| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 2.5 | **Reasonable Alternatives** The National Environmental Policy Act and Council on Environmental Quality require that federally prepared environmental documents develop and evaluate a reasonable range of alternatives to the proposed action, including the No Action Alternative. Alternatives that were considered but deemed unreasonable can be eliminated from further study (i.e., conventional mining, heap leach, and open pit mining). However, reasonable alternatives, related to the ISR process and the No Action Alternative, must be considered in full throughout the document and impacts assessed as they would be for the proposed action. To comparatively evaluate impacts among alternatives please provide: | | |
| | 1 | Information on other sites that were evaluated prior to picking the site where the project is to be accomplished. Also include information on the footprint, such as alternative plant locations, routes for roads, and building locations. | Complete | *Submitted June 19* |
| | 2 | More physical details (size, location, operations) or other information (cost, logistics, technology, etc.) on the three liquid effluent disposal alternatives (overland application, evaporation ponds, and deep well injection). | Complete | Submitted June 19 |
| | 3 | Information on other lixiviants considered, as well as other technologies for underground uranium recovery. | Complete | Submitted June 19 |
| | 4 | Quantitative and qualitative support for the assessments that are made in Table 2.6-1. | Complete | Submitted June 19 |
| ER | 3.2 | **Transportation** The ER does not provide a description of the condition of the roads used to route trucks to the site (State Highways 59, 50, and 387). Please address the following: | | |
| | 1 | Provide a description including the surface (asphalt, gravel, or dirt) and condition (average, hazardous, etc.) which will allow for a complete evaluation of the impacts of ISR facility operation. | Complete | Submitted June 19 |
| | 2 | Please distinguish between the routes proposed during construction, regular operation, aquifer restoration, and decommissioning. | Complete | Submitted June 19 |
| | 3 | What will be the final destination of the radioactive waste, mixed waste, and nonradioactive waste? If this has not yet been decided, provide information on the most likely disposal sites and the proposed transportation routes to these sites. | Complete | Submitted June 19 |
| | 4 | Please specify which new or upgraded roads will not be subject to decommissioning. This information is needed to determine future land use impacts. | Complete | Submitted June 19 |
| | 5 | There will be an impact to wildlife due to a potential increase in vehicle collisions; what is the anticipated increase in traffic? What will be the estimated increase in traffic from current activities at the site to traffic during construction and also during operation? | Complete | Submitted June 19 |
| ER | 4.2.2 | **Traffic Impacts** The ER states that the increase in traffic attributable to the workforce during normal operation would be negligible. Additional information is required to adequately assess the impacts of the proposed project. Please provide the following information: | | |
| | 1 | An assessment of the increase in truck traffic transporting yellowcake | Complete | Submitted June 19 |
| | 2 | Given the increase in traffic caused by the proposed ISR operation, the type of maintenance that is proposed for on-site roads. | Complete | Submitted June 19 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| | | **Surface Waters and Wetlands** | | |
| TR | 2.2.3.1 | **Surface Waters**<br>The assessment of the character of surface waters needs additional clarification: *The description of surface waters in Land Use Section 2.2.3.1 of the TR refers to* streams as being "intermittent," while the ponds are described as occurring on "ephemeral streams." To clear this up, provide a map of each stream channel within the study area and distinguish whether it is an intermittent flow channel or an ephemeral flow channel. | Complete | Submitted August 27 |
| TR | 2.8.5.2 | **Wetlands**<br>The information on wetlands provides *a brief overview of their geophysical condition.* However, this section lacks completeness in terms of data needed to document field conditions and to satisfy regulatory requirements. Wetlands were assigned Cowardin classifications, but no map was provided showing the differing wetlands. Please identify on a map the Cowardin classification for each wetland and surface water feature. For purposes of determining impacts, provide an inventory and specify on a *map exactly which areas are vegetated wetlands (palustrine emergent wetland) and* which areas are un-vegetated (palustrine unconsolidated bottom or palustrine open water) systems. | Under preparation. Necessary to coordinate response with recent submittal to Army *Corps of Engineers.* | Planned submittal date - first week in September. |
| TR | 2.7.1.2 | **Surface Water Runoff**<br>It is unclear which facilities will discharge into either artificially-made or natural wetlands or streams. Please map the locations where there will be a surface discharge from ISR facilities into a stream channel, wetland, or pond. Be sure to label all surface water features as either artificially-made or natural and either intermittent or ephemeral. | Complete | Submitted August 27 |
| TR | 2.7.3.1 | **Surface Water Quality**<br>Information is incomplete on surface water quality to fully understand existing site conditions. | | |
| | 1 | The ER states on page 3.4-17 that "no information on surface water was available for sites MRSW-10 and MRSW-11." This information is needed to assess environmental impacts to surface water surrounding the project. | Response provided, surface water tables are being revised and will be provided as separate response as well as part of Environmental Report revision. | Revised surface water tables submittal date - first week in September. |
| | 2 | Reference is made in the TR regarding water quality sampling data collected in the third quarter of 2007. Please provide these results with a summary statement. | Response provided, surface water tables are being revised and will be provided as separate response as well as part of Environmental Report revision. | Revised surface water tables submittal date - first week in September. |
| TR | 7.2.9.2.2 and 3.1.3 | **Surface Water Impacts and Well Field Design and Operations:** These sections address generalities regarding location of proposed work in relation to surface water features and wetlands. Specific locations or areal descriptions will be needed to determine impacts to jurisdictional wetlands.<br>Please provide a detailed site plan showing proposed well locations, new road work, underground piping, utilities, and processing plants in relation to all channels, wetlands, and ponds. Estimate the number of injection and production wells that will be placed in surface water features. Also, estimate the number of new road crossings, pipe crossings, utility crossings, buildings, storage ponds, etc. that will be placed in surface water features, if any. Please provide justification for the *encroachments, and steps taken to avoid, minimize, and mitigate such impacts.* | Complete | Submitted August 27 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 3.4.1.2 | **Site Area Groundwater Use** | | |
| | 1 | Based on information provided by the Wyoming State Engineer's Office, 439 wells with groundwater rights have been indentified within a two-mile radius of the site. The location of these wells are shown on Figure 3.4.1-1 and a description of each well, including depth, use, yield, and depth to water, is provided in Addendum 3.4-A. However, the screen depth and aquifer sands from which groundwater is pumped have not been identified. This information is necessary to assess the potential impacts of the proposed ISR activities on the wells located within the two-mile radius. Provide depth of each well and identify the specific sand layers from which groundwater is withdrawn for each well. Particular attention should be focused on identifying those wells screened in the 72, 70, 68, and 60 sands or those deeper wells potentially impacted by the deep well injection planned for disposal of waste. | Complete | Submitted August 27 |
| | 2 | Addendum 3.4-A identifies the wells within a two-mile radius of the site that have groundwater rights. No further discussion is provided regarding the nature of the rights granted. The addendum identifies yields for each well, presumably indicating a right to that yield. Verify that the right associated with each well entitles the well to the yield specified in Addendum 3.4-A. Further indicate whether the right also entitles each well to a minimum head (static water level) within the well and if there is a prescribed order of precedence to these rights. Also provide information on whether rights to all available groundwater have been granted in the area of the facility. | Complete | Submitted August 27 |
| ER | 3.4.3.2 | **Site Hydrogeology**<br>To assist in the evaluation of the impact of potential spills or releases at the surface on shallow groundwater, provide an isopach map depicting the thickness of the unsaturated zone above the shallow water table in the 72 sand throughout the license area. | Complete | Submitted August 27 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 3.4.3.3 | **Groundwater Quality**<br>The ER (pg. 3.4-57) summarizes the baseline groundwater quality monitoring by indicating that "general water quality in the shallow Wasatch aquifers within the Moore Ranch License area commonly exceeds [Wyoming Department of Environmental Quality] WDEQ Class I standards for TDS and SO4." The ER also indicates that the "radionuclides radium-226 and uranium are elevated above [Environmental Protection Agency] EPA [Maximum Contaminant Levels] MCLs in the majority of samples collected from the Production Zone aquifer and underlying aquifer."<br>Based on this summary, it would appear that the 72, 70, and 68 sands do not meet the criteria as Class I waters (domestic use) in Wyoming. The class of use of the shallow Wasatch aquifers in and around the Moore Ranch Project area is important for evaluating any potential impacts to groundwater from the facility. Provide the following additional information regarding the class of use of shallow groundwaters: | | |
| | 1 | Since the 60 sand is now considered the underlying aquifer to the production zone in areas where the 70 and 68 sands coalesce, all available groundwater quality data for the 60 sand should be provided and discussed. If sufficient data are not available to characterize groundwater.quality in the 60 sand in the project area, additional groundwater sampling should be undertaken to provide such data. | Complete | Submitted August 27 |
| | 2 | Based on available water quality data, the WDEQ class of use for 72, 70, 68, and 60 sands within the project area should be clearly illustrated. | Complete | Submitted August 27 |
| | 3 | Based on available groundwater quality data, the class of use of the 72, 70, 68, and 60 sands in the project area should also be identified. | Complete | Submitted August 27 |
| | 4 | Any discrepancies between the WDEQ classification and actual use in and surrounding the license area should be identified, discussed, and reconciled. For example, there appear to be several domestic wells in the vicinity of the project area. However, groundwater quality data from the shallow Wasatch aquifer indicates that shallow aquifers in the area may not meet the criteria for domestic use. The failure of shallow groundwater quality to meet WDEQ Class I criteria appears largely due to the secondary standards of total dissolved solids and sulfates. Secondary standards are set based largely on aesthetic considerations (e.g., taste), and such water may still be used for domestic purposes. | Complete | Submitted August 27 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 4.4.2 | **Groundwater Impacts** The October 27, 2008, response to the NRC Request for Technical Information (4.2 d) indicates that an application for a Class V Underground Injection Control Permit has been submitted to the WDEQ. Previous submittals have indicated that the planned deep disposal wells would be permitted as Class I wells. | | |
| | 1 | Provide a discussion of the issues that have led to the application for Class V rather than Class I injection wells for use in waste disposal. | Complete | Submitted August 27 |
| | 2 | In addition, provide a brief description of the disposal wells currently planned, including the strata into which injection is being proposed, the water quality and degree of isolation of those strata, and the potential environmental impacts of the proposed injection into those strata. | Complete | Submitted August 27 |
| | 3 | Identify and discuss any issues or potential problems that the WDEQ has identified in its review of the application for the proposed Class V underground injection control wells. | Complete | Submitted August 27 |
| | None | The applicant should provide an analysis of the potential impacts to surficial soils and shallow groundwater during facility construction, including well field installation and testing. This analysis should clearly address the potential impacts from drilling operations, including the management of drilling fluids and wastes, on shallow groundwater. The analysis should also address other potential spills that may occur during facility construction, including the release of fuels and lubricants. | Complete | Submitted August 27 |
| | None | Best management practices planned during the construction phase to minimize impacts to groundwater during facility construction should also be identified and discussed. | Complete | Submitted August 27 |
| ER | 4.4.2.1 | **Groundwater Consumption** Analysis of drawdowns in groundwater levels in the 70 sand have been revised using the enhanced groundwater model presented in Appendix B-4 of the revised September 2008 TR. The enhanced model provides estimates of drawdown during both ISL operation and restoration. The estimates of drawdown during aquifer restoration are based on revised estimates of net losses of groundwater during restoration (50 gpm per well field). The drawdowns resulting from the assumed operation and restoration scenarios have been depicted on figures contained within the modeling report. However, the predicted drawdowns have only been depicted for a limited area immediately surrounding the ISR well fields. Please provide the following: | | |
| | 1 | A figure depicting predicted drawdowns throughout the model domain should be provided. The location of all wells expected to be screened in the 70 and underlying 68 sands should be superimposed on the figure. Based on this figure, all existing wells in the 70 or 68 sand potentially impacted by drawdown induced by production or restoration pumping should be identified. | Complete | Submitted August 27 |
| | 2 | The characteristics of these wells should be provided. Please identify the screen depths, available drawdown, the predicted drawdown during both ISR operation and restoration, and likely impact of these drawdowns on the assigned yield for each well. | Complete | Submitted August 27 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 4.4.2.3.2 | **Wellfield Spills**<br>While the ER discusses the measures that will be taken in an effort to minimize the potential for a wellfield spill or other unintended release, analysis of the potential impact of any such release on shallow groundwater quality has not been provided. An analysis of the potential impact of a release at the surface on shallow groundwater should be provided. This analysis should include considerations such as depth to the water table, the permeability of the materials in the unsaturated zone, the potential adsorption of constituents in unsaturated zone materials, and the volume of any potential releases. | An unsaturated flow model is being developed to address this comment. | Planned submittal date - first week in September. |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 3.5.5 | **Ecology** | | |
| | 1 | Section 3.5.5 of the ER states that 35.29 acres of wetlands were found during the wetland survey. The wetlands are recommended to be non-jurisdictional; however, final determination lies with the U.S. Army Corps of Engineers. If applicable, provide documentation supporting the non-jurisdictional status of the wetlands (e.g., description of vegetation, soils, etc.). If any of these wetlands are determined to be jurisdictional, what mitigation methods will be applied? | Complete | Submitted August 27 |
| | 2 | Provide information on the impact of exploratory or delineation borings on local ecology | Complete | Submitted August 27 |
| | 3 | Will overhead power lines be constructed? If so, describe the mitigation measures to reduce impacts to raptors. | Complete | Submitted August 27 |
| | 4 | Describe mitigation measures to reduce impacts to wildlife in the vicinity of the mud pits, even if it is only during the construction phase. | Complete | Submitted August 27 |
| ER | 3.7 | **Noise** The ER states existing ambient noise in vicinity of the Moore Ranch Project area is dominated by traffic noise from State Highway 387, surrounding oil and gas operations, and on-site coal bed methane operations. However, it does not provide existing ambient background sound levels. Additional information is required to adequately characterize the existing environment. | | |
| | 1 | Please provide any sound level measurement data to determine background existing sound levels. | Complete | Submitted June 19 |
| | 2 | If no field measurements were taken please provide the methodology of how the ambient background sound levels were determined for comparing future noise impacts after the project commences. | Complete | Submitted June 19 |
| ER | 4.7 | **Noise Impacts** The ER states that impact to noise or congestion is not anticipated within the surrounding two-mile area. However, no projections of sound levels were calculated to determine the severity of noise impact within the two-mile area. Additional information is required to adequately assess the noise impacts of this project. | | |
| | 1 | Please provide existing daily or peak hour traffic volumes and truck percentages on any of the local roadways to be utilized by daily activities at the proposed facility. | Complete | Submitted June 19 |
| | 2 | Please provide any future projections of traffic volumes and the percentage of trucks on these roadways. | Complete | Submitted June 19 |
| ER | 7.1.5 | **Noise Impacts of Construction** The ER, again, states that there will be no noise or congestion impacts within a two-mile area. However, it does not provide any projections due to construction activities associated with the proposed project. Additional information is required to adequately assess the noise impact of the project. | | |
| | 1 | Please provide projections of typical machinery to be used at the project and the reference sound levels associated with construction activities. | Complete | Submitted June 19 |
| | 2 | Please provide projected truck traffic associated with construction on the roadways leading to the proposed facility. | Complete | Submitted June 19 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 3.8 | **Historic and Cultural Resources**<br>Please provide the following: | | |
| | 1 | Information on missing pages from page 21 to the end of Appendix B; it appears that the section continues beyond page 21. If this section of Appendix B does not contain descriptions of the previously reported sites, please provide these descriptions as well. | Complete | Submitted June 19 |
| | 2 | Confirmation in the form of field maps, field notes, or identification of report sections, that a cultural resources assessment was completed for the access roads proposed for use during construction and for the permanent routes that will be used to access the facilities. | Complete | Submitted June 19 |
| | 3 | A map that shows all previously surveyed land blocks and the locations of all sites and isolated finds. The survey maps presented in Appendix B on pages 6 and 7 are not adequate, as they only display those areas surveyed in the 2007 study. | Complete | Submitted June 19 |
| | 4 | Complete descriptions of all structures present within the boundaries of Site 48CA146. Also, the results of any visual assessment completed for these buildings (if present) relative to the facilities proposed for the project. | Complete | Submitted June 19 |
| | 5 | Complete descriptions of all structures within the boundaries of Site 48CA3400. Also, the results of any visual assessment completed for these buildings (if present) relative to the facilities proposed for the project. | Complete | Submitted June 19 |
| | 6 | Complete descriptions of all structures within the boundaries of Site 48CA6173. Also, the results of any visual assessments completed for these buildings (if present), relative to the facilities proposed for the project. | Complete | Submitted June 19 |
| | 7 | A discussion of why 60 acres located in Sections 26 and 27, T42N, R75W were omitted in the archaeological survey report. Information is needed for this tract of land. | Complete | Submitted June 19 |
| | 8 | How the archaeological and historical resources were identified within and near the proposed license area, and subsequently marked and protected. | Complete | Submitted June 19 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| Both | See Comment | **Public and Occupational Health** | | |
| | 1 | The descriptions of the facility design (TR Section 3), controls (TR Section 4), and operation (TR Section 5) are not well defined. Although there is a general process flow diagram (TR Figure 3.5-1, ER 2.2-5), facility layout drawings (TR 3.2-1 and -2, ER 2.3-1 and -2), and general descriptions of control measures, there are few details to actually evaluate the effectiveness of an integrated design and operation. Specifically, information on facility design and operational controls for radioactive waste collection, processing, and storage should be provided. | Complete | Submitted August 27 |
| | 2 | There is no evaluation of the anticipated occupational doses (maximum individual and collective) as needed for demonstrating facility design and planned operation that is as low as is reasonably achievable (ALARA). Please provide this data. | Complete | Submitted August 27 |
| ER | 3.11.1 | **Background Exposure to Ionizing Radiation**<br>This section describes an elevated level of natural background radiation in Wyoming because of higher levels of cosmic radiation at higher altitudes and elevated uranium soil level. However, the subsequent evaluation for the site area background radiation is based on the average United States levels and not area-specific information reflecting the identified elevated levels. Provide additional information on the area-specific background radiation levels. | Complete | Submitted August 27 |
| ER | 3.11.2 | **Occupational Health and Safety**<br>This section presents information on the incident rates of non-fatal occupational injuries and illnesses for Wyoming for 2005, including a reference to Addendum 3.11A. However, the evaluation presented in 3.11.2 is incomplete; it fails to provide an overall estimate of injury and illnesses for the facility operations. Provide information on the anticipated total hours worked by facility personnel as needed for a collective health and safety impact assessment. | Complete | Submitted August 27 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 4.12 | **Public and Occupational Health Impacts** | | |
| | 1 | In response to NRC's Safety RAI 5-5, it has been proposed that monitoring of radioactive releases from the operation (well field and plant) will be accomplished *through the use of Track-Etch radon detectors; monitoring of releases is not* considered practicable. Provide an evaluation that demonstrates the proposed method provides adequate detection level for all potential releases, radon as well as particulate radioactive materials, sufficient for demonstrating compliance with the dose limits for members of the public. | Complete | Submitted August 27 |
| | 2 | An evaluation of the anticipated occupational dose to workers at the facility is required for assessing individual and collective impact, as well as ensuring a design and proposed operation for compliance with occupational dose limits, including the principle of ALARA. Provide an evaluation of the maximum individual and the collective occupational annual dose, including all applicable exposure sources such as radon, uranium inhalation, and direct exposure. | Complete | Submitted August 27 |
| | 3 | ER Section 4.12.1.2, Occupational Health Impacts, states, "The proposed Moore Ranch facilities are consistent with the operating assumptions, site features, and designs examined in the NRC analysis in NUREG/CR-6733." This correlation serves as the basis for the evaluation of occupational health impacts, including accidents. However, specific details/bases are not presented for establishing the validity of the correlation. Provide additional information that compares the Moore Ranch processing designs (processing volumes, inventories and waste projections) with those assumed in NUREG/CR-6733, where this information is needed for substantiating this correlation. | Complete | Submitted August 27 |
| | 4 | ER Section 4.12.2.4, Potential Radiological Accidents, includes a general discussion for the potential accident of a yellowcake thickener with a correlation to the results as presented in NUREG/CR-6733 for consequences. As evaluated in NUREG/CR-6733, this accident poses a potential dose to an unprotected worker in excess of the 10 CFR 20 annual occupational dose limit of 5 rem. The discussion in the ER identified what was considered an unrealistic assumption for this dose analysis (i.e., no timely mitigation measures), but no additional analysis is provided to show how the applicant intends to prevent such consequences. Provide additional information (assumptions and/or protective measures) applicable to ensuring that doses from this potential accident remain small (i.e., below the occupational dose limits). | Complete | Submitted August 27 |
| | 5 | ER Section 4.12.2, Equation 4 under Definitions, has a conversion factor as 3.65E-12, where the correct factor as shown in the equation is 3.65E-10. Provide a corrected value in the definitions. | Complete | Submitted August 27 |

| TR or ER | Section Number | Nature of Comment : Please provide | Actions/Status | Response Date |
|---|---|---|---|---|
| ER | 4.13 | **Waste Management Impacts** | | |
| | 1 | It is proposed that liquid wastes for the most part will be disposed by deep well injection. Provide an evaluation of potential radiological impact for such disposal, addressing proposed total radioactivity, and potential radiological dose to members of the public for any feasible exposure pathways. | Complete | Submitted August 27 |
| | 2 | Provide information showing that there is sufficient capacity at the proposed waste disposal sites to be used for hazardous, mixed, and radioactive wastes. | Complete | Submitted August 27 |
| ER | 5.1.6 | **Procedures for Removing and Disposing of Structures and Equipment** The drilling of the injection and extraction wells has the potential to result in residual surface soils with elevated levels of radioactivity from cuttings where drilling encounters the uranium/radium bearing ore. Provide information on how these soils will be monitored and controlled to ensure residual levels do not exceed acceptable limits. | Complete | Submitted August 27 |
| ER | 6.1 | **Radiological Monitoring Environmental Measurements and Monitoring Program** ER Section 6.1 includes an in-depth evaluation of data from the baseline radiological environmental monitoring program. However, it is not clear as to the specific program (sampling locations and media, frequency, and analysis) that is intended to be continued as the operational program. Provide details for the proposed operational program, including sampling media, locations (with an accompanying map), frequency of sampling, type analyses, detection levels, and quality control measures. | Complete | Submitted August 27 |
| ER | | **Land Use** Please provide more information regarding the proximity of the planned project facilities and infrastructure in relation to the Bozeman trail, and how recreational uses related to the Bozeman trail may be affected by the proposed facility. | Complete | Submitted August 27 |

## SURFACE WATER AND WETLANDS

### Question TR 2.2.3.1 Surface Waters

*RAI Question:*

Surface Waters
The assessment of the character of surface waters needs additional clarification: The description of surface waters in Land Use Section 2.2.3.1 of the TR refers to streams as being "intermittent," while the ponds are described as occurring on "ephemeral streams." To clear this up, provide a map of each stream channel within the study area and distinguish whether it is an intermittent flow channel or an ephemeral flow channel.

*Answer:*

The stream channels within the study area can be categorized as intermittent, according to the data presented in USGS National Hydrography Dataset (USGS 2000) and the Moore Ranch wetland study (Environmental Report Section 3.5). As described in the wetlands study, surface water discharges from numerous CBM wells in the area contribute to the water flow of many of the streams at various times. A map of the Moore Ranch project area has been drafted which includes the stream channels as identified in the wetlands report, as well as CBM water wells that occur within the 2-mile radius review area. In response to this RAI question, section 2.2.3.1 of this Technical Report will be revised.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

*2.2.3.1 Surface Water*

*The Moore Ranch License Area, as well as the western, southern, and eastern portions of the 2-mile radius review area (located in Campbell County, Wyoming) are drained by Ninemile Creek, an intermittent stream which flows through the far southern portion of the property in a southeasterly direction, within the Antelope Basin, Hydrologic Unit Code (HUC) 10120101 (US EPA 2007) (Figure 2.2-4). Simmons Draw, an intermittent stream, flows through the License Area from the northwest to the southeast and joins with Ninemile Creek just south of the License Area near the Van Gordon Ranch as shown in Figure 2.2-5. ~~Another unnamed~~ The second tributary to Simmons Draw, an intermittent stream, flows through the center of the License Area from north to south and converges with Ninemile Creek on the south side near the Van Gordon Ranch. Pine Tree Draw and its tributaries are ~~is an~~ intermittent streams located in the eastern portion of the License Area and flows from north to south, joining with Ninemile Creek southeast, just upstream from Ninemile Ranch. Pine Tree Draw is composed of three distinct branches within the License Area. The most easterly branch of Pine Tree Draw is fed by Pine Tree Spring,* *which is located at an elevation of 5,244 feet above mean sea level (amsl). Ninemile Creek joins with Antelope Creek southeast of the License Area in Converse County, WY about 8 miles downstream. Antelope Creek eventually flows easterly through Thunder Basin National Grassland to its confluence with the Cheyenne River in eastern Wyoming (USGS 1977). The Antelope Basin drains a total of 1,036 square miles and is part of the greater Cheyenne River Basin, which is part of the Northeastern Wyoming River Basin area (US EPA 2007 and HKM et al. 2002).*

*About nine small ponds are located within the License Area (Figure 2.2-3). The ponds are located on ~~ephemeral~~ intermittent streams including Ninemile Creek, Simmons Draw, an unnamed stream, and Pine Tree Draw. Ponds are used to supply range and pasture animals with drinking water or may be used for holding water discharged from coal bed methane and other oil and gas mining operations.*

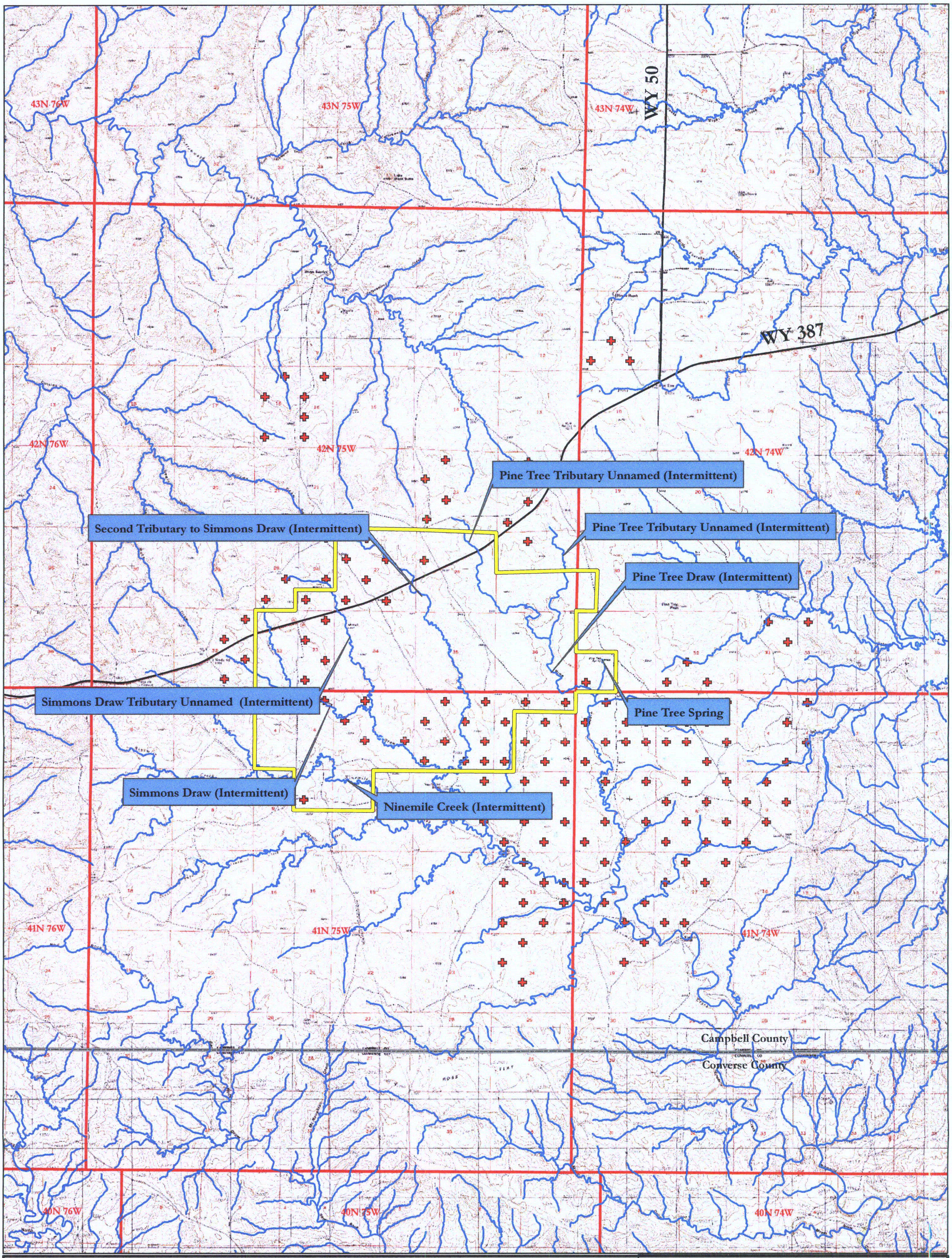
*The northern/northwestern portion of the 2-mile review area drains to the Upper Powder River Basin (HUC 10090202) via Collins Draw and Cottonwood Creek (Figure 2.2-3). Collins Draw and Cottonwood Creek flow northward and join with the Dry Powder River in Johnson County, WY northwest of the License Area. The Dry Powder River flows northwesterly to its confluence with the Powder River just north of Sussex, WY. The total drainage area of the Upper Powder Basin is 2,518 square miles (US EPA 2007).*

*The northeasternmost portion of the 2-mile review area drains to the Belle Fourche River and the Upper Belle Fourche Basin, **HUC** 10120201, which has a drainage area of 2,934 square miles (Figure 2.2-3) (US EPA 2007). In the upper potion of the Belle Fourche River is an intermittent river which eventually joins with the Cheyenne River east of the South Dakota boundary. The Cheyenne River joins the Missouri River in South Dakota.*

*Elevations near the License Area and its surrounding 2-mile review area are approximately 5,500 feet. Climate in the area is arid, typical of a high desert area, with low annual precipitation (13 inches/year) and high evaporation rates. Hydrographs for streams in the upper portions of the Antelope, Upper Belle Fourche, and Upper Powder River watersheds peak during snowmelt in the late spring/early summer. Summer thunderstorms also influence smaller hydrograph peaks.*

Additional Reference:

United States Geological Survey, February 2000, National Hydrography Dataset Users Guide, pg 50.




## Legend

Moore Ranch License/Permit Boundary

Streams

Coalbed Methane Well

0 0.5 1 2 Miles

1 inch equals 6,000 feet

Source: Wyoming Geographic Information Science Center, Wyoming Oil and Gas Conservation Commission

Size: 11"x17"

**Figure 2.2-5**
**Moore Ranch Project**
**Area Streams**

TREC, Inc.
Engineering & Environmental Management
951 Werner Court
Suite 395
Casper, WY 82601
www.treccorp.com
Phone (307) 265-0696
Fax (307) 265-2498

uraniumone investing in our energy

## Question TR 2.7.1.2 Surface Water Runoff

*RAI Question:*

Surface Water Runoff
It is unclear which facilities will discharge into either artificially-made or natural wetlands or streams. Please map the locations where there will be a surface discharge from ISR facilities into a stream channel, wetland, or pond. Be sure to label all surface water features as either artificially-made or natural and either intermittent or ephemeral.

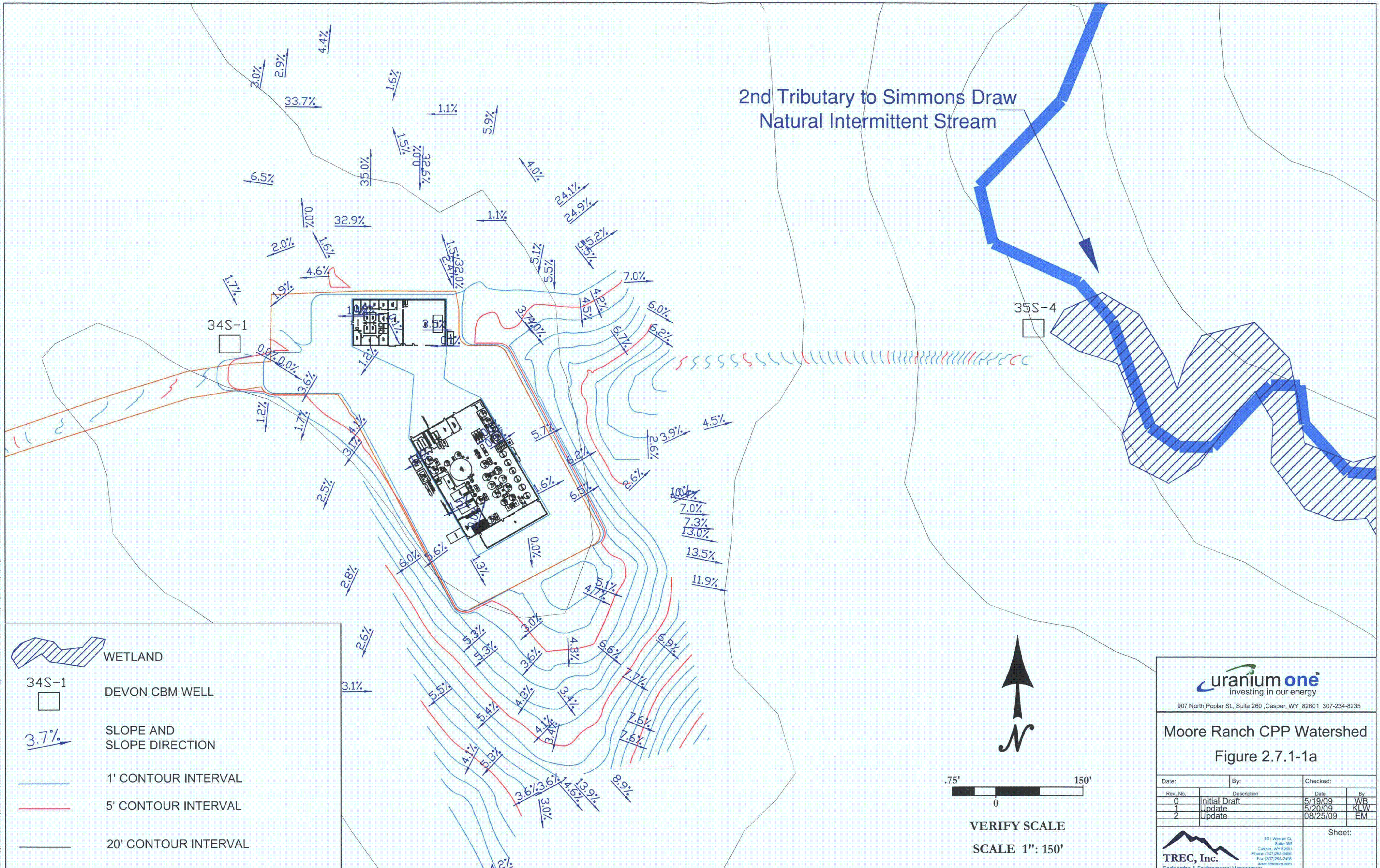
*Answer:*

The ISR facilities will discharge surface water in the form of runoff from the building roofs and parking area at the Central Plant site; this runoff will be discharged to existing drainage features. As requested, this information and a new Figure will be added to Section 2.7.1.2 Surface Water Runoff, of the Technical Report.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

> *2.7.1.2 Surface Water Runoff*
>
> *Surface water runoff from precipitation (rain and snowmelt) at the Moore Ranch ISR facilities will flow from the facilities area to natural drainages. Precipitation runoff is not expected to significantly exceed natural condition, as the increase in runoff from some areas (e.g., building roofs) will be balanced by the decrease in runoff from other areas (flat, gravel parking lots, etc.). Figure 2.7.1-1a shows the reduced slopes anticipated in the vicinity of the restricted, fenced area around the plant site as compared to the natural landform slopes. Additionally, Figure 2.7.1-1a shows the location of the Central Plant area in relation to the location of the nearest natural drainages and wetlands and shows that none of the runoff will flow directly into either artificial or natural streams or wetlands. The potential for contamination of surface-water runoff is also minimal because the processing plant and shop buildings are self-contained and all exterior chemical and fuel tanks will have a means of secondary containment. The Second Tributary to the Simmons Draw, located to the east of the Plant is a natural intermittent stream.*
>
> *Peak flood estimates for each of the drainage basins within and directly adjacent to the Moore Ranch Project area were previously calculated and presented to the NRC in the Environmental Report for the Sand Rock Mill Project, Docket No. 40-8743 (1980) and subsequent Draft Environmental Statement prepared by the NRC (1982). Those documents were referenced to provide the following runoff estimates. These estimates are considered valid.*


2nd Tributary to Simmons Draw
Natural Intermittent Stream
34S-1
35S-4
WETLAND
34S-1
DEVON CBM WELL
3.7%
SLOPE AND
SLOPE DIRECTION
1' CONTOUR INTERVAL
5' CONTOUR INTERVAL
20' CONTOUR INTERVAL
N
.75'
150'
0
VERIFY SCALE
SCALE 1": 150'
uranium one
investing in our energy
907 North Poplar St., Suite 260, Casper, WY 82601 307-234-8235
Moore Ranch CPP Watershed
Figure 2.7.1-1a
Date:
By:
Checked:
Rev. No.
Description
Date
By
0 Initial Draft 5/19/09 WB
1 Update 5/20/09 KLW
2 Update 08/25/09 EM
Sheet:
TREC, Inc.
Engineering & Environmental Management

## SURFACE WATER AND WETLANDS

### Question TR 2.7.3.1 Surface Water Quality

*RAI Question: 1*

Surface Water Quality
The ER states on page 3.4-17 that "no information on surface water was available for sites MRSW-10 and MRSW-11." This information is needed to assess environmental impacts to surface water surrounding the project.

*Answer:*

As described in Section 3.4.2.3 all surface water sample locations within the Moore Ranch project area are characterized as existing stock ponds or areas in drainages where ponding occurs. Water ponded at all the surface water locations are typically feed by springtime snowmelt runoff or summer time short duration – high intensity rain events. This is expressed in the data presented in the table below. Both MRSW-10 and MRSW-11 were dry in March of 2007 and March of 2009 as well as October of 2006 and October 2008. However, samples were collected in July 2008 and 2009 at both sites, which is typically the drier part of the year when small surface water expressions are generally dry. Photographs of the two sites have been provided in this response to provide a perspective of the type and nature of the two sites. Any data collected that is not included in the Environmental Report will be added as a function of the revised version of the report.

| Date Site Visited | MRSW-10 | MRSW-11 |
|---|---|---|
| 10/25/2006 | Dry | Dry |
| 3/23/2007 | Dry | Dry |
| 7/8/2008 | Sample Collected | Dry |
| 10/23/2008 | Dry | Dry |
| 2/9/2009 | Dry | Sample Collected |
| 3/11/2009 | Dry | Sample Collected |
| 4/22/2009 | Dry | Sample Collected |
| 7/23/2009 | Dry | Sample Collected |
| | | |


Moore Ranch SW-10
3rd Quarter 2009
07/23/2009


Moore Ranch
MRSW-11
04/22/2009

*RAI Question: 2*

Surface Water Quality
Reference is made in the TR regarding water quality sampling data collected in the third quarter of 2007. Please provide these results with a summary statement.

*Answer:*

Sample locations may have been visited in the third quarter of 2007 and found to be dry (no samples were collected), but no records of any visits were recorded. EMC has visited, and sampled when water was present, all surface water sites at the Moore Ranch project for five consecutive quarters starting in July of 2008. EMC will continue to visit, and sampled when water is present, through quarter four 2009. All data will be incorporated into report revisions.

## Question TR 7.2.9.2.2 and 3.1.3 Surface Water Impacts

*RAI Question:*

Surface Water Impacts and Well Field Design and Operations: These sections address generalities regarding location of proposed work in relation to surface water features and wetlands. Specific locations or areal descriptions will be needed to determine impacts to jurisdictional wetlands.

Please provide a detailed site plan showing proposed well locations, new road work, underground piping, utilities, and processing plants in relation to all channels, wetlands, and ponds. Estimate the number of injection and production wells that will be placed in surface water features. Also, estimate the number of new road crossings, pipe crossings, utility crossings, buildings, storage ponds, etc. that will be placed in surface water features, if any. Please provide justification for the encroachments, and steps taken to avoid, minimize, and mitigate such impacts.

*Answer:*

Wellfield design has not been finalized. However, a site plan has been drafted and the figure and accompanying discussion will be included in revised section 7.2.9.2.2, Surface Water Impacts, of this Technical Report. Reference to the discussion will be made in the revision of Section 3.1.3 Wellfield Design and Operation.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

***7.2.9.2.2 Surface Water Impacts***

*The proposed Moore Ranch Project facilities have been located to minimize impacts to surface water features. Figure 7.2-2 shows the site plan of the Project area. Included in the site plan are the locations of State Highway 387, the current local access roads, power lines, CBM wells and associated CBM pipelines and gas distribution plants. In addition, the proposed Project facilities are shown on the site plan including the location of the Central Plant, the anticipated layout of the injection well patterns for Wellfields 1 and 2, and the location of the road to be improved from the main access road to the Plant. Local surface water features including two tributaries to the Simmons Draw and their associated wetlands are also shown in Figure 7.2-2.*

*The wellfield design, including header house locations, pipelines, utility lines and header house access roads, is currently being finalized. The project layout described herein is based on information that is currently available as of the date* *of this revision. The Project wellfield patterns will use the five-point well setup where a production well will be located at the center of each pattern and four injection wells at each corner. Six header houses are planned for Wellfield 1 and eight header houses are planned for Wellfield 2, and roads will be constructed to access individual header houses. Individual well lines leading to the injection and production wells will travel to the local header house and trunk lines will lead in and out of the Central Plant through a pipe vault located on the northwest side of the Central Plant. A description of the proposed facilities for the Moore Ranch Project is discussed in Section 3 of this Technical Report.*

*A portion of the Project is located in the second tributary to Simmons Draw and wetlands area in the vicinity of Wellfield 2 as shown in Figure 7.2-1. Within this impacted area there will be no new road crossings. However there will be one trunk-line pipe crossing and 14 small (approximately 1" in diameter) pipe line crossings. The small pipe lines lead from individual injection and production wells to a header house. The small lines will be combined into common trenches wherever possible. There will also be one utility crossing providing power to the header houses east of the second tributary to Simmons Draw. In addition, an estimated eight wellfield patterns are partially or fully within the wetland area in the second tributary to Simmons Draw, including approximately seven production wells and six injection wells. Building construction will not occur in surface water features in the Project area.*

*The wetland delineation study of the Moore Ranch Project area, found in section 3.5.5.2 of the Environmental Report, included a recommendation to the United States Army Corps of Engineers (USACE) that all of the wetlands in the study area be considered non-jurisdictional as the wetlands are isolated and do not support interstate commerce. As of the date of this response, the USACE has not issued a final determination of jurisdiction for the wetlands within the Project area. The ruling on the jurisdiction classification of the wetlands in the Project area will partially determine the method of construction and mitigation activities in the wetland areas.*

*If the wetland area is deemed jurisdictional by the USACE, the proposed impacts will be mitigated, as required by USACE, and proper permitting will be acquired prior to impacting any wetland areas. Impacts to wetlands and drainages will be minimized regardless of their jurisdictional status. The main activities for minimizing surface-water encroachments or impacts to wetlands in Wellfield 2 will be: limiting soil compaction; conducting operations in accordance with standard operating procedures (SOPs) for spill prevention and spill prevention control and countermeasure (SPCC) plans; ensuring that runoff from disturbed areas meet Wyoming pollutant discharge elimination system (WYPDES) permit guidelines for storm water management and sediment reduction; and completing appropriate reclamation practices in a timely manner.*

*Soil compaction during pipeline installation and drilling of production and injection wells can be limited by using existing roads to the extent possible, by designating haul routes where existing roads are not available, and by placing multiple pipelines and/or utilities in the same trench, when possible. Pipelines and utilities that will cross the second tributary to Simmons Draw will cross at a right angle to minimize erosion and impacts to wetlands. However, as it may not always be feasible or warranted to construct crossings at right angles or along elevation contours, implementation of erosion measures appropriate for the situation will occur. Measures that may be implemented to minimize erosion include; contouring and revegetation to stabilize soils; placement of hay bales, engineered sedimentation breaks and traps, and water contour bars; and the use of diversion ditches, engineered culverts, and energy dissipaters to prevent excessive erosion and to control runoff.*

*It is anticipated that one culvert will be installed during the development of site access roads to maintain existing site surface drainage conditions. The culvert is planned for the road leading to the Central Plant from the main access road, along a topographic low point as shown in Figure 7.2-2. Culvert construction will meet all State of Wyoming standards, including inlet and outlet control, head room, and bedding, where appropriate. Locally, surface drainage will be directed away from facilities, roads and topsoil stockpiles using shallow ditches and/or berms.*

*CBM Produced Water Impact*

*An estimated 9 to 52 percent of CBM produced water would contribute to surface flows. Perennial flows would be likely to develop in formerly ephemeral channels. The preferred alternative included management of surface water discharges of produced water by sub-watersheds and the emphasized use of infiltration for produced water management. The Moore Ranch Project is located in the BLM Upper Belle Fourche River watershed. Under modeled conditions, the amount of produced water assumed to reach the main stem of the Upper Belle Fourche River sub-watershed during the peak year of CBM water production (2006) was about 61 cfs (44,168 acre-feet/year).*

*BLM expects noticeable changes in water quality of main stems during periods of low flow. The key water quality parameters of concern due to their impacts on water use for irrigation are sodicity (as measured by the sodium absorption ratio or SAR) and salinity (as measured by conductivity). NPDES permit conditions provide enforceable assurance that water quality standards and designated uses would not be degraded from discharges of CBM produced water. Under modeled conditions, the BLM estimated that the resultant water quality in the Upper Belle Fourche River sub-watershed at Moorcroft, Wyoming, during all months of the year would be adequate to meet the Most Restrictive Proposed Limit (MRPL) for both conductivity and SAR that the WDEQ has adopted in its NPDES permitting process to be protective of downstream irrigation. Under some flow conditions,* *the modeled SAR values and concentrations of sodium may inhibit the use of irrigation on some tributaries in the Upper Belle Fourche River sub-watershed. However, BLM noted that samples collected since the onset of CBM production in the Upper Belle Fourche River sub-watershed had not detected changes in ambient stream water quality which were predicted by the mass balance model.*

*BLM projected that concentrations of suspended sediment in surface waters would be likely to rise above baseline levels as a result of increased flows and runoff from disturbed areas. BLM requires site-specific Water Management Plans (WMPs) as an integral part of mitigation planning to control and monitor the potential effects from increased flows in surface drainages.*

*As a positive impact of CBM development, the discharge of produced water would result in the increased availability of surface water for irrigation and other downstream beneficial uses. Numerous impoundments are constructed to temporarily store CBM produced water for beneficial use. BLM estimated that between 8 to 25 percent of CBM produced water would be held in storage.*

### *3.1.3 Wellfield Design and Operation*

*The proposed Moore Ranch wellfield map is shown in Figure 3.1-2. The map is preliminary based on EMC's current knowledge of the area and the installation of two wellfields. As the Moore Ranch Project is developed, the wellfield map will be updated accordingly. The impacts of the proposed wellfields in relation to surface water features and wetlands are addressed in Section 7.2.9.2.2 of this Technical Report.*

*The wellfield injection/recovery pattern employed is based on the conventional square five spot pattern which is modified as needed to fit the characteristics of the orebody (see Figure 3.1-3). The standard production cell for the five spot pattern contains four injection wells surrounding a centrally located recovery well. The cell dimensions vary depending on the formation and the characteristics of the orebody. The injection wells in a normal pattern are expected to be between 75 feet and 150 feet apart. All wells will be completed so they can be used as either injection or recovery wells, so that wellfield flow patterns can be changed as needed to improve uranium recovery and restore the groundwater in the most efficient manner. Other wellfield designs include alternating single line drives.*

*Within each wellfield, more water is produced than injected to create an overall hydraulic cone of depression in the production zone. Under this pressure gradient the natural groundwater movement from the surrounding area is toward the wellfield providing additional control of the recovery solution movement. The difference between the amount of water produced and injected is the wellfield "bleed."*

*Figure 3.1-2*

*The minimum over production or bleed rates will be a nominal 0.5% of the total wellfield production rate and the maximum bleed rate typically approaches 1.5%. Bleed rates will be adjusted as necessary to ensure that the wellfield cone of depression is maintained.*

*Each injection well and recovery well is connected to the respective injection or recovery manifold in a wellfield headerhouse building. The manifolds deliver the recovery solutions to the pipelines carrying the solutions to and from the ion exchange facilities. Flow meters and control valves are installed in the individual well lines to monitor and control the individual well flow rates and pressures. Wellfield piping is constructed of high density polyethylene (HDPE), polyvinyl chloride (PVC), and/or steel. The wellfield piping will typically be designed for an operating pressure of 150-300 psig, and it will be operated at pressures equal to or less than the rated operating pressure of the pipe and other in-line equipment. If a higher design pressure is needed, the pressure rating of the materials will be evaluated and if necessary, materials with a higher pressure rating will be used.*

*The individual well lines and the trunk lines to the ion exchange facility are buried to prevent freezing. The use of wellfield headerhouses and buried lines is a proven method for protecting pipelines. A typical wellfield development pattern is illustrated in Figure 3.1-3.*

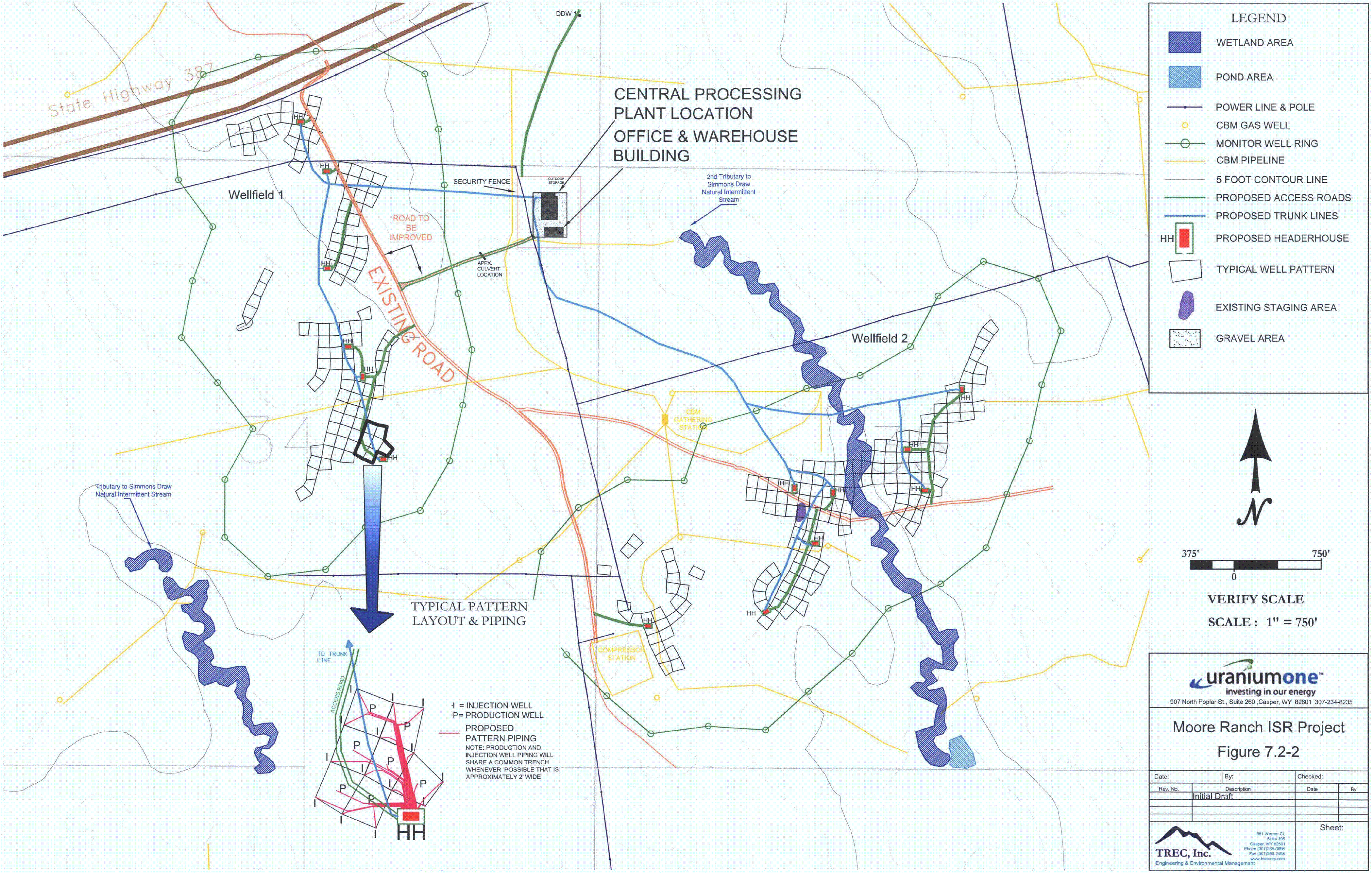
*Monitor wells will be placed in the mining zone and in the first significant water-bearing sand above (overlying) the mining zone and below (underlying) the mining zone. All monitor wells will be completed using the well construction and testing methods discussed above and developed prior to recovery solution injection. Typical locations of the monitor well rings for the proposed wellfields are shown in Figure 3.1-2. As previously noted, the map is based on EMC's current knowledge of the area. As the project is developed, the wellfield map will be updated accordingly.*

*Figure 3.1-3*

*Injection of solutions for mining will be at a maximum rate of approximately 3,000 gpm. A water balance for the proposed Moore Ranch Project is shown on Figure 3.1-4. The liquid waste generated at the central plant will be primarily the production bleed which is estimated at an average of 1%of the production flow. At 3,000 gpm, the average volume of liquid waste generated by production bleed is 30 gpm. EMC proposes to dispose of the liquid waste through deep disposal well injection.*

*As stated, a bleed rate of approximately 30 gpm from the 70 sand is anticipated during full scale operations. As demonstrated from the limited drawdown during the regional aquifer testing, this amount of consumptive use will generate negligible drawdown outside of wellfield areas. As a result, no impact to other* *users of groundwater is expected since there are no other existing users of groundwater in the 70-sand within the immediate proximity to the wellfield areas. For the same reasons, no impacts to water users outside of the proposed license boundary are expected. Impacts to groundwater from consumptive use are discussed in detail in Section 7.2. Furthermore, since coal bed methane (CBM) wells in the area are completed at far greater depths separated by several confining layers, there are no foreseen impacts to CBM operations as a result of the consumptive use of groundwater in the 70-sand.*

*Downhole injection pressures will be maintained below the formation fracture pressure. The formation fracture pressure gradient commonly used is 1.0 psi for every 1 foot of depth' to the top of the screened interval. At Moore Ranch, the depth to the top of the anticipated screened interval varies from approximately 160 feet in Wellfield 3 to 300 feet in Wellfield 1. Accordingly, injection pressures will range from 100 psi at the headerhouses located in shallower ore areas to no greater than 150 psi at the headerhouses located in deeper ore areas. Well casing integrity will be tested at 150 psi plus a 20% engineering factor, or 180 psi.*


State Highway 387
DDW 1
CENTRAL PROCESSING PLANT LOCATION
OFFICE & WAREHOUSE BUILDING
SECURITY FENCE
OUTDOOR STORAGE
Wellfield 1
ROAD TO BE IMPROVED
APPX. CULVERT LOCATION
EXISTING ROAD
2nd Tributary to Simmons Draw Natural Intermittent Stream
Wellfield 2
CBM GATHERING STATION
COMPRESSOR STATION
Tributary to Simmons Draw Natural Intermittent Stream
HH
TYPICAL PATTERN LAYOUT & PIPING
TO TRUNK LINE
ACCESS ROAD
I = INJECTION WELL
P= PRODUCTION WELL
PROPOSED PATTERN PIPING
NOTE: PRODUCTION AND INJECTION WELL PIPING WILL SHARE A COMMON TRENCH WHENEVER POSSIBLE THAT IS APPROXIMATELY 2' WIDE
LEGEND
WETLAND AREA
POND AREA
POWER LINE & POLE
CBM GAS WELL
MONITOR WELL RING
CBM PIPELINE
5 FOOT CONTOUR LINE
PROPOSED ACCESS ROADS
PROPOSED TRUNK LINES
PROPOSED HEADERHOUSE
TYPICAL WELL PATTERN
EXISTING STAGING AREA
GRAVEL AREA
N
375'
750'
0
VERIFY SCALE
SCALE : 1" = 750'
uraniumone
investing in our energy
907 North Poplar St., Suite 260, Casper, WY 82601 307-234-8235
Moore Ranch ISR Project
Figure 7.2-2
Date:
By:
Checked:
Rev. No.
Description
Date
By
Initial Draft
Sheet:
TREC, Inc.
Engineering & Environmental Management

## GROUNDWATER

Note that the following response discusses each RAI question and the response. Proposed revisions to the License Application (Environmental Report), Sections 3.4 and 4.4, follow these responses. Changes to these sections are required to incorporate information that was submitted to NRC in response to the RAI on the Technical Report. These changes are shown in italicized text. Changes made in response to these RAI questions are noted in red-line/strikeout method.

### Section 3.4.1.2 Site Area Groundwater Use

*RAI Question 1:*

Based on information provided by the Wyoming State Engineer's Office, 439 wells with groundwater rights have been identified within a two-mile radius of the site. The location of these wells are shown on Figure 3.4.1-1 and a description of each well, including depth, use, yield, and depth to water, is provided in Addendum 3.4-A. However, the screen depth and aquifer sands from which groundwater is pumped have not been identified. This information is necessary to assess the potential impacts of the proposed ISR activities on the wells located within the two-mile radius. Provide depth of each well and identify the specific sand layers from which groundwater is withdrawn for each well. Particular attention should be focused on identifying those wells screened in the 72, 70, 68, and 60 sands or those deeper wells potentially impacted by the deep well injection planned for disposal of waste.

*Response:*

The table in Addendum 3.4-A has been updated to include completion interval for those wells where data are available. Further, the table has been modified to subdivide the wells into categories of use (e.g., monitoring, industrial, CBM, etc.). Based on the updated search (as of June 2009) and revised table, the number of wells with groundwater rights within two-miles of the License Area, excluding those that have been cancelled or abandoned, is 559. Of the active rights, 465 are indicated as CBM or stock-CBM wells. All of the CBM and stock-CBM wells for which records are available are over 700 feet deep, deeper than the 60 through 72 sands would be projected within the two mile radius. The CBM and stock-CBM wells which have no records of completion depth are unlikely to have been completed in shallow Wasatch Sands as the target for CBM in the area of Moore Ranch is the Fort Union Formation. The Fort Union is encountered at depths exceeding 800 feet within the area of Moore Ranch. Only three wells within the search area are permitted as domestic wells. Two of those wells are located east of the Moore Ranch License Area near the limit of the two-mile radius. One of the wells is located within the License Area in Section 33. That well is permitted as an industrial, domestic well by Rio Algom Mining Corporation. Of the 27 permitted stock wells, only three are located with the License Area. However, at least four non-permitted stock wells are known to be within the License Area. Those four wells have been sampled by EMC as part of the groundwater monitoring network and are believed to be completed within the 68, 70 and 72 Sand sequence. A summary table for groundwater rights is provided below.

**Table CR3.4.1.2-1 Groundwater Rights Within Two Miles of the Moore Ranch License Area**

| Category | No. Wells in Category | No. Wells with TD <700 ft, | No. Wells With TD >700 ft, | No. Wells with No Completion Interval Listed | No. Non-Monitor Wells Probably Completed in 60 68, 70 or 72 Sands |
|---|---|---|---|---|---|
| Cancelled | 125 | NA | NA | NA | NA |
| CBM | 162 | 0 | 125 | 37 | 0 |
| Stock, CBM | 303 | 0 | 119 | 184 | 0 |
| Stock | 27 | 25 | 2 | 0 | 25 |
| Monitor | 57 | 57 | 0 | 0 | 0 |
| Domestic, Irr, Indust, Misc | 10 | 4 | 3 | 3 | 4 |
| Total | 684 | 86 | 147 | 235 | 31 |

Estimates of the completion zone for each of the stock, domestic, industrial and miscellaneous wells within two miles of the License Area are discussed in the response to the NRC RAI Question 1 on section 4.4.2.1.

The shallowest potential target for deep well injection would be the Lance Formation at depths of 3,700 to 7,500 below ground surface in the vicinity of Moore Ranch. The Lance Formation underlies the Fort Union Formation, which is the target interval for CBM production. The deepest well for which water rights are permitted within a two-mile radius of the site is only 1,410 ft (Devon Energy Company, Iberlin 28S-13, located in Sec 28 T42N, R 75W). That well is permitted as a CBM well. There are deeper wells in the area of Moore Ranch that are oil and gas wells, but no water wells deeper than 1,410 ft are indicated in the SEO records search.

*RAI Question 2:*

Addendum 3.4-A identifies the wells within a two-mile radius of the site that have groundwater rights. No further discussion is provided regarding the nature of the rights granted. The addendum identifies yields for each well, presumably indicating a right to that yield. Verify that the right associated with each well entitles the well to the yield specified in Addendum 3.4-A. Further indicate whether the right also entitles each well to a minimum head (static water level) within the well and if there is a prescribed order of precedence to these rights. Also provide information on whether rights to all available groundwater have been granted in the area of the facility.

*Response:*

Groundwater rights in Wyoming are granted on a well by well basis through the Wyoming State Engineers Office (SEO). It is possible that multiple wells could be permitted within an area where radius of influence of the wells may overlap. The yields listed in the table are simply the yields that were reported to the SEO and are not a permit limit. However, domestic and stock wells are limited to 25 gpm per well. Domestic and stock wells do not require adjudication. There are no minimum heads entitled with the rights listed in the table. Priority of the rights is as listed in the table. Not all available groundwater rights have been granted in the area of the facility as permits are granted on a well by well basis and for the completion interval of the specific well. Conceivably, several wells could be placed in the same general vicinity, but could be screened across different intervals. The vast majority of the water rights permitted in the vicinity of Moore Ranch are for CBM activities within the Fort Union Formation, at depths exceeding 800 feet.

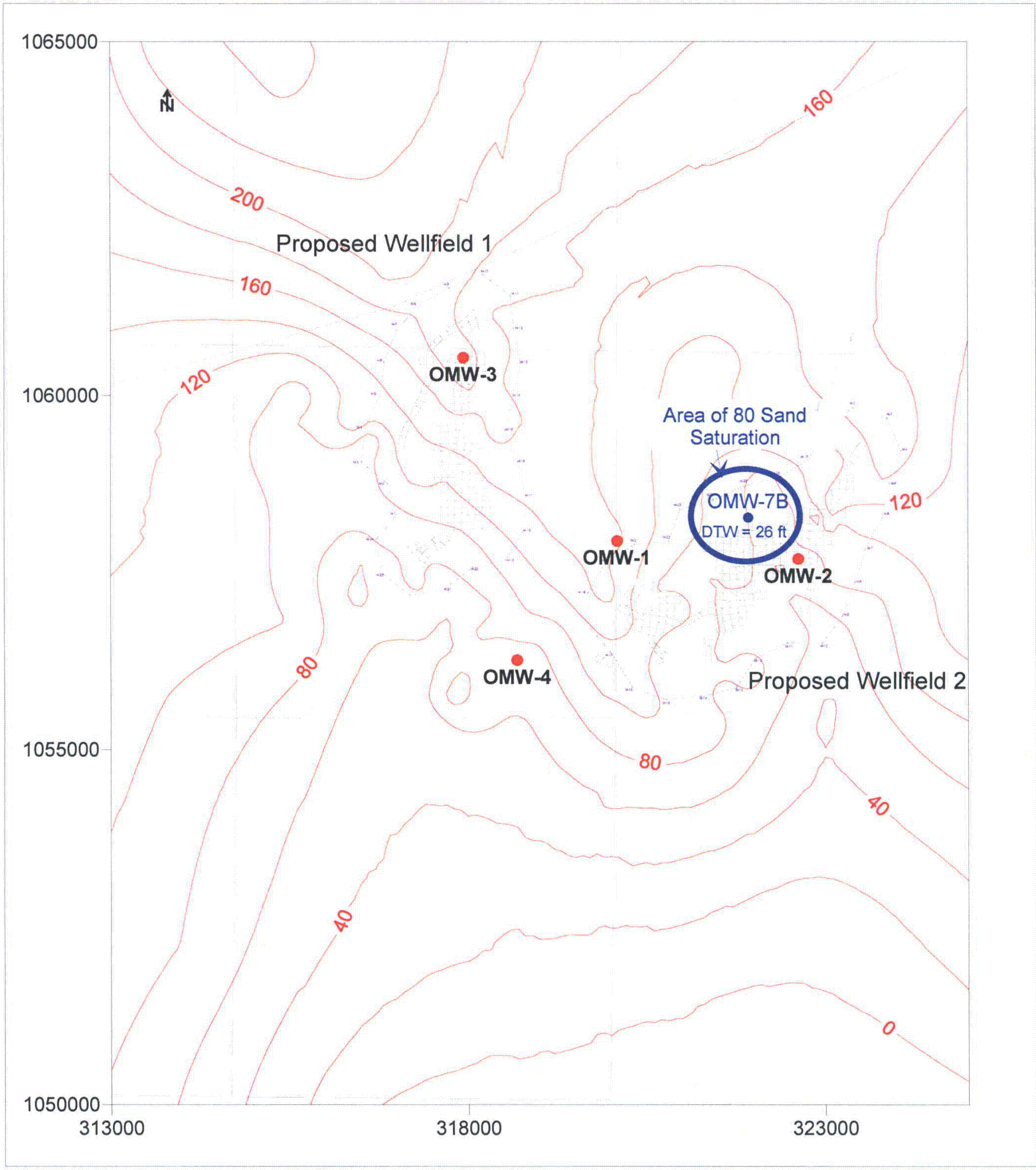
## Sections 3.4.3.2 Site Hydrogeology

*RAI Question 1:*

To assist in the evaluation of the impact of potential spills or releases at the surface on shallow groundwater, provide an isopach map depicting the thickness of the unsaturated zone above the shallow water table in the 72 sand throughout the license area.

*Response:*

An isopach map of the unsaturated zone thickness has been prepared and is included as Figure CR3.4.3.2. Additional drilling has indicated that the 80 Sand contains perched groundwater over small portions of the site. The area where saturated conditions are known to exist in the 80 Sand and the depth to water in that area has also been indicated on the map.




Depth to Water Contour
CI = 20 feet

Wellfield Patterns

Monitor Well 72 Sand

Monitor Well 80 Sand

Petrotek

10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

**URANIUM ONE**

**Figure CR3.4.3.2. Depth to Water - 72 Sand**
**Moore Ranch Uranium Project, Wyoming**

By: EPL Checked: HD File ID:figCR3432.srf Date: 7/28/09

## Section 3.4.3.3 Groundwater Quality

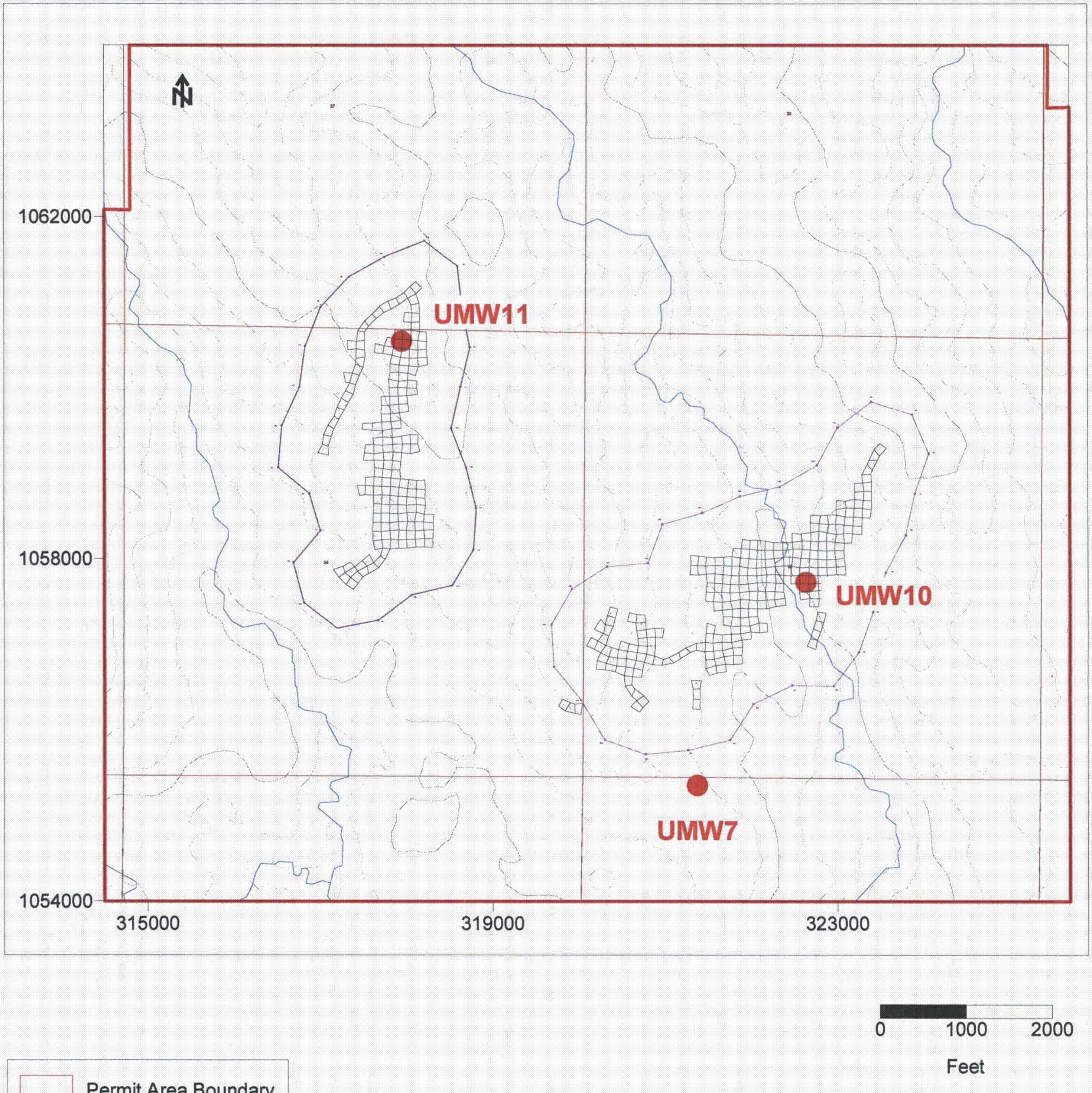
The ER (pg. 3.4-57) summarizes the baseline groundwater quality monitoring by indicating that "general water quality in the shallow Wasatch aquifers within the Moore Ranch License area commonly exceeds [Wyoming Department of Environmental Quality] WDEQ Class I standards for TDS and SO4." The ER also indicates that the "radionuclides radium-226 and uranium are elevated above [Environmental Protection Agency] EPA [Maximum Contaminant Levels] MCLs in the majority of samples collected from the Production Zone aquifer and underlying aquifer." Based on this summary, it would appear that the 72, 70, and 68 sands do not meet the criteria as Class I waters (domestic use) in Wyoming. The class of use of the shallow Wasatch aquifers in and around the Moore Ranch Project area is important for evaluating any potential impacts to groundwater from the facility. Provide the following additional information regarding the class of use of shallow groundwaters:

*RAI Question 1:*

Since the 60 sand is now considered the underlying aquifer to the production zone in areas where the 70 and 68 sands coalesce, all available groundwater quality data for the 60 sand should be provided and discussed. If sufficient data are not available to characterize groundwater quality in the 60 sand in the project area, additional groundwater sampling should be undertaken to provide such data.

*Response:*

Three additional monitor wells have been drilled and completed in the 60 Sand within the project area. The locations of the wells are shown on Figure CR3.4.3.3-1. Initial samples were collected from these wells in May 2009. A total of four quarterly rounds of water quality samples will be collected to evaluate water quality for the 60 Sand representative of the Moore Ranch License Area. One of the wells (UMW-10) is located within proposed Wellfield 2 in the area where the 72 and 68 Sands coalesce. Results of the initial sampling of the 60 Sand are summarized in the following table.




Permit Area Boundary

Topographic Surface
C.I. = 20 feet

Wellfield Patterns

Monitor Well Ring

Petrotek

10288 W.Chatfield Ave, Ste 201
Littleton, CO 80127-4239

URANIUM ONE

**Figure CR3.4.3.3-1. Location Map**
**60 Sand Monitor Wells**
**Moore Ranch Permit Area, Wyoming**

By: EPL Checked: HD File ID:figCR34332lsrf Date: 7/29/09

**Table CR3.4.3.3-1 Initial Water Quality Results from 60 Sand Monitor Wells**

| | | Major Cations and Anions | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Na | K | Ca | Mg | Cl | HCO3 | CO3 | SO4 |
| Well ID | Sample Date | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) |
| UMW-7 | 5/12/09 | 62 | 6 | 48 | 6 | <1 | 280 | <1 | 67 |
| UMW-7 | 5/21/09 | 68 | 7 | 59 | 6 | <1 | 241 | <1 | 93 |
| UMW-10 | 5/18/09 | 64 | 11 | 44 | 5 | 1 | 236 | 12 | 67 |
| UMW-11 | 5/20/09 | 86 | 11 | 70 | 8 | 5 | 148 | 8 | 284 |

| | | General Chemistry | | | Trace Metals | | |
|---|---|---|---|---|---|---|---|
| | | TDS @180 F | Conduct. | pH. | As | Mn | Se |
| | | (mg/l) | (umhos/cm) | (s.u.) | (mg/l) | (mg/l) | (mg/l) |
| UMW-7 | 5/12/09 | 337 | 522 | 7.87 | 0.002 | 0.03 | 0.076 |
| UMW-7 | 5/21/09 | 359 | 594 | 7.97 | <0.001 | 0.02 | 0.075 |
| UMW-10 | 5/18/09 | 354 | 528 | 8.77 | 0.001 | <0.01 | 0.102 |
| UMW-11 | 5/20/09 | 573 | 807 | 8.77 | 0.001 | <0.01 | 0.074 |

| | | Radionuclides | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | G Alpha | G Beta | Pb-210 (dis.) | Po-210 (dis.) | Ra-226 (dis.) | Ra-228 (dis.) | Th-230 (dis.) | U (dis.) |
| | | (pCi/l) | (pCi/l) | (pCi/l) | (pCi/l) | (pCi/l) | (pCi/l) | (pCi/l) | (mg/l) |
| UMW-7 | 5/12/09 | 64.5 | 14.8 | <2.0 | 0.1 | 0.35 | 1.4 | <0.04 | 0.0524 |
| UMW-7 | 5/21/09 | 50.6 | 13.9 | <0.5 | 2.8 | 0.4 | 0.4 | 0.0 | 0.0484 |
| UMW-10 | 5/18/09 | 5.1 | 2.1 | 2.3 | 0.2 | 0.30 | 1 | 0.2 | 0.0645 |
| UMW-11 | 5/20/09 | 70.6 | 21.5 | <0.4 | 0.3 | 0.99 | 0.9 | 0.05 | 0.0360 |

All 60 Sand samples were < detection for F, NH4 as N, Ba, B, Cd, Cr, Cu, Fe, Pb, Hg, Mo, Ni, V and Zn

Of note is that the selenium levels in all three wells exceed the Wyoming Class I Standard of 0.05 mg/l and the uranium levels in all three wells exceed the US EPA MCL of 0.03 mg/l. Sulfate and TDS exceed the Wyoming Class I Standard in UMW-11.

In the area of Wellfield 2 where the 70 and 68 sands coalesce, the 60 sand will be considered the underlying aquifer. Monitor wells will be placed in the underlying 60 sand in the areas where the 70 and 68 sand coalesce at a spacing of 1 well per 4 acres. The number and location of these underlying wells will be determined during final wellfield planning and submitted to the WDEQ-LQD in the Mine Unit Wellfield Data Package.

*RAI Question 2:*

Based on available water quality data, the WDEQ class of use for 72, 70, 68, and 60 sands within the project area should be clearly illustrated.

*Response:*

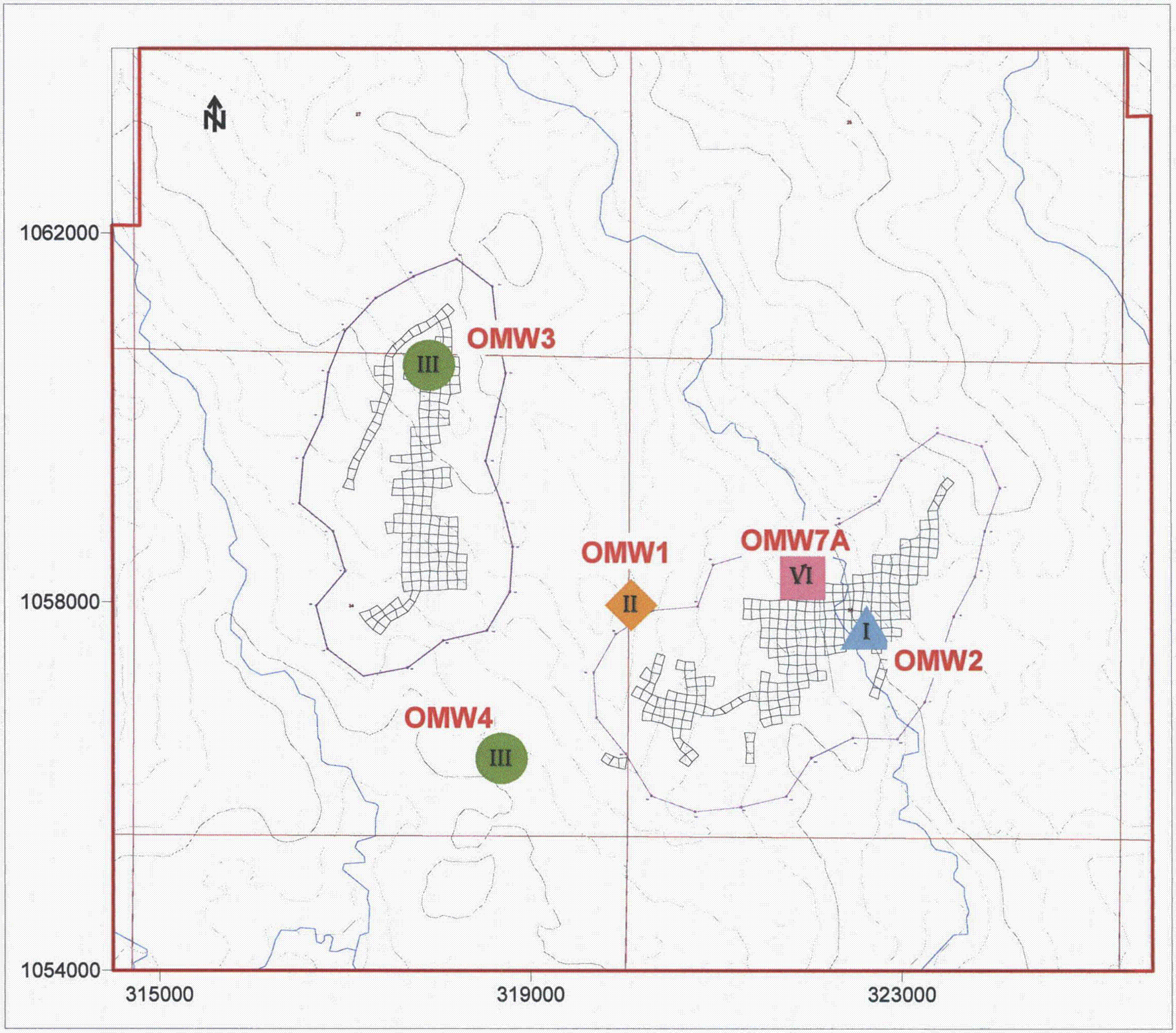
A set of figures has been prepared that identifies the projected WDEQ class of use for the 60 through 72 Sands within the project area, based on the available monitor well water quality data (Figure CR3.4.3.3-2a through 2d). A separate figure is presented that indicates the projected class of use of four private un-permitted stock wells within the License Area that have been sampled by EMC Figure CR3.4.3.3-2e. The completion zones for these wells are estimated from pump depths and projection from site cross sections. Also included on the figure is the projected class of use for two Conoco monitor wells that are completed across multiple aquifers.

*RAI Question 3:*

Based on available groundwater quality data, the class of use of the 72, 70, 68, and 60 sands in the project area should also be identified.

*Response:*

A table has been prepared that identifies the projected class of use of the 72, 70, 68, and 60Sands within the project area based on water quality data collected from available monitor wells (Table CR3.4.3.3-3). The class of use for the 60 Sand is determined from the initial water quality data from the recently completed 60 Sand monitor wells. The designation may be revised once additional sampling rounds have been collected and analyzed.




WDEQ Groundwater
Class of Use

- I — Class I (Drinking)
- II — Class II (Agricultural)
- III — Class III (Livestock)
- VI — Class VI (Not suitable for Class I, II or III uses)

- Permit Area Boundary
- Topographic Surface C.I. = 20 feet
- Wellfield Patterns
- Monitor Well Ring

0 1000 2000

Feet

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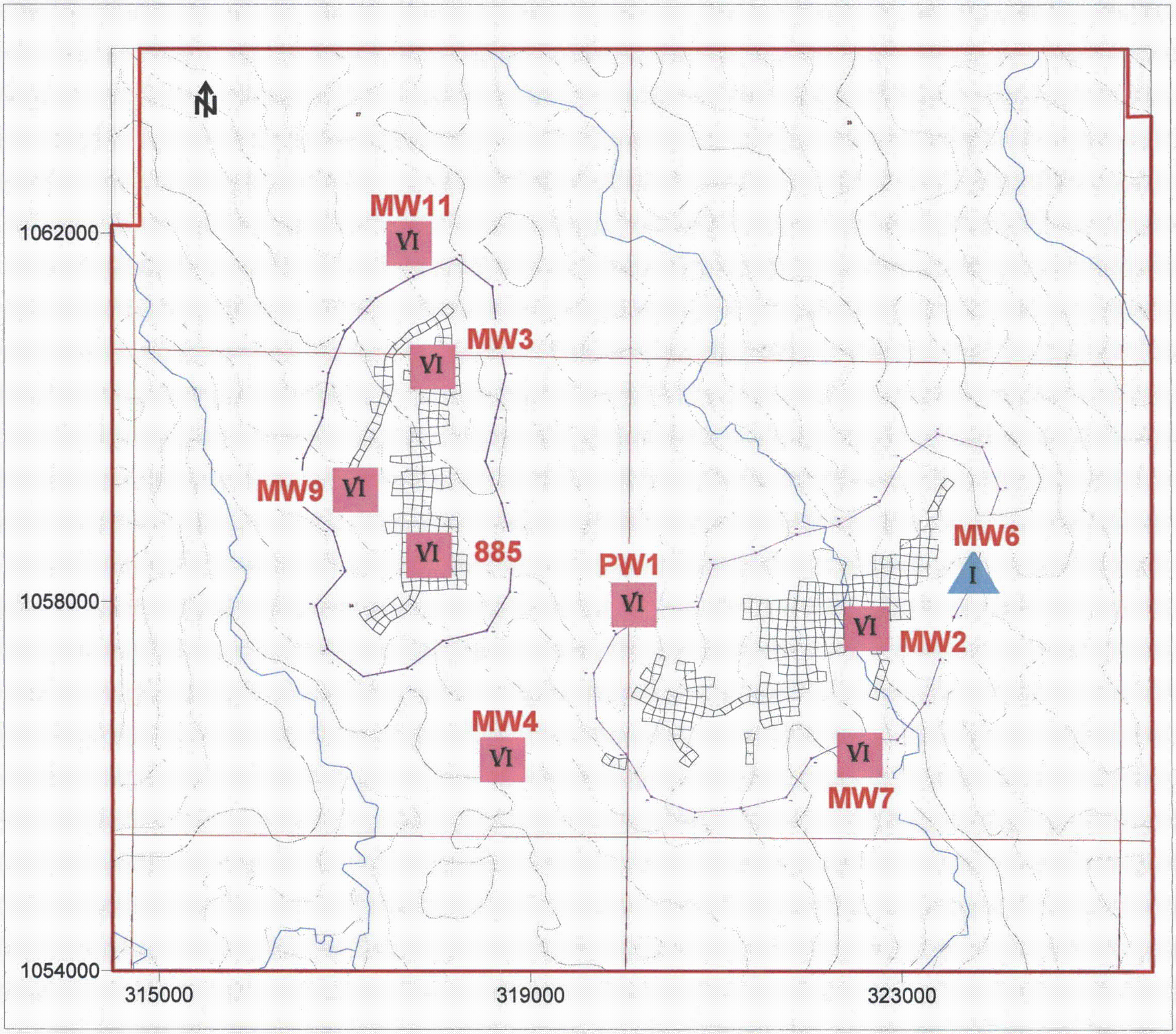
**URANIUM ONE**

**Figure CR3.4.3.3-2a Projected Class of Use 80 and 72 Sand Monitor Wells Moore Ranch Permit Area, Wyoming**

By: EPL Checked: HD File ID:figCR34332lsrf Date: 7/29/09




0 1000 2000
Feet

WDEQ Groundwater Class of Use

- I Class I (Drinking)
- II Class II (Agricultural)
- III Class III (Livestock)
- VI Class VI (Not suitable for Class I, II or III uses)

- Permit Area Boundary
- Topographic Surface C.I. = 20 feet
- Wellfield Patterns
- Monitor Well Ring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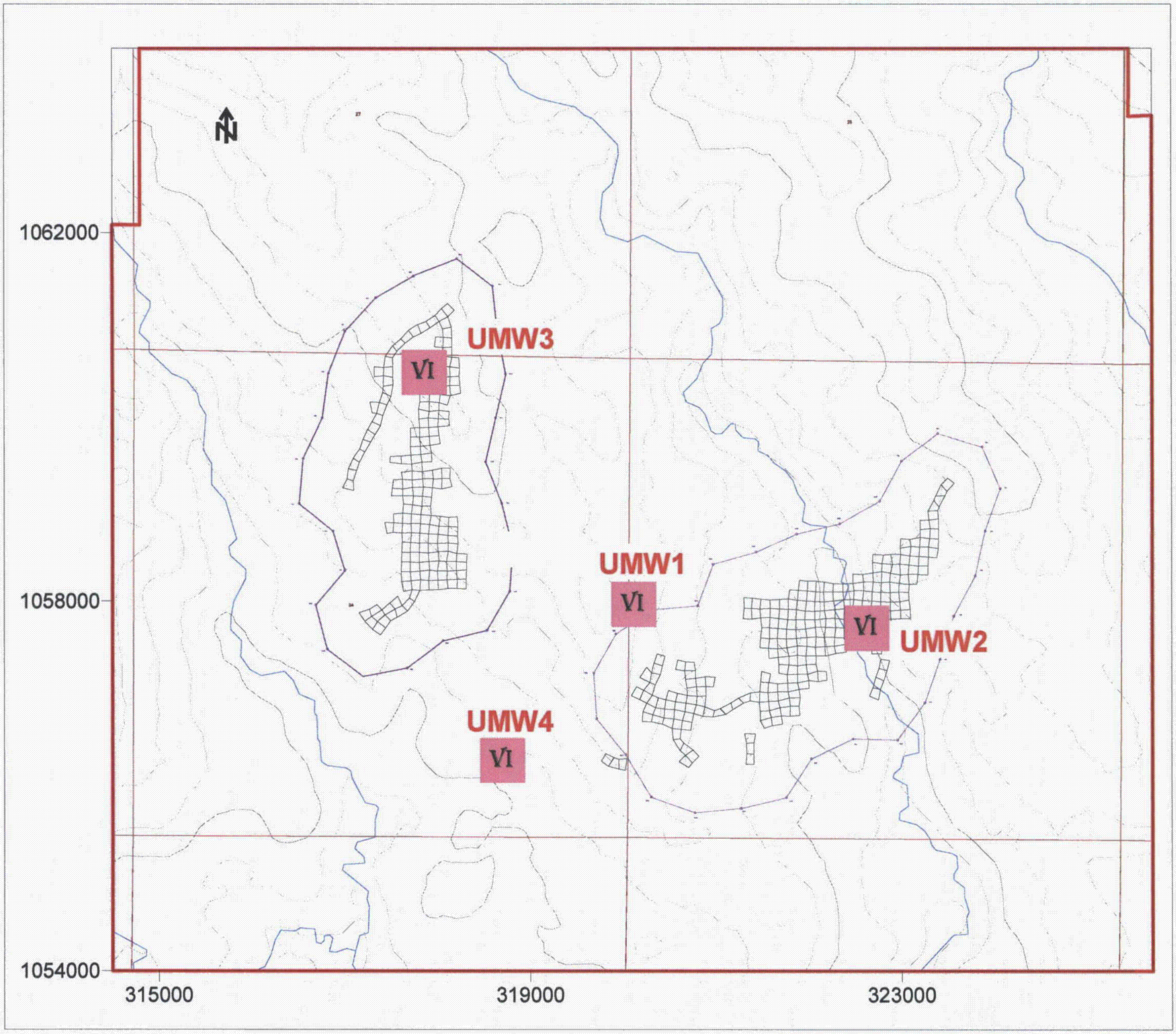
**URANIUM ONE**

**Figure CR3.4.3.3-2b Projected Class of Use**
**70 Sand Monitor Wells**
**Moore Ranch Permit Area, Wyoming**

By: EPL Checked: HD File ID:figCR34332lsrf Date: 7/29/09




0 1000 2000
Feet

WDEQ Groundwater
Class of Use

- I Class I (Drinking)
- II Class II (Agricultural)
- III Class III (Livestock)
- VI Class VI (Not suitable for Class I, II or III uses)

- Permit Area Boundary
- Topographic Surface C.I. = 20 feet
- Wellfield Patterns
- Monitor Well Ring

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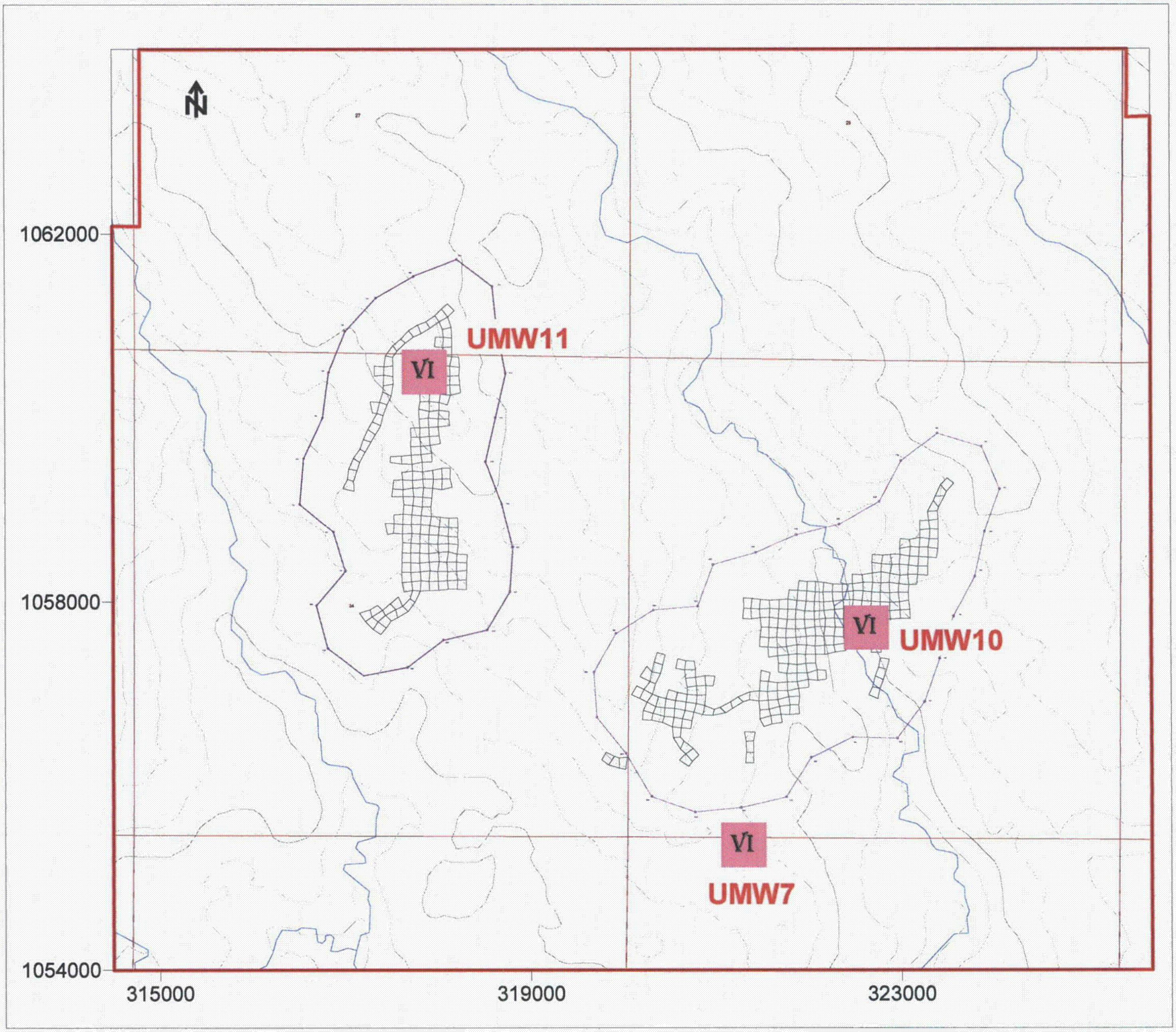
**URANIUM ONE**

**Figure CR3.4.3.3-2c Projected Class of Use**
**68 Sand Monitor Wells**
**Moore Ranch Permit Area, Wyoming**

By: EPL Checked: HD File ID:figCR34332lsrf Date: 7/29/09




WDEQ Groundwater
Class of Use

I Class I (Drinking)

II Class II (Agricultural)

III Class III (Livestock)

VI Class VI (Not suitable for Class I, II or III uses)

Permit Area Boundary

Topographic Surface C.I. = 20 feet

Wellfield Patterns

Monitor Well Ring

0 1000 2000
Feet

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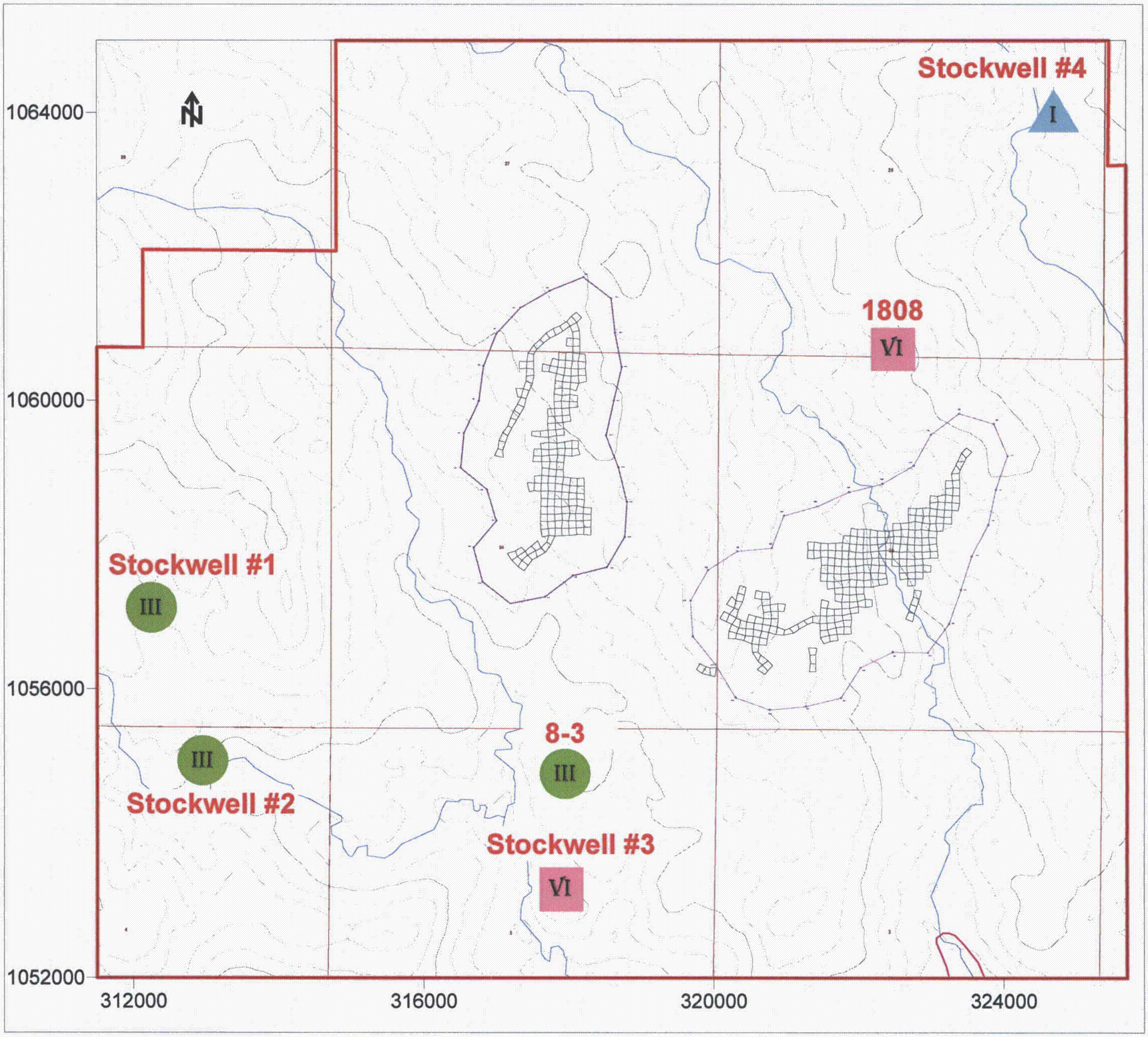
URANIUM ONE

**Figure CR3.4.3.3-2d Projected Class of Use
60 Sand Monitor Wells
Moore Ranch Permit Area, Wyoming**

By: EPL Checked: HD File ID:figCR34332lsrf Date: 7/29/09




WDEQ Groundwater Class of Use

- I — Class I (Drinking)
- II — Class II (Agricultural)
- III — Class III (Livestock)
- VI — Class VI (Not suitable for Class I, II or III uses)

- Permit Area Boundary
- Topographic Surface C.I. = 20 feet
- Wellfield Patterns
- Monitor Well Ring

0 1000 2000
Feet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**URANIUM ONE**

**Figure CR3.4.3.3-2e Projected Class of Use Private (Stock) Wells and Monitor Wells Screened Across Multiple Sands Moore Ranch Permit Area, Wyoming**

By: EPL Checked: HD File ID:figCR34332.srf Date: 7/29/09

**Table CR 3.4.3.3-3 Projected Class of Use Based on Monitor Well Water Quality Moore Ranch License Area**

| | | STANDARDS EXCEEDED | | | | Projected |
|---|---|---|---|---|---|---|
| | Completion Interval | WDEQ Class I | WDEQ Class II | WDEQ Class III | USEPA MCL | Class of Use |
| Well ID | | | | | | |
| UMW-9 | 60 Sand | Se, g. alpha | Se, g. alpha | Se, g. alpha | Se, g. alpha, U | Class VI |
| UMW-10 | 60 Sand | Se, pH | Se, pH | Se | Se, U | Class VI |
| UMW-11 | 60 Sand | SO4, TDS, pH, Se, g. alpha | SO4, Se, g. alpha | Se, g. alpha | Se, g. alpha, U | Class VI |
| UMW-1 | 68 Sand | pH | pH | pH | None | Class VI |
| UMW-2 | 68 Sand | pH, Se, Ra | pH, Se, Ra | pH, Se, Ra | Se, Ra | Class VI |
| UMW-3 | 68 Sand | TDS. Ra | Ra | Ra | Ra | Class VI |
| UMW-4 | 68 Sand | Se | Se | Se | Se, U | Class VI |
| MW-2 | 70 Sand | SO4, TDS, Ra | SO4, Ra | Ra | Ra, U | Class VI |
| MW-3 | 70 Sand | TDS, g. alpha, Ra | G. alpha, Ra | G. alpha, Ra | G. alpha, Ra, U | Class VI |
| MW-4 | 70 Sand | SO4, TDS, g. alpha, Ra | G. alpha, Ra | G. alpha, Ra | G. alpha, Ra, U | Class VI |
| MW-6 | 70 Sand | None | None | None | None | Class I |
| MW-7 | 70 Sand | Se, g alpha | Se, g. alpha | Se, g. alpha | Se, g. alpha, U | Class VI |
| MW-9 | 70 Sand | SO4, TDS, Se, g alpha, Ra | SO4, Se, g alpha, Ra | Se, g alpha, Ra | Se, g alpha, Ra, U | Class VI |
| MW-11 | 70 Sand | SO4, TDS, Fe, g. alpha, Ra | SO4, g. alpha, Ra | g. alpha, Ra | g. alpha, Ra U | Class VI |
| PW-1 | 70 Sand | SO4, TDS, Fe, g. alpha, Ra | SO4, g. alpha, Ra | g. alpha, Ra | g. alpha, Ra U | Class VI |
| 885 | 70 Sand | SO4, TDS, Mn, g. alpha, Ra | SO4, g. alpha, Ra | g. alpha, Ra | g. alpha, Ra U | Class VI |
| 1808 | 68-70 Sand | SO4, TDS, Mn, Ra | SO4, Ra | Ra | Ra | Class VI |
| 8-3 | 68-70 Sand | SO4, TDS, Fe, Mn | SO4, TDS, | None | None | Class III |
| OMW-1 | 72 Sand | pH | None | pH | None | Class II |
| OMW-2 | 72 Sand | SO4, TDS, Mn | SO4 | None | None | Class III |
| OMW-3 | 72 Sand | None | None | None | None | Class I |
| OMW-4 | 72 Sand | SO4, TDS, Fe, Mn | SO4, Mn | None | None | Class III |
| OMW-7B | 80 Sand | TDS. g. alpha | g. alpha | g. alpha | g. alpha | Class VI |
| Stockwell #1 | 70? | SO4, TDS, Fe, Mn | SO4, Mn | None | None | Class III |
| Stockwell #2 | 68? | SO4, TDS, Fe, Mn | SO4, Mn | None | None | Class III |
| Stockwell #3 | 70? | SO4, TDS, Fe, Mn, g. alpha | SO4, TDS, Mn, g. alpha | g. alpha | g. alpha | Class VI |

**Table CR 3.4.3.3-3 Projected Class of Use Based on Monitor Well Water Quality Moore Ranch License Area**

| | | STANDARDS EXCEEDED | | | | Projected |
|---|---|---|---|---|---|---|
| | Completion Interval | WDEQ Class I | WDEQ Class II | WDEQ Class III | USEPA MCL | Class of Use |
| Well ID | | | | | | |
| Stockwell #4 | 72? | None | None | None | None | Class I |

*RAI Question 4:*

Any discrepancies between the WDEQ classification and actual use in and surrounding the license area should be identified, discussed, and reconciled. For example, there appear to be several domestic wells in the vicinity of the project area. However, groundwater quality data from the shallow Wasatch aquifer indicates that shallow aquifers in the area may not meet the criteria for domestic use. The failure of shallow groundwater quality to meet WDEQ Class I criteria appears largely due to the secondary standards of total dissolved solids and sulfates. Secondary standards are set based largely on aesthetic considerations (e.g., taste), and such water may still be used for domestic purposes.

*Response:*

In addition to secondary groundwater quality standards, many of the monitor wells fail to meet Class I (Drinking), II (Agricultural) or III ( Livestock) WDEQ classification standards for radium, gross alpha and selenium as well as USEPA Drinking water standards for uranium, as shown in Table CR 3.4.3.3-3. It should be noted that the EMC monitor wells generally are placed in the vicinity of uranium ore bodies and therefore it is not unexpected that those wells commonly exceed standards that are indicative of uranium mineralization.

The only permitted domestic well within the License Area is identified as an industrial, domestic well for the Rio Algom Mining Corp (P12299W). That well is projected as being completed in the 58 or 60 Sand interval. There are no occupied residences within the License Area. The nearest other permitted domestic wells are located approximately two miles to the east of the License Area. These wells are hydraulically upgradient or cross-gradient to the License Area.

There are numerous permitted and un-permitted stock wells located within the License Area. Water quality data are unavailable from SEO records for any of the permitted stock wells within the two-mile radius of the Moore Ranch License Area. EMC collected water quality from four stock wells within the License Area that are not permitted. Water quality data from those wells indicate that one of the wells meets all WDEQ Class I and USEPA MCL standards for general chemistry, inorganics and radionuclides (Table CR 3.4.3.3-3, previous RAI Question response). Two of the wells meet Class III standards (but not Class I) making them suitable for livestock purposes, consistent with their current use. The fourth stock well exceeds the WDEQ Class III standard for gross alpha, making the Wyoming groundwater classification of this well as Class VI, unsuitable for drinking water, agricultural or livestock uses. EMC has no control over the use of these private wells and can only inform the well owner that the water quality is unsuitable for the wells intended use.

As shown in Table CR3.4.3.3-3, all but one of the 60, 68 and 70 Sand monitor wells exceed Class I, II and III standards for gross alpha and radium and the USEPA MCL for uranium. Many of those wells also exceed selenium standards for Class I, II and III water. All of the 72 sand monitor wells meet the Class III water quality standards. These water quality trends are consistent with the presence of uranium mineralization beneath the 72 Sands within the Moore Ranch License Area.

## Section 4.4.2 Groundwater Impacts

The October 27, 2008, response to the NRC Request for Technical Information (4.2 d) indicates that an application for a Class V Underground Injection Control Permit has been submitted to the WDEQ. Previous submittals have indicated that the planned deep disposal wells would be permitted as Class I wells.

*RAI Question 1:*

Provide a discussion of the issues that have led to the application for Class V rather than Class I injection wells for use in waste disposal.

*Response:*

Uranium One has resubmitted its application for a deep disposal well as a Class I well. The initial Class V Permit Application was received by WDEQ on May 14, 2008. Previous comments were presented by WDEQ in a letter dated July 29, 2008 and were addressed by Uranium One in a response provided to WDEQ on January 13, 2009.

Per direction from WDEQ in an April 27, 2009 letter, the Moore Ranch Class V UIC application has been changed to a Class I UIC application. In response to WDEQ's request, Uranium One has included a plan to drill and test the Teckla, Teapot, and Parkman (TTP) interval as a potential injection zone. Hence, the revised submittal includes two Volumes as follows:

Class I UIC Application: Lance Formation and Fox Hills Sandstone – Volume 1
Class I UIC Application: Teckla, Teapot and Parkman Formations – Volume 2

The revised application was submitted to the Wyoming Department of Environmental Quality – Water Quality Division on August 17, 2009.

*RAI Question 2:*

In addition, provide a brief description of the disposal wells currently planned, including the strata into which injection is being proposed, the water quality and degree of isolation of those strata, and the potential environmental impacts of the proposed injection into those strata.

*Response:*

The UIC permit application was submitted as two volumes. Volume one is an application for the Teapot-Teckla-Parkman interval with depths of 7,916 ft to 9,610 ft (based on logs from the Sun Oil No. 1 Ross API No. 522824, is the No.1 Ross Unit located in T41N R75W, Section 3, NE ¼). Based on available data, the hydrologic properties of this interval would allow injection rates on the order of 30 gpm per well. Based on projected maximum production rates during ISR operations, four injection wells may be required to provide sufficient capacity during maximum periods of injection. Water quality within the TTP interval is anticipated to exceed 3,000 mg/L TDS.

The second volume is a permit application for the Lance Formation at depths of 3,700 to 7,500. The Lance interval has much greater injection capacity than the Teapot-Teckla-Parkman interval, based on regional information. However, water quality may be an issue as the Lance Formation is likely to be less than 3,000 mg/l TDS. If this interval provides a suitable injection interval for permitting, only two wells would be necessary to meet the capacities for the project. Both the Lance or Teapot-Teckla-Parkman injection targets are located at depths that make any environmental impacts negligible. As part of the permitting process, the potential for environmental impacts is thoroughly evaluated.

*RAI Question 3:*

Identify and discuss any issues or potential problems that the WDEQ has identified in its review of the application for the proposed Class V underground injection control wells.

*Response:*

As stated previously, Uranium One submitted the application on August 17, 2009 as a Class I UIC permit.

*RAI Question 4:*

The applicant should provide an analysis of the potential impacts to surficial soils and shallow groundwater during facility construction, including well field installation and testing. This analysis should clearly address the potential impacts from drilling operations, including the management of drilling fluids and wastes, on shallow groundwater. The analysis should also address other potential spills that may occur during facility construction, including the release of fuels and lubricants.

*Response:*

During facility construction, potential impacts to shallow water could occur from consumptive use of groundwater, introduction of drilling fluids and muds during well installation, discharge of pumped water during hydrologic testing and surface spills of fuels and lubricants. Groundwater use during construction is minor relative to the available water supply in the shallow Wasatch aquifers. Most water used for the Moore Ranch project is extracted from a well completed in the 40 and 50 Sand at depths of 470 to 590 ft below ground surface, much deeper than the shallow aquifers beneath the site. Consumptive use of groundwater is generally limited to dust control, drilling support and cement mixing. Impacts from groundwater consumptive use during construction would be minor and temporary to water supplies of the Powder River Basin.

The volume of drilling fluids and muds used during well installation is limited and would have negligible to small impacts on shallow aquifers beneath the License Area. The depth to the water table is generally more than 40 feet across most of the site so infiltration of drilling fluids and muds are unlikely to cause noticeable changes in water quality. Drilling fluids and muds will be placed into mud pits to control the spread of the fluids, to minimize the area of soil contamination and to enhance evaporation.

Pumped waters from hydrologic testing during construction of the wellfields will be discharged in accordance with approved permits. The permits protect near surface aquifers by limiting the discharge volume and prescribing concentration limits to waters that can be discharged.

Groundwater quality of near surface aquifers will be protected by best management practices including implementation of a spill prevention and cleanup program to prevent soil contamination. The volume of fluids and lubricants kept on the License Area is generally small and any spills or leaks will result in immediate cleanup response.

*RAI Question 5:*

Best management practices planned during the construction phase to minimize impacts to groundwater during facility construction should also be identified and discussed.

*Response:*

As noted in the previous RAI Question response, best management practice will include implementation of a spill prevention and cleanup program, extracting water from deeper, more prolific aquifers to minimize consumptive use impacts, compliance with WDQE approved discharge permits, and minimization of surface disturbance through the use of mud pits.

## Section 4.4.2.1 Groundwater Consumption

Analysis of drawdowns in groundwater levels in the 70 sand have been revised using the enhanced groundwater model presented in Appendix B-4 of the revised September 2008 TR. The enhanced model provides estimates of drawdown during both ISL operation and restoration. The estimates of drawdown during aquifer restoration are based on revised estimates of net losses of groundwater during restoration (50 gpm per well field). The drawdowns resulting from the assumed operation and restoration scenarios have been depicted on figures contained within the modeling report. However, the predicted drawdowns have only been depicted for a limited area immediately surrounding the ISR well fields. Please provide the following:

*RAI Question 1:*

A figure depicting predicted drawdowns throughout the model domain should be provided. The location of all wells expected to be screened in the 70 and underlying 68 sands should be superimposed on the figure. Based on this figure, all existing wells in the 70 or 68 sand potentially impacted by drawdown induced by production or restoration pumping should be identified.

*Response:*

Figure CR4.4.2.1-1a shows the location of wells within 2 miles of the License Area that are completed in the Upper Wasatch Sands (Sands 40 through 80). A set of figures has also been prepared showing the predicted drawdown throughout the model domain at the end of production operations, the end of restoration of Wellfield 1, and the end of restoration of Wellfield 2 (Figures CR.4.4.2.1-1b, -1c and -1d, respectively). To the extent the data are available and reliable, existing wells completed in the 70 or 68 sand (excluding monitor wells) potentially impacted by drawdown induced by production or restoration are shown on the figures and cross referenced to Table CR4.4.2.1-2b (below).

*RAI Question 2:*

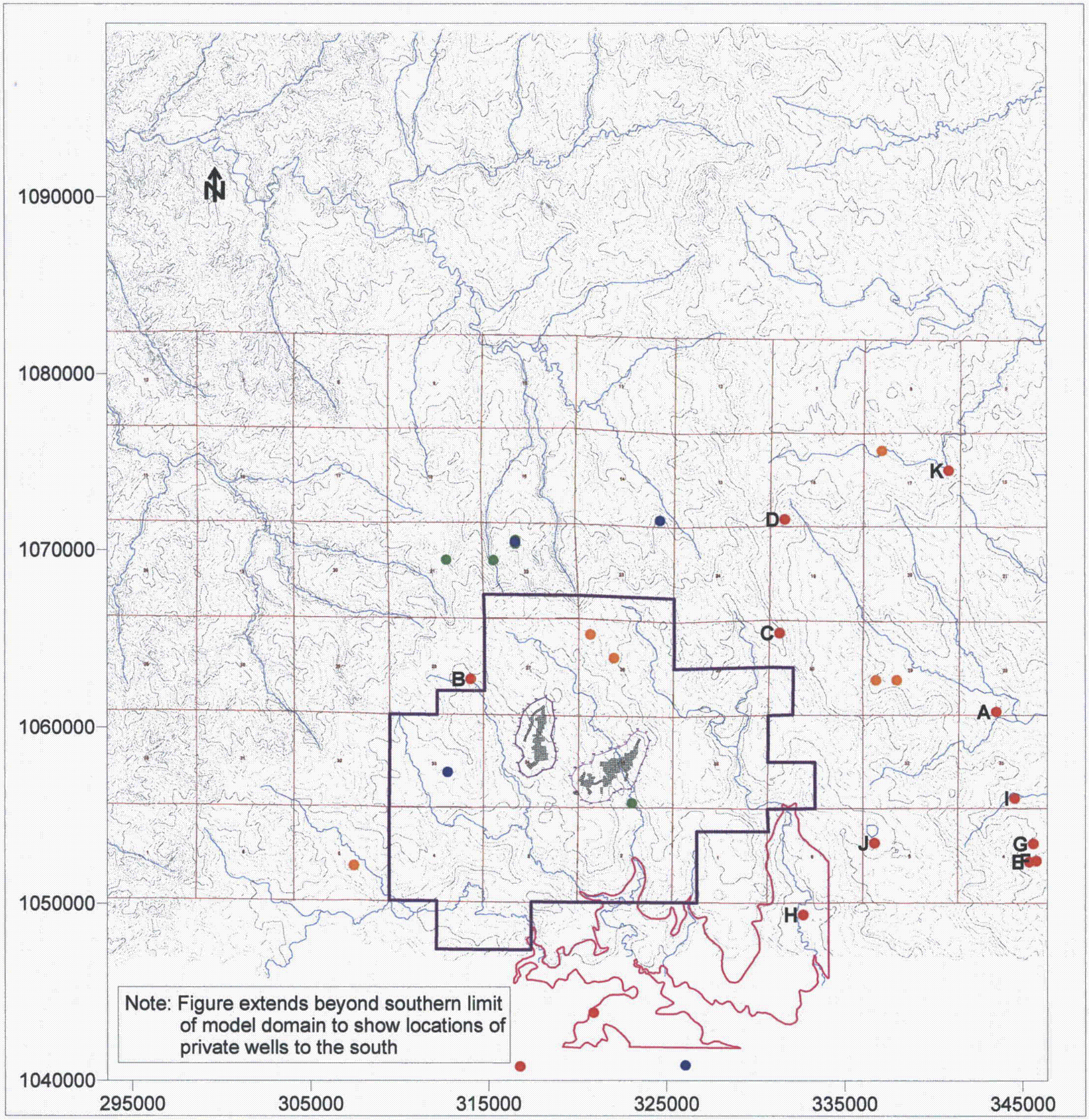
The characteristics of these wells should be provided. Please identify the screen depths, available drawdown, the predicted drawdown during both ISR operation and restoration, and likely impact of these drawdowns on the assigned yield for each well.

*Response:*

A table has been prepared that provides the available data for wells completed, or reasonably expected to be completed, in the 70 or 68 Sands within two miles of the License Boundary (Table CR4.4.2.1-2a). Geologic cross sections were compared to the reported completion depth to project the hydrostratigraphic unit that the wells are completed across. Wells completed in the 70 Sand, and to a lesser extent, the 68 Sand, could potentially be impacted by drawdown from ISR operations. In some cases, particularly for wells that are distant from the License Area, the projection is less certain and may include multiple sands. A total of fourteen domestic, industrial, stock or miscellaneous use wells within two miles of the License Area are projected as being completed within the 68 or 70 sand. None of those wells are within the License Area. Wells projected as being completed across the 40, 50, 58, 60, 72 and 80 Sands are also included in the table for completeness, although these wells are not anticipated to be impacted by ISR activities at Moore Ranch.

The License Area groundwater model was used to predict drawdown at wells completed across the 70 Sand during production and restoration. Results of the model simulations are summarized in Table CR4.4.2.1-2b for wells completed within the 70 (or the combined 68-70 or 70-72 Sands. The table cross references Figures CR.4.4.2.1-1a, -1b and -1c described in response to RAI Question 1 for Section 4.4.2.1 above. Three of the wells (P120983W, P22296P and P78124W) that are projected as 70 Sand completions are located south of the model domain and therefore, no model predicted drawdowns are provided for those wells. The largest predicted drawdown (almost 8 feet after restoration of Wellfield 1) occurs at well P14660 (located in T42N, 75 W, Section 28, approximately 1 mile northwest of proposed Wellfield 1). Most other wells had less than 1 foot of drawdown at any time during the life of the ISR operations. The projected drawdowns represent a small percentage of the total available drawdown.

Potential impacts to the underlying 68 Sand because of coalescing of the 68 and 70 Sand over a small portion of Wellfield 2 have not been quantified at this time. For purposes of this demonstration, it is conservatively assumed that drawdown within the 68 Sand will be the same as in the 70 Sand, (although data from pump tests conducted within the area where the sands coalesce indicate that this is not the case). The drawdown reported for the 68 Sand in the table is what was simulated in the 70 Sand and can be viewed as a worst case (maximum drawdown) scenario.




Permit Area Boundary

Outcrop of 70 Sand

Topographic Surface C.I. = 20 feet

Wellfield Patterns

Monitor Well Ring

A● Well Cross Reference to Table CR4.4.2.1-2b

Projected Well Completion Zones Private Wells Within 2 Miles of Permit Area*

- 40 to 50 Sand
- 58 to 60 Sand
- 68 to 70 Sand
- 72 to 80 Sand

*See table CR4.4.2.1-2a for additional description of private wells

0 5000 10000
Feet

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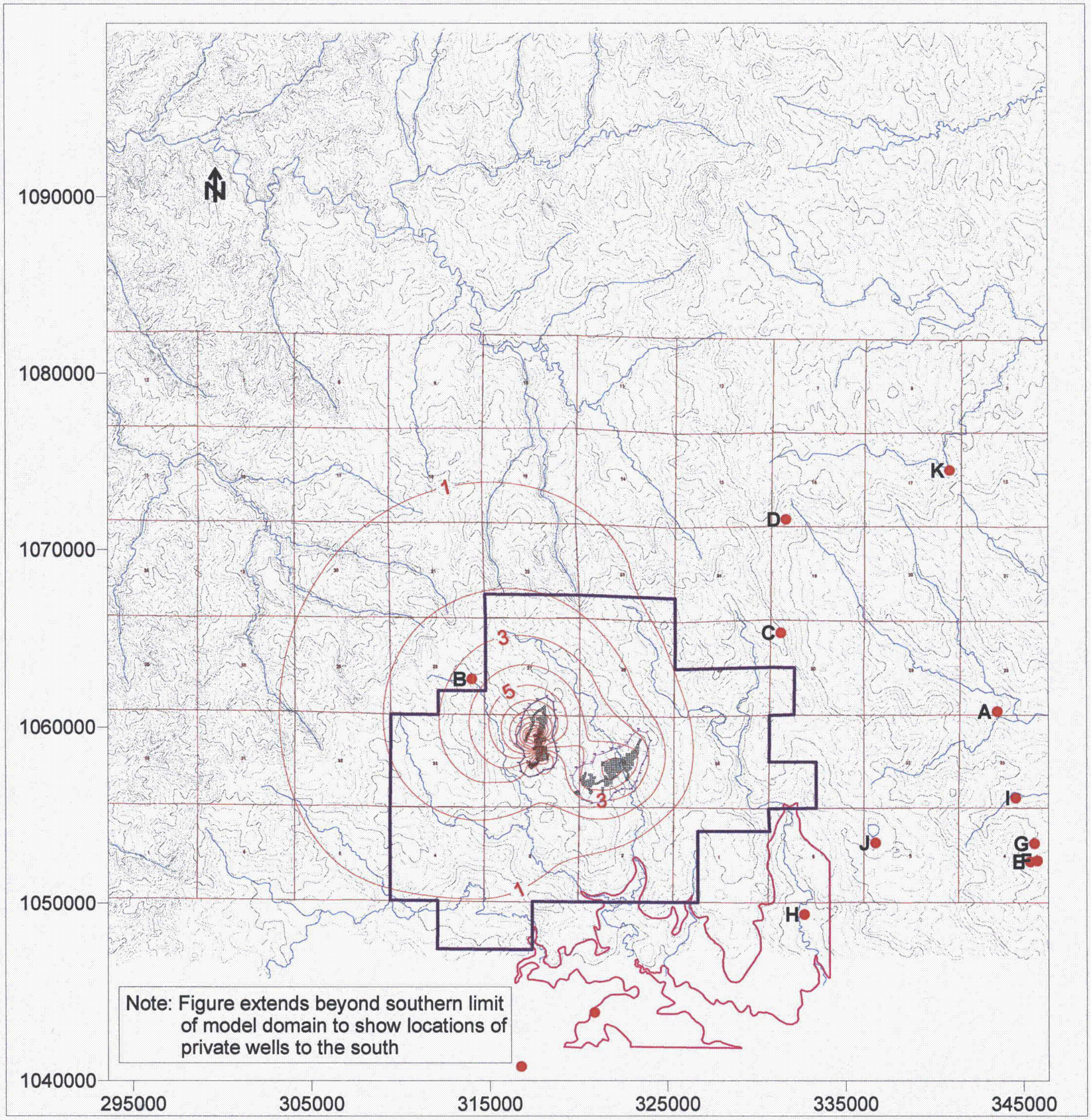
**URANIUM ONE**

**Figure CR4..4.2.1-1a**
**Location of Private Wells (non CBM)**
**Within 2 Miles of Moore Ranch Permit Area**

By: EPL Checked: HD File ID:figCR44211.srf Date: 7/29/09




Permit Area Boundary
Outcrop of 70 Sand
Topographic Surface C.I. = 20 feet
Wellfield Patterns
Monitor Well Ring

Simulated Drawdown C.I. = 1 foot
A ● Private Well Completed in 70 or 68 Sand Cross Referenced to Table CR4.4.2.1-2b

0 5000 10000
Feet

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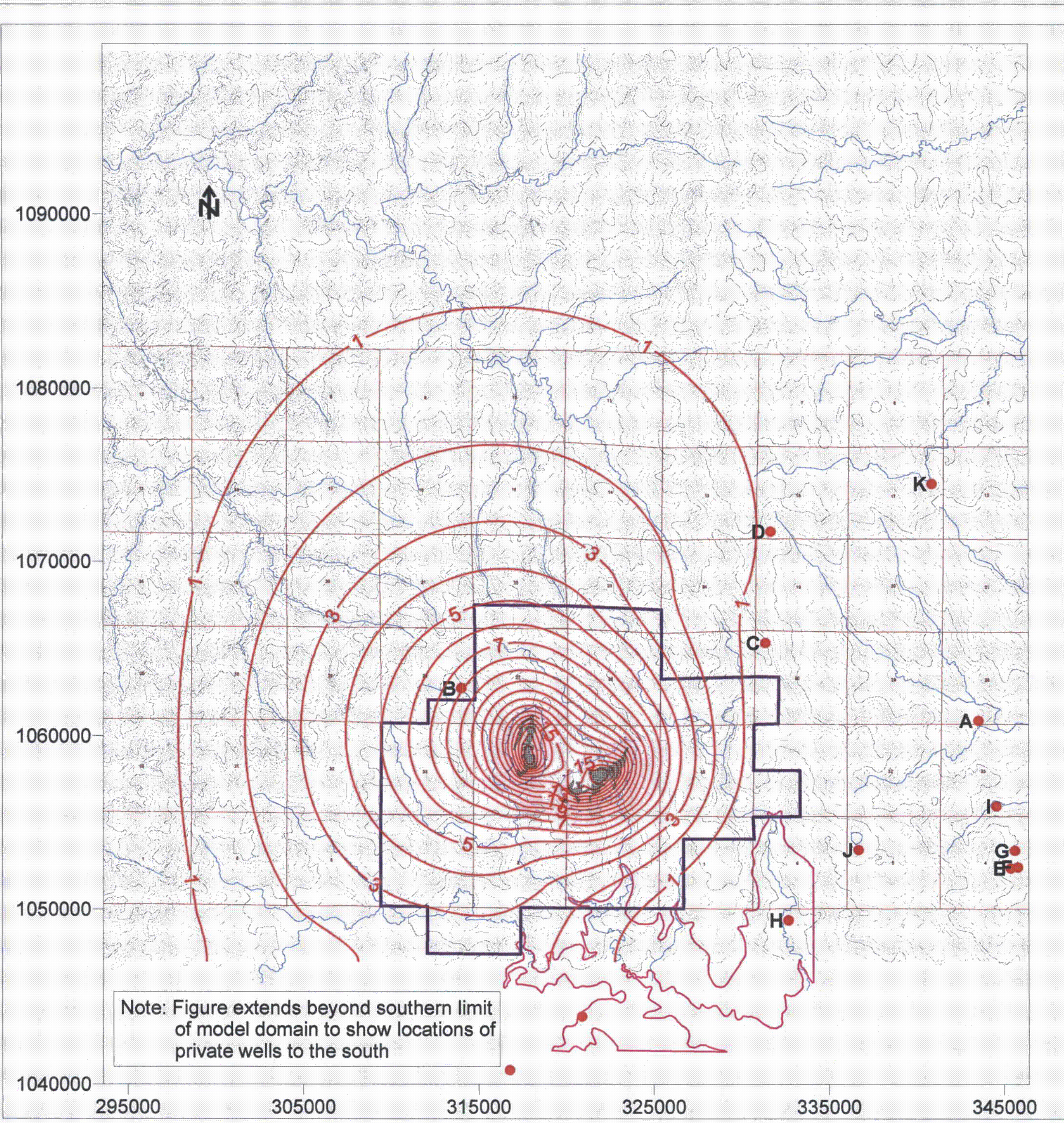
**URANIUM ONE**

**Figure CR4..4.2.1-1b**
**Simulated Drawdown At End of ISR Production**

By: EPL Checked: HD File ID:figCR44211.srf Date: 7/29/09




Permit Area Boundary

Outcrop of 70 Sand

Topographic Surface C.I. = 20 feet

Wellfield Patterns

Monitor Well Ring

Simulated Drawdown C.I. = 1 foot

A ● Private Well Completed in 70 or 68 Sand Cross Referenced to Table CR4.4.2.1-2b

0 5000 10000
Feet

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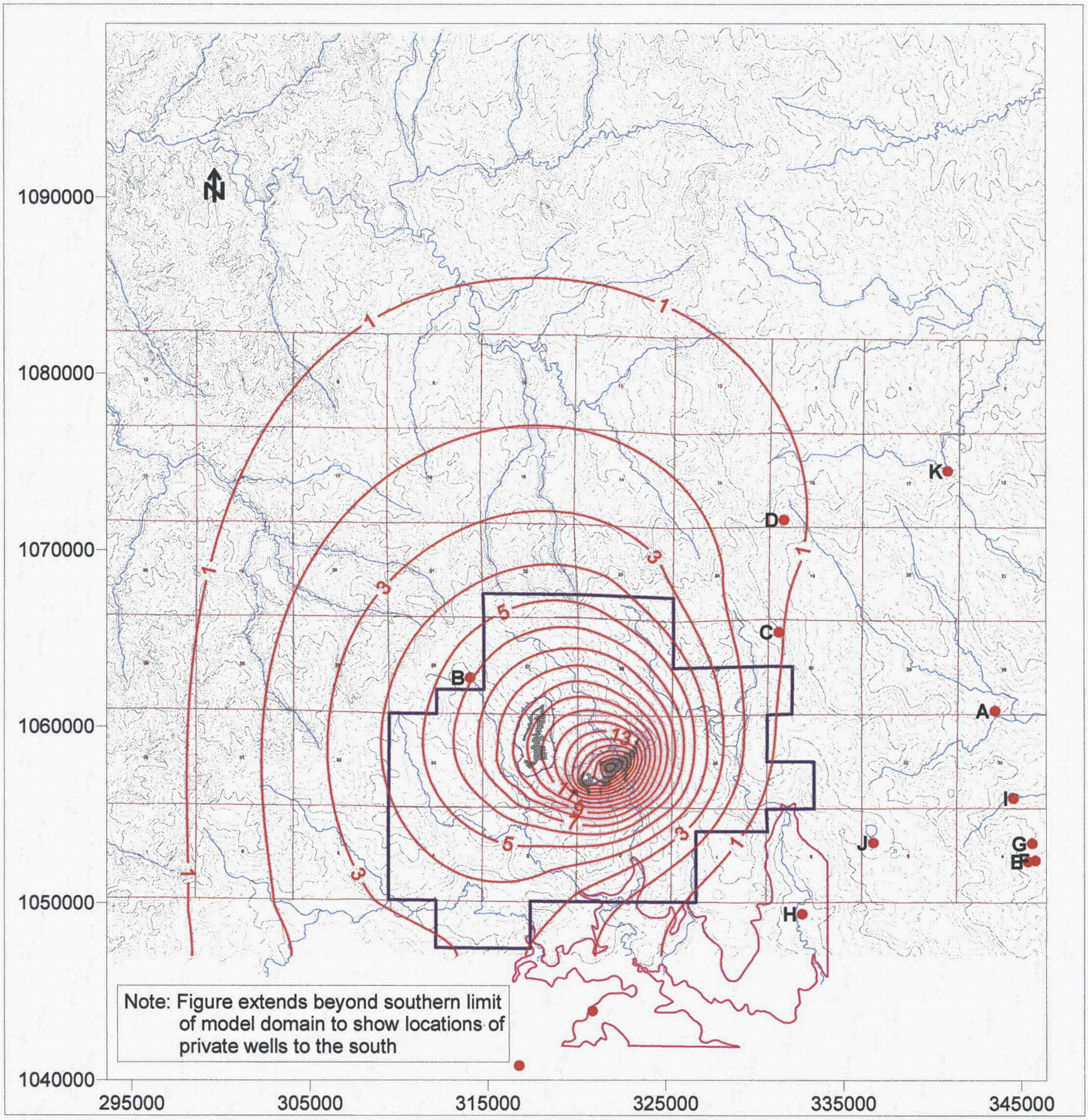
URANIUM ONE

**Figure CR4..4.2.1-1c**
**Simulated Drawdown At End of Wellfield 1 Restoration**

By: EPL Checked: HD File ID:figCR44211.srf Date: 7/29/09




Permit Area Boundary

Outcrop of 70 Sand

Topographic Surface C.I. = 20 feet

Wellfield Patterns

Monitor Well Ring

Simulated Drawdown C.I. = 1 foot

A ● Private Well Completed in 70 or 68 Sand Cross Referenced to Table CR4.4.2.1-2b

0 5000 10000
Feet

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**URANIUM ONE**

**Figure CR4..4.2.1-1d**
**Simulated Drawdown At End of Restoration**

By: EPL Checked: HD File ID:figCR44211.srf Date: 7/29/09

Table CR 4.4.2.1-2a Estimated Completion Intervals of Domestic, Stock, Industrial and Miscellaneous Water Wells Within Two Miles of the Moore Ranch Permit Area

| Permit # | Township | Qtrqtr | Applicant | Facility Name | Uses | Yield (gpm) | Well Depth (ft bgs) | Static Depth (ft bgs) | Mwbz Top (ft bgs) | Mwbz Bottom (ft bgs) | Within Permit Area? | Estimated Completion Zone | Hydraulic Position Relative to Mine Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P17304P | 41N74W Sec 4 | SENE | Pine Tree Ranch Co | Pine Tree # 3 | DOM, STO | 25 | 137 | 80 | Unk | Unk | No | 68 Sd? | UpG |
| P17302P | 41N74W Sec 4 | NESE | Pine Tree Ranch Co | Pine Tree # 2 | DOM, STO | 40 | 165 | 90 | Unk | Unk | No | 68 Sd? | UpG |
| P12299W | 42N75W Sec 33 | NWSE | Rio Algom Mining Corp | UM 1575 2 33 42 75 | IND, DOM | 15 | 440 | 60 | 348 | 440 | Yes | 58-60 Sd | UpG |
| P183672W | 42N75W Sec 35 | SWSE | Energy Metals Corp | MRWW#1 | MIS | ? | 590 | | 470 | 590 | Yes | 40-50 sd | UpG |
| P120983W | 41N75W Sec 23 | SESE | Moore Ranch Co. | F C #4 Spring | STO | 3 | 3 | 0 | Unk | Unk | No | 60 or 68 sd | UpG |
| P120985W | 41N75W Sec 14 | SWNW | Moore Ranch Co. | Frankie #1 Well | STO | 7 | 150 | 30 | Unk | Unk | No | 68 or 70 | UpG |
| P12244P | 42N74W Sec 28 | SESW | J.W. & V.R. Moore | Farm #1 | STO | 20 | 200 | 100 | Unk | Unk | No | 70 sd | XG |
| P14660P | 42N75W Sec 28 | NESE | Taylor Ranch Co. | Taylor #29-1 | STO | 3 | 355 | 150 | Unk | Unk | No | 70 sd | DnG |
| P14670P | 41N75W Sec 5 | NWSE | Taylor Ranch Co. | Taylor #41 1 | STO | 5 | 22 | 5 | Unk | Unk | No | 80 sd | XG |
| P14681P | 42N75W Sec 26 | NWNW | Taylor Ranch Co. | Taylor #55-1 | STO | 3 | 158 | 80 | Unk | Unk | Yes | 72-80 Sd | DnG |
| P14682P | 42N75W Sec 26 | SENW | Taylor Ranch Co. | Taylor #56-1 | STO | 3 | 158 | 80 | Unk | Unk | Yes | 72-80 Sd | DnG |
| P14683P | 42N74W Sec 30 | NWNW | Taylor Ranch Co. | Taylor #57-1 | STO | 3 | 275 | 175 | Unk | Unk | No | 68-70 | DnG |
| P14684P | 42N74W Sec 18 | SWSW | Taylor Ranch Co. | Taylor #57-58-2 | STO | 4 | 350 | 235 | Unk | Unk | No | 68-70 sd | XG |
| P14686P | 42N74W Sec 17 | NWNW | Taylor Ranch Co. | Taylor #58-4 | STO | 5 | 220 | 150 | Unk | Unk | No | 72-80 sd | XG |
| P17301P | 41N74W Sec 4 | NESE | Pine Tree Ranch Co | Pine Tree # 1 | STO | 15 | 130 | 55 | Unk | Unk | No | 68 sd | UpG |
| P17305P | 41N74W Sec 7 | NENW | Pine Tree Ranch Co | Pine Tree # 6 | STO | 20 | 50 | 18 | Unk | Unk | No | 70-72 | UpG |
| P17306P | 42N74W Sec 29 | NWSW | Pine Tree Ranch Co | Pine Tree # 7 | STO | 40 | 150 | 40 | Unk | Unk | No | 72 sd | XG |
| P22296P | 41N75W Sec 22 | NWNW | Ogalla Aldn & Cattle LP | McNaughtin Pasture #1 | STO | 3 | 125 | 50 | Unk | Unk | No | 68-70 | UpG |

Table CR 4.4.2.1-2a Estimated Completion Intervals of Domestic, Stock, Industrial and Miscellaneous Water Wells Within Two Miles of the Moore Ranch Permit Area

| Permit # | Township | Qtrqtr | Applicant | Facility Name | Uses | Yield (gpm) | Well Depth (ft bgs) | Static Depth (ft bgs) | Mwbz Top (ft bgs) | Mwbz Bottom (ft bgs) | Within Permit Area? | Estimated Completion Zone | Hydraulic Position Relative to Mine Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P35330W | 42N75W Sec 14 | SESE | Taylor Ranch Co. | Taylor Bliss #1 | STO | 25 | 500 | 100 | 380 | 460 | No | 58-60 | DnG |
| P35746W | 42N75W Sec 22 | SWNW | Brown Land Co. | Woods #1 | STO | 15 | 660 | 320 | Unk | Unk | No | 50-58 Sd? | DnG |
| P37879W | 42N74W Sec 29 | NESW | Pine Tree Ranch Co | Pine Tree # 5 1 | STO | 2 | 8 | 4 | 4 | 8 | No | 80 sd | XG |
| P50880W | 42N75W Sec 21 | SWNE | T-Chair Livestock | T-Chair Livestock Co #21-1 | STO | 25 | 800 | 130 | 360 | 620 | No | 50 sd | DnG |
| P63571W | 42N75W Sec 22 | NENW | T-Chair Livestock | CCI #8 Upper | STO | 10 | 421 | 266 | 354 | 413 | No | 60 sd | DnG |
| P63572W | 42N75W Sec 22 | NENW | T-Chair Livestock | CCI # 8 Middle | STO | 10 | 534 | 259 | 439 | 531 | No | 58 sd | DnG |
| P63573W | 42N75W Sec 22 | NENW | T-Chair Livestock | CCI # 8 Lower | STO | 10 | 722 | 270 | 636 | 720 | No | 40-50 Sd? | DnG |
| P6972W | 42N74W Sec 33 | SWSE | Pine Tree Ranch Co | Pine Tree # 8 | STO | 25 | 210 | 95 | Unk | Unk | No | 60-68 sd | UpG |
| P6973W | 41N74W Sec 5 | SWNW | Pine Tree Ranch Co | Pine Tree # 9 | STO | 5 | 170 | 60 | 140 | 165 | No | 68 sd | UpG |
| P78123W | 41N75W Sec 13 | SWSW | Moore Ranch Co. | Mona Rae #1 | STO | 20 | 200 | 100 | 150 | 200 | No | 60 sd | UpG |
| P78124W | 41N75W Sec 15 | SESW | Moore Ranch Co. | V B #1 | STO | 5 | 100 | 75 | 40 | 90 | No | 68-70 sd | UpG |
| P85802W | 42N74W Sec 17 | SENE | Iberlin Ranch | PT-WW#1 | STO | 25 | 300 | 180 | 260 | 300 | No | 70-72 sd | XG |

Estimates of completion zones with greatest uncertainty are indicated with a ?
Use categories include domestic, stock, industrial or miscellaneous
gpm - gallons per minute
ft bgs - feet below ground surface
Unk - Unknown

Hydraulic Position relative to Mine Units
UpG - Upgradient
DnG - Downgradient
XG - Cross gradient

Table CR4.4.2.1-2b Simulated Drawdown at Private Wells From ISR Operations, Moore Ranch, Wyoming

| Permit # | Township | Qtrqtr | Uses | Well Depth (ft bgs) | Static Depth (ft bgs) | Estimated Completion Zone | Simulated Drawdown (ft) | | | Cross Reference to Figures* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | End Production | End Restoration Wellfield 1 | End Restoration Wellfield 2 | |
| P12244P | 42N74W Sec 28 | SESW | STO | 200 | 100 | 70 sd | 0.00 | 0.00 | 0.00 | A |
| P14660P | 42N75W Sec 28 | NESE | STO | 355 | 150 | 70 sd | 3.53 | 7.87 | 5.90 | B |
| P14683P | 42N74W Sec 30 | NWNW | STO | 275 | 175 | 68-70 sd | 0.08 | 0.68 | 1.08 | C |
| P14684P | 42N74W Sec 18 | SWSW | STO | 350 | 235 | 68-70 sd | 0.23 | 0.91 | 1.20 | D |
| P17301P | 41N74W Sec 4 | NESE | STO | 130 | 55 | 68 sd | 0.00 | 0.00 | 0.00 | E |
| P17302P | 41N74W Sec 4 | NESE | DOM, STO | 165 | 90 | 68 Sd? | 0.00 | 0.00 | 0.00 | F |
| P17304P | 41N74W Sec 4 | SENE | DOM, STO | 137 | 80 | 68 Sd? | 0.00 | 0.00 | 0.00 | G |
| P17305P | 41N74W Sec 7 | NENW | STO | 50 | 18 | 70-72 sd | 0.00 | 0.06 | 0.12 | H |
| P6972W | 42N74W Sec 33 | SWSE | STO | 210 | 95 | 60-68 sd | 0.00 | 0.01 | 0.01 | I |
| P6973W | 41N74W Sec 5 | SWNW | STO | 170 | 60 | 68 sd | 0.01 | 0.01 | 0.04 | J |
| P85802W | 42N74W Sec 17 | SENE | STO | 300 | 180 | 70-72 sd | 0.06 | 0.22 | 0.30 | K |

Estimates of completion zones with greatest uncertainty are indicated with a ?

Use categories include domestic, stock, industrial or miscellaneous

gpm - gallons per minute

ft bgs - feet below ground surface

* Cross reference to Figures CR4.4.2.1-1a, -1b, -1c and -1d

## Section 4.4.2.3.2 Wellfield Spills

While the ER discusses the measures that will be taken in an effort to minimize the potential for a wellfield spill or other unintended release, analysis of the potential impact of any such release on shallow groundwater quality has not been provided. An analysis of the potential impact of a release at the surface on shallow groundwater should be provided. This analysis should include considerations such as depth to the water table, the permeability of the materials in the unsaturated zone, the potential adsorption of constituents in unsaturated zone materials, and the volume of any potential releases.

*Response:*

An analysis is being prepared using an unsaturated flow model to evaluate travel times as well as potential impacts to the water quality of the water table aquifer. The model simulations are not complete at this time but will account for depth to the water table, permeability of the vadose zone materials, volume of the potential releases and water quality of the potential releases. The model simulations should be complete and submitted to NRC by August 31, 2009.

## ECOLOGY

### Question ER 3.5.5 No.1 Wetlands jurisdictional determination by Army Corp of Engineers

*RAI Question:*

Section 3.5.5 of the ER states that 35.29 acres of wetlands were found during the wetland survey. The wetlands are recommended to be non-jurisdictional; however, final determination lies with the U.S. Army Corps of Engineers. If applicable, provide documentation supporting the non-jurisdictional status of the wetlands (e.g., description of vegetation, soils, etc.). If any of these wetlands are determined to be jurisdictional, what mitigation methods will be applied?

*Answer:*

Moore Ranch Wetlands report was submitted to the ACOE in January 2008. In discussions with the ACOE as late as June 2009, the ACOE has not yet completed its review and jurisdictional determination. The ACOE made a request of EMC for additional information for which EMC submitted a response on August 17, 2009. The ACOE indicated after receipt of the data a jurisdictional determination could be issued within a month.

***Proposed Revisions to Permit Application***

Upon conformation of ACOE report review and jurisdictional determination, the formal documentation will be provided to NRC.

**Question ER 3.5.5 No. 2 Impact of Borings**

*RAI Question:*

Provide information on the impact of exploratory or delineation borings on local ecology.

*Additional clarification provided by NRC:*

The issue was not addressed in Section 4. There is only discussion of the total amount of surface disturbance, but no specific discussion of disturbance from exploratory borings. Please provide the approximate number of exploratory or delineation borings completed (or to be drilled) and the anticipated ecological impacts associated with this activity.

*Answer:*

As of June 17, 2009, EMC/Uranium One has drilled 40 completed wells and 686 exploratory/delineation holes within the proposed license area. Future drilling at Moore Ranch will include approximately 370 delineation/exploratory holes and approximately 900 wells.

EMC/Uranium One discussed these impacts with NRC on July 6, 2009. Impacts from drilling were considered as part of the ecology impacts during operations. EMC/Uranium One also provided background information on the drilling process for use by NRC in analyzing impacts. No changes to the Environmental Report are proposed in response to this question.

**Question ER 3.5.5 No.3 Power Line Mitigation**

*RAI Question:*

Will overhead power lines be constructed? If so, describe the mitigation measures to reduce impacts to raptors.

*Answer:*

Overhead power lines are planned for the Moore Ranch Project. Potential impacts to raptors would include electrocution hazards. Since this question involves a proposed mitigation measure, the response is included in Section 5.5.4 of the Environmental Report.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

*5.5.4 Raptors*

*Wildlife studies on the Moore Ranch Project will include annual raptor surveys. It is not anticipated that mining related activities will adversely affect a raptor nest, or disturb a nesting raptor as there is a lack of nesting raptors on and near the plant and wellfield areas due to the lack of trees and other nesting sites. Additionally, mining related activities are limited to relatively small areas for limited periods of time. According to surveys summarized in Section 3, eight raptor nests were observed within the proposed Moore Ranch License Area including 5 ferruginous hawks, 2 great horned owls, and one red-tailed hawk. Seventy five other nests were observed within one mile of the license area,*

*In accordance with WDEQ-LQD requirements, a raptor nest survey is conducted in late April or early May each year to identify any new nests and assess whether known nests are being utilized. The survey covers all areas of planned activity for the life of mine (i.e., wellfields and central plant facility) and a one mile area around the activity. Status and production at known nests will be determined, if possible. This survey program is primarily intended to protect against unforeseen conditions such as the construction of a new nest in an area where operations may take place.*

*No raptor nests were observed within one-half-mile of the proposed central plant facilities in the 2007 survey. As a result, it is very unlikely that any raptor nests will be disturbed in the future. In the very unlikely event that it is necessary to disturb a raptor nest, a mitigation plan and appropriate permit will be acquired* *from the U.S. Fish and Wildlife Service, Wyoming Field Office, in Cheyenne, Wyoming.*

*Overhead power lines can present an electrocution hazard to raptors. In order to mitigate this hazard, all new power lines will be constructed using designs that meet or exceed current APLIC (2006) recommendations, thus minimizing any risks of electrocution on those structures. Those designs include, but are not limited to:*

- *a minimum of 60 inches between parallel phase lines (energized wires) achieved using 10-foot cross arms or by lowering the cross arm to increase spacing from the center wire*
- *the use of perch deterrents where 60-inch spacing cannot be achieved and between lightening arrestors or other hardware that might result in electrocution;*
- *covered/insulated jumper lines;*
- *covered ground wires;*
- *bushing covers on transformers;*
- *insulation on other energized hardware on transformers, cross arms, etc.; and*
- *other appropriate equipment, as needed to minimize impacts to perched raptors.*

Additional References:

*Avian Power Line Interaction Committee (APLIC). 2006. Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, CA. 207pp.*

## Question 3.5.5 #4 – Protection of Wildlife from Mud Pits

*RAI Question:*

Describe mitigation measures to reduce impacts to wildlife in the vicinity of the mud pits, even if it is only during the construction phase.

*Answer:*

Uranium One currently provides protection for wildlife and livestock from mud pits by the installation of temporary fencing around mud pits. This practice will be continued throughout the course of the project for the protection of wildlife. Protection for livestock will not be necessary since the use of the wellfield areas as rangeland will be excluded during the construction, operations, and reclamation/decommissioning phases of the project. Drilling activities are considered in the operations impact portions of the Environmental Report since these activities occur during the initial construction and operations phase of the project. Since this question involves a proposed mitigation measure, the response is included in Section 5.5.2 of the Environmental Report.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

*5.5.2 Wildlife and Fisheries*

*The likelihood for the impacts resulting in injury or mortality for wildlife is greatest during the construction phase due to increased levels of traffic and physical disturbance during that period. Traffic will persist during production, but should occur at a reduced, and possibly more predictable level. Speed limits will be enforced during all construction and maintenance operations to reduce impacts to wildlife throughout the year, but particularly during the breeding season.*

*During the construction and operation phases of the project, open mud pits used for well drilling and maintenance activities could pose a hazard to wildlife. This potential impact will be mitigated by the use of temporary fencing around all open mud pits to protect wildlife from this hazard.*

## PUBLIC AND OCCUPATIONAL HEALTH

### TR and ER Comment Number 1, Byproduct Material Storage

*RAI Question:*

The descriptions of the facility design (TR Section 3), controls (TR Section 4), and operation (TR Section 5) are not well defined. Although there is a general process flow diagram (TR Figure 3.5-1, ER 2.2-5), facility layout drawings (TR 3.2-1 and -2, ER 2.3-1 and -2), and general descriptions of control measures, there are few details to actually evaluate the effectiveness of an integrated design and operation. Specifically, information on facility design and operational controls for radioactive waste collection, processing, and storage should be provided.

*Additional Clarification Provided by NRC:*

The focus on the RAI is for the handling and storage of radioactive waste. The information and facility diagrams provided do not include sufficient details on controls and storage for radioactive waste. No radioactive waste storage area was identified or discussed. A concern relates to the facility having adequately designed and sufficient storage capacity to handle waste generation and potential accumulation, considering the restricted waste disposal options.

*Answer:*

EMC will store a minimal amount of 11e.(2) byproduct material at the Moore Ranch project. Section 4.13.3.2 of the ER estimates that approximately 100 cubic yards of byproduct material will be produced each year and notes that the byproduct material will be stored inside the restricted area until such time that a full shipment can be made to a licensed disposal facility. Byproduct material will be collected and stored within the Central Processing Plant (CPP) in appropriate containers (e.g., 55-gallon drums with drum liners). When these containers are full, they will be closed and stored within the CPP or will be moved to a byproduct storage area and stored in a strong tight container as defined by DOT regulations. The strong tight containers will be capable of preventing the spread of contamination and contact with precipitation. EMC plans to use covered roll-off containers with an approximate capacity of 20 cubic yards. Larger items such as contaminated equipment that cannot be stored in a roll-off container will be stored in the CPP or covered/sealed in manner that will prevent the spread of contamination in the byproduct storage area.

In response to RAI Question 3.2 No. 3, EMC estimated approximately five shipments per year based on the planned use of 20 cubic yard roll-off containers. These roll-off containers will be used to provide storage of byproduct material as it is generated. Once a roll-off container is full, arrangements will be made for shipment of the byproduct material for disposal. The proposed disposal site is Pathfinder Mines Shirley Basin facility, located approximately 132 miles from Moore Ranch. Due to winter weather conditions in this part of Wyoming, EMC estimates that up to three 20 cubic yard roll-off containers will be necessary for storage of byproduct material awaiting disposal.

10 CFR §20.1301(a)(2) requires that a licensee conduct operations so that the dose in any unrestricted area from external sources does not exceed 2 millirem in any one hour. It is likely that the byproduct roll-off containers may occasionally contain material that could exceed this surface dose rate limit. In addition, source materials licenses typically contain a License Condition that requires that the licensee maintain an area within the restricted area boundary for storage of contaminated materials prior to disposal. In order to meet these requirements, EMC will construct a fenced restricted area with adequate storage space for three 20 cubic yard roll-off containers. The area will be locked and will be posted as a restricted area. EMC is currently completing final site layout designs for the Moore Ranch Central Processing Plant and support facilities and has not determined the final location for a byproduct storage facility. However, the final location will be based on the following considerations:

- Close proximity to the Central Processing Plant to allow observation of the byproduct storage facility by operating personnel;
- Convenience for moving byproduct material from the generation point(s) to the byproduct storage location; and
- Ready access for transport equipment to pick up loaded containers and position empty containers.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. A new Section 2.4.5 will be added to the Environmental Report. An identical new Section 3.3.5 will be added to the Technical Report.

*Proposed new Section 2.4.5 to Environmental Report:*

### *2.4.5 Byproduct Material Disposal*

*Byproduct material will be collected and stored within the Central Processing Plant (CPP) in appropriate containers (e.g., 55-gallon drums with drum liners). When these containers are full, they will be closed and stored within the CPP or will be moved to the byproduct storage area and stored in a strong tight container as defined by DOT regulations. The strong tight containers will be capable of preventing the spread of contamination and contact with precipitation. EMC plans to use covered roll-off containers with an approximate capacity of 20 cubic yards. Byproduct material will be collected and stored in roll off containers with an approximate capacity of 20 cubic yards. Once full, these containers will be shipped for disposal to a licensed disposal facility. During storage, the containers will be located within a restricted area. Access to the byproduct storage facility will be controlled through the use of security fencing, locked gates, and proper posting as a restricted area.*

*Larger items such as contaminated equipment that cannot be stored in a roll-off container will be stored in the CPP or covered/sealed in manner that will prevent the spread of contamination in the byproduct storage area.*

*Proposed new Section 3.3.5 to Technical Report:*

### ***3.3.5 Byproduct Material Disposal***

*Byproduct material will be collected and stored within the Central Processing Plant (CPP) in appropriate containers (e.g., 55-gallon drums with drum liners). When these containers are full, they will be closed and stored within the CPP or will be moved to the byproduct storage area and stored in a strong tight container as defined by DOT regulations. The strong tight containers will be capable of preventing the spread of contamination and contact with precipitation. EMC plans to use covered roll-off containers with an approximate capacity of 20 cubic yards. Byproduct material will be collected and stored in roll off containers with an approximate capacity of 20 cubic yards. Once full, these containers will be shipped for disposal to a licensed disposal facility. During storage, the containers will be located within a restricted area. Access to the byproduct storage facility will be controlled through the use of security fencing, locked gates, and proper posting as a restricted area.*

*Larger items such as contaminated equipment that cannot be stored in a roll-off container will be stored in the CPP or covered/sealed in manner that will prevent the spread of contamination in the byproduct storage area.*

**TR and ER Comment Number 2, Occupational Dose**

*RAI Question:*

There is no evaluation of the anticipated occupational doses (maximum individual and collective) as needed for demonstrating facility design and planned operation that is as low as is reasonably achievable (ALARA). Please provide this data.

*Answer:*

This question relates to public and occupational health impacts and is answered in RAI question 4.12 Number 2.

## Question 3.11.1 Background Exposure to Ionizing Radiation

*RAI Question:*

This section describes an elevated level of natural background radiation in Wyoming because of higher levels of cosmic radiation at higher altitudes and elevated uranium soil level. However, the subsequent evaluation for the site area background radiation is based on the average United States levels and not area-specific information reflecting the identified elevated levels. Provide additional information on the area-specific background radiation levels.

*Answer:*

Section 3.11.1 of the Environmental Report provided a short discussion of average exposures to background sources of ionizing radiation in the United States. Since the submittal of the original license application, revised estimates of total average exposures of the U.S. population to background radiation (both naturally occurring and manmade) have been published in NCRP Report Number 160 (NCRP, 2009). The average annual radiation dose for individuals has been increased from 360 mrem/yr to 620 mrem/yr, primarily due to a significant increase in the use of ionizing radiation for medical diagnostics and treatment.

Detailed site-specific data on naturally occurring sources of background radiation at the Moore Ranch site can be found in Section 2.9 of the Technical Report in the original license application. In response to this RAI question, Section 3.11.1 will be revised to include the new NCRP data as well as regional and site-specific estimates of natural background sources of radiation at the Moore Ranch site.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

*3.11.1 Background Exposure to Ionizing Radiation*

*Everyone is exposed to a certain level of background radiation from naturally occurring radioactive substances in the ground (terrestrial radiation), associated radon gas, radiation from outer space (cosmic radiation), and from naturally occurring radiation in our bodies. These natural radiation sources are commonly referred to as natural background radiation. The combined annual dose from natural background radiation (both external and internal) is thought to average about 3 millisievert [mSv], about 73% of which is due to indoor radon. In addition, people are exposed to manmade sources of radiation from medical procedures, consumer products, and occupational sources. Medical procedures are now estimated to contribute nearly as much dose to the average individual as that from all natural background sources combined.*

*Levels of natural background radiation can vary greatly from one location to the next. People residing in Wyoming are generally exposed to more natural background radiation because of higher levels of cosmic radiation at higher elevations and in some areas, higher levels of* *terrestrial radiation from soils enriched in naturally occurring radionuclides (uranium, thorium, and/or potassium-40). A map of estimated gamma radiation exposure rates from terrestrial sources across the United States is shown in Figure 3.11-1 (USGS, 1993). In general, the State of Wyoming has higher levels of soil radionuclides relative to many parts of the country, but the range of values varies across the State. Above average levels of naturally occurring uranium or thorium in the soil can result in a higher exposure to radon gas, depending on various factors such as the potential for migration into homes and buildings.*

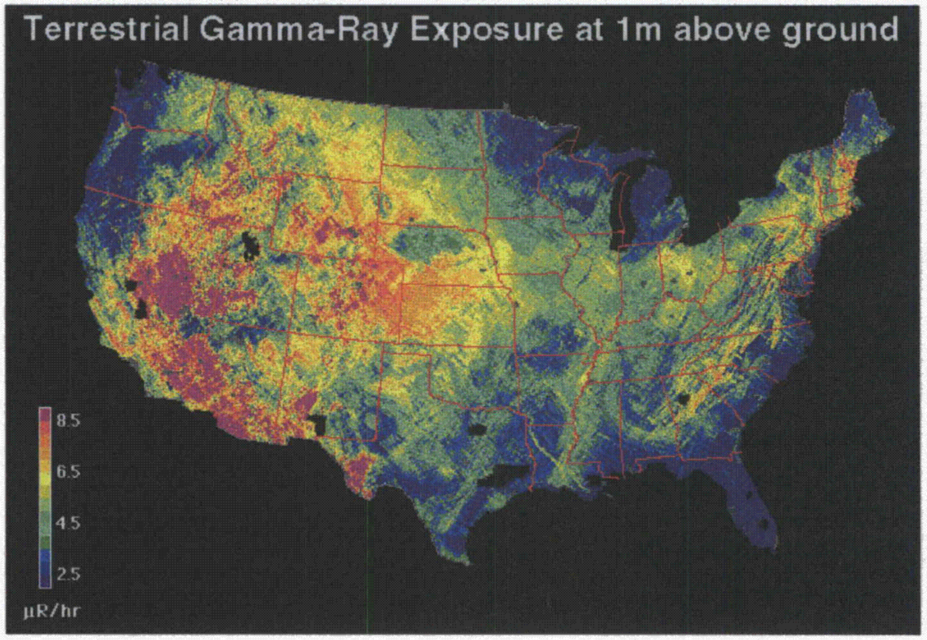


*Figure 3.11-1. Gamma exposure rates in microroentgen per hour (μR/hr) from terrestrial sources of background radiation (from NURE aerial surveys, USGS, 1993)*

*Estimates of total average exposures of the U.S. population to background radiation (both naturally occurring and manmade) have been published by the National Council on Radiation Protection and Measurements (NCRP). The latest estimates are found in NCRP Report Number 160 (NCRP, 2009). The average annual radiation dose for individuals has been increased to 620 mrem/yr (versus an estimate published in the 1980's of 360 mrem/yr), primarily due to a significant increase in the use of ionizing radiation for medical diagnostics and treatment. Shown in the Figure 3.11-2 are the average annual radiation doses received per capita in the United States from naturally occurring and manmade sources of radioactivity. The average total yearly dose per individual is now estimated to be 0.0062 Sv (i.e., 6.2 mSv or 620 mrem).*

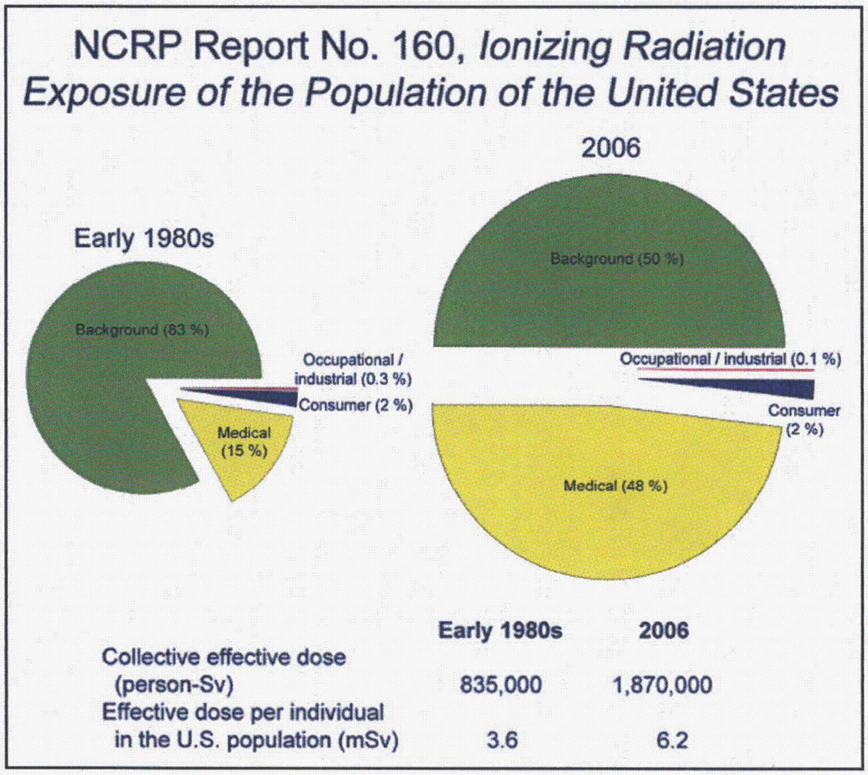


*Figure 3.11-2. Average radiation doses to the U.S. population (NCRP, 2009)*

*Background sources of radiation at the Moore Ranch site are extensively characterized in Section 2.9 of the Technical Report for the license application. Site-specific estimates of background sources of radiation at the Moore Ranch site are summarized in Table 3.11-1.*

*Table 3.11-1. Estimated average levels of naturally occurring sources of background radiation at the Moore Ranch site based on baseline monitoring data.*

| Natural Background Radiation Source | Mean value | Units |
|---|---|---|
| Uranium-238 in soil[1] | 1.5 | pCi/g |
| Thorium-232 in soil[1] | 1.3 | pCi/g |
| Potassium-40 in soil | 20.3 | pCi/g |
| Cosmic radiation[2] | 5.1 | µR/hr |
| Terrestrial gamma radiation[3] | 9.3 ± 0.9 | µR/hr |
| Mean total exposure rate[3] | 14.4 ± 0.9 | µR/hr |
| Average external dose rate[4] | 0.015 | mrem/hr |
| Average ambient radon[5] | 0.43 | pCi/L |

**Basis of Estimation**

[1]Equilibrium assumed across all decay products
[2]Based on elevation (Stone et al., 1998; NCRP, 1987)
[3]Based on gamma survey / soil radionuclide data (includes uncertainty between estimation methods)
[4]Based on environmental dosimeter data
[5]Based on radon monitoring data

*As discussed in Section 4.12.2, the maximum total effective dose equivalent (TEDE) calculated by MILDOS-AREA for the Moore Ranch project is 0.8 mrem/yr. This dose is located at the northwest property boundary and represents about a 0.1 percent increase over the annual* *average total radiation dose received by members of the general public in the United States. The corresponding percent increase in dose at this location relative to an annual baseline dose received by a hypothetical local resident may be slightly less due to higher than average natural background radiation in this region of Wyoming. Because of uncertainties associated with the many assumptions, potential sources and pathways required to model a realistic receptor scenario for baseline doses to a hypothetical local resident, and because there are no residents currently living in the immediate vicinity of the site, average annual baseline dose to a hypothetical local resident was not estimated. MILDOS modeling of potential operational releases resulted in an estimated TEDE of 0.7 mrem/yr for the nearest resident to the Moore Ranch facility, which is 0.7 percent of the regulatory dose limit to the general public from NRC-licensed operations of 100 mrem/yr.*

*Expressed another way, the maximum radiological effect of the Moore Ranch operation would be to increase the TEDE of the continental population by about 0.000045 percent.*

*REFERENCES*

*Stone, J.M.; Whicker, R.D. Ibrahim, S.A.; Whicker, F.W. 1999. Spatial Variations in Natural Background Radiation: Absorbed Dose Rates in Air in Colorado. Health Physics, Vol. 9(5), May, 1999.*

*NCRP (National Council on Radiation Protection and Measurements). 1987. Exposure of the Population in the United States and Canada from Natural Background Radiation. NCRP Report No. 94. NCRP, 7910 Woodmont Avenue, Bethesda, MD 20814.*

*NCRP (National Council on Radiation Protection and Measurements). 2009. Ionizing Radiation Exposure of the Population of the United States. Report No. 160. Bethesda, Maryland. http://www.ncrponline.org/PDFs/Elec_prepub_160.pdf*

*USGS (United States Geological Survey). 1993. NURE aerial gamma-ray data presented in United States Geological Survey Digital Data Series DDS-9, "National Geophysical Data Grids: Gamma-Ray, Magnetic, and Topographic Data for the Conterminous United States", by J.D. Phillips, J.S. Duval, and R.A. Ambrosiak, 1993. URL: http://energy.cr.usgs.gov/radon/DDS-9.html*

**Question ER 3.11.2 - Occupational Health and Safety**

*RAI Question:*

This section presents information on the incident rates of non-fatal occupational injuries and illnesses for Wyoming for 2005, including a reference to Addendum 3.11A. However, the evaluation presented in 3.11.2 is incomplete; it fails to provide an overall estimate of injury and illnesses for the facility operations. Provide information on the anticipated total hours worked by facility personnel as needed for a collective health and safety impact assessment.

*Clarification provided by NRC:*

The purpose for the request for total hours worked is for the purpose of comparing current environmental risks with those potential occupational injury rates for the working population as a measure of increased environmental risk. Including this information in Section 4.12.1.2 would be acceptable.

*Answer:*

EMC has obtained current (2007) nonfatal occupational injury and illness statistics for the mining industry in the State of Wyoming and will include these in a revision to Section 3.11.2 of the Environmental Report.

EMC has also estimated total site hours for employees and contractors and estimated the potential occupational injury rates for the Moore Ranch project. This information is included in a revision to Section 4.12.1.2 of the Environmental Report.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

*3.11.2 Occupational Health and Safety*

*Table 3.11-1 contains the incident rates of nonfatal occupational injuries and illnesses for the mining industry in the State of Wyoming for 2007. Incidence rates represent the number of injuries and/or illnesses per 100 full-time workers (10,000 full-time workers for illness rates) and were calculated using the following formula:*

Deleted: Addendum 3.11A
Deleted: by
Deleted: and case type
Deleted: 2005
Deleted: The incident rate is calculated

$\left(N/_{EH}\right) \times 200{,}000$ (20,000,000 for illness rates)

*Where:*

| | | |
|---|---|---|
| *N* | = | *number of injuries and illnesses* |
| *EH* | = | *total hours worked by all employees during a calendar year* |
| *200,000* | = | *base for 100 equivalent full-time workers* |
| *20,000,000* | = | *base for 10,000 equivalent full-time workers* |

*The incident rates for mining are contained under NAICS code 21 and include mining, and support activities for mining. ISR uranium mining would be included in metal/nonmetal mining.*

**Deleted:** *oil and gas extraction,*

**Table 3.11-1**
**Number and rate[1] of nonfatal occupational injuries and illnesses for the Mining Industry, Wyoming, 2007**

(Numbers in thousands)

| Characteristic | Mining (except oil and gas) (code 212) | |
|---|---|---|
| | Number | Rate |
| **Injuries and Illnesses** | | |
| Total cases | 0.3 | 2.7 |
| Cases with days away from work, job transfer, or restriction | 0.2 | 1.7 |
| Cases with days away from work | 0.1 | 1.2 |
| Cases with job transfer or restriction | 0.1 | 0.6 |
| Other recordable cases | 0.1 | 1.0 |
| **Injuries** | - | - |
| Total cases | 0.3 | 2.6 |
| **Illnesses** | - | - |
| Total cases | ( 1 ) | ( 1 ) |
| **Illness categories** | - | - |
| Skin disorders | ( 1 ) | ( 1 ) |
| Respiratory conditions | ( 1 ) | ( 1 ) |
| Poisoning | ( 1 ) | ( 1 ) |
| Hearing loss | ( 1 ) | ( 1 ) |
| All other illness cases | ( 1 ) | ( 1 ) |

*Source: State of Wyoming, Department of Employment, Number and rate of nonfatal occupational injuries and illnesses by 3-digit NAICS industry, Wyoming, 2007, http://doe.state.wy.us/lmi/OSH/OSH_07/3_digit_07.htm, accessed June 18, 2009.*

*Notes: 1 Data too small to be displayed*

*4.12.1.2 Occupational Health Impacts*

*Accidents involving human safety associated with the ISR uranium mining technology typically have far less severe consequences that accidents associated with underground and open pit mining methods. In-situ mining provides a higher level of safety for employees and neighboring communities when compared to conventional mining methods or other energy related industries. Accidents that may occur would generally be considered minor when compared to other industries. Radiological accidents that might occur would typically manifest themselves slowly and are therefore easily detected and mitigated. The remote location of the Moore Ranch facility and the low level of radioactivity associated with the process combine to decrease the potential hazard of an accident to the general public.*

*For the purposes of estimating the potential occupational injury and illness rates for the Moore Ranch project, EMC estimates that the total site work hours for EMC employees and contractors will be 142,000 hours per year. Using the 2007 Wyoming mining industry total nonfatal occupational injury and illness rate of 2.7 from Table 3.11-1, operations at Moore Ranch could potentially result in 1.9 nonfatal occupational injuries and illnesses per year of operation.*

## PUBLIC AND OCCUPATIONAL HEALTH IMPACTS

### Question ER 4.12. Question No. 1 – Air Monitoring Sensitivity and Public Doses (addresses NRC references to RAI 5-5 and Section 5.7.1)

*RAI Question:*

In response to NRC's Safety RAI 5-5, it has been proposed that monitoring of radioactive releases from the operation (well field and plant) will be accomplished through the use of Track-Etch radon detectors; monitoring of releases is not considered practicable. Provide an evaluation that demonstrates the proposed method provides adequate detection level for all potential releases, radon as well as particulate radioactive materials, sufficient for demonstrating compliance with the dose limits for members of the public.

*Answer:*

Both radon and air particulate monitoring data will continue to be conducted during site operations. The DAC values for U-nat, Ra-226, Pb-210, and Th-230 are many orders of magnitude greater than LLD values recommended in Regulatory Guide 4.14 for air particulates. The application will be updated to include an analysis showing that detection limits for these parameters can be achieved with the proposed air particulate monitoring method, and that the method is sensitive enough to measure potential doses to members of the public that are well below the annual 100 mrem/yr limit. A similar analysis will be included for radon track-etch detectors with respect the recommended radon detection limit indicated in Regulatory Guide 4.14.

Note that the question involves environmental monitoring methods. In order to follow the current organization of the application as specified in NUREG-1748, the proposed application changes will be made to Section 6.

*Proposed Revisions to License Application*

In response to RAI question number 6.1, Uranium One has prepared a new Section 6.2, Airborne Effluent and Environmental Monitoring Program. The proposed new text for the air particulate and radon portions of Section 6.2 is included here with the additional text to address this RAI question highlighted in red.

### *6.2 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAM*

<u>Air Particulate</u>

*Potential air particulate releases from the central plant processes will be monitored at the same air monitoring locations (MRA-1 through MRA-4) that were used for baseline* *determination of air particulate concentrations as described in Section 6.1. Sampling locations are shown on Figure 6.2-1. These locations were selected as recommended in Regulatory Guide 4.14, which calls for a minimum of three air monitoring stations at or near the site boundaries, one station at or close to the nearest occupiable structure with 10 km of the site, and one station at a control or background location. Monitoring will be performed using low volume air particulate samplers. Filters will be collected weekly to help prevent dust loading and will be composited on an approximate quarterly basis to provide respective estimates of average radionuclide concentrations and detection levels as specified in Regulatory Guide 4.14. Each quarterly batch of air filters from the four monitoring stations will be submitted to a contract laboratory for analysis of Ra-226, U-nat, Th-230, and Pb-210. Results of the operational air particulate monitoring program will be reported in the semi-annual effluent reports required by 10 CFR § 40.65.*

*The lower limit of detection (LLD) values for air particulate radionuclides as recommended in Regulatory Guide 4.14 (including U-nat, Ra-226, Pb 210, and Th-230) are readily achieved by the proposed air particulate monitoring method. These LLD values are many orders of magnitude smaller than respective derived air concentration (DAC) values. The DAC represents an air concentration for each radionuclide that is expected to result in an annual committed effective dose equivalent (CEDE) of 5 rem to an average occupationally exposed receptor. The DAC for each of these radionuclides was used to assess the total CEDE to a receptor, using hypothetical air concentrations equivalent to their respective LLD values (from Regulatory Guide 4.14), and assuming continuous exposure for 365 days (24 hours per day). The following equation was used for this assessment:*

$$\text{CEDE (mrem/yr)} = \sum_{i=1}^{n} \text{CEDE}_i = \left(\text{LLD Concentration}_i\right)\left(\frac{2.5\ \text{mrem/hr}}{\text{DAC}_i}\right)\left(8{,}760\ \text{hrs/yr}\right)$$

*Parameter values and the results of these calculations are shown in the following table. An approximate overall detection limit for total air particulate inhalation dose to a receptor that can be measured by these monitoring systems is equivalent to less than 1 mrem/yr. This represents about 1% of the annual limit to members of the general public, and demonstrates the adequacy of this method for monitoring potential public doses due operational releases.*

***Table 6.2-1Environmental Air Monitoring Dose Detection Limits***

| *Radionuclide* | *DAC (uCi/mL)* | *RG 4.14 LLD (uCi/mL* | *LLD Dose Mrem/yr)* |
|---|---|---|---|
| *U-nat ($UO_2$, $U_3O_8$)* | *1.00E-10* | *1.00E-16* | *2.19E-02* |
| *Ra-226* | *3.00E-10* | *1.00E-16* | *7.30E-03* |
| *Pb-210* | *3.00E-10* | *2.00E-15* | *1.46E-01* |
| *Th-230* | *3.00E-12* | *1.00E-16* | *7.30E-01* |

*Overall detection limit for CEDE (mrem/yr)=0.91*

*These air particulate monitoring systems have been operated during the current pre-operational phase at Moore Ranch to establish background concentrations of airborne particulate radionuclides prior to facility operation. Because the systems are designed to follow applicable regulatory guidance concerning LLD values for airborne particulate radionuclides, and because they are operated continuously with filter analyses performed quarterly by a qualified contract laboratory, their ability to demonstrate compliance with dose limits for members of the public is adequate.*

Radon

*Preoperational radon monitoring locations were selected prior to placement of air particulate monitoring stations and final selection of the central plant site. Air particulate station locations during preoperational monitoring were slightly different from "associated" radon monitoring stations due to logistical issues related to the availability of hard line electrical power for long-term site monitoring. Although some of the preoperational radon stations did not exactly coincide with air particulate station locations, in each case there was one or more radon station reasonably close to each air particulate station. Baseline Rn-222 results indicated a relatively minor degree of spatial variability in radon concentrations across the site.*

*Operational radon monitoring will be accomplished at the four air particulate stations as recommended in Regulatory Guide 4.14. The control/background air monitoring station will be represented by station number MRA-4 as shown in Fig. 6.2-1. This location is at least one mile west/southwest (i.e., upwind) of the plant location and wellfield areas.*

*Monitoring will be performed using Track-Etch radon cups. The cups will be exchanged on a semiannual basis in order to achieve the required lower limit of detection (LLD). In addition to the manufacturer's Quality Assurance program, EMC will expose one duplicate radon Track Etch cup per monitoring period. Track-etch integrating radon monitors are routinely used throughout the industry for similar purposes. Landauer Inc. reports the minimum level of detection for the RadTrack® track-etch device to be 30 pci/l-days, or 0.33 pCi/l when the detectors are emplaced for a period of one quarter, and analyzed under normal protocols at the Landauer laboratory. Special high-sensitivity analysis is available on request and can reduce this LLD to 0.06 pCi/L for a quarterly exposure period. The actual LLD that can be achieved is partially dependent on the exposure duration.*

*The LLD recommended by Regulatory Guide 4.14 for radon monitoring (0.2 pCi/L) will be met during site operations. As with the air particulate monitoring systems, this LLD for Track-Etch detectors can be quantitatively evaluated in terms of committed effective dose equivalent relative to the 100 mrem/yr dose limit for members of the public. The calculation is as follows:*

$$\text{CEDE (mrem/yr)} = \frac{0.2\ \text{pCi/L}\left(\dfrac{\text{WL}}{(100\ \text{pCi/L})}\right)(8760\ \text{hrs/yr})(0.7)(500\ \text{mrem/WLM})}{170\ \text{hrs/month}} = 36\ \text{mrem/yr}$$

*This calculation assumes a conservative occupancy factor of 1, an outdoor radon equilibrium ratio of 0.7 (NCRP Report 78, 1984), and a dose conversion factor of 500 mrem/WLM (ICRP 65, 1994). Thus, an approximate lower limit of detection for radon dose due to site operations that can be measured by the proposed track-etch monitoring system is about 36 mrem/yr, or about 36% of the annual limit to members of the general public. This level of sensitivity, along with that associated with the air particulate monitoring, indicates that the proposed air monitoring program for operations at Moore Ranch is sufficient to measure and demonstrate compliance with the 100 mrem/yr public dose limit.*

*In addition to the environmental monitoring, the release of radon from process operations will be estimated using the source term method described in Section 4.12.2 and will be reported in the semi-annual effluent reports required by 10 CFR § 40.65.*

Additional References:

*ICRP (International Commission on Radiological Protection). 1994. Protection against Radon-222 at home and at work. ICRP Publication 65. Annals of the ICRP, Volume 23/2.*

*NCRP (National Council on Radiation Protection and Measurements). 1984. Report No. 78, Recommendations of the National Council on Radiation Protection and Measurements, Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States. Bethesda, Maryland.*

## Section 4.12.2, Evaluation of Occupational Dose

*RAI Question 1:*

There is no evaluation of the anticipated occupational doses (maximum individual and collective) as needed for demonstrating facility design and planned operation that is as low as is reasonably achievable (ALARA). Please provide this data.

*RAI Question 2:*

An evaluation of the anticipated occupational dose to workers at the facility is required for assessing individual and collective impact, as well as ensuring a design and proposed operation for compliance with occupational dose limits, including the principle of ALARA. Provide an evaluation of the maximum individual and the collective occupational annual dose, including all applicable exposure sources such as radon, uranium inhalation, and direct exposure.

*Answer:*

These two NRC questions are very similar and will be addressed collectively in one response. The best way to estimate anticipated occupational doses is to examine actual worker dose data for existing ISR sites with similar process/plant designs and subject to similar environmental conditions. The proposed Moore Ranch ISR design is very similar to that of the nearby Smith Ranch Facility operated by Power Resources, Inc. in Converse County, Wyoming. Both sites are subject to similar environmental conditions and have very similar industrial designs. The application will be updated to include an assessment of the maximum credible individual and collective occupational doses that could be expected on average, based on published worker dose data for the Smith Ranch Facility. A number of modern engineered safety controls are planned for the Moore Ranch facility which is expected to further reduce the maximum potential for occupational doses. These controls will be discussed with respect to ALARA principles.

*Proposed Revisions to License Application*

Section 4.12.2, Radiological Impacts will be re-titled as "Public Radiological Impacts". A new Section, 4.12.3, Occupational Radiological Impacts, will be added to the Environmental Report. The following new text is proposed.

***Section 4.12.3 Occupational Radiological Impacts***

*The potential occupational doses for the Moore Ranch facility can be best estimated by comparison with doses actually reported for similar, operating facilities. The (operating) Smith Ranch Facility in Converse County, Wyoming is very similar to the planned design of the Moore Ranch Facility. Both plants employ the following elements to control worker exposure to ionizing radiation:*

- *The use of downflow pressurized ion exchange columns to limit the release of radon gas from the lixiviant;*

- *The use of vacuum dryers to minimize the potential release of dried yellowcake during packaging operation.*
- *The use of building ventilation systems to minimize airborne concentrations of radioactive materials during operations.*

*These sites are in close proximity to one another and both are subject to similar environmental conditions and are likely to involve similar industrial circumstances. Occupational dose data has been published for Smith Ranch in a site inspection report (NRC, 2009) and several ALARA audit reports (Rio Algom Mining Corporation, 2000, 2001, 2002). This published information was used to compile estimates of average maximum doses to workers at Smith Ranch for both external and predominant internal sources in the following table.*

***Table 4.12-7 Estimated Average Maximum Doses for Predominant Sources at Smith Ranch***

| *Year* | *External (mrem/yr)* | *Internal from U Inhalation* (mrem/yr)* | *Internal from Radon** (mrem/yr)* | *Max Internal (inhalation only) (mrem/yr)* | *External + Internal (mrem/yr)* | *Reported Max TEDE (Mrem/yr)* |
|---|---|---|---|---|---|---|
| *1999* | *205* | *57* | *63* | *120* | *325* | *301* |
| *2000* | *244* | *21* | *42* | *63* | *307* | *583* |
| *2001* | *878* | *58* | *21* | *79* | *957* | *1080* |
| *2008* | *431* | - | - | - | - | *538* |
| *Average* | *440* | *45* | *42* | *87* | *530* | *626* |

*Notes:* **Mean annual maximum based on reported DAC-Hours and 2.5 mrem/DAC-hr*
***Mean annual maximum based on reported WLM, and equilibrium ratio of 0.5, and 500 mrem/WLM (ICRP 65)*

*The resulting average values indicated in this table provide a reasonable estimate of expected doses to the maximally exposed worker at the Moore Ranch Facility. It is also reasonable to assume that average worker doses would be considerably less than these maximums as only a limited number of employees would be working consistently near primary source areas such as the ion exchange columns, satellite facilities, dryer area, or header house locations. Furthermore, the proposed Moore Ranch facility has been designed to take into account the ALARA principle, with increased ventilation air exchange rates, a vacuum dryer, and pressurized downflow ion exchange column design expected to significantly reduce radon concentrations in the plant.*

*Use of pressurized downflow ion exchange (IX) columns, and operating wellfields under pressure, will result in the majority of radon in the production fluids remaining in solution and not being released to the environment. It is estimated that only 10% of radon-222 in production fluids IX columns will be released to the atmosphere. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted outside the building. This venting will minimize employee exposures. Small amounts of radon-222 may be released via solution spills, filter changes, IX resin transfer, reverse osmosis (RO) system operation during groundwater restoration, and maintenance activities. These will be small radon gas releases, on an infrequent basis. The general* *exhaust system in the plant will have increased ventilation to further reduce employee exposure. Air in the central plant and other structures will be sampled for radon daughters to assure that concentration levels of radon and radon daughters are maintained as low as reasonably achievable (ALARA).*

*While no quantitative estimate can be made with regard to expected dose reduction associated with these ALARA-based design features, the annual Moore Ranch doses are not expected to exceed the doses reported for the Smith Ranch facility. Assuming that the average dose is approximately half of the average maximum dose (a conservative assumption given the limited number of employees that would routinely work in primary exposure areas) and that the plant will employ 40 workers, the collective occupational dose for Moore Ranch is expected to be 12.5 person-rem per year or less.*

Additional References:

*Rio Algom Mining Corporation, "Annual ALARA Review, Smith Ranch Facility", April 5, 2000.*

*Rio Algom Mining Corporation, "Year 2000 Annual ALARA Review, Smith Ranch Facility", March 30, 2001.*

*Rio Algom Mining Corporation, "Year 2001 Annual ALARA Review, Smith Ranch Facility", April 1, 2002.*

*U.S. Nuclear Regulatory Commission, "NRC Inspection Report 040-08964/09-001", April 17, 2009.*

**Question ER 4.12.2 Question No. 4 - Public and Occupational Health Impacts**

*RAI Question:*

ER Section 4.12.2.4, Potential Radiological Accidents, includes a general discussion for the potential accident of a yellowcake thickener with a correlation to the results as presented in NUREG/CR-6733 for consequences. As evaluated in NUREG/CR-6733, this accident poses a potential dose to an unprotected worker in excess of the 10 CFR 20 annual occupational dose limit of 5 rem. The discussion in the ER identified what was considered an unrealistic assumption for this dose analysis (i.e., no timely mitigation measures), but no additional analysis is provided to show how the applicant intends to prevent such consequences. Provide additional information (assumptions and/or protective measures) applicable to ensuring that doses from this potential accident remain small (i.e., below the occupational dose limits).

*Answer:*

The single incident of a thickener failure and spill discussed in NUREG/CR-6733 was due to the installation of a thickener in an existing facility in an area where the cement pad was not designed for the weight load. NUREG/CR-6733 noted that "*This scenario makes the unrealistic assumption that no efforts will be made to clean up the spill*". NUREG/CR-6733 also noted that "*If proper remedial action is taken, it is reasonable to assume that much smaller doses would be incurred by offsite receptors. Proper remedial action would contain and recover the spilled U308 before it was transported offsite by the wind. It is also reasonable to assume that cleanup personnel would be outfitted with protective equipment*".

In Section 5.12.2.2 of the ER ("Radiological Impacts from Accidents"), EMC provides the proposed mitigation measures for radiological accidents. In that section, it is stated that "*EMC will prepare spill response procedures, provide spill response equipment and materials, require the use of protective equipment, and will train employees in proper spill response methods*". In addition, Section 5 of the Technical Report provides an extensive discussion of the following radiological protection procedures:

- Radiation Safety Training including training on emergency procedures (TR Section 5.5);
- Spill contingency plans (TR Section 5.7.1.3);
- Airborne uranium particulate monitoring (TR Section 5.7.3.1);
- Respiratory protection program (TR Section 5.7.3.3);
- Bioassay program (5.7.5);

In response to this RAI request, a reference to the mitigation measures in Section 5.12.2.2 of the ER will be added to the revised section 4.12.2.4 of this Environmental Report. In addition, a reference to Section 5 of the TR will be added to Section 5.12.2.2 of the ER.

*Proposed Revisions to License Application*

The following changes are proposed to Section 4.12.2.4 of the ER in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

*4.12.2.4 Potential Radiological Accidents*

*The following sections discuss potential accident scenarios that could have radiological impacts. Mitigation measures to reduce or eliminate these impacts are discussed in Section 5.12.2.*

*4.12.2.4.1 Tank Failure*

*A spill of the materials contained in the process tanks at the Moore Ranch Project will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the central plant. The tanks at Moore Ranch will contain injection and production solutions, ion exchange resin, pregnant eluant, yellowcake, and liquid waste. All tanks will be constructed of fiberglass or steel with the exception of the hydrogen peroxide storage tank, which will typically be constructed of aluminum. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary.*

*NUREG/CR-6733 analyzed the potential impacts of a failure of a yellowcake thickener resulting in a release of 20% of the contents outside the plant structure. This postulated accident scenario was based on an event at the Irigaray ISR facility in 1994. The event in question was caused by the failure of an inadequate concrete pad supporting the thickener. The subsequent release from the building was a result of the proximity of the thickener to the plant wall. NUREG/CR-6733 concluded that, based on conservative calculations of this unlikely event, the dose to the public would be below the limits in 10 CFR Part 20. The calculations resulted in a dose to an unprotected worker in excess of the exposure limits from 10 CFR Part 20 (i.e., 5 rem). However, this dose estimate was based on a number of unlikely, conservative assumptions. The scenario made the unrealistic assumption that no efforts would be made to clean up the spill, allowing the yellowcake to dry and become transportable. The dose was based on lung clearance class Y uranium, which produces the highest dose estimates. No allowance in the dose calculation was made for the use of protective equipment, including protection factors from the use of respiratory protection equipment.*

*Section 5.12.2.2 discusses mitigation measures that EMC will implement to mitigate the potential impacts radiological accidents. These mitigation measures include the preparation of spill response procedures, provisions for spill response* *equipment and materials, the use of protective equipment, and employees training in proper spill response methods.*

The following changes are proposed to Section 5.12.2.2 of the ER in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

*5.12.2.2 Radiological Impacts from Accidents*

*The Moore Ranch Central Plant will be designed in accordance with standard industry building codes and will incorporate containment adequate to contain the contents of the largest tank in the facility at a minimum. The central plant building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, and/or double-walled tanks will perform a similar function for any process chemical vessels located outside the central plant building.*

*As discussed in Section 2, area ventilation will be provided to control concentrations of airborne radioactive material in the central plant.*

*All piping from the plant, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.*

*Each wellfield will have a number of headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures (e.g., failed fusion weld). EMC will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service.*

*EMC will prepare spill response procedures, provide spill response equipment and materials, require the use of protective equipment, and will train employees in proper spill response methods. A detailed discussion of these radiological protection measures is contained in Section 5.0 of the License Application Technical Report (TR). These measures include the following:*

- *Radiation Safety Training including training on emergency procedures (TR Section 5.5);*

- *Spill contingency plans (TR Section 5.7.1.3);*
- *Airborne uranium particulate monitoring (TR Section 5.7.3.1);*
- *Respiratory protection program (TR Section 5.7.3.3);and*
- *Bioassay program (5.7.5);*

## Question ER 4.12.2 Question No. 5 – Equation Correction

*RAI Question:*

ER Section 4.12.2, Equation 4 under Definitions, has a conversion factor as 3.65E-12, where the correct factor as shown in the equation is 3.65E-10. Provide a corrected value in the definitions.

*Answer:*

A correction is provided.

*Proposed Revisions to License Application*

The following changes are proposed to Section 4.12.2 of the ER in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

Resin Transfer Releases

*Radon-222 releases resulting from resin transfers from neighboring satellite facilities were estimated using methods described in NUREG-1569 as follows:*

$$Rn_x = 3.65x10^{-10} F_i C_{Rn} \quad \text{(Equation 4)}$$

*Where:*

| | | |
|---|---|---|
| $Rn_x$ | = | *Radon release rate from resin transfers (Ci yr$^{-1}$)* |
| $F_i$ | = | *water discharge rate from resin unloading (L d$^{-1}$)* |
| $C_{Rn}$ | = | *Steady state radon-222 concentration in process water (pCi L$^{-1}$)* |
| $3.65x10^{-10}$ | = | *unit conversion factor (Ci pCi$^{-1}$)(d yr$^{-1}$)* |

Deleted: 2

**Question ER 4.12.1.2 No. 3 – Correlation with NUREG/CR-6733**

*RAI Question:*

ER Section 4.12.1.2, Occupational Health Impacts, states, "The proposed Moore Ranch facilities are consistent with the operating assumptions, site features, and designs examined in the NRC analysis in NUREG/CR-6733." This correlation serves as the basis for the evaluation of occupational health impacts, including accidents. However, specific details/bases are not presented for establishing the validity of the correlation. Provide additional information that compares the Moore Ranch processing designs (processing volumes, inventories and waste projections) with those assumed in NUREG/CR-6733, where this information is needed for substantiating this correlation.

*Answer:*

EMC has performed analysis for occupational health impacts from chemical risks at the Moore Ranch facilities. Based on the current design for the facility, there are several changes noted from the original application. First, EMC has determined that anhydrous ammonia will not be used for pH control and that sodium hydroxide will be used for this purpose. Second, the acid system design is based on the use of sulfuric or hydrochloric acid. Therefore, the application will be revised to reflect these changes.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Please note that a draft revision of the Environmental Report has been prepared that contains revisions that correspond to changes made in the Technical Report in response to an RAI issued by NRC in June 2008. These revisions included substantial changes to the information presented in section 4.12.1.2. To aid in NRC review of the proposed revisions to the Environmental Report, the changes that will be made to reflect the RAI responses for the Technical Report are shown in italics. Changes to the Environmental Report in response to this RAI question are noted in red-line/strikeout method.

4.12.1.2 Occupational Health Impacts

Accidents involving human safety associated with the ISR uranium mining technology typically have far less severe consequences that accidents associated with underground and open pit mining methods. In-situ mining provides a higher level of safety for employees and neighboring communities when compared to conventional mining methods or other energy related industries. Accidents that may occur would generally be considered minor when compared to other industries. Radiological accidents that might occur would typically manifest themselves slowly and are therefore easily detected and mitigated. The remote location of the Moore Ranch facility and the low level of radioactivity associated with the process combine to decrease the potential hazard of an accident to the general public.

NRC has previously evaluated the effects of accidents at conventional uranium milling facilities in NUREG–0706 and specifically at ISR uranium facilities in NUREG/CR-6733. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The proposed Moore Ranch facilities are consistent with the operating assumptions, site features, and designs examined in the NRC analyses in NUREG/CR-6733.

NUREG-0706 considered the environmental effects of accidents at single and multiple uranium milling facilities. Analyses were performed on incidents involving radioactivity and classified these incidents as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 are applicable to ISR facilities, such as transportation accidents. NUREG/CR-6733 specifically addressed risks at ISR facilities and identified the "risk insights" that are discussed in the following sections.

4.12.1.2.1 Chemical Risk

NUREG/CR-6733 noted that the scope of the NRC mission includes hazardous chemicals to the extent that mishaps with these chemicals could affect releases of radioactive materials. Industrial safety aspects associated with the use of hazardous chemicals at Moore Ranch is regulated by the *Wyoming Occupational Safety and Health Administration (OSHA).*

**Sulfuric Acid**

Sulfuric acid may be used to split the uranyl carbonate complex from rich eluate into carbon dioxide gas and uranyl ions in preparation for precipitation using hydrogen peroxide. A 93 percent sulfuric acid solution will be stored outdoors and outside the processing plant in a cross-linked high-density polyethylene flat bottom tank. The tank will be founded in a concrete secondary containment system that is sized to hold 100% of the tank's volume plus a 25-year precipitation episode for 24 hours. The surface of the concrete containment area will be treated with an appropriate coating that could include

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but not be limited to an acid proof epoxy coating. No other chemicals will be stored in the sulfuric acid secondary containment area. A vent pipe will be fitted to the storage tank and will route vapors to a water bath or circulating water system. Here, acid vapors quickly react with the water to form a dilute sulfuric acid solution. The solution will then be treated with an appropriate base such as soda ash to neutralize the dilute acid solution. Alternately, the vent pipe will be fitted with a demister system to mitigate any acid vapors from releasing to the atmosphere.

In the presence of 93 percent sulfuric acid, the interior of carbon steel pipe will initially corrode to form a thin film of iron sulfate on the surface of the metal. Once formed, the iron sulfate film prevents further corrosion of the underlying material. For this reason, Schedule 80 black steel pipe with forged welding fittings will be used to transport the acid from the storage tank to the elution tanks or other points of application. Proper valving will be installed at the tank exit, both sides of the redundant pumps, and a re-routing piping arrangement down stream from the pumps will be installed to purge the exit lines to the pregnant eluant tanks and return any residual acid in the lines to the outdoor storage tank. A programmable logic control system integrated to the plant automation system will control the pump starts, flow rates, and time as it relates to volume needed. Standard operating procedures (SOPs) will be developed and operators will be trained on using these systems, both automated and manual.

NUREG\CR-6733 does not specify the size of the sulfuric acid storage tank but considers the use of a smaller 450 gallon day tank located within the plant building. EMC does not plan to use a day tank in order to mitigate this potential source for leaks and spills of sulfuric acid. The concentration of sulfuric acid fumes that are immediately dangerous to life and health (IDLH) is 15 mg/m3. In the risk analysis from NUREG/CR-6733, a spill of 93 percent sulfuric acid was not deemed a significant inhalation hazard to workers as long as normal air dilution is available from the facility ventilation system. If the ventilation system for the Moore Ranch CPP were not operational at the time of a sulfuric acid spill, workers would be required to exit the building. This scenario is unlikely since the ventilation system design includes redundant ventilation blowers to ensure adequate ventilation at all times for the control of chemical and radioactive fumes and gases. NUREG/CR-6733 also noted that sulfuric acid reacts vigorously with sodium carbonate and water, both of which will be present at Moore Ranch.

The use of sulfuric acid is subject to Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 1,000 pounds. The Moore Ranch design includes a sulfuric acid tank with a capacity of 12,000 gallons. Based on the design capacity, EMC will be subject to the Emergency Response Plan requirements.

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*Accident Prevention*

*Prevention methods utilized to minimize potential impacts to human health and the environment from a release of sulfuric acid include the following:*

- *To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, the sulfuric acid storage tank will be located separately from other process tanks.*

- *Construction of all storage tanks, piping, and associated appurtenances will be in accordance with current industry standards.*

- *The acid tank will be enclosed and will employ a vapor control system on the tank vent, limiting the amount of vapors that can escape to the atmosphere.*

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- *Daily shift inspections of plant and chemical storage facilities are conducted for early detection of potential deficiencies.*

- *Containment will be provided for 100 % of the total storage capacity plus a 25-year precipitation episode for 24 hours. Containment will be constructed of chemically compatible materials.*

- *Typically, a Concentrated Acid Work Permit will be required for maintenance work on tanks, pipes, or equipment that contains or may contain concentrated acid or to the use of concentrated acid to prepare decontamination or cleaning solutions as required by site industrial safety procedures.*

- *Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.*

*Mitigation/Accident Response*

*Upon detection of a release of sulfuric acid, steps will be taken to stop or limit the extent of the release that can be performed without endangering the health of the responders. EMC will develop emergency response procedures for an accidental release of sulfuric acid and employees will be trained on those procedures. Emergency response procedures will include instructions in the following:*

- *Immediate notifications*
- *Evacuation procedures*
- *Perimeter establishment*
- *Personal Protective Equipment requirements*
- *Site mitigation, neutralization, and cleanup*
- *Reporting*

As a minimum, an acid-rated respirator, face shield, overall or apron and gloves will be required during the cleanup of any acid spill. Additionally, eye wash stations as well as deluge type emergency showers will be located in close proximity to any areas where will be used.

**Hydrochloric Acid**

As an alternative to sulfuric acid discussed in the previous section, hydrochloric acid may be used to split the uranyl carbonate complex from rich eluate into carbon dioxide gas and uranyl ions in preparation for precipitation using hydrogen peroxide. A 35 percent hydrochloric acid solution will be stored outdoors and outside the processing plant in a cross-linked high-density polyethylene flat bottom tank. The tank will be founded in a concrete secondary containment system that is sized to hold 100% of the tank's volume plus a 25-year precipitation episode for 24 hours. The surface of the concrete containment area will be treated with an appropriate coating that could include but not be limited to an acid proof epoxy coating. No other chemicals will be stored in the hydrochloric acid secondary containment area. A vent pipe will be fitted to the storage tank and will route vapors to a water bath or circulating water system. Here, acid vapors quickly react with the water to form a dilute sulfuric acid solution. The solution will then be treated with an appropriate base such as soda ash to neutralize the dilute acid solution. Alternately, the vent pipe will be fitted with a demister system to mitigate any acid vapors from releasing to the atmosphere.

CPVC (chlorinated PVC) schedule 80 piping with Latharge Viton or EDPM gaskets will be used to transport the hydrochloric acid from the storage tank to the elution tanks or other points of application. Proper valving will be installed at the tank exit, both sides of the redundant pumps, and a re-routing piping arrangement down stream from the pumps will be installed to purge the exit lines to the pregnant eluant tanks and return any residual acid in the lines to the outdoor storage tank. A programmable logic control system integrated to the plant automation system will control the pump starts, flow rates, and time as it relates to volume needed. Standard operating procedures (SOPs) will be developed and operators will be trained on using these systems, both automated and manual.

Hazard Analysis Calculations:

NUREG\CR-6733 does not specify the size of the hydrochloric acid storage tank. EMC performed an analysis of the potential air concentrations of hydrochloric acid fumes using a scenario similar to that considered in NUREG\CR-6733 and applying the following specific characteristics of the Moore Ranch design:

- Flow rate of 35 percent HCl to the process = 11.355 L/min (3 gpm)
- Volume of the process building = (200 x 140 x 24) $ft^3$ = 672,000 $ft^3$ = (672,000 x 0.02831) = 19,024 $m^3$.
- Process building HVAC system is designed for 3 air changes per hour.

Similar to NUREG\CR-6733, a leak in the piping system of 150 ml/min (0.04 gpm) which goes undetected for 30 min was assumed.

Volume of leak = (0.04 x 30) L = 4.5 L (1.19 gal.)

Mass of leak = 4.5 L x 1.1493 kg/L = 5.2 kg (5.2 x $10^6$ mg)

Mass of HC1 in leaked solution = (5.2 x $10^6$) x 0.35 = (1.82 x $10^6$) mg in 30 min

In 30 minutes the building HVAC system will have performed 1.5 air change volumes of the process building = 28,536 $m^3$

Volume of air in which the leaked HCl can volatilize = (1 + 1.5) x 19,024 $m^3$ = 47,560 $m^3$

Concentration of HC1 vapor in process building = (1.82 x $10^6$) mg/47,560 $m^3$ = 38.3 mg/$m^3$

IDLH for HCl vapor = 50 ppm = (50 x 1.52) mg/m3 = 76 mg/m3

This analysis illustrates that an HCl piping system leak at the Moore Ranch facility would have the potential to result in localized vapor concentrations of about half the IDLH value within approximately 30 min.

The use of hydrochloric acid is subject to Reporting Quantities (RQs) contained in 40 CFR Part 302.4 for quantities in excess of 5,000 pounds. Based on the design capacity, EMC will be subject to the Reporting Quantities.

*Accident Prevention*

*Prevention methods utilized to minimize potential impacts to human health and the environment from a release of sulfuric acid include the following:*

- *To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, the hydrochloric acid storage tank will be located separately from other process tanks.*
- *Construction of all storage tanks, piping, and associated appurtenances will be in accordance with current industry standards.*
- *The acid tank will be enclosed and will employ a vapor control system on the tank vent, limiting the amount of vapors that can escape to the atmosphere.*
- *Daily shift inspections of plant and chemical storage facilities are conducted for early detection of potential deficiencies.*
- *Containment will be provided for 100 % of the total storage capacity plus a 25-year precipitation episode for 24 hours. Containment will be constructed of chemically compatible materials.*

- *Typically, a Concentrated Acid Work Permit will be required for maintenance work on tanks, pipes, or equipment that contains or may contain concentrated acid or to the use of concentrated acid to prepare decontamination or cleaning solutions as required by site industrial safety procedures.*

- *Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.*

*Mitigation/Accident Response*

*Upon detection of a release of hydrochloric acid, steps will be taken to stop or limit the extent of the release that can be performed without endangering the health of the responders. EMC will develop emergency response procedures for an accidental release of sulfuric acid and employees will be trained on those procedures. Emergency response procedures will include instructions in the following:*

- *Immediate notifications*
- *Evacuation procedures*
- *Perimeter establishment*
- *Personal Protective Equipment requirements*
- *Site mitigation, neutralization, and cleanup*
- *Reporting*

As a minimum, an acid-rated respirator, face shield, overall or apron and gloves will be required during the cleanup of any acid spill. Additionally, eye wash stations as well as deluge type emergency showers will be located in close proximity to any areas where will be used.

**Sodium Hydroxide**

Sodium hydroxide is used for pH adjustment during the precipitation process. The sodium hydroxide will be stored in a tank located in the processing plant for use in the precipitation circuit. The 50% sodium hydroxide solution will be stored in an 11,844 gallon fiberglass tank with a vent pipe routed through the roof to the atmosphere outside and above the CPP. A concrete containment berm will be constructed within the plant to contain spills to the immediate area. The berm will be constructed to a height of 6 inches. The sodium hydroxide will be transported using conventional PVC piping from the fiberglass storage vessel into the CPP precipitation tanks. Sodium hydroxide reacts vigorously with sulfuric and hydrochloric acid, one of which will also be present in the precipitation circuit.

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**Deleted:** Ammonia in the liquid form is not the primary hazard. The liquid will evaporate to a gaseous state. The IDLH concentration of ammonia is 300 parts per million (ppm). NUREG/CR-6733 identified an ammonia leak as a significant risk factor within a plant structure because ventilation rates adequate to dilute ammonia fumes in a localized area to maintain concentrations below the IDLH in the event of a leak would not be feasible. An additional hazard associated with ammonia is that it

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Hazard Analysis Calculation:

NUREG\CR-6733 only considered the use of sodium hydroxide for pH control during radium removal from the barren lixiviant bleed stream using a conventional barium/radium sulfate co-precipitation process. 55-gallon drum were assumed for storage. NUREG\CR-6733 did not consider the use of bulk sodium hydroxide for pH control during precipitation, which is curious since this application is common at operating facilities. EMC has performed a hazard analysis similar to the spill scenario contained in NUREG\CR-6733 using specific design data for the Moore Ranch CPP. NUREG\CR-6733 noted that sodium hydroxide is not volatile and that a spill of 50-percent sodium hydroxide solution would not pose a significant inhalation hazard to workers.

The use of sodium hydroxide is subject to the following regulatory program:

- Reportable Quantities (RQs) for spills from the Comprehensive Environmental, Response, Compensation and Liability Act (CERCLA) in 40 CFR § 302.4 for spills in excess of 1,000 pounds.

As discussed, the Moore Ranch design includes a sodium hydroxide tank with a capacity of 11,844 gallons. Based on this design capacity, EMC will be subject to all of the aforementioned regulatory programs.

**Hydrogen Peroxide**

Hydrogen peroxide will be used in the precipitation phase at Moore Ranch. A 50-percent solution of hydrogen peroxide will be added to the acidified uranium-rich eluant to form an insoluble uranyl peroxide compound. Hydrogen peroxide is a strong oxidizer and is a reactive, easily decomposable compound. Its hazardous decomposition products include oxygen and hydrogen gas, heat, and steam. Decomposition can be caused by mechanical shock, incompatible materials including alkalies, light, ignition sources, excess heat, combustible materials, strong oxidants, rust, dust, and a pH above 4.0. When sealed in strong containers, the decomposition of hydrogen peroxide can cause excessive pressure to build up which may then cause the container to burst explosively.

A 50% solution of hydrogen peroxide will be stored in a horizontal aluminum pressure vessel tank with a pressure actuated relief valve installed in the vent pipe for safety. The storage tank will be located outdoors and outside the main plant. Upon relief, the vapors dissociate to water and oxygen, therefore no vapor scrubbing system is required. A containment berm will be constructed meeting 40 CFR §264.193 for spill mitigation. Hydrogen peroxide will be transported using PVC piping from the exterior storage vessel into the main plant to the precipitation tanks. Proper valves will be installed at the tank exit and both sides of the redundant pumps. A programmable logic control system integrated to the plant automation system will control the pump starts, flow rates, and time as it relates to volume needed. Standard operating procedures (SOP's) will be developed and operators will be trained on using these systems, both automated and

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<#>Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 500 pounds; and¶

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**Deleted:** **In addition to the listed regulatory programs, the Process Safety Management (PSM) of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119 applies to anhydrous ammonia for TQs in excess of 10,000 pounds. In the State of Wyoming, industrial safety at ISR mines is regulated by OSHA, so the PSM standard applies. Therefore, EMC will apply OSHA's PSM standard during the development of the ammonia system design and operating procedures.¶**
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manual. Eye wash stations as well as deluge type emergency showers will be located in close proximity to the areas where hydrogen peroxide is used.

Hazard Analysis Calculations:

NUREG\CR-6733 does not specify the size of the hydrogen peroxide storage tank, simply stating that it is typically a large tank located outdoors. EMC performed an analysis of the potential air concentrations of hydrogen peroxide using a scenario similar to that considered in NUREG\CR-6733 and applying the following specific characteristics of the Moore Ranch design:

- Flowrate of 50-percent $H_2O_2$ solution = 1.14 Lpm (0.3 gpm)
- Volume of the process building = (200 x 140 x 24) $ft^3$ = 672,000 $ft^3$ = (672,000 x 0.02831) = 19,024 $m^3$.
- Process building HVAC system is designed for 3 air changes per hour.

Similar to NUREG\CR-6733, a leak in the piping system of 0.38 LPM (0.1 gpm) which goes undetected for 10 min was assumed.

Volume of leak = (0.1 gpm x 3.7854 L/gal. x 10) = 3.7854 L.

Mass of leak = (3.7854 L x 1.1 kg/L) kg = (4.063 x $10^6$) mg.

Mass of $H_20_2$ in leaked solution = (4.063 x $10^6$)/2 = (2.032 x $10^6$) mg.

In 10 min., the building HVAC system will have performed (3 x 10/60) air changes = 0.5 air changes.

Volume of the process building = 19,024 $m^3$.

Volume of air in which the leaked $H_20_2$ can volatilize = (1 + 0.5) x 19,024 $m^3$ = 28,536 $m^3$.

Concentration of $H_20_2$ vapor in process building = (2.032 x $10^6$ mg)/28,536 $m^3$ = 71.2 mg/$m^3$ or 99.7 ppm.

IDLH for $H_20_2$ vapor = 75 ppm = (75 x 1.4) mg/m3 = 105 mg/m3.

As noted in NUREG/CR-6733, a hydrogen peroxide piping system leak in a process building has the potential to result in localized vapor concentrations in excess of the IDLH value of 75 ppm within several minutes. A leak in a confined space has the potential to generate lethal concentrations of vapor at an even faster rate. EMC will incorporate recommendations concerning materials of construction for tanks and piping systems and the use of local ventilation with explosion-proof fans to control vapors in the event of a leak of hydrogen peroxide. The building HVAC system is designed for 3 air changes per hour with the capacity to expand to 6 air exchanges per hour. In addition, local exhaust fans will be installed along the outer plant wall to sweep vapors and gases near the floor level.

The use of hydrogen peroxide at concentrations greater than 52 percent is subject to the following regulatory programs:

- Process Safety Management of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119 for TQs in excess of 7,500 pounds; and
- Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 1,000 pounds.

As discussed in Section 2, the Moore Ranch design includes the use of hydrogen peroxide at a concentration of 50 percent contained in a hydrogen peroxide tank with a capacity of 10,000 gallons. With the design hydrogen peroxide concentration and capacity, EMC will not be subject to the aforementioned regulatory programs.

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*Accident Prevention*

*Prevention methods utilized to minimize potential impacts to human health and the environment from a release of hydrogen peroxide include the following:*

- *To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, the hydrogen peroxide storage tank will be located separately from other process tanks.*

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- *Construction of all storage tanks, piping, and associated appurtenances will be in accordance with current industry standards.*

- *The hydrogen peroxide tank will be enclosed, limiting the amount of vapors that can escape to the atmosphere.*

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- *Daily shift inspections of plant and chemical storage facilities are conducted for early detection of potential deficiencies.*

- *A containment will be constructed meeting 40 CFR §264.193 for spill mitigation and will be constructed of chemically compatible materials.*

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- *Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.*

*Mitigation/Accident Response*

*Upon detection of a release of hydrogen peroxide, steps will be taken to stop or limit the extent of the release that can be performed without endangering the health of the* *responders. EMC will develop emergency response procedures for an accidental release of hydrogen peroxide and employees will be trained on those procedures. Emergency response procedures will include instructions in the following:*

- *Immediate notifications*
- *Evacuation procedures*
- *Perimeter establishment*
- *Personal Protective Equipment requirements*
- *Site mitigation, neutralization, and cleanup*
- *Reporting*

Oxygen

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. The oxygen will be delivered to Moore Ranch by truck and stored on site under pressure in a cryogenic tank in liquid form. The oxygen will be allowed to evaporate and will be added to the barren lixiviant upstream of the injection manifold.

The oxygen storage system will consist of 30-ton bulk liquid oxygen pressure vessel(s) at each wellfield. The tanks will be supplied and maintained by the liquid oxygen supplier. All oxygen deliveries and tank fillings are performed by the tank supplier. Gaseous oxygen, formed by the air heated evaporators, is then routed via low carbon steel piping that has been properly degreased from the bulk storage tank to individual header houses. After entering the header house the oxygen supply line is routed into the barren lixiviant using a single injection port and mixed with the lixiviant along a common manifold. Oxygen saturated lixiviant is metered from the common manifold and routed to the individual injection wells. Oxygen saturation pressure is a function of the water head or pressure above the uranium bearing sands. Totally enclosed fan cooled (TEFC) motors, solenoids, valves, pressure gauges, exhaust ventilation systems and alarm safety devices are included in the design for accident mitigation.

*Accident Prevention*

*Prevention methods utilized to minimize potential impacts to human health and safety from a release of oxygen include the following:*

- The design and installation of underground and above-ground gaseous oxygen piping at Moore Ranch including material specifications, velocity restrictions, location and specifications for valves, and design specifications for metering stations and filters will be in accordance with industry standards contained in CGA G-4.4.
- Header houses will be equipped with an exhaust ventilation system to reduce the risks of $O_2$ accumulation in case of a leak.
- *Oxygen monitoring will be conducted prior to entry into confined spaces where oxygen buildup could occur.*
- Normally closed solenoids will reduce the risk of $O_2$ leaks in the lixiviant injection piping.

Combustibles such as oil and grease will burn in oxygen if ignited. EMC will ensure that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1.

*Mitigation/Accident Response*

EMC will develop procedures that implement emergency response instructions for a spill or fire involving oxygen systems.

*Emergency response procedures will include instructions in the following:*

- *Immediate notifications*
- *Evacuation procedures*
- *Perimeter establishment*
- *Personal Protective Equipment requirements*
- *Reporting*

Carbon Dioxide

The primary hazard associated with the use of carbon dioxide is concentration in confined spaces, presenting an asphyxiation hazard. Bulk carbon dioxide facilities are typically located outdoors and are subject to industry design standards. Floor level ventilation and carbon dioxide monitoring at low points will be performed to protect workers from undetected leaks of carbon dioxide within the central plant.

The carbon dioxide storage system will consist of one 50-ton bulk liquid carbon dioxide pressure vessel tank supplied and maintained by the carbon dioxide supplier. The tank will be located outdoors and outside the main plant. All carbon dioxide deliveries and tank fillings will be performed by the supplier. Gaseous carbon dioxide is routed via carbon steel piping from the bulk storage tank to both the production and injection main lines.

EMC will incorporate recommendations concerning materials of construction for tanks and piping systems and the use of ventilation to control vapors in the event of a leak of carbon dioxide. The building HVAC system is designed for 3 air changes per hour with the capacity to expand to 6 air exchanges per hour. In addition, local exhaust fans will be installed along the outer plant wall to sweep vapors and gases near the floor level.

Sodium Carbonate and Sodium Chloride

Sodium carbonate and sodium chloride are primarily inhalation hazards. Soda ash and carbon dioxide will be used to prepare sodium carbonate for injection in the wellfield. Sodium carbonate and sodium chloride are also used for regeneration of ion exchange resin. Dry storage and handling systems will be designed to industry standards to control the discharge of dry material.

A 26 percent sodium chloride saturated solution will be created from pure salt solids transferred using aluminum piping into two 15,230 gallon vertical flat bottom reinforced fiberglass tanks with a vent pipe vented through the roof to the atmosphere outside and above the main plant. Water is pumped into the storage tanks using PVC piping and the salt dissolves until solution saturation is achieved.

A 32 percent soda ash saturated solution will be created from dense soda ash solids transferred into a 16,920 gallon vertical flat bottom reinforced fiberglass tank with a vent pipe vented through the roof to the atmosphere outside and above the main plant. Hot water is pumped using copper pipe into the storage tank and the soda ash dissolves until solution saturation is achieved. Solution temperature is maintained at a minimum of 95°F to avoid solids precipitation of the soda ash solution.

All piping from both systems to the eluate system will be conventional PVC. Proper valving will be installed at the tank exits and both sides of the redundant pumps. A programmable logic control system integrated to the plant automation system will control the pump starts, flow rates, and time as it relates to volume needed. Standard operating procedures (SOPs) will be developed and operators will be trained on using these systems, both automated and manual.

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*Accident Prevention*

*Prevention methods utilized to minimize potential impacts to human health and the environment from a release of sodium carbonate and sodium chloride include the following:*

*To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, storage tanks will be located separately from other process tanks with incompatible chemicals.*

- *Dry storage and handling systems will be designed to industry standards to control the discharge of dry material.*

- *All tanks are enclosed limiting the amount of dust that can escape to the atmosphere.*

- *Daily shift inspections of plant and chemical storage facilities are conducted for early detection of potential deficiencies.*

- *Bulk storage facilities will be located inside of the central plant providing full containment of released materials.*

- *Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.*

*Mitigation/Accident Response*

*Upon detection of a release, steps will be taken to stop or limit the extent of the release that can be performed without endangering the health of the responders. EMC will develop emergency response procedures for an accidental release of sodium carbonate and sodium chloride and employees will be trained on those procedures. Emergency response procedures will include instructions in the following:*

- *Immediate notifications*
- *Evacuation procedures*
- *Perimeter establishment*
- *Personal Protective Equipment requirements*
- *Site mitigation, neutralization, and cleanup*
- *Reporting*

Sodium Sulfide

Sodium sulfide may be used as a reductant during groundwater restoration. Sodium sulfide is corrosive and will cause severe eye and skin burns. Routes of entry into the body include inhalation, ingestion, and contact with the skin. Under low pH conditions, sodium sulfide can react with water to liberate hydrogen sulfide gas.

*Accident Prevention*

*Prevention methods utilized to minimize potential impacts to human health and the environment from a release of sodium sulfide include the following:*

- *Sodium sulfide can be flammable and contact with heat, flame, or other sources of ignition will be avoided.*

- *Sodium sulfide will be stored separately from incompatible chemicals such as hydrogen peroxide and sulfuric acid.*

- *Construction of all storage tanks, piping, and associated appurtenances will be in accordance with current industry standards.*

- *All tanks are enclosed limiting the amount of dust and vapors that can escape to the atmosphere.*

- *Daily shift inspections of plant and chemical storage facilities are conducted for early detection of potential deficiencies.*

- *Containment will be provided for 100% of the total storage capacity of the largest tank within the secondary containment area. The containment area will be constructed of chemically compatible materials.*

**Deleted:** *of the largest tank within the secondary containment area. The containment area will be*

- *Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.*

*Mitigation/Accident Response*

*Upon detection of a release of sodium sulfide, steps will be taken to stop or limit the extent of the release that can be performed without endangering the health of the responders. EMC will develop emergency response procedures for an accidental release of sodium sulfide and employees will be trained on those procedures. Emergency response procedures will include instructions in the following:*

- *Immediate notifications*
- *Evacuation procedures*
- *Perimeter establishment*
- *Personal Protective Equipment requirements*
- *Site mitigation, neutralization, and cleanup*
- *Reporting*

*4.12.1.2.2 Facility Areas Where Fumes or Gases May Be Generated*

*A description of the areas in the proposed plant facility where radiological gases or air particulate could be generated is contained in Section 6.2 and are shown in Figure 6.2-1 as monitoring locations.*

*Other potential sources of non-radiological fumes or gases can result from use of process related chemicals. The potential sources of non-radiological fumes or gases are minimal in the ion exchange process area since the mining solutions contained in the process* *equipment are maintained under a positive pressure. The area within the plant facility with the greatest potential to generate non-radiological fumes or gases is the precipitation area. As described in Section 2.2, the primary chemicals used in the precipitation area are sulfuric or hydrochloric acid, hydrogen peroxide, and sodium hydroxide. A description of the preventive/mitigative controls and monitoring for each of these potential chemical fumes is provided in the following list:*

**Deleted:** *anhydrous ammonia*

- *Sulfuric or Hydrochloric Acid Fumes*

*Sulfuric or hydrochloric acid fumes may be generated from leaks in acid piping and process tanks contained within the central plant precipitation area. Preventive/mitigation measures include construction of all storage tanks, piping, and associated appurtenances in accordance with current industry standards, all tanks are enclosed limiting the amount of vapors that can escape to the atmosphere, and daily shift inspections of plant and chemical storage facilities are conducted. Monitoring may be conducted using colorimetric tubes if it is believed that acid fumes may be present in an area.*

*Typically, a Concentrated Acid Work Permit will be required for maintenance work on tanks, pipes, or equipment that contains or may contain concentrated acid or to the use of concentrated acid to prepare decontamination or cleaning solutions as required by site industrial safety procedures. Employees who may be exposed to concentrated sulfuric or hydrochloric acid must wear chemical goggles and face shield, chemical suit, and acid resistant gloves. A respirator with an acid cartridge is necessary when fumes may be encountered. An emergency eyewash station will also be maintained near the precipitation area in case an employee comes into contact with sulfuric or hydrochloric acid.*

- *Hydrogen Peroxide Fumes*

*Hydrogen peroxide fumes may be generated from leaks in piping and process tanks contained within the central plant precipitation area. Preventive/mitigation measures include construction of all storage tanks, and associated piping in accordance with current industry standards; all tanks are enclosed limiting the amount of vapors that can escape to the atmosphere; and daily shift inspections of plant and chemical storage facilities are conducted.*

*Hydrogen peroxide will be stored in bulk storage vessel located outside of the building away from any organics or other incompatible substance. Rubber gloves and face shield should be worn when there is any possibility of contact with this chemical. In the event of a spill, ample quantities of water will be used to dilute the spill. An emergency eyewash station will also be maintained near the precipitation area in case an employee comes into contact with hydrogen peroxide.*

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- *. Anhydrous Ammonia Fumes*¶

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*Ammonia fumes may be generated from leaks in piping and process tanks contained within the central plant precipitation area (if used). Preventive/mitigation measures include construction of all storage tanks, and associated piping in accordance with current industry standards; all tanks are enclosed limiting the amount of vapors that can escape to the atmosphere; and daily shift inspections of plant and chemical storage facilities are conducted. If ammonia is used in the precipitation process, then continuous ammonia detectors will be placed in the precipitation area to monitor for any significant release of ammonia. The detectors will activate an alarm if determined allowable air concentrations of ammonia are detected. Monitoring may also be done with colorimetric tubes if it is believed that ammonia fumes may be present in an area.*¶

¶

*If used, anhydrous ammonia will be piped from a bulk storage vessel located outside of the building. The chemical is stored as a liquid under pressure, but it immediately evaporates when the pressure is reduced to atmospheric. In situations where there is a possibility for the unexpected release of anhydrous ammonia, such as during work on ammonia lines, personnel shall wear a suitable respirator with appropriate canisters, chemical suit, gloves resistant to anhydrous ammonia, goggles, and a face shield. An emergency eyewash station will also be maintained near the precipitation and ammonia storage area in case an employee comes into contact with anhydrous ammonia.*¶

*If any of the potential fumes described above are detected, then building ventilation in the process equipment area will be accomplished by the use of the HVAC system that draws in fresh air and sweeps the plant air out to the atmosphere.*

Deleted: *an exhaust*

*In addition to the fumes described above in the plant area, the potential exists for buildup of carbon dioxide or oxygen gases may also occur in confined spaces such as headerhouses if carbon dioxide and oxygen lines are present. Procedures will require monitoring for these gases in confined spaces or basements where these gases may be present prior to employees conducting work in these areas.*

## WASTE MANAGEMENT IMPACTS

### Question 4.13 #1 – Potential Exposures from Deep Disposal

*RAI Question:*

It is proposed that liquid wastes for the most part will be disposed by deep well injection. Provide an evaluation of potential radiological impact for such disposal, addressing proposed total radioactivity, and potential radiological dose to members of the public for any feasible exposure pathways.

*Answer:*

A primary benefit of the disposal of liquid waste using deep disposal wells is that the waste is permanently isolated from the human environment. Regulatory requirements for the construction, operation, maintenance, and testing of these well from the EPA Underground Injection Control program ensure that there are no releases of injected waste. The response to this question reviews the stringent controls in place to protect human health through the use of deep disposal wells.

In order to estimate the potential radiological impacts and total radioactivity from disposal of liquid waste at the Moore Ranch project the flow and radiological characteristics of the waste stream must be estimated. Uranium One provided the anticipated waste stream water quality in a response to the RAI issued by NRC for the Moore Ranch Technical Report. That data is contained in Table 4-1 submitted in the revised Technical Report submitted to NRC in September 2008. Similar changes will be made to Section 4.13 of the Environmental Report for submittal with the completed response to this RAI. To support NRC review of this response, the data that will be submitted in new Table 4.13-1 is included in this response.

**Table 4.13-1** Summary of Anticipated Waste Stream Water Quality

| | Estimated Range of Waste Stream Water Quality | |
|---|---|---|
| Chemical Species | Minimum (mg/l) | Maximum (mg/l) |
| pH | 6 | 9 |
| Ammonia as Nitrogen | 50 | 500 |
| Sodium | 150 | 3,000 |
| Calcium | 200 | 1,000 |
| Potassium | 10 | 1,000 |
| Bicarbonate as HCO3 | 1,500 | 4,000 |
| Carbonate as CO3 | 0 | 500 |
| Sulfate | 80 | 2,000 |
| Chloride | 200 | 4,000 |
| Uranium as U3O8 | 1 | 15 |
| Ra-226 (pCi/l) | 300 | 3,000 |
| TDS | 4,000 | 15,000 |

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

*4.13.2.5 Liquid Waste Disposal*

*EMC expects that the liquid waste stream generated at the Moore Ranch Facility will be chemically and radiologically similar to the waste disposed in the current disposal wells in operation at existing ISR sites in the Powder River Basin. It is anticipated that the maximum volume of liquid waste stream for disposal will be approximately 45 gpm during normal operations and approximately 100 gpm during restoration. The average net consumptive use during the operational and restoration phases of the Moore Ranch Project was estimated at 105 gpm as discussed in Section 4.4.2.1. This waste stream will require effective disposal.*

***Total Radioactivity Related to Liquid Waste Disposal***

*As previously noted, the average consumptive use during the operational and restoration phases of the Moore Ranch project is 105 gpm. Based on the* *discussion of the consumptive use of groundwater contained in Section 4.4.2.1, this average flow will occur over a period of 12.5 years, resulting in a total groundwater use during the operational and restoration phases of 6.899E+8 gallons (2.61E+9 liters). Using the maximum anticipated radionuclide content for uranium and radium-226 from Table 4.13-1, the expected total radioactivity associated with uranium and radium-226 that will be disposed over the course of the Moore Ranch project is 26.5 and 7.83 Curies, respectively.*

***Feasible Exposure Pathways from Deep Well Injection***

*Deep well injection technology and the EPA and state Underground Injection Control ("UIC") Programs established by the Safe Drinking Water Act ("SDWA") (42 U.S.C. §§ 1420, et. seq.) to regulate this technology are major tools for protecting human health and the environment by preventing the endangerment of drinking water sources. A UIC permit cannot even be issued unless potential underground sources of drinking water (USDWs) are protected. The foundational assumptions of the Class I UIC program are that: (1) injected fluids will be permanently removed from the accessible environment, (2) the fate and transport of waste is well defined and understood, and (3) underground sources of drinking water will be protected. By definition, there cannot effectively be an exposure pathway for injectate to move from the injection zone and reach the public if a permit is to be granted.*

*The approved Wyoming UIC program must demonstrate that deep well injection facilities are maintained and operated in accordance with federal and state regulations and the UIC permits (see 40 C.F.R. §144.1(b)(1) and 40 CFR §147.2550). Consistent monitoring and enforcement assure that the wells will continue to be protective of human health and the environment. Permits allow for the injection and containment of substances within deep geological formations located thousands of feet below the Earth's surface where the injected fluids will remain isolated and contained for thousands of years, which is an effective way to protect human health and the environment, as well as underground and surface sources of drinking water.*

*EPA has repeatedly noted that "[w]hen wells are properly sited, constructed, and operated, underground injection is an effective and environmentally safe method to dispose of wastes" (EPA, 2001). EPA has found deep well injection to be "safer than virtually all other waste disposal practices" (EPA 1993). Implementation of EPA's current technical requirements for Class I wells, which are located at 40 C.F.R. 146, include extensive construction, monitoring, operating and reporting requirements. When wells comply with these regulations, the EPA has consistently found that "underground injection is an effective and environmentally safe alternative to surface disposal" (EPA 1999). Furthermore, the EPA has noted for Class I industrial deep wells that "there are no documented problems with the effectiveness of the UIC regulations." (55 Fed. Reg. 22,529, 22,658; June 1, 1990).*

*There are two potential pathways through which injected fluids can migrate to an underground source of drinking water (USDW) and present a potential exposure to the public: (1) failure of the well or (2) improperly plugged or completed wells or other pathways near the well (EPA 2001).*

*Contamination due to well failure may be caused by leaks in the well tubing and casing or when injected fluid is forced upward between the well's outer casing and the well bore should the well lose mechanical integrity. Internal mechanical integrity is the absence of significant leakage in the injection tubing, casing, or packer. An internal mechanical integrity failure can result from corrosion or mechanical failure of the tubular and casing materials. External mechanical integrity is the absence of significant flow along the outside of the casing. Failure of the well's external mechanical integrity occurs when fluid moves up the outside of the well due to a casing failure or improper installation of the cement. To reduce the potential threat of well failures, operators must demonstrate that there is no significant leak or fluid movement through channels adjacent to the well bore before the well is issued a permit and allowed to operate. In addition, operators must conduct appropriate mechanical integrity tests (MITs) every 5 years (for nonhazardous wells) thereafter to ensure the wells have internal and external mechanical integrity and are fit for operation. It is important to note that failure of an MIT, or even a loss of mechanical integrity, does not necessarily mean that wastewater will escape the injection zone. Class I wells have redundant safety systems to guard against loss of waste confinement.*

*The multi-layer construction of a Class I deep well, which is required in Wyoming, provides redundant safety features that guarantee injected wastes do not migrate from the well bore into protected aquifers due to well failure. These wells must be constructed with multiple layers of concentric tubing (made of steel or other materials designed to be compatible with the injected fluids) and cement which provides redundant layers of protection to the injection structure. This construction amounts to a pipe within a pipe within a pipe (three tubes, two layers of cement, and a fluid barrier) (EPA, 1994). Thus, "Class I wells have redundant safety systems and several protective layers to reduce the likelihood of failure. In the unlikely event that a well should fail, the geology of the injection and confining zones serves as a final check on movement of wastewaters to USDWs" (EPA 2001).*

*The Area of Review (AoR) is the zone of endangering influence around the well, or the radius at which pressure due to injection potentially could cause the migration of the injectate and/or formation fluid into a USDW if a conduit for flow (such as an improperly plugged well) existed. Improperly plugged or completed wells that penetrate the confining zone near the injection well could provide a pathway for fluids to travel from the injection zone to USDWs. These potential pathways are most common in areas of oil and gas exploration. To protect against migration through this pathway, wells that penetrate the zone* *affected by injection pressure must be properly constructed or plugged. Before injecting, operators must identify all wells within the AoR that penetrate the injection or confining zone, and repair all wells that are improperly completed or plugged before a permit is issued. Fluids could potentially be forced upward from the injection zone through transmissive faults or fractures in the confining beds which, like abandoned wells, can act as pathways for waste migration to USDWs. Faults or fractures may have formed naturally prior to injection or may be created by the waste dissolving the rocks of the confining zone. Artificial fractures may also be created by injecting wastewater at excessive pressures. To reduce this risk, injection wells are sited such that they inject below a confining bed that is free of known transmissive faults or fractures. In addition, during well operation, operators must monitor injection pressures to ensure that fractures are not propagated in the injection zone or initiated in the confining zone. It is noted that some states, including Wyoming, allow creation of artificial fractures during* *<u>completion</u>* *of a Class I injection well. However, such fractures must be contained within the injection zone, and the maximum operational injection pressure must be below fracture propagation pressure (e.g., the fracture cannot be extended during operations).*

*The 2001 EPA Risk Report discusses a study that quantitatively estimated the risk of waste containment loss as a result of various sets of events associated with Class I hazardous wells. Through a series of "event trees," the study estimated the probability that an initiating event will occur and be undiscovered, followed by subsequent events that could ultimately result in a release of injected fluids to a USDW. The study assumed that, given the redundant safety systems in a typical Class I well, loss of containment requires a string of improbable events to occur in sequence. For example, a leak develops in the packer, followed by a drop in annulus pressure that is undetected due to a simultaneous malfunction of the pressure monitoring system, followed by a leak in the long string casing between the surface casing and the upper confining layer, resulting in a loss of waste isolation (EPA 2001).*

*The study concluded that Class I hazardous injection wells which meet EPA's minimum design and operating requirements pose risks that are well below acceptable levels. According to the study, the probability of containment loss resulting from each of the scenarios examined ranges from one-in-one-million to one-in-ten-quadrillion. The risks for each are ranked as follows (from most probable to least probable): cement microannulus leak, inadvertent extraction from the injection zone, major injection tube failure, major packer failure, breach of the confining zone(s), leak in the packer, and leak in the injection tubing.*

*EPA attributed this low risk to the use of engineered systems and geologic knowledge to provide multiple barriers to the release of wastewater to USDWs. Although the risk analysis was primarily concerned with Class I hazardous wells, many of the well design and construction requirements also apply to Class I* *nonhazardous wells and can be extrapolated to the wells planned for the Moore Ranch project.*

*A third potential pathway would involve drilling through the injection zone. In the unlikely event that a well were drilled through the injection zone, potential exposure is limited by many factors, which are discussed below.*

*The first factor that would limit potential exposure is that the radius of fluid displacement is limited. For example, for a 10-year operation of the proposed Moore Ranch deep disposal wells the radius of fluid displacement (based on piston-like displacement) is calculated to be 327 feet from each injection well. For the purposes of this discussion it is assumed that this pathway would only exist after the operational life of the Moore Ranch project since EMC would certainly detect drilling activity within the limited radius of fluid displacement during active operations at the site.*

*In addition, standard drilling practices used in the Power River Basin dictate drilling with mud which provides a hydraulic head in the well greater than the head in the formation drilled. As such, there would be no mechanism for flow from the injection zone into a well that was being drilled with mud. Rather, fluid is continually lost from the well into the formation while drilling proceeds.*

*Further, concentrations of radionuclides will decrease due to natural dispersion as fluid is displaced from the injection wells. An analogy for the concentration reduction due to dispersion was evaluated for COGEMA (2004; Wellfield Restoration Report, Irigaray Mine). For that project, a MODFLOW/MT3D model was used to assess transport of metals and radionuclides. Model simulations indicated that, on average, the concentration metals and radionuclides were reduced by a factor of seven over a transport distance of 400 feet due solely to dispersion (no retardation or precipitation was assumed).*

*The mobility of specific radioactive constituents of concern (uranium and radium-226) also is limited by natural retardation. The magnitude of retardation has been researched by Carlos, 2001; Johnson, 1994; U.S. DOE, 1996; and U.S. NRC, 1990. For the same project (COGEMA, 2004), sorption was implemented in some of the solute transport simulations. Sorption refers to the mass transfer between the constituent dissolved in groundwater and the constituent sorbed on the porous medium. Equilibrium conditions are generally assumed to exist between the aqueous phase and the solid phase concentrations and the sorption reactions are fast enough relative to groundwater velocity to be treated as instantaneous. A linear sorption isotherm assumes that the sorbed concentration (Cs) is directly proportional to the dissolved concentration (C):*

*$Cs = K_d C$*

*where: $K_d$ is the distribution coefficient (L/kg).*

*The equilibrium controlled linear sorption isotherm is incorporated into the MT3DMS code through the use of a retardation factor, defined as:*

$$R = 1 + p_b K_d / \phi$$

*where: $p_b$ = bulk density*
*$\phi$ = effective porosity*

*Representative retardation ($K_d$) values in published literature include:*

| Constituent | Range of $K_d$ Values (L/Kg) | Source |
|---|---|---|
| Uranium | 0.4 – 10 | Carlos, 2001<br>Johnson, 1994<br>U.S. DOE, 1996<br>U.S. NRC, 1990 |
| Radium-226 | 5 – 6,700<br>10 | Moody, 1982<br>U.S. NRC, 1980 |

*MODFLOW simulations using MT3D for transport were run to assess transport of radionuclides at Irigaray. Conservative $K_d$ values on the lower end of the range identified in the literature search were used. Model simulations showed that the concentration of uranium at a distance of 400 feet was only 10% of the initial concentration when a $K_d$ of 0.5 L/Kg was used. At 1,000 years of simulation time, the Ra-226 concentration at a distance of 400 feet was 5 pCi/L (the MCL for Ra-226) using a $K_d$ of 5 L/Kg. This represents an order of magnitude decrease from the initial concentration of 50 pCi/L.*

*In summary:*

- *Based on piston-like flow, the radius of fluid displacement for the operational lifetime is small (approximately 327 feet)*

- *Because of the head induced by drilling mud, it is extremely unlikely that there would be flow from the injection zone into a well that was being drilled with mud. The amount of drilling cuttings generated, and the potential radioactive dose from those cuttings, is expected to be minimal.*

- *Dispersion alone likely will reduce concentrations of radionuclides by an approximate factor of seven over a 400-foot displacement distance*

- *Sorption/retardation will further reduce concentrations at 400 feet from the well by approximately one order of magnitude.*

*Based on the analogies from the COGEMA study, it is reasonable to assume that, if a well was drilled through the injection zone at a distance of 400 feet from the injection well, the concentration of radionuclides would be one to two orders of magnitude less than the original concentration injected into the Class I well. In addition, the use of drilling mud will prevent injected wastes from leaving the injection zone. Hence, potential exposure from a well drilled through the injection zone, even for a well located only 400 feet from the injection well, is minimal.*

*Additional References*

*COGEMA Mining, Inc., 2004: Wellfield Restoration Report, Irigaray Mine; prepared by Petrotek Engineering Corporation.*

*Carlos, F., Colon, J., Brady, P., Siegel, M., and E. Lindgren, 2001. Historical Case Analysis of Uranium Plume Attenuation. Soil and Sediment Contamination 10(1): 71-115.*

*Johnson, R. 1994. Nonlinear Adsorption of Uranyl: Analytical Modeling of Liner Migration. Groundwater, Vol. 32; 293-304. U.S. DOE Contract DE-AC05-84OR21400.*

*Moody, J.B., 1982. Radionuclide migration/retardation: research and development technology status report. Battelle Mem. Inst. Report ONWI-321, Columbus, OH.*

*U.S. Department of Energy, 1996. Selected Radionuclides Important to Low Level Radioactive Waste Management. DOW/LLW-238 Section 15.*

*U.S. Environmental Protection Agency, "1991 Toxics Release Inventory: Public Data Release, EPA 745-R-93-003" (May 1993) ("1991 TRI PDR Report") at 305.*

*U.S. Environmental Protection Agency. "USEPA's Program to Regulate the Placement of Waste Water and Other Fluids Underground" (December 1999).*

*U.S. Environmental Protection Agency, "Class I Injection Wells and Your Drinking Water", July 1994*

*U.S. Environmental Protection Agency, "Class I Underground Injection Control Program: Study of the Risks Associated with Class I Underground Injection Wells" (March 2001).*

*U.S. Nuclear Regulatory Commission, 1980; Final Generic Environmental Impact Statement on Uranium Milling, September 1980. NUREG-0706, Volume II Appendix A-3.*

*U.S. Nuclear Regulatory Commission, 1990. Mobilization and Transport of Uranium at Uranium Mill Tailings Disposal Sites. NUREG/CR-5169; Prepared by R. Erickson, C. Hostetler and M. Kemmner; Pacific Northwest Laboratory.*

## Question 4.13 No. 2 – Available Waste Disposal Capacity

*RAI Question:*

Provide information showing that there is sufficient capacity at the proposed waste disposal sites to be used for hazardous, mixed, and radioactive wastes.

*Answer:*

Hazardous waste impacts are discussed in Section 4.13.3.4 of the Environmental Report. As noted in that discussion, EMC believes that the facility will be defined as a Conditionally-Exempt Small Quantity Generator (CESQG) under the WDEQ Hazardous Waste Rules and Regulations and that hazardous waste generated on the project will be limited to used oil and universal hazardous wastes such as spent batteries. EMC plans to recycle the limited quantity of used oil generated on site through a properly licensed oil recycler. Universal wastes may be disposed with solid waste generated by the facility under WDEQ rules.

EMC does not expect to produce mixed waste as a result of the proposed processes at Moore Ranch.

Although a disposal agreement has not been finalized, the preferred destination for radioactive waste produced from the Moore Ranch project is the Pathfinder Mines Corporation (PMC) Shirley Basin site, which is licensed to receive 11e.(2) byproduct materials. PMC is limited under an agreement with the WDEQ to receiving a total of 49,000 cubic yards of waste. This capacity limit is not related to the actual physical capacity of the disposal cell at Shirley Basin and could be increased should PMC desire to negotiate an increase with the WDEQ.

As an alternative to the PMC Shirley Basin facility, the EnergySolutions, LLC disposal site in Clive, Utah is licensed by the State of Utah to receive 11e.(2) byproduct material. Under License # UT 2300478, Amendment 6, EnergySolutions is allowed to possess 5.5 million cubic yards of 11e.(2) byproduct material.

As discussed in Section 4.13.3.2 of the ER, EMC estimates that 100 cubic yards of byproduct material will be produced each year.

*Proposed Revisions to License Application*

EMC does not propose to make any revisions to the license application in response to this RAI question.

## Question ER Section 5.1.6 - Procedures for Removing and Disposing of Structures and Equipment

*RAI Question:*

The drilling of the injection and extraction wells has the potential to result in residual surface soils with elevated levels of radioactivity from cuttings where drilling encounters the uranium/radium bearing ore. Provide information on how these soils will be monitored and controlled to ensure residual levels do not exceed acceptable limits.

*Answer:*

On May 14, 2008, NRC Staff issued a RAI for the Moore Ranch Technical Report (TR). TR RAI question 6.2.a requested "*a discussion of the pre-reclamation radiological survey regarding how it and the baseline survey will be used to identify potential contamination areas*". On July 11, 2008, EMC submitted a response to this RAI question that included a description of pre-reclamation radiological surveys that will be performed and compared to baseline surveys to identify radiological impacts from operations before reclamation activities commence. The response also provided additional information on final status surveys and a revision to Section 6.2 of the TR was submitted to NRC. Corresponding revisions to Section 5.1 of the ER will be submitted to NRC.

The information developed for the TR RAI partially addresses this RAI question. The pre-reclamation surveys will include a comprehensive gamma scan of the site using an equivalent method employed during baseline surveys. These data sets will be kriged in GIS to develop continuous estimates across the site, making direct spatial comparisons with baseline survey maps possible for any given area at the site. Both qualitative assessments and quantitative statistical comparisons between kriged data sets will be made to assess significant differences, taking into account potential magnitudes of estimation uncertainty. In cases of identified contamination at the soil surface, subsurface soil sampling will be conducted to determine the vertical extent of contamination that would require remediation under applicable soil cleanup criteria.

Concerning control of drill cuttings that could potentially contain elevated concentrations of natural uranium and it's daughters, the drilling method employed at Moore Ranch will be rotary mud drilling, which is the standard method used throughout the ISL uranium mining industry. In this method, drilling fluid is introduced from a drill pit at the surface through the drill stem. The drilling fluid returns to the drill pit at the surface where the drill cuttings settle out of the drilling fluid. When drilling is complete, the pit, which is typically 4 to 5 feet deep, is allowed to air dry. When the pit is dry, the drill cuttings in the pit are covered with native soil and the site is revegetated.

Drill cuttings that have not been exposed to lixiviant are classified as Technically Enhanced Naturally Occurring Radioactive Material (TENORM). If the cuttings have been exposed to lixiviant, they are classified as 11e.(2) byproduct material. Drill cuttings will be managed using the following methods:

- TENORM drill cuttings will be buried in the drill pits. This method is discussed in a recent EPA report (EPA, 2007), which states "*these wastes are typically deposited in pits on site, which are subsequently buried during reclamation. Some slight radioactivity may occur in accumulated solids in the pit bottoms*". As discussed in Section 2.2.5 of the ER, the Moore Ranch orebody ranges in grade from less than 0.05% to greater than 0.5%, with an average grade estimated at 0.1%. The relatively small volume of low concentration TENORM drill cuttings deposited at the bottom of the drill pits will not present a hazard. Additionally, TENORM material is not subject to the soil clean-up criteria from 10 CFR Part 40 Appendix A.
- ISL operations occasionally require drilling or recompletion of wells into an active mining zone. In these instances, the drill cuttings are considered 11e.(2) byproduct material and must be collected. The cuttings will be removed, dewatered, packaged and disposed at a facility licensed to receive byproduct material.

The RAI addresses Section 5.1.6, Procedures for Removing and Disposing of Structures and Equipment, which provides information for decommissioning plant structure and equipment. Additional information concerning pre-reclamation and final status radiological surveys will be added to Section 5.1. Additional information concerning management of drill cuttings will be added to Section 5.1.2, Surface Disturbance.

*Proposed Revisions to License Application*

The following changes are proposed to the Environmental Report in response to this RAI question. The revisions made to ER Section 5.1 in response to the RAI for the Technical Report in July 2008 are shown in blue text and will be made in the updated ER. Additional changes proposed to address this RAI question are noted in red-line/strikeout method.

## *5.1 MITIGATION MEASURES FOR LAND USE IMPACTS*

*As discussed in Section 3.1 of this Environmental Report (ER), rangeland is the primary land use within the Moore Ranch License Area and the surrounding 2.0-mile review area. Oil and gas production facilities and infrastructure are also located on rangeland throughout the review area. The review area also contains pastureland to the west. Based on a site reconnaissance conducted in May 2007 and a 2006 aerial photo, there are no occupied housing units in the License Area. Figure 3.1-1 depicts land use in the review area.*

*Construction of the Moore Ranch Central Plant and associated structures will encompass approximately 11 acres. Operation of the Moore Ranch Project will ultimately encompass approximately 150 acres. Use of the land as rangeland will be excluded from this area during the life of the project. Oil and gas production facilities will not be affected. Considering the relatively small size of the area* *impacted by construction and operation, the exclusion of grazing from this area over the course of the Moore Ranch project will have an insignificant impact on local livestock production. These impacts are considered temporary and reversible by returning the land to its former grazing use through post-mining surface reclamation. Mitigation measures for the temporary loss of agricultural production over the course of the project include site reclamation and decommissioning efforts to return the land to its beneficial use(s) before the proposed project and are discussed in this section.*

*All lands disturbed by the Moore Ranch project will be returned to their pre-mining land use of livestock grazing and wildlife habitat unless an alternative use is justified and is approved by the state and the landowner, i.e. the rancher desires to retain roads or buildings. The objectives of the surface reclamation effort is to return the disturbed lands to production capacity of equal to or better than that existing prior to mining. The soils, vegetation and radiological baseline data will be used as a guide in evaluating final reclamation. This section provides a general description of the proposed facility decommissioning and surface reclamation plans for the Moore Ranch Project. The following is a list of general decommissioning activities:*

- *Plug and abandon all wells as detailed in Section 5.1.1.*
- *Determination of appropriate cleanup criteria for structures (Section 5.1.6) and soils (Section 5.1.7).*
- *Radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.*
- *Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation as discussed in Section 5.1.6.*
- *Decontamination of items to be released for unrestricted use to levels consistent with the requirements of NRC.*
- *Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility.*
- *Perform final site soil radiation surveys.*
- *Backfill and recontour all disturbed areas.*
- *Establish permanent revegetation on all disturbed areas.*

*Pre-reclamation radiological surveys will be conducted in a manner consistent with the baseline radiological surveys so that the data can be directly compared for identification of potentially contaminated areas. For example, a comprehensive gamma scan of the site will be performed, including conversion of raw scan data to 3-foot HPIC equivalent gamma exposure rate readings and/or to estimates of soil Ra-226 concentration. These data sets will be kriged in GIS to develop continuous estimates across the site, making direct spatial comparisons with baseline survey maps possible for any given area at the site. Both qualitative assessments and quantitative statistical comparisons between kriged data sets can be made to assess significant differences, taking into account potential magnitudes of estimation uncertainty. In cases of identified contamination at the soil surface, subsurface soil sampling will also be conducted to determine the vertical extent of contamination that would require remediation under applicable soil cleanup criteria.*

*Final status surveys after any remediation has occurred will also be conducted such that results can be directly compared to pre-operational baseline survey data. As with pre-reclamation surveys, final status gamma scan data will be converted to 3-foot HPIC equivalent gamma exposure rates and/or to estimates of soil Ra-226 concentrations, then kriged using GIS for comparative assessments against pre-operational baseline data. For aspects of the final status survey, pre-operational baseline data may be used instead of a physically separated reference area to provide information on background conditions for statistical comparative testing. Subsurface sampling will be conducted as part of the final status survey only if residual subsurface contamination is known to remain after any remediation has been completed. Other post-operational environmental monitoring data such as sediments, surface waters, groundwater, air particulates, radon, and vegetation may also be compared quantitatively and/or qualitatively against pre-operational baseline data.*

*The following sections describe in general terms the planned decommissioning activities and procedures for the Moore Ranch facilities. EMC will, prior to final decommissioning of an area, submit to the NRC a detailed Decommissioning Plan for their review and approval at least 12 months before planned commencement of final decommissioning.*

### *5.1.2 Surface Disturbance*

*The primary surface disturbances associated with ISR mining are the sites containing the central processing plant, maintenance and office areas. Surface disturbances also occur during the well drilling program, pipeline and well installations, and road construction. These more superficial disturbances involve relatively small areas or have very short-term impacts.*

*Disturbances associated with the central processing plant, office and maintenance buildings, and field header buildings, will be for the life of those* *activities and topsoil will be stripped from the areas prior to construction. Disturbance associated with drilling and pipeline installation is limited, and is reclaimed and reseeded as soon as weather conditions permit. Vegetation will normally be reestablished over these areas within two years. Surface disturbance associated with development of access roads will occur at the Moore Ranch site and topsoil will be stripped from the road areas prior to construction and stockpiled.*

*Surface reclamation in the wellfield production units will vary in accordance with the development sequence and the mining/reclamation timetable. Final surface reclamation of each wellfield production unit will be completed after approval of groundwater restoration stability and the completion of well abandonment activities. Surface preparation will be accomplished as needed so as to blend any disturbed areas into the contour of the surrounding landscape.*

*Wellfield decommissioning will consist of the following steps:*

- *The first step of the wellfield decommissioning process will involve the removal of surface equipment. Surface equipment primarily consists of the injection and production feed lines, wellhouses, electrical and control distribution systems, well boxes, and wellhead equipment. Wellhead equipment such as valves, meters or control fixtures will be salvaged to the extent possible.*

- *Removal of buried wellfield piping.*

- *The wellfield area may be recontoured, if necessary, and a final background gamma survey conducted over the entire wellfield area to identify any contaminated earthen materials requiring removal to disposal.*

- *Final revegetation of the wellfield areas will be conducted according to the revegetation plan.*

- *All piping, equipment, buildings, and wellhead equipment will be surveyed for contamination prior to release in accordance with the NRC guidelines for decommissioning.*

*An ongoing process during ISL mining operations is drilling, which results in the production of drill cuttings. Drill cuttings that have not been exposed to lixiviant are classified as Technically Enhanced Naturally Occurring Radioactive Material (TENORM). If the cuttings have been exposed to lixiviant, they are classified as 11e.(2) byproduct material. Drill cuttings will be managed using the following methods:*

- *TENORM drill cuttings will be buried in the drill pits. This method is discussed in a recent EPA report (EPA, 2007), which states "these wastes are typically deposited in pits on site, which are subsequently buried during reclamation. Some slight radioactivity may occur in accumulated solids in the pit bottoms". As discussed in Section 2.2.5 of the ER, the Moore Ranch orebody ranges in grade from less than 0.05% to greater than 0.5%, with an average grade estimated at 0.1%. The relatively small volume of low concentration TENORM drill cuttings deposited at the bottom of the drill pits will not present a hazard. Additionally, TENORM material is not subject to the soil clean-up criteria from 10 CFR Part 40 Appendix A.*
- *ISL operations occasionally require drilling or recompletion of wells into an active mining zone. In these instances, the drill cuttings are considered 11e.(2) byproduct material and must be collected. The cuttings will be removed, dewatered, packaged and disposed at a facility licensed to receive byproduct material.*

*It is estimated that a significant portion of the equipment will meet release limits, which will allow disposal at an unrestricted area landfill. Other materials that are contaminated will be decontaminated until they are releasable. If the equipment cannot be decontaminated to meet release limits, it will be disposed of at a NRC licensed disposal facility.*

*Wellfield decommissioning will be an independent ongoing operation throughout the mining sequence. Once a production unit has been mined out and groundwater restoration and stability have been accepted by the regulatory agencies, the wellfield will be scheduled for decommissioning and surface reclamation.*

Additional references:

U.S Environmental Protection Agency, "*Technologically Enhanced Naturally Occurring Radioactive Material From Uranium Mining, Vol. 1: Mining and Reclamation Background*", EPA 402-R-05-007, revised June 2007.

## Question 6.1 Radiological Environmental Monitoring

*RAI Question:*

Radiological Monitoring Environmental Measurements and Monitoring Program, ER Section 6.1 includes an in-depth evaluation of data from the baseline radiological environmental monitoring program. However, it is not clear as to the specific program (sampling locations and media, frequency, and analysis) that is intended to be continued as the operational program. Provide details for the proposed operational program, including sampling media, locations (with an accompanying map), frequency of sampling, type analyses, detection levels, and quality control measures.

*Answer:*

New section 6.2, Airborne Effluent and Environmental Monitoring, is provided. In addition, new Addendum 6.5-A is included to provide the Uranium One Wyoming In Situ Recovery Projects Quality Assurance Plan.

*Proposed Revisions to License Application*

The following changes are proposed to the license application in response to this RAI question. Changes to the original text as submitted to NRC are noted in red-line/strikeout method.

**New Section 6.2:**

### *6.2 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAM*

*Air Particulate*

*Potential air particulate releases from the central plant processes will be monitored at the same air monitoring locations (MRA-1 through MRA-4) that were used for baseline determination of air particulate concentrations as described in Section 6.1. Sampling locations are shown on Figure 6.2-1. These locations were selected as recommended in Regulatory Guide 4.14, which calls for a minimum of three air monitoring stations at or near the site boundaries, one station at or close to the nearest occupiable structure with 10 km of the site, and one station at a control or background location. Monitoring will be performed using low volume air particulate samplers. Filters will be collected weekly to help prevent dust loading and will be composited on an approximate quarterly basis to provide respective estimates of average radionuclide concentrations and detection levels as specified in Regulatory Guide 4.14. Each quarterly batch of air filters from the four monitoring stations will be submitted to a contract laboratory for analysis of Ra-226, U-nat, Th-230, and Pb-210. Results of the operational air particulate monitoring program will be reported in the semi-annual effluent reports required by 10 CFR § 40.65.*

*Radon*

*Preoperational radon monitoring locations were selected prior to placement of air particulate monitoring stations and final selection of the central plant site. Air particulate station locations during preoperational monitoring were slightly different from "associated" radon monitoring stations due to logistical issues related to the availability of hard line electrical power for long-term site monitoring. Although some of the preoperational radon stations did not exactly coincide with air particulate station locations, in each case there was one or more radon station reasonably close to each air particulate station. Baseline Rn-222 results indicated a relatively minor degree of spatial variability in radon concentrations across the site.*

*Operational radon monitoring will be accomplished at the four air particulate stations as recommended in Regulatory Guide 4.14. The control/background air monitoring station will be represented by station number MRA-4 as shown in Fig. 6.2-1. This location is at least one mile west/southwest (i.e., upwind) of the plant location and wellfield areas.*

*Monitoring will be performed using Track-Etch radon cups. The cups will be exchanged on a semiannual basis in order to achieve the required lower limit of detection (LLD). In addition to the manufacturer's Quality Assurance program, EMC will expose one duplicate radon Track Etch cup per monitoring period.*

*In addition to the environmental monitoring, the release of radon from process operations will be estimated using the source term method described in Section 4.12.2 and will be reported in the semi-annual effluent reports required by 10 CFR § 40.65.*

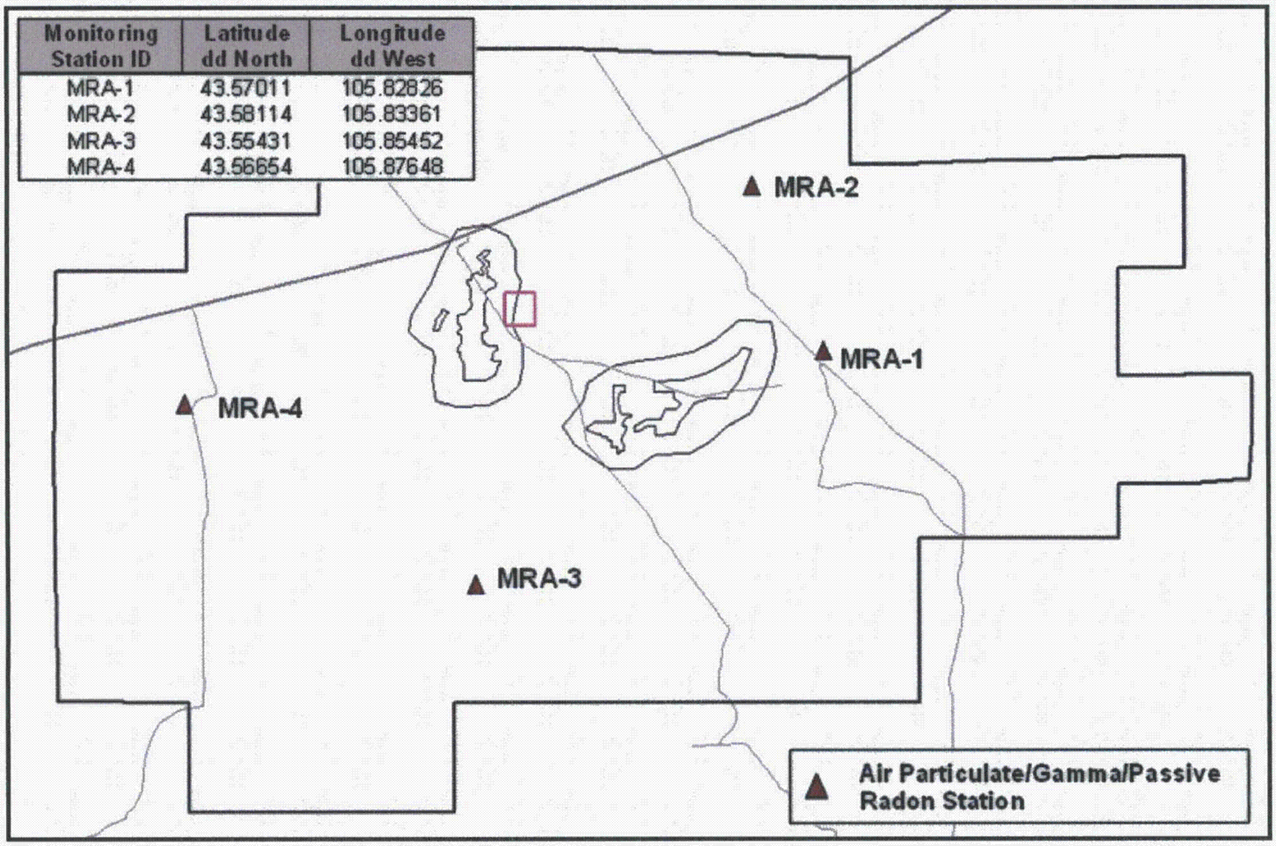
*Surface Soil*

*Operational soil sampling will be conducted on an annual basis. Locations will include each of the four air particulate sampling locations located within the site boundaries. Samples will be collected as discrete grab samples of surface soils as indicated in Table 2 of Regulatory Guide 4.14, and will be analyzed for U-nat, Ra-226, and Pb-210. Sampling depth will be 5 cm for consistency with Regulatory Guide 4.14 baseline soil sampling surveys conducted at the site.*

*Subsurface Soil*

*Regulatory Guide 4.14 does not indicate subsurface soil sampling during operational phases of the site. Post operational subsurface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.*

*Figure 6.2-1*
*Proposed Moore Ranch Uranium Project Operational Environmental Monitoring Locations*




| Monitoring Station ID | Latitude dd North | Longitude dd West |
|---|---|---|
| MRA-1 | 43.57011 | 105.82826 |
| MRA-2 | 43.58114 | 105.83361 |
| MRA-3 | 43.55431 | 105.85452 |
| MRA-4 | 43.56654 | 105.87648 |

*Vegetation*

*Preoperational vegetation samples from the Moore Ranch Uranium Project site were collected in 2007 at the locations described in Section 6.1.*

*EMC does not propose to perform operational vegetation sampling at the environmental monitoring stations. In accordance with the provisions of USNRC Regulatory Guide 4.14, Footnote (o) to Table 2 requires that "vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway..." defined as a pathway which would expose an individual to a dose in excess of 5% of the applicable radiation protection standard. This pathway was evaluated by MILDOS-Area and is discussed further in Section 4.12.2.*

*Direct Radiation*

*Environmental gamma radiation levels will be monitored continuously at the air monitoring stations (MRA-1 through MRA-4). Gamma radiation will be monitored through the use of environmental dosimeters obtained from a NVLAP certified vendor. The environmental dosimeter used for direct radiation measurements will be the InLight dosimeter from Landauer or equivalent. The InLight has a lower limit of detection of 0.1mrem. Dosimeters will be exchanged on a quarterly basis.*

*Deep Disposal Well Monitoring*

*Monitoring of liquid effluent disposed of through the deep disposal well(s) will be conducted in accordance with the Class I Underground Injection Control Permit(s) issued by the Wyoming Department of Environmental Quality-Water Quality Division.*