State of Utah

GARY R. HERBERT
Governor

GREG BELL
Lieutenant Governor

Department of
Environmental Quality

Amanda Smith
Executive Director

DIVISION OF RADIATION CONTROL
Rusty Lundberg
Director

March 21, 2011

CERTIFIED MAIL
(Return Receipt Requested)

David C. Frydenlund, Vice President, Regulatory Affairs and Counsel
Denison Mines (USA) Corp.
1050 17th Street, Suite 950
Denver, CO 80265

Subject: February 18, 2011 Denison Mines (USA) Corporation, "Work Plan and Schedule for Supplemental Contaminant Investigation Report for White Mesa Mill Nitrate Investigation": DRC Review Comments

Dear Mr. Frydenlund:

DRC Review comments regarding the February 18, 2011 Denison Mines (USA) Corporation (DUSA) "Work Plan and Schedule for Supplemental Contaminant Investigation Report for the White Mesa Mill Nitrate Investigation (Work Plan), are enclosed. The review and comments were prepared by URS Corporation per contract agreement with the DRC.

Please note that the comments present a dynamic approach to completing the work plan, including the development of a conceptual site model (CSM) and a phased approach to contaminant source investigation, including water and sediment sampling. This dynamic approach was not anticipated by the DRC/DUSA tolling agreement signed and executed on 12/15/2010.

Item 6 of the 12/15/2010 tolling agreement states, "This Agreement shall terminate on the earlier of: (a) April 30, 2011 ("Automatic Termination Date") unless extended by prior written agreement executed by the parties; and (b) the date of execution and delivery of the revised or replacement Consent Agreement contemplated by paragraph 5 above." Therefore, a meeting (or telephone conference call) amongst DRC, DUSA and URS staff is necessary, and needs to be arranged as soon as possible to determine a schedule for DUSA revision of the Work Plan and anticipated timelines to execute a revised Consent Agreement.

We suggest this meeting or call take place during the week of April 4, 2011. Please contact me at (801) 536-0080 to arrange a time for the meeting or call.

Sincerely,

Tom Rushing, P.G.
Geotechnical Services Section

F:\DUSA\Nitrate Contamination Investigation\URS Nitrate Work Plan Comments\WorkplanReviewCommentsTransmittalLtr.doc

URS

MEMORANDUM

To: Tom Rushing (DRC), Loren Morton (DRC), Phil Goble (DRC)

From: Paul Bitter (URS), Jeremy Cox (URS), Michael J. Singleton (SC)

cc: Robert Baird (URS)

Date: 21 March 2011

Re: Comments on Work Plan and Schedule for Supplemental Contaminant Investigation Report for White Mesa Mill Nitrate Investigation dated Feb. 18, 2011

This memorandum contains the URS and DRC comments on the Work Plan and Schedule for Supplemental Contaminant Investigation Report for White Mesa Mill Nitrate Investigation (Work Plan) dated Feb. 18, 2011, which was prepared for Denison Mines USA (DUSA) by Intera Corporation. This review has been performed as a deliverable for Contract No. 116259 issued through the Utah Department of Environmental Quality, Division of Radiation Control (DRC). This review also is in accordance with the Memorandum of Understanding (MOU) between the DRC and DUSA dated February 17, 2011. For purposes of expediency, the URS and state comments are edited for conciseness and combined into one memo.

The review of the Work Plan has been informed by the following documents:

- *Summary of work completed, data results, interpretations and recommendations for the July 2007 Sampling Event at the Denison Mines, USA, White Mesa Uranium Mill Near Blanding, Utah*, prepared by T. Grant Hurst and D. Kip Solomon of the Department of Geology and Geophysics at the University of Utah, submitted May 2008.
- *Nitrate Contamination Investigation Report, White Mesa Uranium Mill Site, Blanding, Utah*, prepared by Intera Corporation, dated December 30, 2009.
- The "Notice of Additional Required Action Letter" (NOTICE) dated October 5, 2010 from DRC to DUSA regarding DRC review of the 2009 report.
- The letter dated November 15, 2010 from DUSA to DRC responding to the NOTICE listed above.
- A spreadsheet of monitoring well construction data (DUSA WELLCOMP.xls) and as-built reports for monitoring wells provided to URS by DRC on February 28, 2011.

DRC and URS have reviewed the Work Plan with the support of Michael Singleton, Ph.D., of Singleton Consulting. Dr. Singleton has approximately 14 years of experience in stable isotope and geochemical data analysis, including the application of this experience to the assessment of recharge and impacts to groundwater from human and animal waste. Dr. Singleton is the author or co-author of 17 published papers. His qualifications are available upon request.

The comments regarding the Work Plan are presented below.

In summary, our reviews suggest the following: 1) a dynamic conceptual site model should be produced in the work plan based on current information; 2) the model should be updated during the investigation to include results of samples analyzed in accordance with the work plan, 3) more potential sources should be analyzed to test the hypotheses regarding nitrate sources, 4) isotopic analyses for sulfur and oxygen in sulfate should supplement the proposed isotopic analyses of nitrate and water to better distinguish potential sources, and 5) the sampling be conducted in more than one phase so the results can be discussed during a conference call with DRC, URS, and Michael Singleton for the purpose of conducting further phase(s) of investigation with focus and efficiency.

1. General Comment: The 2009 Nitrate Contamination Investigation Report (CIR) attempted to present a conceptual site model (CSM) to explain the presence of elevated levels of nitrate and chloride in the groundwater beneath the mill. Although it was not referred to as a "CSM" in that report, the CSM displays the possible formation of the nitrate/chloride plume in the center of the property due to one potential source. Since submittal of the CIR, DUSA has brought forward two other explanations and potential sources of the nitrate and chloride contamination in meetings with the DRC. Other potential sources (see comment #2 below) were not fully evaluated in the CSM in the 2009 Nitrate CIR. Ideally, a CSM that comprises plan and cross section depictions of potential sources should provide the following evaluation structure, documentation and conclusions regarding potential sources of the plume:
   a. Each potential source, described in text and shown on one or more figures; the figure(s) should be supplemented with site-specific chemical, lithological, hydrogeological, and physical data that affect the fate and transport of source material.
   b. The physical and chemical means and pathways by which the potential source could be conveyed to the present location of contamination, described in text and displayed in the conceptual drawings.
   c. Discussion of the analytical and geological data that are available and displayed on one or more of the figures to support the potential source of the nitrate and chloride contaminants in groundwater; data that do not support the potential source of the contaminants also can be displayed to eliminate a potential source.
   d. Discussion of the analytical and geological data that are lacking (i.e., data gaps) in the evaluation of the potential source's fate and transport.
   e. Description of the data that will be generated during the investigation that will be used to update the CSM.

   The Work Plan should present the CSM with the attributes discussed above, near the beginning of the document, with all of the successive sections discussed in terms of how the sections contribute to the structure of the CSM. The details of the CSM are discussed in the following comments.
2. General Comment: All potential sources for the nitrate and chloride contamination in the groundwater beneath the mill site must be addressed by the CSM. It is noted and accepted

that one potential source of the nitrate and chloride, the Frog Pond, was dismissed by DRC in the October 2010 NOTICE and that Denison did not produce any additional evidence for that potential source in the November 2010 letter responding to the NOTICE. An additional source, upgradient of the DUSA property, was also dismissed in the 2009 Nitrate Contamination Investigation Report as being too far from the plume at the center of the property to possibly be the source of the plume due to the time required for groundwater to travel from the northern boundary of the site to the center of the property. The DRC requires that the CSM identify three (or more if practical) potential sources for the elevated concentrations of nitrate and chloride that were outlined in the 2009 Nitrate CIR and the November 2010 DUSA memo: namely, (1) naturally-occurring deposits of nitrate and chloride in the vadose zone mobilized by recharge from the wildlife ponds or other locations, such as Lawzy Lake (the "New Theory"), (2) possible soil / groundwater contamination caused by the US Army missile activities on or near White Mesa, and (3) activities in or around the mill site, including the leach fields, historical stock watering ponds, and other potential source areas. The latter would be sub-divided into multiple potential source areas, as listed in the source review report in the 2009 Nitrate CIR. The three potential sources could be contributing individually or in combination to the current nitrate and chloride plumes.

3. Throughout the work plan, figures, maps and cross sections discussed in comment #1, should be cited as appropriate. The figures must provide the current hydrogeologic understanding of contaminant sources and their fate and transport at the site. Specifically, DUSA needs to provide the following regarding the development of maps and cross sections:
   a. All potential sources.
   b. For cross-sections, the soil types at each depth interval in the subsurface along the path of the cross-section, based on the available boring logs for at least five wells or sampling locations.
   c. For cross-sections, the depth to groundwater and the direction of groundwater flow; for maps, the direction of groundwater flow.
   d. All relevant analytical data for soil at the locations shown on the maps and cross-sections.
   e. All relevant analytical data for groundwater at the locations shown on the maps, with the current plume boundaries depicted on the cross-section.
   f. All relevant site features at the surface along the path of the cross-sections or in the view of the map.
   g. A minimum of two cross-sections should be generated: one roughly north to south, and one roughly east to west.
4. General Comment: The Work Plan should be structured in such a way that each component of the Work Plan presents a hypothesis relative to proving or disproving each potential source of nitrate contamination, methods and measurements to test each hypothesis, including the purpose of sample collections and analysis, and specific criteria to determine whether each hypothesis has been verified. A "weight of evidence" approach using multiple data to test or support a hypothesis should be employed whenever possible when evaluating hypotheses.

5. General Comment: DUSA must provide DRC with written notice at least two weeks prior to the beginning of each phase of field work associated with the investigation to allow for DRC observation of field work. The cost of the DRC observation of field work will be borne by DUSA.
6. Section 4.1, third paragraph: Figures 12 through 14, which are referenced in this paragraph, identify a historical stock watering pond that, upon comparison to Figure 15, is located on the south end of the investigation area, approximately half a mile southeast of MW-20 (near MW-22). The Work Plan should explain the purpose of identifying this pond. If this pond is illustrated in these figures as part of a response to DRC's discussion of nitrate concentrations in groundwater downgradient of the site in the October 2010 NOTICE, then such a response should be presented in the framework of the CSM and in the context of a hypothesis (e.g., a historical stock watering pond is the source of the elevated nitrate concentrations in MW-20). Then data that support or refute the hypothesis, and DUSA's conclusion, based on the weight of evidence, should be identified in the work plan.
7. Section 4.1, last paragraph and Section 4.2, last paragraph: The assertion of a "strong potential for military operations on White Mesa that may have led to some or all of the observed present-day groundwater contamination problems" is a statement that should be presented as a hypothesis in the work plan and analytical methods should be identified to test the hypothesis, as discussed above. A calculation of the mass of nitrate in the groundwater beneath the mill, as discussed in the 2009 Nitrate CIR, demonstrates that a significant mass of nitrate is present in the saturated zone beneath the mill. It is not clear that launching rockets from the property is likely to have contributed a significant mass of ammonium or nitrate to the subsurface. Unlike static rocket motor testing with quenching through water jets, there would be no mechanism to transport the contaminants to the saturated zone during rocket launches. Further, the presumed location of the launches is reported to be downgradient of the current location of the plume. There currently is no historical evidence that would identify the location or nature of support activities associated with the rocket launches. If DUSA wishes to test the hypothesis that missile operations may have served as source of nitrate contamination, then the DRC requests that the groundwater at the site be analyzed for perchlorate. The Pershing rocket motors likely would have contained some amount of perchlorate that would have been transported to the saturated zone with the other components of the rocket fuel. The determination as to whether this potential source will be examined needs to be included in the Work Plan now. If it is to be included, full details regarding the examination must be provided. If DUSA elects to eliminate past military activities as a source of nitrate and chloride, this decision will be considered final by the DRC.
8. Section 5.0, last paragraph: The 2005 study that is referenced supposedly cites concentrations with units of milligrams per liter. The text characterizes the concentrations as concentrations in soil, which should be in units of mass only. The units and results more likely reflect the leachable concentrations of nitrogen measured during the leachate tests conducted on the soil samples. Please resolve the discrepancy, and clarify what the concentrations of nitrate represent in this and other leachate-test discussions in the work plan.

9. Section 5.1, first paragraph: DRC agrees that some Geoprobe sampling of a naturally-occurring source of nitrate in the vadose zone is warranted for undisturbed areas during the investigation, providing that the number of samples is sufficient to characterize a potential source and its fate and transport. The proposed number of samples has not been explained or justified in the work plan. DRC requests that DUSA provide a statistical basis for the number of Geoprobe sample locations in the undisturbed areas in this section of the work plan.
10. Section 5.1, Step 7: If multiple soil lithologies are visible within the one-foot core, one sample shall be collected and analyzed from each lithology. Please revise the sampling procedure accordingly.
11. Section 5.1, Step 10: Please provide the source (i.e., agency) of the SPLP procedure and method number and repeat this information in the footnote to Table 2.
12. Section 5.2: The expected minimum number of borings must be listed in this section. Table 1 indicates that up to four borings are planned. The work plan should be constructed such that the number and depth of bedrock borings will be based on the number and results of Geoprobe sampling locations finally determined necessary to test the nitrogen reservoir hypothesis, and subject to DRC approval prior to commencement of further drilling.. .
13. Section 5.2, first paragraph: Background for the facility shall be determined by the 95% upper confidence level on the mean (95% UCL) of all 20 "background" samples collected from soil sampling locations in undisturbed areas (not altered by anthropogenic activities) and will be subject to DRC approval. Admittedly, some flexibility should be incorporated into the decision to core into consolidated material based on the overall results of the Geoprobe investigation. However, decisions to drill should be made jointly with DRC and should be reflected in the process flow diagram included in the work plan. The decision to bore further may benefit from a calculation of the concentration of nitrate in the soil that is expected to result in a groundwater concentration exceeding the compliance standard for nitrate (i.e., a soil to groundwater screening level).
14. Section 5.2, fourth and fifth paragraphs: DUSA desires to test the hypothesis that naturally-occurring deposits of nitrate and chloride in the unsaturated zone are contributing to the elevated concentrations of these compounds in the saturated zone beneath the mill. DRC requests that an additional sample be collected in the unconsolidated interval that contains the highest concentration of nitrate, as determined by the results of the Geoprobe investigation, for each drilling location. The additional sample should be analyzed for nitrate isotopes (nitrogen and oxygen) in addition to the nitrate and chloride analyses via the synthetic precipitation leaching procedure (SPLP) prescribed in the work plan. The characterization of the nitrate isotopes in these deposits, if present, will assist in determining whether the nitrate in the groundwater may have originated from the deposits.
15. Section 5.2: DRC requests that DUSA ensure that enough soil is collected from each interval to allow for the SPLP analyses for nitrate and chloride and for isotope analyses for sulfate and nitrate (see comments regarding isotope analyses below). DUSA must confirm the required sample volumes with the contract laboratory and list the required volumes in this section of the Work Plan.

16. Section 6.1: Geoprobe sampling around the potential source areas in the mill area is warranted. However, two of the potential source areas listed with a high priority for investigation in the source review report (Attachment 2 of the 2009 Nitrate CIR) were not included in the list of source investigation areas. These two areas are the historical stock watering pond (near the current location of the sulfuric acid tank) and the northern wildlife pond. DRC requests that these two areas be added to the list of potential source areas in Section 6.1, and included in the CSM discussion.
17. Section 6.1: Including the chlorate tanks as a potential source of nitrate may be incorrect. Based on the information in the source review report, the tanks hold sodium chlorate. If the tanks are being investigated as a source of chloride in groundwater, they should be characterized as a potential source of chloride. If the tanks have historically held ammonium chlorate, then this should be noted with the entry for the chlorate tanks as a potential source for nitrate. If the tanks have never held ammonium chlorate and are not considered a potential source for nitrate in the groundwater based on operating records, then this potential source area should be deleted from the list of investigation areas.
18. Figure 21: The red line for a potential nitrate or chloride source and the red outline for a leach field scheduled for investigation are indistinguishable. As a result, it is not possible to determine from Figure 21 which areas were potential sources that have been determined not to warrant any investigation. DRC requests that the coloring for these two categories of areas in Figure 21 be revised to make the figure legible.
19. Section 6.1, fourth and fifth paragraphs: DRC disagrees with the assertion that no subsurface soil sampling is necessary at the two active leach fields if the current influent to the leach fields is sampled. The current content of the influent to the leach fields could be very different from the influent to the leach fields twenty or thirty years ago. DRC requests that subsurface soil sampling should occur at these locations and should be supplemented by, not replaced by, analyses of the influent to the leach field. Performing direct push sampling in several locations within the unconsolidated (shallow) interval in the active leach fields will not create preferential pathways for waste water to reach the groundwater table, particularly if the boreholes are sealed with bentonite as stated in the work plan. DRC agrees with the sampling of the waste water and the use of a mass balance as outlined in this paragraph.
20. Section 6.1, fourth paragraph and Section 6.2 first paragraph: The text in these sections appears to differ regarding which leach fields (SAG leach field or CCD/SX leach field) are active. Please clarify.
21. Section 6.1: The minimum number of proposed mill site Geoprobe borings should be listed in this section. Table 1 indicates that as many as 13 borings are planned. As discussed above, the number of mill site borings must be statistically proportionate with the number of shallow borings drilled in undisturbed areas to determine background nitrate / chloride soil content. The current maximum of 13 appears to correspond to one boring per inactive potential source area. One boring per potential inactive source area is inadequate characterization of these areas. In addition, the active areas should be sampled (see comment #19). DRC requests two Geoprobe sample locations for each potential source area that was

rated as a low priority in the source review report (Attachment 2 of the 2009 Nitrate CIR) and four Geoprobe sample locations for each of the sources rated as a high priority or those regarded as likely contributors to the nitrate contamination in the source review report. This corresponds to two Geoprobe sampling locations in each of nine areas (sewage vault/lift station, former vault/lift station, ammonia tanks, Cell 1 leach field, fly ash pond, chlorate tanks [assuming this area is retained], ammonium sulfate tanks, truck shop leach field, and CCD/SX leach field), and four Geoprobe sampling locations in each of eight areas (scale house leach field, former office leach field, northern wildlife pond, Lawzy Lake, Lawzy sump, the historic pond in the location of the sulfuric acid tank, the SAG leach field, and the main leach field) for a total of 50 Geoprobe locations at potential source areas in and around the mill site. In addition, the list of sampling locations shall include, but not be limited to, all of the potential sources listed on Figure 21 of the Work Plan. The proposed sampling locations must be shown on a figure in the Work Plan.

22. Section 6.1, Step 3: The number of samples analyzed from each Geoprobe sample location within the mill site differs from the number of samples proposed for each Geoprobe sampling location in the undisturbed areas. Please justify the difference in the number of samples per location between the two areas. If the current text for Step 3 is not changed to match the procedure for the undisturbed area, please specify the criteria for which two intervals within the alluvial material are to be sampled for the Geoprobe sampling locations at the mill site for review by the DRC.
23. Section 6.2, first paragraph: It is unclear whether the procedure for determining whether nitrate concentrations are "elevated" is the same as that stated in Section 5.2. This section specifies that the procedures for drilling and sampling are identical to those described in Section 5.2, but does not explicitly state that the criteria for drilling at a location are the same. Please clarify.
24. Section 6.2, first paragraph: DRC disagrees with the categorical exclusion of coring in the active leach fields. This exclusion seems to be based on the theory (presented in Section 6.1) that the drilling would create preferential pathways for wastewater fluids to reach the saturated zone. DRC agrees that the deep drilling within the vadose zone underneath active leach fields could potentially create contaminant transport pathways to groundwater. However, the creation of pathways may be minimized by the procedures for backfilling the borings described in Section 5.2. DRC requests that the decision whether to drill in the active leach fields (if elevated concentrations of nitrate are discovered in the unconsolidated material) should be deferred pending further discussion with DRC after analytical data are available from the Geoprobe sampling and are assessed, rather than pre-emptively ruling out drilling in these areas The Work Plan must present the process for evaluating the analytical data from the Geoprobe sampling and determining whether deep coring is required. Consultation with, and approval of, the DRC regarding the decision to drill and the drilling locations must be part of the process presented in the work plan. The general planned locations for coring, if required, must be included in the work plan.

25. Section 6.2, first paragraph: In order to test the hypothesis that elevated concentrations of nitrate and chloride in the unsaturated zone due to milling activities are contributing to the elevated concentrations of these compounds in the saturated zone beneath the mill, DRC requests that an additional sample be collected in the unconsolidated interval with the highest concentration of nitrate, as determined by the results of the Geoprobe investigation, for each drilling location, and that a nitrate isotope analysis (nitrogen and oxygen) be performed on these samples in addition to the nitrate and chloride analyses via the SPLP. The characterization of the nitrate isotopes in these locations, if elevated concentrations are present, will assist in determining whether the nitrate in the groundwater may have originated from these activities.
26. Section 6.2: DRC requests that DUSA ensure that enough soil is collected from each interval to allow for the SPLP analyses for nitrate and chloride and for isotope analyses for sulfate, nitrate, and water (see comments regarding isotope analyses below). DUSA must confirm the required sample volumes with the contract laboratory and list the required volumes in this section of the Work Plan.
27. Section 6.2, first paragraph: DRC agrees that drilling of 13 bedrock drilling locations should be sufficient to characterize the concentrations of nitrate and chloride in the deeper vadose zone. Although many potential source areas have been identified, DRC anticipates that many of the potential source areas will not contain elevated concentrations of nitrate and chloride. Accordingly, the decision of how many bedrock drilling sites selected at the mill site must be determined after consultation and approval of the DRC.
28. General comment: The work plan must state that all Geoprobe and drilling locations will be logged by a qualified, Utah Licensed Professional Geologist. Photographs of soil cores are recommended. The boring logs should be recorded on a form similar to that used for borehole WMMW-16 that was included in the as-built reports for the wells around the tailings ponds. The lithological (boring) logs for the installation of the nitrate wells in October 2009 did not provide all of the necessary information or may not have a location to provide necessary information, such as sampling intervals, survey data, and other details, and appear to inconsistently show whether the alluvial materials are consolidated or unconsolidated. This problem in record keeping is unacceptable. Please revise the field forms to provide a complete and comprehensive record of field activities and the information required.
29. Section 7: DRC and URS request the identification of additional locations for isotope analysis in order to better characterize the source(s) of the nitrate contamination in groundwater. Only six wells are scheduled to be sampled for stable isotopes of nitrate and water. Only two of these are within the Mill Site -- too few to assess the nitrate sources in this area. Please revise the location and number of groundwater isotope samples to be collected on the mill site to provide statistical power, and be representative of the groundwater quality. There may be multiple sources and locations contributing to the nitrate plume below the Mill Site. In addition, only one of the wells (MW-31) scheduled to be sampled for stable isotopes was also sampled in the Hurst and Solomon (2008) study. Additional wells should be sampled for stable isotopes that were part of the Solomon study in

order to leverage the valuable groundwater age data from that study in identifying nitrate sources. Wells MW-19 and MW-27 are especially important to include since they are presumed to represent recharge from the Wildlife Ponds. Well MW-30 should also be included to increase the coverage of high nitrate groundwater below the Mill Site where groundwater age is known. Well TW4-24 should be included because it has contained the highest recorded concentrations of nitrate and chloride in groundwater at the site and is located adjacent to the mill site. Additionally, stable isotope analysis should be performed at TW4-4, which is located in a separate "lobe" of the nitrate plume and is also located within the chloroform plume. Finally, the influent to the sewage vaults and the active leach fields, like the slimes drain of tailings cell 2, should be sampled to characterize the isotope signature of any nitrogen compounds used in mill processing activities and released into wastewater streams. Therefore, DRC requests that MW-19, MW-27, MW-30, TW4-4, TW4-24, contents of sewage vaults, the influent to the main leach field, and the influent to all other active leach fields be added to the list of locations in Section 7 for stable isotope analyses of nitrate and water. The list of active leach fields and sewage vaults shall include, but not be limited to, all active leach fields and sewage vaults shown on Figure 21 of the Work Plan.

30. Section 7: In addition to the stable isotope analyses for groundwater, nitrate from samples of vadose zone soils, from both undisturbed areas and potential source areas within the mill site, should be analyzed for stable isotope composition as discussed in comments #14 and #25 above; i.e. nitrogen and oxygen isotopes of nitrate found in the soil / rock matrix and/or pore fluids / groundwater. Such samples are critical for establishing the isotopic signature of nitrate sources in the vadose zone at this site. Isotope analyses should also be conducted on 1:1 distilled water leaches of core samples.
31. Section 7 and Table 2: (a) Two methods are currently used to determine oxygen and nitrogen isotope compositions in dissolved nitrate. The first method (Ion Exchange Method) uses ion exchange columns to separate nitrate from cations present in the sample, and then uses chemical treatments to remove sulfate and organic compounds before producing a silver nitrate salt that is then analyzed by combustion/pyrolysis of the salt to produce N2 and CO gas which is analyzed by isotope ratio mass spectrometry (Silva et al., 2000). The lab identified in the work plan (Isotech) uses this Ion Exchange Method. A more recent method (Denitrifier Method) uses a particular strain of denitrifying bacteria to produce N2O gas from nitrate in the water sample, which is then analyzed by isotope ratio mass spectrometry (Sigman et al., 2001; Caciotti et al., 2002). The study proposed for DUSA would benefit from using a lab capable of carrying out the Denitrifier Method to determine oxygen and nitrogen isotope compositions in dissolved nitrate for two reasons. 1) The Denitrifier Method requires much less sample volumes and lower concentrations than the Ion Exchange Method. This will make it possible to analyze the small samples collected from distilled water leached from sediment core samples. 2) The Ion Exchange method can give erroneous results for oxygen isotope compositions in nitrate if the sulfate is not completely removed from the sample before producing the silver nitrate salt. If this occurs, both nitrate and sulfate oxygen contribute to the oxygen isotope composition of the salt produced, thus incorrectly identifying

the nitrate source. Interference from sulfate is a particular concern at this study site, since sulfate concentrations are much higher than typical groundwaters. Please resolve this problem in the work plan.

References Cited:

Silva, S.R., Kendall, C., Wilkison, D.H., Ziegler, A.C., Chang, C.C., and Avanzino, R.J, 2000. A new method for collection of nitrate from fresh water and the analysis of nitrogen and oxygen isotope ratios, J. of Hydrology, 228: 22-36.

Sigman, D.M., Casciotti, K.L., Andreani, M., Barford, C., et al. (2001) A bacterial method for the nitrogen isotopic analyses of nitrate in seawater and freshwater.Anal. Chem., 73, 4145-4153.

Casciotti, K.L., Sigman, D.M., Hastings, M.G., Bohlke, J.K. et al. (2002) Measurement of the oxygen isotopic composition of nitrate in seawater and freshwater using the denitrifier method, Anal. Chem., 74, 4905-1226.

(b) Some laboratories that may perform isotopic analyses for nitrate may not be able to perform isotopic analyses for ammonium. Wastewater samples (see comment #29) may contain primarily ammonium rather than nitrate. Please determine whether the majority of the nitrogen in the wastewater streams is in the form of ammonium or nitrate. If the majority is present as ammonium, confirm that the laboratory has the ability to perform isotopic analyses for ammonium, and adjust the work plan to indicate that the wastewater samples will have isotopic analyses for ammonium rather than nitrate.

32. Section 7: It is not clear which sources will be differentiated using the isotope compositions of nitrate. There is a possibility that isotopic signatures of nitrate from ammonium compounds used in processing at the Mill Site may be similar to those of nitrate derived from septic effluent and treated waste water effluent. Typically, these ammonium sources have higher delta-15N values than natural pools of nitrate in the soil zone, but as noted, the ranges for these sources can also overlap in both nitrogen and oxygen isotope composition. It is likely that stable isotope analyses of nitrate may be useful for testing the hypothesis that nitrate below the Mill Site is due to mobilization of a natural pool of nitrate in the unsaturated soil zone vs. contamination by an ammonium source. However, there are numerous potential ammonium sources (wastewater effluent, septic effluent, ammonium processing chemicals), which lead to nitrate with similar isotopic signatures. It is unlikely that stable isotope analyses of nitrate will allow for differentiation of the various ammonium sources. Denitrification can further complicate the use of nitrate isotope compositions for identifying source compositions by enriching residual nitrate in the isotopically heavier nitrogen and oxygen. The recharge from the Wildlife Ponds identified by Hurst and Solomon (2008) may carry organic carbon into the groundwater system where it acts as an electron donor to support denitrification.

Per the study conducted by Hurst and Solomon, it was noted that sulfate isotopic study is useful to differentiate sulfur sources from the tailings ponds (tailings sulfate) and natural deposits (gypsum). This is because of fractionation processes occurring in the ore refining process, and the use of sulfuric acid from an outside source in ore refinement. DRC requests

that stable isotope analysis of sulfur (sulfur- 32 and 34) and oxygen (oxygen-16 and 18) in sulfate be included with the analysis of every groundwater and wastewater sample analyzed for nitrate isotopic ratio in Section 7 and Table 2 of the work plan to assist in interpretation and differentiation of the nitrogen sources. Please confirm that the contract laboratory can perform this analysis. It is unlikely that a sufficient volume of leachate could be produced from the soil cores (see comment #30) to analyze the isotopic signatures of both nitrate and sulfate in the soil samples. For this reason, DRC is not requesting isotopic analysis of sulfur and oxygen in sulfate in the soil cores. Analysis for sulfate by Method 300.0 shall accompany the sulfate isotopic analysis on every groundwater and wastewater sample to provide an additional level of comparison, similar to the 2008 study.

33. Table 2: Usually one sample container can be used for oxygen and hydrogen isotopes in water. One liter is probably more than the analytical lab will need for O and H in water. Table 2 may need to be revised based on input from the analytical lab(s).
34. Section 7.0: Please add analysis for ammonia-nitrogen by Method 350.2 to the list of conventional laboratory analyses for groundwater and wastewater samples.
35. Section 7.1: Standard reference materials used by the analytical lab to calculate isotopic values shall be reported. Section 7.1 addresses the need to assess the precision of isotope measurements, but does not address accuracy. DRC requests that split samples of groundwater and wastewater samples be collected at a frequency of at least 10% of samples for isotope analyses; the split samples will be analyzed by a second, independent laboratory to provide some additional support for the accuracy of isotope analyses. The laboratories selected by DUSA are subject to approval by DRC prior to collection of any samples for isotope analysis. The collection of split samples for soil isotope analysis will not be required by DRC due to the limited sample volume. In order to ensure consistent QA/QC procedures for the laboratories, commercial laboratories, rather than university laboratories, shall be used for all stable isotope analyses, unless DUSA demonstrates that a commercial laboratory is unavailable to perform a particular isotope analysis and the DRC then waives the requirement. All non-isotope laboratory analyses shall be performed by a laboratory certified by the State of Utah.

    The work plan needs to include more narration and additional tables (flow charts) outlining the process for collecting Denison (in-house) QA/QC samples to self assess laboratory performance (in addition to the laboratory QA/QC protocols). Such planning needs to include specific sample types [e.g. blind duplicates, field collected spiked blanks, and field collected spiked matrix (spiked duplicates)] to allow full evaluation of precision and accuracy. The tables need to include specific wells where the Denison field QA/QC will be collected as well as specific reference to the matrix used for spike analysis. The justifications for QA/QC protocols should be included in the narrative (with references where applicable) and all sample collection (water and soil) should be summarized on appended tables (see comment 41 below).

36. Section 8: DRC agrees with the conceptual approach of using mass balances as a line of evidence for potential source areas. However, the comparison of the estimated mass of nitrate in the groundwater beneath the mill site to the required amount of leachate from the tailings pond is drawn directly from the 2009 Nitrate CIR. Since leakage from the tailings ponds has been ruled out, it would be preferable to compare the mass of nitrate in the groundwater beneath the mill site to the mass of nitrate that could have been delivered from naturally-occurring nitrate deposits. In addition, an estimation of the mass of chloroform in the groundwater beneath the mill site would be helpful for comparing the mass of nitrate or waste water that could have been delivered to the groundwater through leach fields.
37. Figure 1: DRC requests that the figure number be inserted into the title. The use of a decision logic diagram is helpful, and could be included in the framework of a CSM. The current logic diagram (Figure 1 flow chart) included in the work plan is not sufficient as clarified in comments above. The work plan is required to contain a comprehensive logic diagram. Also as stated above, the logic diagram could be included as part of a larger conceptual model structure, but at minimum this element needs to include specific hypothesis statements for each activity undertaken for the study in order to definitively accept or reject identified potential sources. Refer to comments #1, 2, and 4 for additional details.
38. Figure 3: the legibility of the values and label on the x-axis could be improved.
39. Figure 20: The word "Missile" is misspelled on the legend.
40. Figure 21: Please explain why the number of leach fields shown on this figure differs from previous reports.
41. Table 2: DRC requests that the planned sampling be summarized in a table showing the sample locations; number, and types of samples for each location; the types of analyses and the associated container type, holding time, and preservative; and the planned QA/QC samples at pre-determined locations. Some of these details are present in Table 2, but insufficient detail is currently presented in the table. Sampling and analysis should conform to the existing Quality Assurance Plan for the mill, but the work plan will need to specify the QA/QC measures for isotopic analysis. Specifically, DUSA needs to clarify the QA/QC protocols which will be used for each sample type and list the proposed sample locations with an identifier. For example, at least 10% of the groundwater and wastewater samples must be split, with analysis of the split samples by a second, independent laboratory. The locations of the split samples must be identified in the Work Plan. The work plan needs to clarify which samples will conform with the facility QAP plan, as identified in the section 7.1 narrative, and which samples will require additional QA/QC validation based on inadequacy or inapplicability of the QAP requirements. The laboratories selected by DUSA for isotope analyses are subject to approval by DRC, based on a review of their internal QA/QC procedures, prior to collection of any samples for isotopic analysis.

Thank you.

URS Corporation

Paul R. Bitter, P.E.
Senior Remediation Engineer