72,012
M. COST-SHARING: PROPOSED LEVEL \$						

ORGANIZATION				Year 2					
University of Wyoming									
PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR									
	CAL	ACAD	SUMR	FUNDS REQUESTED FROM AGENCY	NON-FEDERAL MATCHING FUNDS	TOTAL PROJECT COSTS			
1 M. A. Smith	0.			\$0	\$4,200	\$4,200			
2 K.J. Reddy	0.			\$8,611	\$0	\$8,611			
3 M. F. Raisbeck	0.			\$4,700	\$4,700	\$9,400			
4.						\$0			
5. () OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)						\$0			
6. () TOTAL SENIOR PERSONNEL (1-5)				0.25	0.00	0.00	\$13,311	\$8,900	\$22,211
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)									
1. () POST DOCTORAL ASSOCIATES									\$0
2. () OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)									\$0
3. () GRADUATE STUDENTS							\$14,087		\$14,087
4. GRADUATE STUDENT HEALTH INSURANCE									
5. () UNDERGRADUATE STUDENTS									\$0
6. () SECRETARIAL-CLERICAL									\$0
7. () OTHER									\$0
TOTAL SALARIES AND WAGES (A+B)							\$27,398	\$8,900	\$36,298
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS) 40%							\$5,324	\$3,560	\$8,884
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)							\$32,722	\$12,460	\$45,182
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$1,000)									
TOTAL PERMANENT EQUIPMENT									\$0
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)									\$0
2. FOREIGN									\$0
F. PARTICIPANT SUPPORT COSTS									
1. Workshoop STIPENDS \$									
2. TRAVEL									
3. SUBSISTENCE									
4. OTHER including TUITION									
TOTAL PARTICIPANT COSTS							\$346		\$346
G. OTHER DIRECT COSTS									
1. MATERIALS AND SUPPLIES									\$0
2. PUBLICATION COSTS/PAGE CHARGES									\$0
3. CONSULTANT SERVICES									\$0
4. COMPUTER (ADPE) SERVICES							\$1,000		\$1,000
5. SUBCONTRACTS									\$0
6. OTHER									\$0
TOTAL OTHER DIRECT COSTS							\$1,000	\$0	\$1,000
H. TOTAL DIRECT COSTS (A THROUGH G)							\$34,068	\$12,460	\$46,528
I. INDIRECT COSTS (SPECIFY)									
TOTAL INDIRECT COSTS Approved rate of 40.5%							\$13,657	\$5,046	\$18,704
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)							\$47,725	\$17,506	\$65,232
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)							\$47,725	\$17,506	\$65,232
M. COST-SHARING: PROPOSED LEVEL \$									

ORGANIZATION University of Wyoming				SUMMARY		
PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR						
	CAL	ACAD	SUMR	FUNDS REQUESTED FROM AGENCY	NON-FEDERAL MATCHING FUNDS	TOTAL PROJECT COSTS
1.	0.10	0.00	0.00	\$0	\$8,400	\$8,400
2.	0.20	0.00	0.00	\$17,222	\$0	\$17,222
3.	0.20	0.00	0.00	\$9,400	\$9,400	\$18,800
4.	0.00	0.00	0.00	\$0	\$0	\$0
5. () OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)	0.00	0.00	0.00	\$0	\$0	\$0
6. () TOTAL SENIOR PERSONNEL (1-5)	0.50	0.00	0.00	\$26,622	\$17,800	\$44,422
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)						
1. () POST DOCTORAL ASSOCIATES	0.00	0.00	0.00	\$0	\$0	\$0
2. () OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	0.00	0.00	0.00	\$0	\$0	\$0
3. () GRADUATE STUDENTS				\$27,503	\$0	\$27,503
4. GRADUATE STUDENT HEALTH INSURANCE				\$809	\$0	
5. () UNDERGRADUATE STUDENTS				\$0	\$0	\$0
6. () SECRETARIAL-CLERICAL				\$0	\$0	\$0
7. () OTHER				\$0	\$0	\$0
TOTAL SALARIES AND WAGES (A+B)				\$54,934	\$17,800	\$72,734
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS) 40%						
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				\$65,906	\$24,920	\$90,826
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING \$1,000)						
TOTAL PERMANENT EQUIPMENT				\$0	\$0	\$0
E. TRAVEL POSSESSIONS						
1. DOMESTIC (INCL. CANADA AND U.S.)				\$0	\$0	\$0
2. FOREIGN				\$0	\$0	\$0
F. PARTICIPANT SUPPORT COSTS						
1. Workshop STIPENDS \$						
2. TRAVEL						
3. SUBSISTENCE						
4. OTHER including TUITION						
TOTAL PARTICIPANT COSTS				\$346	\$35	\$381
G. OTHER DIRECT COSTS						
1. MATERIALS AND SUPPLIES						\$0
2. PUBLICATION COSTS/PAGE CHARGES				\$0	\$0	\$0
3. CONSULTANT SERVICES				\$0	\$0	\$0
4. COMPUTER (ADPE) SERVICES				\$2,200	\$0	\$2,200
5. SUBCONTRACTS				\$0	\$0	\$0
6. OTHER				\$4,386	\$0	\$4,386
TOTAL OTHER DIRECT COSTS				\$6,586	\$0	\$6,586
H. TOTAL DIRECT COSTS (A THROUGH G)						
				\$72,837	\$24,955	\$97,792
I. INDIRECT COSTS (SPECIFY)						
TOTAL INDIRECT COSTS Approved rate of 40.5%				\$29,359	\$10,093	\$39,452
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)						
				\$102,197	\$35,048	\$137,244
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)						
				\$102,197	\$35,048	\$137,244

Budget Justification

Funds are requested for a graduate student for 2 years. Inflation of 5% is allowed for the second year's salary. This project requires a degree of independent and critical thought that is unusual in a UW MS candidate. Such an individual is unlikely to accept a position that does not assure him/her of completing the degree. The student will have to have sufficient time to complete coursework *and* do the footwork necessary to find and analyze the necessary documents. The alternative is to hire a trained RAI for a shorter period, which, by the time fringe and benefits are included, is more expensive.

Funds are requested for copying, office supplies, interlibrary document retrieval and long distance telephone calls (section G line 4) to obtain the data necessary to successful completion of the project. Since this is going to be primarily a knowledge-based study, these are somewhat larger than in a typical experimental project.

Funds are requested to purchase a used computer for the graduate student (also section G line 4)

Funds are requested for 1 trip to Cheyenne (round trip 100 miles) to consult with DEQ during each of the two years and one overnight trip to the Powder River Basin (round trip 602 miles, motel and *per diem*) to present results of the study at a meeting (Section F).

Cost sharing is shown in an amount of approximately 35% of the funds requested from DOE, primarily as investigators' salary.