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July 11, 2008

Attn: Document Control Desk
Myron Fliegel
Senior Project Manager
Uranium Recovery Licensing Branch
Division of Waste Management
and Environmental Protection,
Office of Federal and State Materials
and Environmental Management Programs,
US Nuclear Regulatory Commission
Two White Flint North, MS T8F5
11545 Rockville Pike
Rockville, MD 20852

RE: ADDITIONAL INFORMATION REQUESTED FOR THE MOORE RANCH IN SITU URANIUM RECOVERY PROJECT LICENSE APPLICATION (TAC JU011), FIRST SET OF RESPONSES

Dear Mr. Fliegel:

By letter dated May 14, 2008, the U.S. Nuclear Regulatory Commission (NRC) staff requested additional information (RAI) to complete review of the license application for the Moore Ranch In Situ Uranium Recovery Project. In a letter dated June 13, 2008, Uranium One informed the NRC that responses to those RAI's would be in two parts. The first response would contain information for RAI's related to effects of coal bed methane, radiological protection and environmental monitoring, geologic descriptions, ISR operations and reclamation, effluent control, and other requests, and the second response would address the RAI's regarding unconfined conditions in the production zone, restoration pore volumes, and other concerns regarding aquifer conditions.

By this letter, Uranium One is submitting the first response to RAI's. The response includes:

Energy Metals Corporation (US)
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- A detailed written response to each RAI. If revisions to the Technical Report were made, then a reference to the applicable section where the revisions were made is provided with each response. These written responses also note which information will be contained in the second set of responses.

- 4 copies of revised sections of the Technical Report. The revised sections included in this first response include Sections 2.1, 2.5, 2.9, 3, 4, 5, and 6.

- A revision index providing instructions on replacement of revised portions of the application into the original application.

While the written responses contain detailed information on the effects of coal bed methane (CBM) operations, revisions to the Technical Report containing the CBM are anticipated to be placed in Section 2.7, Hydrology. Section 2.7 is also anticipated to contain much of the revisions addressing RAI's regarding groundwater modeling, unconfined conditions in the production zone, restoration pore volumes, and other concerns regarding aquifer conditions. As a result, Section 2.7 containing revisions related to the effects of CBM will be submitted in the next set of responses. Additionally, responses for RAI 3-2 and 3-3 will also be provided in the next set of responses as more time is needed for adequate responses.

Furthermore, the updated geologic information requested is largely complete. However, final drafting of the additional geologic cross sections and isopachs is currently underway. As a result, the additional geologic descriptions requested will be submitted with the second set of responses as noted.

A final revised Table of Contents for the revised Technical Report will also be submitted with the second set of responses once all revisions have been made. As noted in the June 13, 2008 letter, Uranium One anticipates that responses, and corresponding document revisions, for the remaining RAI's to be addressed will be complete and submitted to the NRC near the end of July, 2008.

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If you should have any questions, please contact me by phone at (307) 234-8235 ext. 330 or by email at ken.milmine@uranium1.com.

Sincerely,

Ken Milmine

Ken Milmine
Manager of Environmental and Regulatory Affairs

Enclosures: Responses to NRC Request For Additional Information
Technical Report Revision Index
Technical Report Revised Sections 2.1, 2.5, 2.9, 3, 4, 5, and 6

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URANIUM ONE AMERICAS
MOORE RANCH URANIUM PROJECT
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
TECHNICAL REPORT REVISION INDEX

VOLUME NUMBER	PAGE, MAP OR OTHER PERMIT ENTRY TO BE REMOVED	PAGE, MAP OR OTHER PERMIT ENTRY TO BE ADDED
I	All of Section 2.1	Revised Section 2.1
I	All of Section 2.5	Revised Section 2.5
II	Section 2.9, Pages 2.9-53 and 2.9-58	Revised Pages 2.9-53 and 2.9-58
II	All of Section 3	Revised Section 3
II	All of Section 4	Revised Section 4
II	All of Section 5	Revised Section 5 and Addendum 5-A
II	All of Section 6	Revised Section 6
III	All of Appendix D	Revised Appendix D-Reclamation Cost Estimate

2-1. Site Location and Layout (Section 2.1)

The applicant has not provided sufficient information regarding the site location and layout in section 2.1, to enable the staff to fully understand this topic and to support other reviews dependent on that understanding. Specifically, the following information should be provided:

a. the coordinates of the central processing plant and the distance to Casper and other major population centers;

Response:

Coordinates of the Central Processing Plant and distances to Casper and other major population centers was added to Section 2.1.

b. the total area within both the proposed license boundary and restricted area;

Response:

The total area within the proposed License boundary and restricted areas was added to Section 2.1.

c. a topographic map of the entire proposed licensed area; and

Response:

Figure 2.1-2 was revised to include the entire proposed license area.

d. a map of the main processing area showing the topography, site drainage, layout of and access to buildings, and proposed roads.

Response:

New Figure 2.1-3 was developed showing the main processing area showing the topography, site drainage, layout of and access to buildings, and proposed roads

2-2. Meteorology (Section 2.5)

The applicant has not provided sufficient information regarding the meteorological and atmospheric diffusion characteristics of the site in section 2.5. Specifically, the following information should be provided:

a. The applicant indicated that no onsite meteorological data was collected at the Moore Ranch site but instead, used meteorological data collected from Antelope Coal (ACC) and Glenrock Coal (GCC) to represent the Moore Ranch site. However, the applicant has not discussed its basis to assume that the data can be used to represent the Moore Ranch site without any data from the Moore Ranch site. Therefore, provide the justification to use the data from these two sites (ACC and GCC), without onsite meteorological data, to represent the Moore Ranch site.

Response:

The proposed project is situated in east-central Wyoming. It is encompassed by the area between the North Platte valley and the Montana border, generally referred to as the Powder River Basin (PRB). Due to uniformities in geography and climate, the PRB is treated by state and federal regulators as a single air quality control area.

As stated in the conclusion of the Climatology Report, the Antelope Mine (ACC) meteorology most nearly represents that of the Moore Ranch project site, and is therefore proposed as the source of meteorological data to be substituted for on-site monitoring. Data from the Glenrock Mine (GCC) was intended only to supplement ACC and to support the general conclusions made regarding local meteorology. To illustrate the similarities between Moore Ranch and ACC, several images from Google Earth are presented below. Figure 2.2a-1 shows an aerial view of the Moore Ranch area, and Figure 2.2a-2 shows a similar view of the ACC site (with meteorological station pinpointed). The ACC site has similar topographic features (Figure 2.2a-3) and is about 25 miles from the project site (Figure 2.2a-4). Both sites are characterized by mildly rolling hills covered with grass and sparse shrubs. The nearest mountain ranges are:

- the Bighorn Mountains, approximately 50 miles from the Moore Ranch project site and 75 miles from ACC
- the Black Hills, approximately 60 miles from ACC and 85 miles from the Moore Ranch
- the northern Laramie Range, approximately 50 miles south of Moore Ranch and 65 miles southwest of ACC

Due to these large distances, neither the ACC site nor the Moore Ranch site experiences significant wind channeling or shielding from any of the three mountain ranges. Also, there are no major bodies of water affecting the meteorology of these two sites. The ACC site is several hundred feet lower in elevation than Moore Ranch. Both, however, are situated on the southeasterly side of the hydrologic divide with a similar vertical relationship to the divide.

FIGURE 2.2a-1

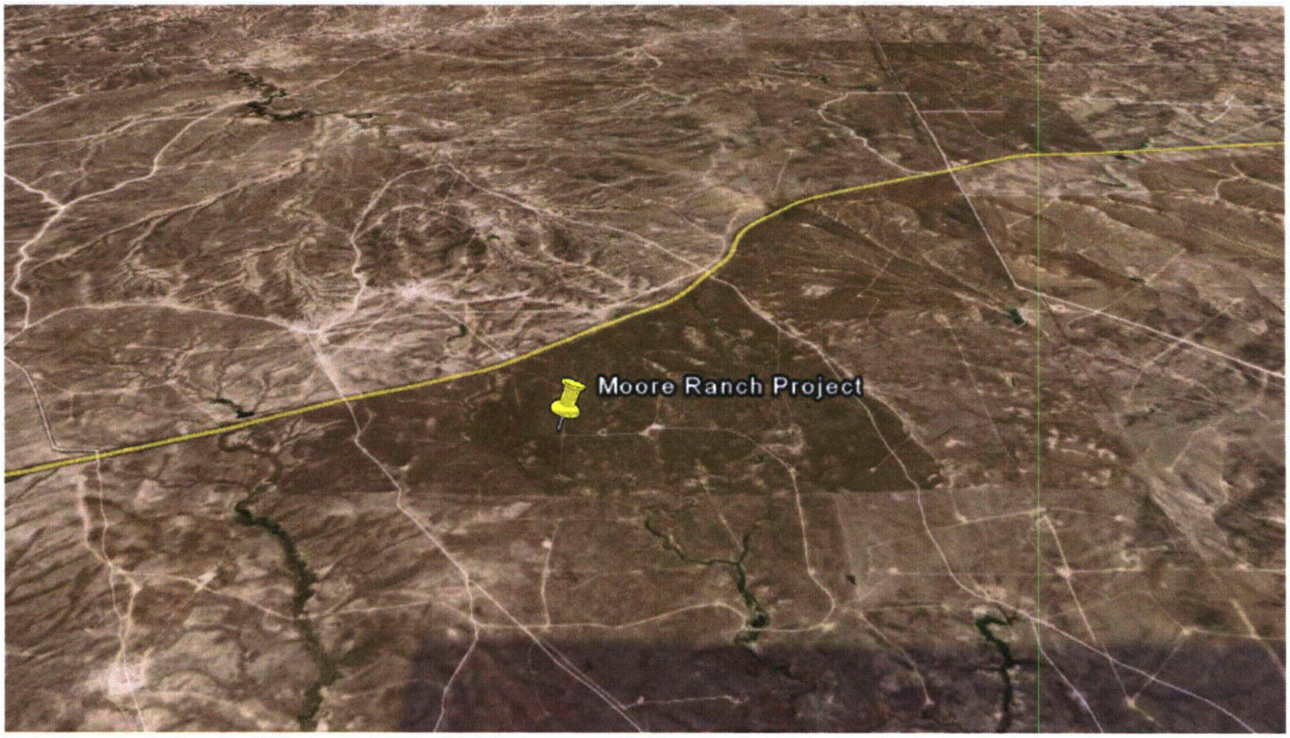


FIGURE 2.2a-2

FIGURE 2.2a-3

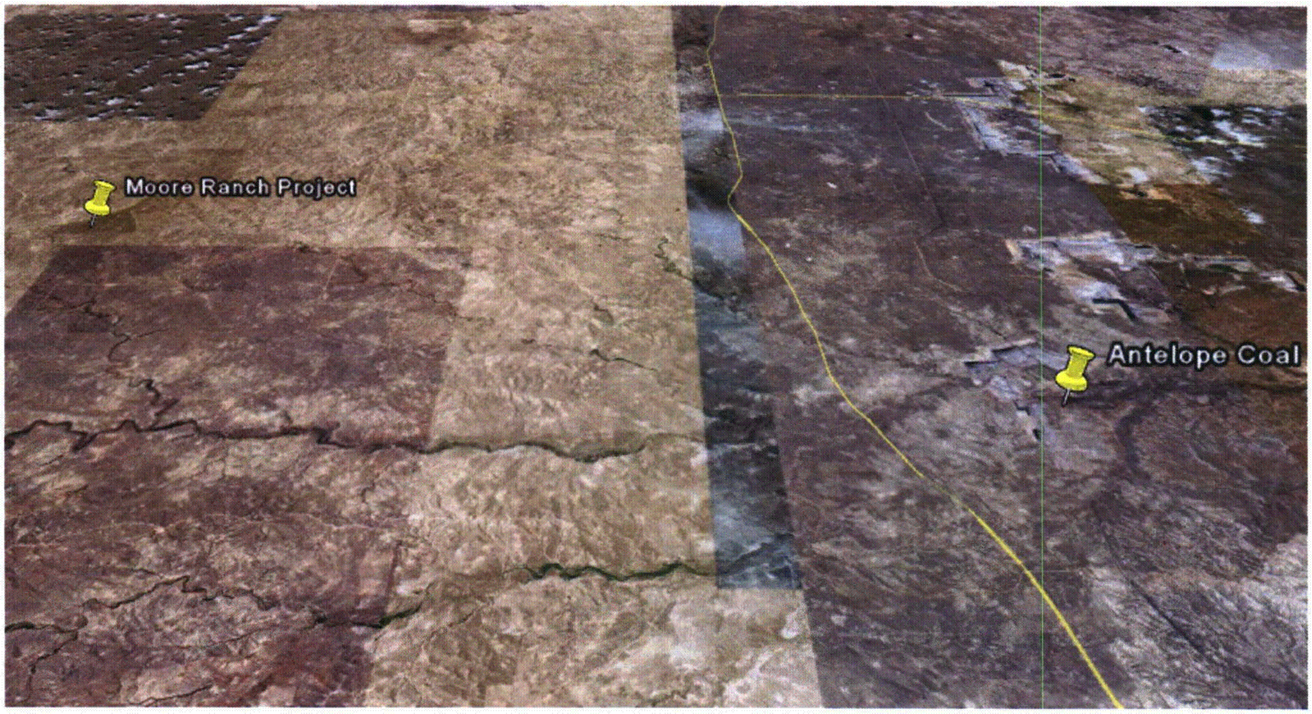
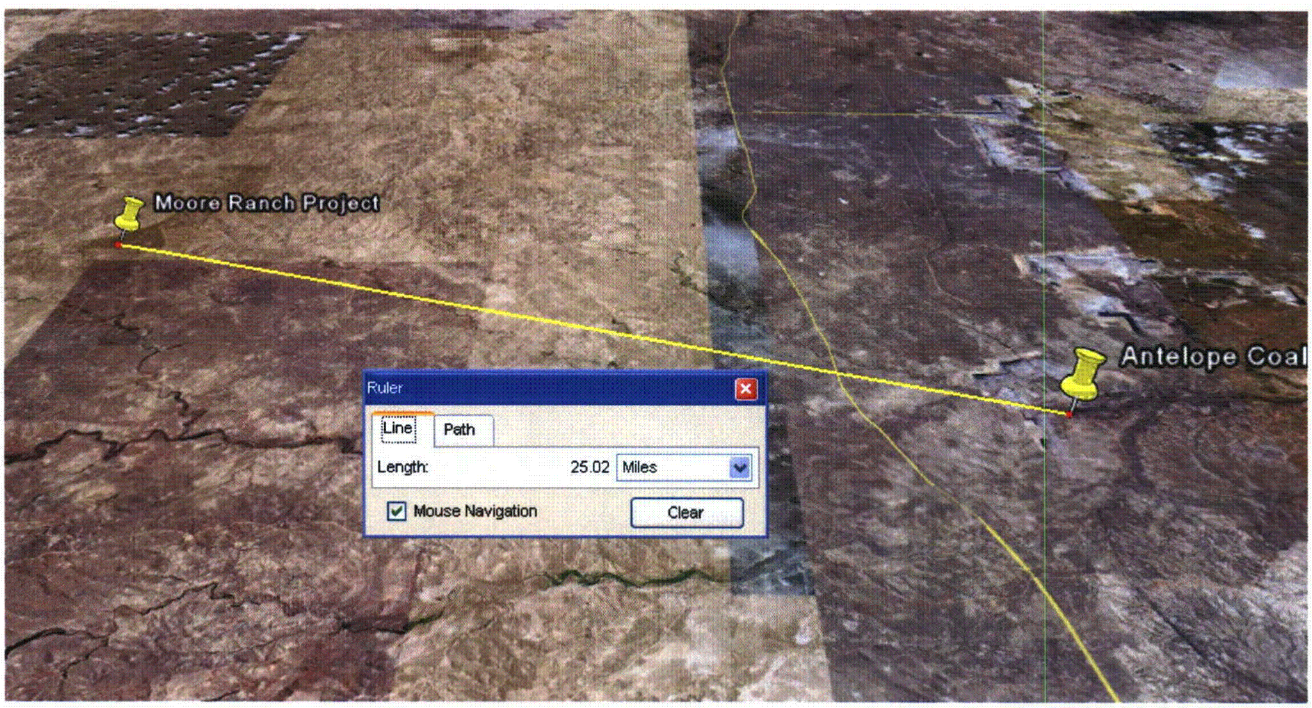


FIGURE 2.2a-4



Section 2.5 of the application was revised to include the above information.

2-2. Meteorology (Section 2.5) Cont.

b. The joint frequency data for each site (ACC and GCC) are shown in Table 2.5-9 and Table 2.5-10 of the Technical Report, respectively. However, the joint frequency data in Appendix E appears to be different from the data shown in Tables 2.5-9 and 2.5-10. Please explain the relationship between the joint frequency data from these tables (Table 2.5-9 and Table 2.5-10) and the joint frequency data in Appendix E of the Technical Report. Specifically, how was the joint frequency data generated in Appendix E and what time period does it represent? Also describe the instruments, locations and heights of the instruments, average inversion height, and annual average mixing layer heights.

Response:

The joint frequency distributions (JFD's) provided in Table 2.5-9 and Table 2.5-10 were taken from 10 years of meteorological data (1997-2006) at the ACC and GCC sites. The star distribution provided in Appendix E is from 5 years (2001-2006) of data at ACC. For all the JFD's, Pasquill stability classes were determined from the standard deviation of horizontal wind direction (sigma theta method).

Inversion and mixing heights were not presented in the original Climatology Report. The nearest upper-air data available from the National Weather Service are from Riverton, Wyoming or Rapid City, South Dakota. In both cases, the large distance from the southern PRB and the proximity to prominent mountain ranges make them ill suited to represent the Moore Ranch project site.

The Air Quality Division of the Wyoming Department of Environmental Quality (WDEQ-AQD) has provided statewide mixing heights to be used in dispersion modeling with the Industrial Source Complex (ISC3) model. These are based on the methods of Holsworth (1972) as applied to Lander, located in central Wyoming. For modeling purposes, the annual average mixing heights are assigned according to stability class as follows:

Class A	3,450 meters
Class B	2,300 meters
Class C	2,300 meters
Class D	2,300 meters
Class E	10,000 meters
Class F	10,000 meters

Stability classes E and F are given an arbitrarily high number to indicate the absence of a distinct boundary in the upper atmosphere.

In August of 2000, IML Air Science conducted Sound Detection and Ranging (SODAR) monitoring at the Black Thunder Mine, located approximately 20 miles north of the ACC site. The purpose of this monitoring was to support a comprehensive study of NO_x dispersion characteristics following overburden and coal blasting events. The SODAR instrument provided 3D wind speeds, wind directions, temperatures, temperature gradients, and other atmospheric parameters as a function of height above the ground.

The vertical range of the SODAR was 1,500 meters, with a sounding performed every 15 minutes. Each sounding resulted in a calculated "inversion height / mixing height" (the two terms are used interchangeably by the SODAR system supplier). For purposes of this response to NRC, these mixing heights were downloaded into a database and queried, with results shown in Table 2.2b-1. Morning and afternoon time intervals were taken from EPA modeling guidance.

TABLE 2.2b-1

Time Period (Filtered)	Number of Data Points	Average Mixing / Inversion Height
Morning (2 am – 6 am)	193	641 meters
Afternoon (12 pm – 4 pm)	152	1,052 meters

Since the SODAR definition of mixing height appears somewhat ambiguous, and these measurements were all from August, it is not known whether they would qualify as meteorological inputs to the MILDOS model.

Because of the extensive surface coal mining that has developed over the last 30 years, the PRB airshed is one of the most heavily monitored in the country. Coal production in the PRB grew from a few million tons in 1973 to over 400 million tons in 2006. The Clean Air Act and the Surface Mining Control and Reclamation Act of the 1970's prompted a parallel growth in ambient air quality monitoring throughout the PRB. This has led to over 100 particulate monitoring samplers and more than 20 meteorological monitoring towers, all configured to support air quality permitting, compliance and research objectives.

The monitoring programs at these sites meet the Wyoming Department of Environmental Quality requirements for land and air quality permit compliance. Methods used in collecting and validating these data adhere to EPA's "On-Site Meteorological Program Guidance For Regulatory Modeling Applications." Hourly average values for various parameters are generated by field instruments and recorded by continuous data loggers, all operated and maintained by IML Air Science. Data recovery has typically exceeded 95%. Depending on the mine, meteorological parameters logged include wind speed, wind direction, sigma theta, ambient temperature, barometric pressure, solar radiation and precipitation. All hourly data are downloaded to IML Air Science's relational database. The database software provides for quality assurance, invalidation of suspect or erroneous data, and various forms of data presentation.

Table 2.2b-1 lists the meteorological instruments employed at the Antelope (ACC) and Glenrock (GCC) mines. The coordinates and elevations of both sites are presented, along with instrument models, accuracy specifications, and instrument heights above the ground.

Section 2.5 of the application was revised to include the above information.

TABLE 2.2b-1

Antelope	10m tower	CR10X Data Logger		Lat: 43° 28' 08.92" Elev. 4,680 ft Long: -105° 20' 57.56"	
Parameter	**Instrument**	**Range**	**Accuracy**	**Threshold**	**Instrument Height**
Wind Speed	RM Young Wind Monitor AQ	0-112 mph	±0.4 mph or 1% of reading	0.9 mph	10 meters
Wind Dir	RM Young Wind Monitor AQ	0-360°	±3°	1.0 mph	10 meters
Temp	Fenwall Electronics Model 107	-35°- 50° C	±0.5° C @ given Range	--	2 meters
Precip	Met One 12" tip	Temp: -20° - 50° C	±0.5% @ 0.5 in/hr rate	--	1 meter
Bar Press	Vaisala PTB 101B	600 -1060 mb	±0.5 mb @ 20°C	--	2 meters
Glenrock	10m tower	CR10 Data Logger		Lat: 43° 03' 36" Elev. 4,910 ft Long: -105° 50' 24"	
Parameter	**Instrument**	**Range**	**Accuracy**	**Threshold**	**Instrument Height**
Wind Speed	RM Young Wind Monitor AQ	0-112 mph	±0.4 mph or 1% of reading	0.9 mph	10 meters
Wind Dir	RM Young Wind Monitor AQ	0-360°	±3°	1.0 mph	10 meters
Temp	Fenwall Electronics Model 107	-35°- 50° C	±0.5° C @ given Range	--	2 meters
Precip	Met One 8" tip	Temp: -20° - 50° C	±0.5% @ 0.5 in/hr rate	--	1 meter

2-2. Meteorology (Section 2.5) Cont.

c. Please discuss any bodies of water or special terrain features that may affect the meteorological conditions at the Moore Ranch Uranium Project site.

Response:

As mentioned above, there are no bodies of water or special terrain features that would alter the general meteorological conditions at either the Moore Ranch site or the ACC site. Nearby drainages support small, ephemeral streams. The maximum relief throughout this gently rolling terrain is a few hundred feet.

2-3. Geology and Seismology (Section 2.6)

The cross sections and some geologic descriptions provided in section 2.6 are insufficient to interpret the geology of the license area. Please provide the following:

a. All of the cross sections redrawn to a MSL datum with surface elevations clearly shown to ensure their proper interpretation with respect to site topography.

Response:

This information will be submitted with the next RAI response package.

b. Where possible, develop cross sections using more and deeper boring logs to better define the presence or absence of overlying and underlying shales, and sandstones. At least one cross section should show the coal bed methane (CBM) production zone relative to the proposed mining zone.

Response:

This information will be submitted with the next RAI response package.

c. Where possible, the cross sections should also be lengthened past the edges of the well fields to at least the locations of the proposed monitoring well rings.

Response:

This information will be submitted with the next RAI response package.

d. Redraw cross sections to show the "60 sand" which is located below the "68 sand" and the shale layer which separates them. Provide an isopach of the "60 sand" if possible.

Response:

This information will be submitted with the next RAI response package.

e. Provide more cross sections which show the two deeper sand zones, the "50 sand" and "40 sand", and isopachs if possible. These sands are noted on cross sections C-C' (one well log) and E-E' (three well logs), but their interpretation is questionable given the minimal number of logs used to define them.

Response:

This information will be submitted with the next RAI response package.

f. The isopach for the shale overlying the "70 sand" indicates it is missing across about 500 feet in Wellfield 3, just west of cross section B-B'. Please confirm this observation. If true, address the impact of its absence on hydrology and excursion monitoring of Wellfield 3 to determine if mining can be undertaken. (see also RAI 2-7.e.)

Response:
This information will be submitted with the next RAI response package.

2-4. Surface Water Hydrology (Section 2.7)

The analysis of the surface water hydrology in the proposed license area is currently insufficient to determine the potential for floods to disrupt the operation of the facility nor to interpret the impact of mining on water quality in and around the license area. Please provide the following:

a. Provide maps clearly showing the location, size and shape of surface water features within the proposed license area, including the area around the central plant facility. Provide maps showing areas inundated during major flood events.

Response:

Figure 2.8.5-2 shows the locations, size and shape of surface water features within the proposed license area, including the area around the central plant facility. These surface water features will be areas of inundation during major flood events caused from short term rapid runoff resulting from major precipitation or snow melt events. As can be see in Figure 2.8.5-2, the process facilities are located on the top of a high ridge and will not be inundated during major runoff events.

b. Provide maps which show the NPDES permitted CBM produced water discharge points in or surrounding the license area which discharge into surface water features including drainages.

Response:

Currently, three Wyoming Pollutant Discharge Elimination System (WYPDES) permits exist within or adjacent to the license area. The following table summarizes these permits.

Table 2-4.b WYPDES Permits in or near the Moore Ranch Project

WYPDES Permit	Facility Name	Operator
WY0040436	East Pine Tree Unit	Devon Energy Production Company
WY0051217	Palm Tree Project	Bill Barrett Corporation (BBC)
WY0055131	BBC Pine Tree Area	Bill Barrett Corporation (BBC)

Outfalls permitted under the three WYPDES permits are presented on Figure 2.7.-A1. The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

c. For each CBM produced water discharge point, provide NPDES permit volumes and water quality standards for discharge. Also describe the presence of structures or any other features which enhance groundwater infiltration at these CBM water discharge points.

Response:

Table 2-4.c provides the WYPDES effluent limitations for Devon's East Pine Tree Unit CBM Facility (WY0040436), Bill Barrett Corporation's (BBC) Palm Tree Project CBM Facility (WY0051217) and BBC Pine Tree Area Permit (WY0055131).

Table 2-4.c WYPDES Effluent Limitations for Permits in or near the Moore Ranch Project

Devon – East Pine Tree Unit (Outfalls 001-002, 004-015, 017-030)[1]	
Effluent Characteristic	**Daily Maximum**
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, mircromhos/cm	2000
Total Recoverable Arsenic, µg/L	2.4
Total Recoverable Barium, µg/L	1800
Total Dissolved Solids, mg/L	5000
Total Flow[4], MGD	0.68
BBC – Palm Tree Project (Outfalls 001 - 025)[2]	
Effluent Characteristic	**Daily Maximum**
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, mircromhos/cm	2000
Total Recoverable Arsenic, µg/L	3.0
Total Recoverable Barium, µg/L	1800
Total Flow[4], MGD	5.3
BBC – BBC Pine Tree Area (Outfalls 004 - 008)[3]	
Chlorides, mg/L	46
Dissolved Iron, µg/L	1000
pH, su	6.5 – 9.0
Sodium Adsorption Ratio	10
Specific Conductance, micromhos/cm	2000
Total Recoverable Arsenic, µg/L	3.0
Total Recoverable Barium, µg/L	1800
Total Flow[4], MGD	1.02

[1] Devon's East Pine Tree Unit permit (WY0040436), effective August 30, 2007.
[2] BBC's Palm Tree Project permit (WY0051217), effective February 4, 2008.
[3] BBC's BBC Pine Tree Area permit (WT0055131), effective October 4, 2007.
[4] Total flow is for all outfalls permitted under each permit number, in million gallons per day.

Table 2-4.c1 provides a list of reservoirs permitted through the Wyoming State Engineers Office (WSEO) within the license area that may be impacted by CBNG produced water discharge. The reservoir locations are depicted on Figure 2.7.1-1

Table 2-4.c1 WSEO Permitted Reservoirs with the Moore Ranch License Area

SEO Permit No.	Qtr-Qtr	Section	Township	Range
P16543S	NWSW	1	41N	75W
P14042S	NWNE	25	42N	75W
P14041S	SESW	25	42N	75W
P14040S	SWSE	25	42N	75W
P14043S	NWNE	26	42N	75W
P14036S	SWSW	26	42N	75W
P14037S	NESE	27	42N	75W
P14038S	SWSE	35	42N	75W
P14039S	NWSE	36	42N	75W

The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

d. Provide provisions for erosion protection against the effects of flooding from drainages Wash No.1 and Upper and Lower Wash No. 2 which pass near or through planned wellfields. All berms, culverts, rock riprap, drainage or diversion channels are suggested to follow a design which meets the requirements of 10 CFR Part 40, Appendix A.

Response:

Several small dams and ponds exist within and downstream of the project that provide a level of control and storage of surface water. During normal runoff conditions, these ponds will contain all upgradient runoff. Many of these water features may contain higher levels of water after spring runoff or after large precipitation events but are generally reduced to small, isolated pools or are completely dry by the end of the summer. Relatively small amounts of surface discharge from coal-bed methane operations may also maintain small pools of water in these ponds during dry summer months.

Installation of Wellfield 2 monitor, injection, and production wells in main ephemeral stream channels will be avoided if possible. If it is necessary to install a well within the high water marks of a ephemeral channel, then adequate structural wellhead protection will be installed to protect the wells during potential flood conditions. Wellhead protection could include concrete berms, or reinforced steel/concrete well covers, etc. Properly sized culverts will be used for secondary access roads crossing across small drainages. Efforts will be made to construct secondary access roads to avoid crossing major drainages. However, if crossing a major drainage is required, then adequately sized culverts will be utilized and embankments will be protected from erosion using adequate best management practices (rip rap, rock, etc.) in accordance with WDEQ-LQD Rules and Regulations, Chapter 3. Culverts across significant drainages will be designed to pass the 25-year peak runoff event using head available at the entrance. The minimum culvert size of 18" will be utilized to divert drainage from roads or for crossing small drains or swayles. Crossings for major drainages will be constructed at or near right angles.

Section 2.7.1.4 was revised to include this information. Revisions to Section 2.7 will be submitted with the next RAI response package.

e. Discuss the potential for flooding of the area around the central plant facility and the provisions to protect critical equipment and components.

Response:

Figure 2.8.5-2 and 2.8.5-8 show surface water features within the Moore Ranch Project Area in relation to proposed facilities and wellfields. Figures 2.1-2 and 2.1-3 also show the facilities in relation to surrounding topography. The central processing area and wellfield are located well above any surface water features that would be inundated during flooding events, and also located in a manner that insignificant runon will occur from upgradient sources. Runoff in these areas will consist primarily of overland sheet flow. The central plant and facilities area will be graded and sloped to direct precipitation runoff away from building foundations in all directions to a storm water conveyance system. Potential runon will also be intercepted and directed around the central plant area. The stormwater conveyance system will be designed to meet the flow capacity of a ???-year runoff event. Due to the location of Wellfield 1 and the central plant area related to the surrounding topography, impacts from flooding are expected to be minimal.

The stream channel in Upper and Lower Wash No. 2 is located near the center portion of Wellfield 2. The previous hydrologic analysis conducted by Conoco determined representative channel cross sections for Upper and Lower Wash No. 2 and water crest heights for 100-year and 5-year floods (see Appendix B for previous hydrologic analysis conducted by Conoco. Channel cross sections for Upper Wash No. 2 in the vicinity of Wellfield 2 (approximately 650 feet upstream) show a channel inundation depth of approximately 2.9 feet at a velocity of 7.4 ft/second. As shown Figure 2.8.5-8, the channel widens somewhat through Wellfield 2, so the water depth and velocity in the channel during a 100-year flood through Wellfield 2 is anticipated to be less than 2.9 feet and 7.4 ft/second. However, due to the ephemeral nature of the drainages in the area, this channel is typically contains no flow.

Section 2.7.1.3 was added to Section 2.7 to include this information. Also, previous hydrologic analysis conducted by Conoco was added to Appendix B. Revisions to Section 2.7 will be submitted with the next RAI response package.

2-5. Ground Water Hydrology – 72 sand aquifer (Section 2.7)

The applicant must provide a comprehensive description and explanation of the presence of the "72 sand aquifer" which appears to be an artificial perched aquifer created by coal bed methane (CBM) produced water discharge at the surface. If true, its compromised water quality may have implications for the operation of an ISL operation where it will be defined as both the surficial and overlying aquifer. Please provide the following:

a. EMC has identified the "72 sand" as the overlying aquifer. It is not clear to NRC if the "72 sand" aquifer is or has been historically present across the license area. Provide information on the presence or absence of this perched aquifer including the potentiometric surface in the "72 sand" over time as discussed in NUREG-1569.

Response:

Between 1979 and 1981 Conoco installed 35 piezometers in section 35, T42N, R75W and section 1, T41N, R75W as part of an evaluation of proposed mine tailings and evaporation pond sites. The piezometers were installed in discrete lithologic units (silts, sands, coals and alluvium) contained in the 72 sand aquifer. Two of these piezometers were completed near OMW-2 in sandy sections of the aquifer. The measured water elevations for both wells are similar to the elevations measured currently in the 72 sand. Data from the piezometers and monitor well OMW-2 are presented in Table 2-5.a. While saturated thickness levels are below those currently measured in OMW-2, this is likely a relict of completion methods versus quantity of water in the formation. Of the 35 piezometers completed for Conoco's Appendix D-6, only two lacked groundwater. EMC believes the presence of water in the 72 sand in 1979-1980 (some 21 years prior to CBNG development) indicates that the aquifer has been historically present in the area and is not the result of CBNG development. Additionally, stockwell P14682P, located in the SENW quarter of section 26, T42N, R75W and completed in the 72 sand aquifer has been a source of livestock water since the early sixties.

Table 2-5.a Shallow Tailings Area Piezometer Characteristics

Well/Piezometer I.D.	Total Depth	Depth to Water (Ft)	Saturated Thickness (Ft)	Static Water Elevation (Ft. AMSL)	Water Level Date
OMW-2	**78**	**67.62**	**10.38**	**5244.88**	**2/9/2007**
35N-6	**90**	**86.87**	**3.13**	**5236.5**	**5/15/1980**
35N-7C	**84**	**82.09**	**1.91**	**5229.3**	**5/15/1980**

The above information was included in Section 2.7. Revisions to Section 2.7 will be submitted with the next RAI response package.

b. It is possible that the "72 sand" may have received infiltration of CBM produced water at WPDES permitted surface discharge points in the license area. Provide information on the possible infiltration of CBM produced water to the "72 sand" in the past or explain why no CBM produced water would have entered or will enter the "72 sand" from CBM WPDES discharge points on the surface.

Response:

As noted in the License Application, the groundwater within the 72 sands is of the calcium-sulfate type. Shallow groundwater monitoring associated with CBNG water storage facilities in the area also indicates calcium-sulfate type water under baseline conditions (WDEQ-WQD, Sheridan Office, 2008). Groundwater quality data from three monitor wells installed by methane producers in sections 4, 15 and 22 of T42N, R75W, are also of the calcium-sulfate type (MW4-2, MW23-15 and MW22-1). These three wells are under water table conditions and have not received any infiltration from water produced during coal-bed development because they were installed prior to the discharge of CBNG produced water. Based on elevation relationships, it is highly likely that the wells in sections 15 and 22 are installed in the 72 sand aquifer. Similarly, the groundwater encountered in piezometers 35N-6 and 35N-7C (Conoco, 1981) is of the calcium-sulfate type. Both of these piezometers were completed in sandy portions of the 72 sand aquifer.

Shallow aquifer systems which have received CBNG water typically display an evolution from calcium-sulfate to sodium-bicarbonate type (WDEQ-WQD, Sheridan Office, 2008). CBNG water within this area is of the sodium-bicarbonate type. Data from a monitor well (MWAL21-20-1) installed in a shallow alluvial system located in the NENW of section 20, T43N, R77W have been included on the attached Piper diagram. These data show the influence from infiltration of CBNG water as sodium and bicarbonate become the dominant ions in the shallow groundwater. The evolution from a calcium-sulfate based water type to sodium-bicarbonate occurred along with a decrease in total dissolved solids. Although groundwater in OMW-3 is somewhat atypical because of the significant presence of the bicarbonate ion, bicarbonate concentrations are far below those observed from nearby CBNG outfalls and the dominant cation remains calcium versus the prevalent sodium from CBNG discharges.

Comparison of the ambient water quality measured in the 72 sand to data from a system being altered by infiltration, indicates that the 72 sand has not received infiltration from nearby discharges. The potential for the water quality of the 72 sand to be impacted by infiltrating CBNG discharges was evaluated through a basic linear velocity analysis using conservative estimates to delineate; 1) minimum travel time for CBNG produced water to infiltrate from the surface through the overlying silts and clays to the top of the sandy portion of the 72 aquifer, and 2) minimum travel time between infiltration into the sandstone (either underlying an impoundment or recharge directly into a sandstone outcrop) to the closest monitoring point. The basic assumptions that were made lead to exceedingly conservative velocities and travel times (see attached Table 2-5.b). Fundamentally, utilizing conservative values for thickness, hydraulic conductivity and porosity it is theoretically possible for the 72 sand to receive water during the lifespan of the Moore Ranch Project. Infiltration into outcrops or subcrops of the 72 sand to where it could potentially reach monitoring locations is less likely, with travel times on the order of tens to hundreds of thousands of years.

Anecdotal evidence provided by the WDEQ-WQD for surface water facilities permitted to receive CBNG produced water provides few instances in which water infiltrating from the facilities has adversely impacted groundwater resources. Groundwater quality has been adversely affected and class of use has changed at only 16 out of 109 permitted impoundments due to infiltration from overlying reservoirs/infiltration pits. Typically, the class of use has changed due to increases in the concentrations of selenium, TDS or sulfate. These data represent nearly four years of data collection from 259 monitor wells installed at sites across the Powder River Basin. Based on the lack of change in groundwater chemistry in the 72 sand aquifer from 1980 to the present, there is no evidence to suggest that this aquifer is impacted.

The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

Table 2-5.b Estimated Linear Travel Times to the 72 Sand Aquifer System

Unit	Thickness (ft)		Thickness (cm)	K (cm/sec)	Porosity (unitless)	(dh/dl)	Average Linear Velocity (cm/sec)	Average Linear Velocity (ft/day)	Travel Time (days)	Travel Time (years)
Overburden Siltstone	Minimum	30	914	1.0E-04	0.35	1	2.9E-04	0.810	37	0.1
		30	914	1.0E-05	0.35	1	2.9E-05	0.081	370	1.0
		30	914	1.0E-06	0.35	1	2.9E-06	0.008	3704	10.1
	Average	115	3505	1.0E-04	0.35	1	2.9E-04	0.810	142	0.4
		115	3505	1.0E-05	0.35	1	2.9E-05	0.081	1420	3.9
		115	3505	1.0E-06	0.35	1	2.9E-06	0.008	14199	38.9
	Maximum	200	6096	1.0E-04	0.35	1	2.9E-04	0.810	247	0.7
		200	6096	1.0E-05	0.35	1	2.9E-05	0.081	2469	6.8
		200	6096	1.0E-06	0.35	1	2.9E-06	0.008	24694	67.7

Unit	Distance to monitoring point (ft)	Distance (cm)	K (cm/sec)	Porosity (unitless)	(dh/dl)	Average Linear Velocity (cm/sec)	Average Linear Velocity (ft/day)	Travel Time (days)	Travel Time (years)
72 Sand	9151	2.8E+05	1.0E-06	0.25	0.004	1.6E-08	4.4E-05	2.1E+08	5.7E+05
	851	2.6E+04	1.0E-06	0.25	0.004	1.6E-08	4.4E-05	1.9E+07	5.3E+04

Indicates most conservative travel time and velocity estimate (thinnest overburden, highest K)
Indicates measured variables used in calculations. Values are from Conoco, 1981 and EMC, 2007
Distance is measured from approximate sandstone outcrop on South Fork Ninemile Creek (NESE, S10, T41N, R75W) to monitor well OMW-4
Distance is measured from outfall 020 EPTD to OMW-2 (area where overburden siltstone is thinnest)

The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

c. If EMC determines the "72 sand" has received infiltration from CBM produced water discharge, it may influence the water quality in the "72 sand" at different locations which receive the infiltration. This could affect the evaluation of ISL operation impacts on surface water, surface spills and how to monitor excursions to the "72 sand" monitoring wells. Explain how EMC will monitor surface water, spill impacts and the "72 sand" to separate CBM impacts from ISL impacts including how excursion indicators be chosen and upper control limits will be determined or justify why it will not be a problem and the proposed indicators are sufficient.

Response:

As stated in the previous response, the 72-sand does not indicate impacts from nearby CBM discharges, which. As a result, the proposed indicators are sufficient.

2-6. Ground Water Hydrology – unconfined aquifer (Section 2.7)

The unconfined aquifer in the proposed "70 sand" production zone is a unique setting for an ISL operation. The unconfined aquifer setting presents an entirely different hydrogeologic flow regime which has implications for well field balancing, communication with monitoring wells and overlying and underlying aquifers, excursion monitoring /correction, lixiviant behavior and restoration. Please provide the following information:

a. Only one potentiometric surface was provided for the "70 sand." Provide the potentiometric surface in the "70 sand" over time as discussed in NUREG-1569.

   Response:

   This information will be submitted with the next RAI response package.

b. EMC states the "70 sand" is unconfined across the license area. However, EMC used a confined analysis method to evaluate all of the Conoco pump tests and EM 2007 pump tests in the "70 sand." Provide the details which show the confined analysis is an acceptable approach or revaluate the "70 sand" pump tests using an unconfined analysis to provide estimates of unconfined conductivity and specific yield for the "70 sand."

   Response:

   This information will be submitted with the next RAI response package.

c. The EMC pump tests show very small drawdowns and lack of response in observation wells over the license area in the unconfined "70 sand" even when pumping rates were large over many days. These pump tests confirm the small drawdown may make it difficult to demonstrate communication across the production zone, with monitoring wells and isolation from the overlying and underlying aquifers. Explain how future pump tests will be designed for the "70 sand" to provide adequate hydrogeologic characterization of the wellfields given this small drawdown. This may include the use of more pump tests with observation wells on closer spacing.

   Response:

   This information will be submitted with the next RAI response package.

d. EMC acknowledges that reduced drawdowns are occurring in the unconfined aquifer in the "70 sand" in response to pumping. NRC staff is concerned this will impact wellfield balancing, excursion prevention/correction and excursion monitoring. Explain how EMC will operate the well fields to address the impact of small drawdowns on operations and excursion prevention/control or justify why it is not an issue.

   Response:

   This information will be submitted with the next RAI response package.

e. NRC staff is concerned that lixiviant composition and flow could be impacted by the unconfined aquifer setting (e.g. added oxygen may evolve out of solution to create a gas and liquid phase in the ore body, which can lead to reduced permeability and preferential flow paths). Therefore, address in detail the implications to lixiviant composition and flow of the unconfined aquifer setting.

Response:

This information will be submitted with the next RAI response package.

f. NRC staff is concerned that unconfined conditions may impact restoration if sweep can not be achieved in all zones in the "70 sand". Explain how EMC will ensure sweep of all zones in the unconfined aquifer during restoration or explain why it is not an issue.

Response:

This information will be submitted with the next RAI response package.

g. EMC has stated that recharge enters the "70 sand" one mile southeast of the license area. NRC is concerned that the influx of oxidized water entering the unconfined "70 sand" from the nearby recharge zone may impact the stability of the restoration if chemical or biological reductants are employed to achieve restoration. Explain how EMC will ensure stability in this case or why it is not an issue.

Response:

This information will be submitted with the next RAI response package.

2-7. Ground Water Hydrology – 70 sand aquifer communication with 68 sand (Section 2.7)

The confinement of the "70 sand" is in question based on the acknowledged absence of the underlying shale between the "70 sand" and "68 sand" in a large portion of Wellfield 2, the potential absence of the underlying shale in Wellfield 1, and the absence of overlying shale on the isopach just northwest of Wellfield 3.

a. Provide the potentiometric surface variability in the "68 sand" over time as discussed in NUREG 1569 and determine the vertical gradients between it and the "70 sand" over the license area.

Response:

This information will be submitted with the next RAI response package.

b. EMC states that in Wellfield 2, the "70 sand" and the "68 sand" coalesce in a large section. This is confirmed by isopachs, geological cross sections, and by pump tests. NRC staff is concerned that ISL operations in the "70 sand" in this wellfield will significantly impact the water quality in the "68 sand". Explain how EMC will prevent any excursions into the "68 sand" and monitor for excursions in the "68 sand" in Wellfield 2.

Response:

See Response to RAI 5-12(b) and 6-1(b)

c. EMC indicated that there is potential communication between the "70 sand" and underlying aquifer "68 sand" in the southern portion of Wellfield 1 as shown by the Conoco pump test. Either confirm if there is communication or provide evidence of no communication. If communication exists, explain how EMC will prevent and monitor for excursions in this location.

Response:

Pump tests were conducted in this area and no communication between the 68 and 70 sand was evident. This information will be submitted with the next RAI response package.

d. EMC describes an unexplained drawdown of 25 ft in UMW 3 in Wellfield 1 in the "68 sand" starting in Feb. 2007 and continuing until mid-August. NRC staff is concerned that there may be a nearby unidentified pumping well which is impacting the "68 sand," given the characteristics of this drawdown and recovery. Provide an explanation for this drawdown during this period.

Response:

The unexplained drawdown observed in the water levels of UMW-3 from February through July of 2007 does not correspond with production from nearby CBNG wells. Production from the six closest wells was ongoing through both drawdown and subsequent recovery of the water levels in UMW-3. Water production from the CBNG wells in March 2008 was more than 5,780 bbls/day (WOGCC, 2008), while the water levels in UMW-3 stabilized in February 2008. The majority of this has come from the 34S-1 (NENE, Section 34, T42N, R75W) and 35S-4 (NWNW, Section 35, T42N, R75W). Impacts to the monitor well due to CBNG production seems highly unlikely given this scenario.

e. EMC shows that the overlying shale is missing on the isopach on the northwest side of Wellfield 3. NRC staff is concerned there will be communication between the "70 sand" and the overlying "72 sand" in this area during production operations. Determine whether there is communication of the "70 sand" with the "72 sand" where this overlying shale is missing. If you determine that there is communication, explain how EMC will prevent and monitor excursions into the overlying aquifer. If you determine that there is no communication, provide the basis for that conclusion.

Response:

This information will be submitted with the next RAI response package.

2-8. Background Water Quality (Section 2.7)

The analysis of the surface water and ground water quality in the proposed license area is currently insufficient to interpret the impact of ISL recovery on water quality in and around the license area. Please provide the following:

a. EMC states that there are CBM discharge points in the license area. NRC is concerned that the baseline water quality in the surface water and overlying aquifer "72 sand" may have been and will be impacted by CBM produced water discharge. Provide the location, water quality, permitted volume and known volume of CBM produced water discharged to the surface within the license area and an estimate of how much has infiltrated to the "72 sand". Provide an estimate of the location, predicted water quality and volume of CBM discharge to the license area during future ISL operations.

   Response:

   Table 2-8.a provides a list of the discharge points located within the license area. These discharge points are also presented on Figure 2.7.-A1, as are a number of others outside of the license area.

Table 2-8.a CBNG WYPDES Permits and Outfall Locations Within or Upstream of the Moore Ranch Project

Company	Permit #	Outfall #	Qtr-Qtr	Sec	Twp	Rng	Latitude	Longitude
Devon	WY0040436	001 EPTD	NWNE	25	T42N	R75W	43.59012	-105.81289
		002 EPTD	SENE	25	T42N	R75W	43.58458	-105.80856
		004 EPTD	SESE	25	T42N	R75W	43.5806	-105.8100
		005 EPTD	SWSE	25	T42N	R75W	43.5769	-105.8122
		006 EPTD	NWNE	36	T42N	R75W	43.5719	-105.8117
		007 EPTD	SWNE	36	T42N	R75W	43.5694	-105.8122
		008 EPTD	SESE	36	T42N	R75W	43.5639	-105.8008
		009 EPTD	NESW	24	T42N	R75W	43.59653	-105.81550
		010 EPTD	SWSW	31	T42N	R74W	43.5626	-105.8043
		011 EPTD	NESW	34	T42N	R75W	43.5647	-105.8586
		012 EPTD	SWSE	34	T42N	R75W	43.5647	-105.8547
		017 EPTD	NESE	27	T42N	R75W	43.5814	-105.8465
		019 EPTD	NWNW	35	T42N	R75W	43.5743	-105.8430
		020 EPTD	SENW	35	T42N	R75W	43.5688	-105.8374
		021 EPTD	NESW	35	T42N	R75W	43.5657	-105.8259
		022 EPTD	SWSE	35	T42N	R75W	43.5628	-105.8345
		023 EPTD	SWSE	35	T42N	R75W	43.5623	-105.8345
		024 EPTD	SWSE	23	T42N	R75W	43.59174	-105.83319
		025 EPTD	SESE	26	T42N	R75W	43.5775	-105.8261
		026 EPTD	SWSW	25	T42N	R75W	43.5763	-105.8227
		027 EPTD	NENW	36	T42N	R75W	43.5738	-105.8176
		030	NENW	10	T41N	R75W	43.5442	-105.8581

		EPTD						
BBC	WY0051217	018	NWSW	1	T41N	R75W	43.55252	-105.82161
		020	SWSE	2	T41N	R75W	43.54840	-105.83423
		021	SWSW	2	T41N	R75W	43.54722	-105.84404
BBC	WY0055131	004	NWNE	9	T41N	R75W	43.54492	-105.87229
		005	NESE	28	T42N	R75W	43.58020	-105.86910
		006	SWSW	28	T42N	R75W	43.57640	-105.88350
		007	SWSE	31	T42N	R75W	43.56395	-105.91549
		008	NESW	33	T42N	R75W	43.56641	-105.87995

*Shading indicates outfalls that are upstream of Moore Ranch License Area

Discharge data and WYPDES permit limits for outfalls located within the license area are provided in the tables on the following pages. Data provided in response to comment 2-5.b indicates that infiltration to the 72 Sand has not occurred to date.

A conservative annual declination rate of 5% is assumed for future CBM discharge based on Devon's East Pine Tree Unit (WY0040436) historic data, as presented in the following table. All three WYPDES permits will up for renewal in early 2009 with an expiration date in 2014. Personal communications with permit holders indicates that the permits will not likely be renewed in 2014. Flow from Devon's WY0040436 outfalls is anticipated to be less than 0.006 MGD by 2013. Based on historic CBNG water discharge data within the license area, water quality will not vary significantly as CBNG water production declines.

Table 2-8.a1 Historic and Projected Discharge Rates at CBM Discharge Points (Devon – East Pine Tree Unit, WY0040436)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Maximum Flow (MGD)	0.1006	0.0694	0.0572	0.0302	0.0183	0.0111	0.0092	0.0120	0.0114	0.0108	0.0103	(
Average Flow (MGD)	0.0895	0.0615	0.0388	0.0243	0.0143	0.0078	0.0078	0.0082	0.0078	0.0074	0.0070	(
Annual Decline		36.0%	35.2%	11.1%	11.1%	17.4%	5.9%	5.9%	5.0%	5.0%	5.0%	

Table 2-8.a2 BBC Pine Tree Area (WY0055131) Average Water Quality and Discharge Rates

PARAMETER	UNIT	PERMIT LIMIT[1]	OUTFALL				
			004	005	006	007	008
Total Flow (MGD) - MAX	MGD	1.02	0.0042	0.0261	0.0146	No Dis	No Dis

Total Flow (MGD) - AVG	MGD		0.0028	0.0197	0.0124	No Dis	No Dis
Bicarbonate	mg/L		952	1293	1126	No Dis	No Dis
Dissolved Calcium	mg/L		74	82	73	No Dis	No Dis
Dissolved Magnesium	mg/L		26	33	34	No Dis	No Dis
Dissolved Sodium	mg/L		222	305	197	No Dis	No Dis
pH	SU	6.5-9.0	7.57	7.55	7.43	No Dis	No Dis
Sodium Adsorption Ratio	Calculated	10	5.7	7.6	6.0	No Dis	No Dis
Specific Conductance	micromhos/cm	2000	1350	1686	1415	No Dis	No Dis
Total Alkalinity	mg/L as CaCO3		780	1059	922	No Dis	No Dis
Chlorides	mg/L	46	10.3	6.9	6.8	No Dis	No Dis
Dissolved Iron	ug/L	1000	160	1257	570	No Dis	No Dis
Total Recoverable Arsenic	ug/L	3	0.67	1.73	1.60	No Dis	No Dis
Total Recoverable Barium	ug/L	1800	1050	2023	1157	No Dis	No Dis
Dissolved Cadmium	ug/L		0.1	ND	N/A	No Dis	No Dis
Dissolved Manganese	ug/L		97	104.5	84.5	No Dis	No Dis
Fluorides	mg/L		0.56	0.90	0.66	No Dis	No Dis
Potassium	mg/L		9	12.3	12.4	No Dis	No Dis
Sulfates	mg/L		2.6	3	7.5	No Dis	No Dis
Total Petroleum Hydrocarbons	mg/L		1	ND	ND	No Dis	No Dis
Total Radium 226	pCi/L		0.6	1.05	0.4	No Dis	No Dis

[1] – Data is provided for outfalls within and flowing through the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0051217 (total number outfalls is 25)
N/A - Was not monitored, No Dis – No discharge reported, ND – Reported as non-detect by laboratory

Table 2-8.a3 Devon East Pine Tree Unit (WY0040436) WYPDES Average Water Quality and Discharge Rates[1]

PARAMETER	UNIT	PERMIT LIMIT[2]	OUTFALL																			
			004	005	006	007	008	010	011	012	013	017	018	019	020	021	022	023	025	026	027	030
Flow - MAX	MGD	0.68	0.0443	0.0239	0.0109	0.0213	0.0256	0.0348	0.0283	0.0290	No Dis	0.0414	No Dis	0.0183	0.0086	0.0041	0.0066	No Dis	0.0130	0.0057	0.0032	0.0175
Flow - AVG	MGD		0.0367	0.0150	0.0096	0.0206	0.0232	0.0266	0.0217	0.0135	No Dis	0.0291	No Dis	0.0158	0.0076	0.0021	0.0044	No Dis	0.0108	0.0046	0.0021	0.0139
Alkalinity	mg/L		468	615	762	670	663	572	1217	995	No Dis	997	No Dis	602	702	498	434	No Dis	796	302	407	617
Total Recoverable Arsenic	ug/L	2.4	0.8	1.4	0.9	1.6	1.3	1.4	2.6	1.4	No Dis	5.6	No Dis	0.5	2.1	2.0	0.6	No Dis	0.6	1.6	1.1	1.8
Total Recoverable Barium	ug/L	1800	628	1032	1092	902	883	486	2476	1694	No Dis	1433	No Dis	577	925	600	421	No Dis	1153	296	360	980
Bicarbonate	mg/L		660	741	921	817	804	695	1471	1190	No Dis	1211	No Dis	723	828	605	517	No Dis	960	365	496	741
Calcium	mg/L		29	42	52	51	46	36	131	103	No Dis	88	No Dis	55	54	36	28	No Dis	68	17	26	59
Chlorides	mg/L	46	10	9	9	10	9	10	8	11	No Dis	5	No Dis	5	5	7	8	No Dis	6	9	No Dis	9
Dissolved Iron	ug/L	1000	189	482	1043	1089	60	671	380	174	No Dis	353	No Dis	467	351	1060	90	No Dis	498	892	905	0
Dissolved Cadmium	ug/L		N/A	N/A	N/A	N/A	N/A	N/A	0.6	0.6	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1820
Dissolved Manganese	ug/L		109	50	66	176	50	143	117	114	No Dis	77	No Dis	48	70	61	30	No Dis	88	119	74	57
Fluorides	mg/L		0.6	0.5	0.5	0.7	1.4	0.7	0.6	0.5	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.7
Magnesium	mg/L		8	9	16	11	13	9	44	29	No Dis	32	No Dis	16	14	8	6	No Dis	16	4	5	19
pH	SU	6.5 – 9.0	7.81	7.87	7.76	7.69	7.81	7.64	7.44	7.62	No Dis	7.55	No Dis	7.51	7.34	7.05	7.60	No Dis	7.16	7.66	7.22	7.84
Potassium	mg/L		5	6	7	7	7	6	15	11	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9
Sodium	mg/L		146	215	256	221	231	199	305	274	No Dis	298	No Dis	209	232	180	160	No Dis	255	117	153	178
Sodium Adsorption Ratio	Calculated	10	7.6	7.9	8.0	7.6	7.9	8.1	5.9	6.2	No Dis	7.0	No Dis	6.4	7.2	7.1	6.9	No Dis	7.2	6.7	7.2	5.1
Specific Conductance	umhos/cm	2000	859	1093	1348	1204	1175	1008	2068	1665	No Dis	1684	No Dis	1145	1186	912	798	No Dis	1316	585	735	1076
Sulfates	mg/L		13	2	4	3	2	2	5	2	No Dis	1	No Dis	40	1	1	8	No Dis	16	9	ND	2
Total Petroleum Hydrocarbons	mg/L		0.7	1.0	1.0	0.7	1.0	0.5	1.0	1.0	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.0
Total Radium 226	pCi/L		0.5	0.3	0.5	0.3	0.3	0.3	0.8	0.6	No Dis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5

1 – Data is provided for outfalls within the license area.
2 - Permit Limit set for all outfalls discharging under Permit WY0040436 (total number outfalls is 30)

Table 2-8.a4 BBC Palm Tree Project (WY0051217) Average Water Quality and Discharge Rates

PARAMETER	UNIT	PERMIT LIMIT[1]	OUTFALL		
			018	020	021
Total Flow (MGD) - MAX	MGD	5.3	0.0403	0.0079	0.0083
Total Flow (MGD) - AVG	MGD		0.0147	0.0079	0.0083
Bicarbonate	mg/L		723	744	674
Dissolved Calcium	me/L		5.72	7.89	11.78
Dissolved Magnesium	me/L		1.97	2.14	2.96
Dissolved Sodium	me/L		40.30	43.88	48.96
pH	SU	6.5-9.0	8.03	8.03	7.94
Sodium Adsorption Ratio	Calculated	10	7.9	7.4	6.4
Specific Conductance	micromhos/cm	2000	880	1052	967
Total Alkalinity	mg/L as CaCO3		449	615	555
Chlorides	mg/L	46	9	8	9
Dissolved Iron	ug/L	1000	1810	1514	2020
Dissolved Manganese	ug/L		63	119	66
Sulfates	mg/L		18	1	ND
Total Recoverable Arsenic	ug/L	3	0.8	1.0	1.6
Total Recoverable Barium	ug/L	1800	608	713	832
Total Petroleum Hydrocarbons	mg/L		ND	ND	ND
Total Radium 226	pCi/L		0.36	0.47	0.23

[1] – Data is provided for outfalls within and flowing through the license area.
[2] - Permit Limit set for all outfalls discharging under Permit WY0051217 (total number outfalls is 25)
ND – Reported as non-detect by laboratory

The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

b. EMC states that surface water in the license area is impacted by CBM produced water discharge. NRC is concerned that the baseline surface water quality and surficial aquifer water quality have been affected CBM produced water. Explain how EMC can assess baseline surface water and surficial aquifer ground water quality when it is variably impacted by CBM discharge.

Response:

As detailed in response to comment 2-5.b, the surficial aquifer water quality does not indicate any impact from CBNG discharges at this time. The seasonal variability of surface water quality apparent during baseline characterization is largely due to the influence from Devon Energy's outfalls permitted under WY0040436. The lack of water at MRSW-10 and MRSW-11 indicates that Bill Barrett's discharges upstream infiltrate into the shallow alluvial system and do not directly contribute to surface hydrological features within the license area. Assessment of surface water quality in light of the contributions from CBNG water discharges present at or upstream of monitoring sites must account for the seasonal variability present in the area. Following permit renewals in late summer/early fall 2008, WYPDES permits WY0040436, WY0051217 and WY0055131 will be active into 2014.

The above information was included in Addendum 2.7-A. Revisions to Section 2.7 will be submitted with the next RAI response package.

2-9. Air Particulate Monitoring (Section 2.9)

A total of four air particulate air sampling stations and 10 radon monitoring stations were identified in Figure 2.9-25. Background sampling station(s) are not identified in Figure 2.9-25. Regulatory Guide 4.14, Revision 1, April 1980, Table 1, (Type of Sample, Air), discusses three air sampling stations at or near the site boundaries, one air sampling station at or close to the nearest residence or occupiable offsite structure(s) (if within 10 km of the site), and one control air sampling station. Please describe the basis of the selection process for each air sampling location (particulate and radon) and how this comports with the guidance regarding location in Regulatory Guide 4.14 for the type of sample, i.e., air. Also, please identify or include a background or remote air sampling location.

Response:

Baseline radon monitoring station locations were selected prior to placement of air particulate monitoring stations. Air particulate station locations 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 radon stations do not exactly coincide with air particulate station locations, in each case there is one or more radon station reasonably close by each air particulate station.

There were no known residences within 10 km of the site so a fifth air particulate station was not considered applicable according to the protocols outlined in Table 1 of Regulatory Guide 4.14. Also, the control/background air particulate location was chosen to be on site rather than at a location "remote from the site". This is consistent with footnote (c) to Table 1 which states a need for the background location to be representative of site conditions. That footnote also states that the background air particulate station should be upwind of the site. Because of the large amount of area included within the boundaries of this ISR site, it seemed reasonable to place the background station within site boundaries, but at considerable distance upwind of operational areas (it is currently located at least 1 mile west/southwest of the plant location and wellfield areas). This also seemed to be a practical background location as it is readily accessible and hard line electrical power has limited availability in the area.

The control/background air particulate and radon monitoring stations are represented by ID numbers MRA-4 and MR-1 (as respectively shown in Fig. 2.9-25). Again, these locations are generally upwind of the plant location based on annual prevailing wind directions presented in the earlier response to comment 2.10 (d).

Regulatory Guide 4.14 calls for a minimum of 5 radon sampling stations, each located at the five recommended air particulate sampling stations. Because of the very large size of the site, 10 radon monitoring stations were used instead of the recommended 5 stations. Furthermore, each air particulate sampling station has at least 1 radon monitoring station in the general vicinity. Baseline Rn-222 results indicated a relatively minor degree of spatial variability in radon concentrations across the site. Because additional radon monitoring stations are placed in many locations around the site, any significant localized changes in conditions due to ISR operations should be detected and can be compared against pre-operational baseline data and where applicable, against data from the nearest air monitoring station or other stations.

2-10. Groundwater, Surface Water, Vegetation, and Food Sampling (Section 2.9)

The applicant has not provided sufficient information in section 2.9 regarding radiological sampling of the environs of the Moore Ranch site. Specifically, the following information should be provided

a. It is stated in section 2.9.8 that baseline groundwater sampling is conducted at eleven wells on a quarterly sampling basis. The wells are shown in Figure 2.9-34 of the Technical Report. Please identify which monitoring wells are considered up gradient and which monitoring wells are considered down gradient. Also, please identify or include a background or remote groundwater sampling location. Please include the dates when these groundwater samples were collected.

   Response:

   Section 2.7.2.2 (Figure 2.7.2-5) provides a description of the hydraulic gradient of the Moore Ranch Project Area. In general, groundwater flow direction for the wells shown on Figure 2.9-34 is predominantly to the north. Therefore, wells on south side of the proposed development areas are up gradient and those wells on the north side are down gradient. Dates of all groundwater sampling and results can be found on Tables 2.7.3-17 through 2.7.3-21. Section 2.9.8 was revised to include the above information on hydraulic gradient and reference to Section 2.7.3.

b. It states in Section 2.9.8.2 that parameters in suspended form were also evaluated but can be found in Section 2.9.2.7.2 of the Technical Report. This information could not be found, as there is no Section 2.9.2.7.2 in Volume II of the Technical Report. Please provide this information.

   Response:

   Information on surface water quality, including suspended radiological parameters, are included in Section 2.7.3. The reference in Section 2.9.8.2 was corrected

c. It is stated in Section 2.9.9.2 that suspended surface water samples were evaluated but all results were below analytical reporting limits and the data, reporting limits, and other details can be found in Section 2.7.1, but this information could not be found in that section. Please provide this information.

   Response:

   Information on surface water quality, including suspended radiological parameters, are included in Section 2.7.3. The reference in Section 2.9.8.2 was corrected

d. It is stated in section 2.9.10 that vegetation sampling was collected from three locations in April 2007. The sample locations are depicted in Figure 2.9.38 of the Technical Report. The samples were analyzed for natural uranium, Th-230, Ra-226, Po-210 and Pb-210. Please describe the basis of the selection process for each vegetation sampling location and how this meets the guidance regarding location in Regulatory Guide 4.14 for the type of sampling (i.e., vegetation).

Response:

Vegetation sampling locations were selected based on the Regulatory Guide 4.14 recommendation that locations be selected in three different grazing areas with "highest predicted airborne radionuclide concentration due to milling operations." Locations at Moore Ranch for vegetation sampling were selected to be just downwind of the plant area (to the NE, E, and SE of the plant area). Prevailing annual wind information is presented in Section 2.5 (prevailing winds are out of the west and southwest). Consideration was also given to choose areas with sufficient vegetation density that the volume of vegetation collected could be large enough to help meet specified analytical detection limits.

e. in Section 2.9.11, Food Sampling, it states, "Sampling of food items from the site such as meat from local grazing livestock is not planned at this time." Please explain why food sampling is not planned.

Response:

Baseline food sampling (e.g. livestock) was not conducted as radiological baseline parameters relevant to food chain dose pathways (e.g. soil, sediment, water, and forage vegetation) have been well characterized. Changes in these parameters due to site operations could be used to model corresponding radiological changes in food items such as meat or milk from agricultural livestock. Respective radionuclide transfer factors can be found in the literature (e.g. IAEA, 1994; Yu, 2001). Larger game animals such as deer or pronghorn have extensive ranges and are not confined to the site. Potential for bioaccumulation of radionuclides in these animals would be limited as they would likely derive only a small fraction of total sustenance from the site. Finally, the historical Conoco baseline study included food sampling data for various locally raised agricultural products as presented in the application (Table 2.9-19).

References:

International Atomic Energy Agency (IAEA). 1994. Handbook of parameter values for the prediction of radionuclide transfer in temperate environments. Technical reports series No. 364. International Union of Radioecologists and International Atomic Energy Agency, Vienna, Austria.

Yu, C., et al. 2001. User's manual for RESRAD, Version 6, ANL/EAD-4, Argonne national Laboratory, Argonne, Illl., July.

f. Please explain why fish samples were not collected.

Response:

No fish species are found on site as all water bodies are ephemeral in nature and do not contain sufficient water to support aquatic species.

3-1. ISL Leaching Process and Equipment (Section 3.1)

The applicant has not provided sufficient information regarding the ISL leaching process and equipment to enable the staff to fully understand this topic and to support other reviews dependent on that understanding. Specifically, the following information should be provided:

Response:

In addition to the responses to the RAIs listed below, EMC has made other revisions in Section 3. These revisions include:

- Wellfield 3 was combined into Wellfield 2 making one wellfield (Wellfield 2). Maps and schedules were revised to reflect this.
- Section 3 was also amended to include use of sodium hydroxide and/or ammonia in the precipitation circuit.

a. The number, design, operation, and monitoring of the wellfield headerhouses where fluids will be injected and recovered from well fields.

Header houses will be used to distribute injection fluid to injection wells and collect production solution from recovery wells. Each header house will be connected to two trunk lines, one for receiving injection fluid from the processing plant and one for conveying recovery fluids to the processing plant. The header house includes manifolds, valves, flow meters, pressure meters, booster pumps and oxygen for incorporation into the injection lixiviant, if and when required. Each header house will service approximately 40 to 60 wells (injection and recovery). Figure 3.1-3A illustrates a plan view of a typical headerhouse. Currently, approximately 8 headerhouses are planned to be constructed for Wellfield 1 and 11 are planned for Wellfield 2. Section 3.1.3 was revised to include the information above and new Figure 3.1-3A.

Injection well and production well flow rates and pressures are monitored at the headerhouse_in order that injection and production can be balanced for each pattern and the entire wellfield. The flow rate of each production and injection well is continuously monitored by monitoring individual electronic flow meters in each wellfield headerhouse. The pressure of each production and injection trunk line will be monitored at the headerhouse with electoronic pressure gauges. The flow meters and pressure gauges will be tied into the headerhouse control panel, which will be in communication with the central plant control room.

High and low pressure and flow alarms will be in place to alert wellfield and plant operators if specified ranges are exceeded in conjunction with automatic shutoff valves to stop flow if significant changes in flow or pressure occur.

Section 3.1.3.1 was revised to reflect the headerhouse monitoring activities described above.

b. An in-depth discussion of how the bleed will be adjusted to maintain an inward gradient in the atypical unconfined aquifer conditions in the "70 sand" production zone. The discussion should account for the reduced drawdown anticipated in the unconfined setting and for dewatering and mounding of fluids at the production/injection wells.

Response:

This information will be submitted with the next RAI response package.

c. Identify the locations for the underlying and overlying aquifer monitoring wells.

Response:

As described in Section 5.7.8.2, monitor wells will be installed within the overlying aquifer (72-Sand) and underlying aquifer (68-sand) at a density of one well per every four acres of pattern area. Final locations of these wells will be determined when final design of the wellfield and submitted with the wellfield package to WDEQ-LQD. Underlying monitoring in areas where the production sand and underlying sand coalesce is described in the response to RAI 6-1(b).

d. Present methods for timely detection and cleanup of leaks in the wellfield at wellheads and in surface and buried lines in the wellfield.

Response:

Each Mine Unit will have a number of headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells, along with main trunk lines, will have high and low flow alarm limits set in the header house. 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 (at a minimum of daily) inspections of each wellfield that is in service or in restoration.

Secion 3.1.3.1 was revised to include this description of timely leak detection.

e. Provide a description of the number, location, design, and capacity of deep disposal wells.

Three disposal wells are planned for the Moore Ranch Project. The location of these wells is shown on Figure 3.1-4A. These proposed wells will be permitted for a capacity of 125 gpm per well, giving a total of 375 gpm of disposal capacity. The estimated depth of the disposal wells and target zone is approximately 6,400 feet. Section 4.2.2 was updated to include this information.

f. Provide an explanation for how EMC will handle waste fluids should the disposal wells become inoperable short term or long term.

As shown in Figure 3.1-5, anticipated disposal during operations is approximately 40gpm and during restoration could be as high as 140 gpm. A minimum of Two disposal wells will be constructed for the first several years of operation (40 gpm) which will provide capacity of 125 gpm each. One well will handle all disposal flow from operations during this period. If a well becomes inoperable for a short time during maintenance or integrity testing, then the additional well will provide adequate disposal capacity. A third disposal well may be constructed to provide a backup well once restoration disposal flows commence. Section 4.2.2 was updated to include this information.

3-2. Central Processing Plant and Other Facilities – Equipment Used and Materials Processed (Section 3.2)

In addressing areas of the facility where fumes or gases may be generated, rather than just a reference to Section 7.3 of the application, which is focused on environmental impacts, the applicant should provide specific listing of each potential source of emission or release, the planned monitoring associated with the potential release, and the preventive/mitigative controls for the potential release.

Response:

This response will be submitted with the next RAI response package.

3-3. Instrumentation and Control (Section 3.3)

The applicant provides only a cursory commitment to have instrumentation and controls to monitor production, injection, and waste flows, and to have instrumentation to alarm for system leaks. The descriptions of the process instrumentation and controls and radiation safety monitoring instrumentation need to be more detailed and specific, including their minimum specifications and operating characteristics (alarms, interlocks, etc.). Additional information on backup systems, monitoring criteria, and yellowcake dryer instrumentation and control (with specific reference to 10 CFR Part 40, Appendix A, Criterion 8) needs to be included. The descriptions should focus on how the instrumentation and controls are adequate to identify quickly and remedy all potential processing problems that can increase exposures to radiological and chemical hazards.

Response:

This response will be submitted with the next RAI response package.

4-1. Gaseous and Airborne Particulates (Section 4.1)

The applicant has not provided sufficient information in section 4.1 regarding the effluent control systems for gaseous and airborne particulates. Specifically, the following information should be provided:

a. The applicant states that discharge stacks will be located away from building ventilation intakes to prevent introducing exhausted radon into the facility. Describe the locations of these discharge stacks and demonstrate how the locations of these discharge stacks will prevent introducing exhausted radon into the facility.

   Response:

   Discharge stacks will be located on the leeward side of the building and ventilation intakes will be on the upwind side of the building to ensure exhausted radon is not taken back into the facility from prevailing winds.

   Section 4.1 was revised to include the above information

b. The applicant states that the work ventilation system will be designed to force air to circulate within the plant process areas. The ventilation system will exhaust outside the building, drawing fresh air in. Describe the work ventilation system in more detail. The discussion should include the number and locations of fans used to ventilate the facility, the intake flow rate into the facility, the exchange rate, operation during periods of extreme outdoor temperature, and how radiation monitors will be used to measure effluent releases. Also, describe the acceptable radiation monitoring criteria and flow rates for these systems.

   Response:

   The work area ventilation system will consist of 4 fans with a capacity 10,000 gpm. 2 fans will be located in the ion exchange area, one fan will be located in the resin transfer area, and one fan will be located in the precipitation area. The air exchange rate of the four fans is approximately 1.25 air exchanges per hour. During favorable weather conditions, open doorways and convection vents in the roof will provide satisfactory work area ventilation. During extreme cold outdoor temperatures, the ventilation system will provide adequate work area ventilation if doorways need to be shut. Buildings will be heated during winter months to maintain temperatures in the plant area. Section 4.1 was revised to include the above information.

   See response to RAI 5-5(c) for radiation monitors, effluent releases, criteria, and flow rates.

4-2. Liquid Effluents (Section 4.2)

The applicant needs to provide the following additional information related to the liquid effluents at the proposed facility:

a. Provide information on the expected chemical and radiological composition of the liquid waste stream to be disposed of in the deep wells.

Response:

The anticipated liquid waste stream is non-hazardous under the Resource Conservation and Recovery Act. The anticipated water chemistry of the injected waste stream is presented in Table 4-1. Minor concentrations of corrosion inhibitors, scale inhibitors, and/or biocides may be used as needed to maintain the well in optimum condition. These waste streams are benefication wastes, exempt from RCRA regulation under the Bevill Amendment found in 40 CFR 261.4(b)(7).

Table 4-1 Summary of Anticipated Waste Stream Water Quality

Chemical Species	Estimated Range of URANIUM ONE Waste Stream Water Quality 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

Section 4.2.1.1 was revised to include this information on waste stream water quality.

b. The applicant states that two or more deep wells will be installed as the primary liquid waste disposal method. Provide the basis for reaching a conclusion on the number of deep wells that will be needed for liquid waste disposal. If deep well disposal is the primary (i.e., not the only) method, provide plans for the secondary/other method for liquid waste disposal.

Response:

See previous response to RAI 3-1(e).

c. Provide the basis for stating that EMC believes deep well disposal is "preferable" to other liquid waste disposal options.

Response:

Deep well disposal is preferable to other liquid waste disposal options for the following reasons:

- Liquid waste disposed of through deep wells is secluded from human contact eliminating risk to human health.
- Large evaporation ponds have the potential for leaks and impacts to the environment. Also, a much larger volume of 11(e)(2) byproduct is created through use of evaporation ponds.
- Land application methods have the potential to impact surface media from prolonged discharge and would require extensive treatment to meet land application standards.

Section 4.2 was revised to include the basis described above.

d. Provide the status of the application to Wyoming for the Class I UIC Permit.

Response:

The application for deep disposal wells at Moore Ranch was submitted to the WDEQ-WQD on May 12, 2008 and is under review.

e. Provide information on how EMC will ensure backup storage capacity for liquid waste in the event that the deep wells need to be shut down for a short time.

Response:

See previous response to RAI 3-1(e).

f. Discuss the health and safety impacts of the liquid system failures presented in Section 4.2.3.

Response:

Should a leak in the wellfield buildings, pipelines, or at wellheads occur, the primary health and safety hazards presented by the spilled mining solutions would be ingestion or inhalation of the spilled liquid or dried residue, direct gamma exposure, and release of radon gas. These hazards would primarily apply to EMC personnel responding to the spill. Section 5 discusses in detail the administrative controls that will be implemented by EMC to maintain radiological exposures as low as reasonably achievable, including employee training and the use of standard operating procedures (SOPs) or radiation work permits (RWPs). All employees will receive training in the proper response to solution spills during radiation worker training. SOPs and/or RWPs will specify worker monitoring and protective equipment requirements for spill response.

Spilled mining solutions will contain elevated concentrations of uranium, radium-226, and trace metals. Although these concentrations are not high enough to present a significant health and safety risk when absorbed in soil, they could present an increased hazard in areas where spilled solutions may pond or build up over time. All cleanup of spilled material will be performed with proper protective equipment. If soil cleanup of a spill area is necessary due to the exceedance of the soil concentration limits in 10 CFR Part 40, Appendix A, engineering controls will be used to minimize the generation of dust. Direct gamma radiation exposure is not expected to be a significant hazard from solution spills due to the low concentrations of gamma-emitting radionuclides in the mining solution. Radon may be a hazard in enclosed spaces (e.g., within a headerhouse) but this hazard can be controlled through the use of ventilation (Section 4.2.3.1 was revised with the above information)

The potential health and safety hazards from spills within the Central Plant are similar to those discussed in section 4.1.1.1 above. However, the Central Plant will be equipped to handle liquid spills. The building will include sumps that will recover spilled solutions and direct them to the wastewater system. Building ventilation will control the radon released by spilled solutions (Section 4.2.3.2 was revised with the above information). .

g. As part of the discussion of potential spills from pipelines and well heads, provide the plans for inspection of these aspects of the facility, including frequency of inspection, and provide the contingency plans and procedures for responding to system failures resulting in liquid waste release, including notifications and recordkeeping.

Response:

Each Mine Unit will have a number of headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells, along with main trunk lines, may have high and low flow alarm limits set in the header house. 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).

Occasionally, leaks (typically small) at pipe joints and fittings in the wellhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. Surface and subsurface soil at a solution mine may become contaminated by leaks and spills of process solutions. Although the specific concentration of radionuclide's in these process solutions is relatively low, the concentration of contamination in the soil may exceed regulatory limits if the solution is confined to a small area or if there are multiple spills in the same location. EMC will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic (at a minimum of daily) inspections of each wellfield that is in service or in restoration. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination. Following repair of a leak, EMC will require that the affected soil be surveyed for contamination and the area of the spill documented as required by the NRC. The soils potentially impacted by a spill of injection or production fluid are typically sampled and scanned for Gamma radiation. The surface extent of any spill will be delineated horizontally by use of a field GPS system. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed immediately if concentrations exceed regulatory requirements or left in place and documented for future clean up (if necessary) during the decommissioning phase of site closure. Section 4.2 was revised to include the above information.

Reporting of excursions and corrective actions will be conducted as described in Section 5.7.8.

The WDEQ-LQD will be verbally notified (per telephone or email) within 24 hours of discovery of a spill of ISR process fluids exceeding 420 gallons. A written report will be provided to the WDEQ-LQD within 5 days of discovery containing the information described in WDEQ-LQD Rules and Regulations, Chapter 11, Section 12(a)(B)(ii).

The NRC will be verbally notified (per telephone or email) within 48 hours of discovery of a spill of ISR process fluids reportable to the WDEQ-LQD. A written report will be provided to the NRC within 30 days of discovery containing the information required per NRC License Conditions.

Other unanticipated spills of reportable quantities from chemicals bulk storage areas will be reported to the WDEQ in accordance WDEQ-WQD, Rules and Regulations, Chapter 17, Part E and 40 CFR 302 (CERCLA).

Other operational reporting and applicable requirements include the following:

- Corrective Actions and Compliance Schedules- WDEQ-LQD Rules and Regulations, Section 13 and NRC License Conditions.
- Quarterly Monitoring Reports- WDEQ-LQD Rules and Regulations, Section 15.
- Annual Operations Reports- WDEQ-LQD Rules and Regulations, Section 15.
- Well Abandonment Reports- WDEQ-LQD Rules and Regulations, Section 15
- Deep Disposal Well Monitoring Reports- Done in accordance with UIC injection well permit issued by the WDEQ-LQD.
- NRC Semi-Annual Report- Done in accordance with NRC License Conditions.

New Section 4.5 was added to include the above reporting information.

h. Provide information on the ability of the sump system to handle the volume of the largest hazardous materials source.

Response:

As described in Section 4.2.3.3, a concrete curb will be built around the entire process building. This pad will be designed to contain the contents of the largest tank within the building in the event of a rupture. Any spill of plant fluids will be contained within the containment allowing for all fluids to drain to the sump system and be pumped to the waste disposal system.

4-3. Solid Wastes (Section 4.2)

Provide the details of a waste disposal agreement for 11e.(2) byproduct material disposal at an NRC or Agreement State licensed facility. The agreement should include commitments to notify NRC within 7 days if it is terminated and to submit a new agreement for NRC approval within 90 days of expiration or termination. Also, discuss why soils contaminated from operations (spills, leaks, etc.) are not included in the listing of contaminated solid wastes.

Response:

EMC is currently in discussions with several potential companies licensed to accept 11e(2) byproduct material from the Moore Ranch Project. A disposal agreement will be in place prior to start of operations.

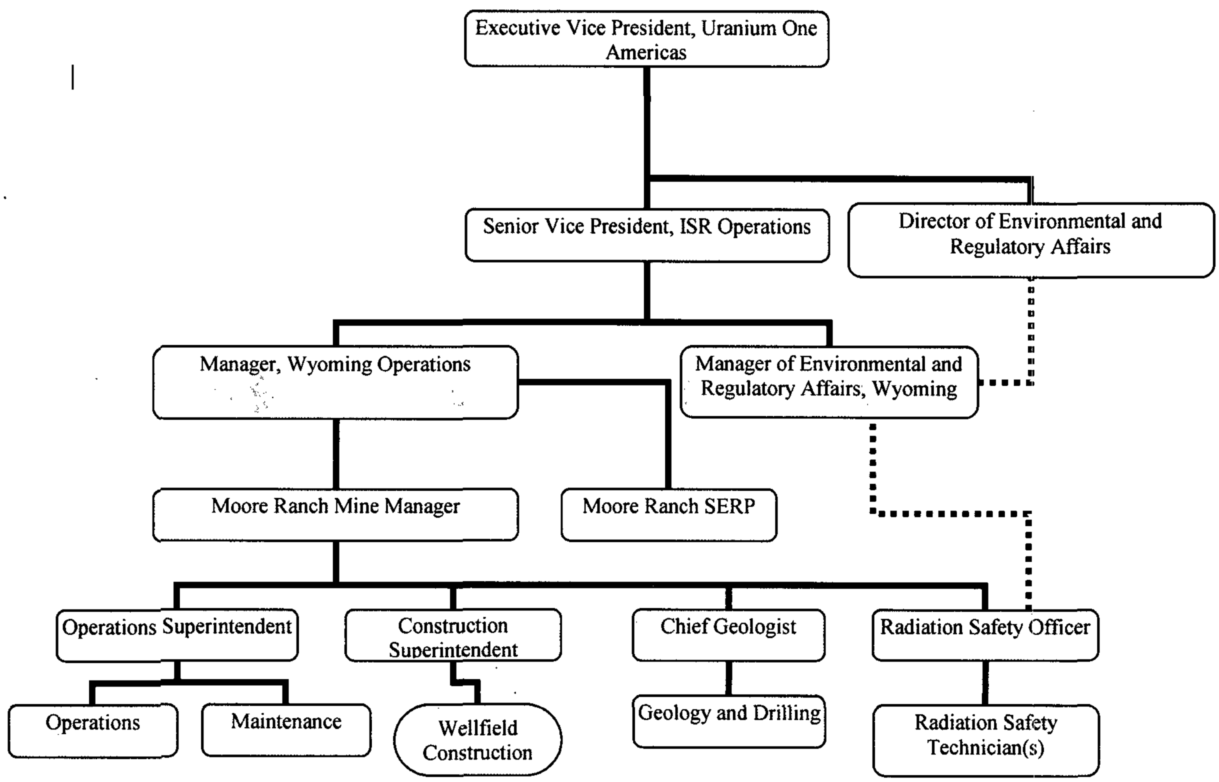
See response to previous RAI 4-2(g) for discussion on soils contaminated from operations.

5-1. Corporate Organization and Administrative Procedures (Section 5.1)

Other than the RSO and the Radiation Safety Technicians, the description of the Moore Ranch organization provides no information regarding site management, i.e., the plant supervisor and those that report to that position. Please discuss the corporate organization to the site level management positions. This should include the independence of the plant supervisor, RSO, and SERP for raising significant safety issues to senior management, and show the integration among groups that support construction, operation, and maintenance of the facility.

Response:

The organizational chart in Section 5.1 was revised to reflect site level management positions as shown below. Position descriptions for the site level management were also provided in Section 5.1



5-2. Management Control Program – Cultural Resources (Section 5.2)

EMC has not provided sufficient discussion of how cultural resources will be preserved. Please provide additional discussion related to preservation of cultural resources (i.e., perform a cultural resources inventory before engaging in any development activity not previously assessed by NRC). Note that any disturbances associated with cultural resource surveys will be completed in compliance with the National Historic Preservation Act, the Archeological Resources Protection Act, and their implementing regulations. In addition, please provide discussion related to the discovery of previously unknown cultural artifacts.

Response:

A Class III Cultural Resource Survey was conducted for the entire area within the proposed license boundary. Section 2.4 and Appendix A contains results of this survey.

5-3. Management Control Program – Records Program (Section 5.2)

In section 5.2.3 EMC simply states that records will be maintained until termination. Please discuss which records will be maintained (i.e., as-built drawings and photographs of the facility structures, well fields, and storage areas); that the records will be maintained with appropriate safeguards against tampering and loss; and that they will be readily retrievable for NRC inspection. Note that reporting requirements should be in accordance with NRC regulations located in 10 CFR Part 40.

Response:

The following specific records will be permanently maintained and retained until license termination:

- Records of disposal of byproduct material on site through the deep disposal wells as required in 10 CFR §20.2002 and transfers or disposal off site of source or byproduct material;
- Records of surveys, calibrations, personnel monitoring, and bioassays as required in 10 CFR §20.2103;
- Records containing information pertinent to decommissioning and reclamation such as descriptions of spills, excursions, contamination events, etc. including the dates, locations, areas, or facilities affected, assessments of hazards, corrective and cleanup actions taken, and potential locations of inaccessible contamination;
- Records of information related to site and aquifer characterization and background radiation levels;
- As-built drawings and photographs of structures, equipment, restricted areas, well fields, areas where radioactive materials are stored, and any modifications showing the locations of these structures and systems; and
- Records of the radiation protection program including program revisions, standard operating procedures, radiation work permits, training and qualification records, SERP proceedings, and audits.

The RSO will be responsible for ensuring that the required records are maintained and controlled. Hard copies of all records will be maintained on site in a controlled environment to protect them from damage or deterioration and will be available for NRC inspection. Electronic copies may be maintained in addition to hard copies with backup protection. Duplicates of all records will be maintained in the corporate office or other offsite location(s).

Section 5.2.3 was revised to include this information.

5-4. Qualifications for Personnel Conducting the Radiation Safety Program (Section 5.4)

Section 5.4 describes the qualification of key personnel conducting the radiation safety program. The applicant identifies the minimum qualification for the Radiation Safety Officer (RSO) to include a bachelor's degree or an associate's degree in the physical sciences, industrial hygiene, or engineering from an accredited college or university, or an equivalent combination of training and relevant experience in uranium mill/solution mining radiation protection. Regulatory Guide 8.31, Section 2.4.1, states that two years of relevant experience are generally considered equivalent to one year of academic study. However, the minimum educational qualification is not met if the candidate has only an associate's degree. Please describe how the applicant will meet the minimum educational qualification if the candidate only has an associate degree.

Response:

Two years of relevant experience are generally considered equivalent to 1 year of academic study. For example, an RSO candidate with an Associates Degree would also require an additional 4 years of relevant experience to meet this education requirement. Section 5.4.1 was revised to include this description.

5-5. Effluent Control Techniques (Section 5.7.1)

The applicant has not provided sufficient information regarding the external radiation exposure monitoring program. Specifically, the following information should be provided:

a. This section discusses the effluent control techniques used by the applicant for Rn-222. However, there is no discussion of effluent control techniques for uranium. Therefore, discuss the radioactive effluents controls and monitoring (i.e., ventilation, confinement and/or filtration), for uranium, especially under nonroutine operations (i.e., maintenance and emergency).

Response:

Final processing of uranium to produce yellowcake will be performed in a vacuum dryer. As described in Section 4, there are no emissions from these systems. By design, vacuum dryers do not discharge any uranium when operating. The vacuum drying system is proven technology, which is being used successfully in several ISR sites where uranium oxide is being produced. Air particulate controls of the vacuum drying system include a bag house, condenser, vacuum pump, and packaging hood.

The bag house is an air and vapor filtration unit mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house is heated to prevent condensation of water vapor during the drying cycle. It is kept under negative pressure by the vacuum system.

The condenser unit is located downstream of the bag house and is water cooled. It is used to remove the water vapor from the non-condensable gases coming from the drying chamber. The gases are moved through the condenser by the vacuum system. Any particulates that pass through the bag filters are wetted and entrained in the condensing moisture within this unit.

The vacuum pump is a rotary water sealed unit that provides a negative pressure on the entire system during the drying cycle. It is also used to provide ventilation during transfer of the dry powder from the drying chamber to fifty-five (55) gallon drums. The water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams.

The packaging system is operated on a batch basis. When the yellowcake is dried sufficiently, it is discharged from the drying chamber through a bottom port into drums. A level gauge, a weigh scale, or other suitable device will be used to determine when a drum is full. Particulate capture is provided by a sealed hood that fits on the top of the drum, which is vented through a sock filter to the condenser and the vacuum pump system when the dried yellowcake is being transferred.

The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures. The system will alarm if there is an indication that the emission control system is not performing within operational specifications. If the system is alarmed due to the emission control system, the operator will follow standard operating procedures to recover from the alarm condition. If the dryer is loaded, yellowcake will not be packaged until the emission control system is returned to service within specified operational conditions. Similarly, if the dryer is empty, it will not be reloaded until the emission control system is returned to service.

To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signal an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is checked and documented during dryer operations. In the event this system fails, the operator will perform and document checks of the differential pressure or vacuum every four (4) hours. Additionally, during routine operations, the air pressure differential gauges for other emission control equipment will be observed and documented at least once per shift during dryer operations.

During dryer maintenance, all work will normally be performed under an RWP unless a standard operating procedure has been prepared and approved. The RWP will specify control measures to minimize the release of airborne particulates, including but not limited to removal of yellowcake from system components and establishing airborne radioactivity areas before maintenance is begun.

During emergency situations such as fire or severe weather, the yellowcake dryers will be shut down in a safe configuration until the emergency has passed. Vacuum systems will be left in operation and the dryer room(s) will be closed as potential airborne radioactivity areas.

Section 5.7.1.1.2 was added containing the above discussion on radioactive effluent controls for uranium.

b. Radioactive effluents controls and monitoring for the laboratory and other areas (e.g., the control room and lunch room) are not discussed. Therefore, provide a discussion of radioactive effluents controls and monitoring for those areas.

Response:

Laboratory areas will be used for the analysis of groundwater and process samples. Most of the analytical load for the laboratory will consist of routine semimonthly analysis of monitor well samples for chloride, conductivity, and total alkalinity. In laboratory areas where reagents are in use or fumes could be generated by the analytical method in use, laboratory fume hoods will be used to control emissions. Process samples will be analyzed within the restricted area and fumes hoods will be used as necessary to control emissions. New Section 5.7.1.1.3 was added to Section 5 containing the above description of effluent controls for the laboratory.

As shown on revised Figure 3.2-1, there will not be a lunch room located in the restricted area of the plant.

c. The plant building will be equipped with exhaust fans to remove any radon that may be released in the building. However, the application does not discuss monitoring to determine the magnitude of effluents released, as suggested in Regulatory Guide 8.37. Discuss how the effluent control techniques will ensure that the magnitude of such effluents is known with a sufficient degree of confidence to estimate public exposure.

Response:

Monitoring for combined plant and wellfield releases at the site airborne monitoring stations will be accomplished through the use of Track-Etch radon cups as discussed in Section 5.7.7. Monitoring for radon gas releases from the plant building and ventilation discharge points is not practicable. 10 CFR §20.1302 allows demonstration by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from licensed operations does not exceed the annual dose limit of 100 mrem. Regulatory Guide 8.37, section 3.3 notes that where monitoring effluents points is not practicable, a licensee should estimate the magnitude of these releases and include these estimated releases in demonstrating compliance with the annual dose limit.

As discussed in Section 7.3, EMC has used MILDOS-Area to model the dose from facility operations resulting from releases of radon gas. The central plant will include pressurized downflow ion exchange columns, which do not routinely release radon gas except during resin transfer and column backwashing. In these systems, the majority of radon released to the production fluid stays in solution and is not released. The radon which is released is generated by occasional venting of process vessels and tanks, small unavoidable leaks in ion exchange equipment, and maintenance of equipment. For the purposes of determining the source term for MILDOS-Area, radon gas release was estimated as 10% of the radon-222 in the production fluid from the wellfields and an additional 10% in the ion exchange circuit in the central plant. Release of radon-222 at this concentration did not result in significant public dose. The maximum TEDE of 0.8 mrem/yr. was located at the northwest property boundary and is 0.8 percent of the public dose limit of 100 mrem. The closest resident to the Moore Ranch facility received an estimated TEDE of 0.7 mrem/yr, which is 0.7 percent of the regulatory limit.

Section 5.7.1.1.1 was revised to include the discussion above.

5-6. External Radiation Exposure Monitoring Program (Section 5.7.2)

The applicant has not provided sufficient information regarding the external radiation exposure monitoring program. Specifically, the following information should be provided:

a. Describe some of the possible major work activities in the plant and well fields and the anticipated exposure rate levels that may be expected in these areas.

Response:

Based on the experience of other ISR operations, EMC believes that it is not likely that any employee working at the Moore Ranch Plant will exceed 10 percent of the regulatory limit (i.e., 500 mrem/yr).

- The typical wellfield dose rate will not exceed background gamma exposure rates except immediately adjacent to wellheads and headerhouses, where scale formed on the inside surfaces of piping may contain radium-226, resulting in increased gamma exposure rates. Experience at operating ISR facilities indicates that annual doses for wellfield workers generally do not exceed 1 percent of the regulatory limit (i.e., 50 mrem/yr.).
- Process plant workers will be exposed to elevated gamma exposure rates during operations and maintenance activities in the central plant including work in Radiation Areas. Experience at operation ISR facilities indicates that annual doses to process plant workers are generally less than 10 percent of the regulatory limit.

Although monitoring of external exposure may not be required in accordance with §20.1201(a) due to the low exposure rates typically encountered at ISR facilities, EMC will issue dosimetry to all process plant employees and will exchange them on a quarterly basis.

Section 5.7.2.2 was revised to reflect the information described above.

b. Describe those areas onsite where elevated exposure rates are anticipated to be found.

Response:

See previous response.

c. Describe how the external radiation exposure monitoring program will be integrated with the exposure calculations.

Response:

Results from personnel dosimetry will provide the individual Deep Dose Equivalent (DDE) for use in determining Total Effective Dose Equivalent (TEDE). The TEDE is defined in Regulatory Guide 8.30 as the sum of the DDE and the committed effective dose equivalent (CEDE) for internal exposures. Determination of the CEDE is discussed in further detail in Section **Error! Reference source not found.**.

Sections 5.7.2.2, 5.7.3.1, and 5.7.3.2 were revised to reflect this description.

d. Describe in more detail what is meant by the statement "Beta evaluations may be substituted for surveys using radiation survey instruments" and how this will be accomplished. What radiation instrumentation will be used to evaluate beta radiation levels?

Response:

The beta dose rate on the surface of yellowcake just after separation from ore is negligible. Over a period of several months, the beta dose from aged yellowcake increases due to the ingrowth of protactinium-234 and thorium-234. EMC plans to ship yellowcake on a schedule that minimizes the dose from aged yellowcake.

EMC will perform beta surveys at least once for each operation and whenever there is a change in procedures or equipment that may affect the beta dose. Beta surveys will be performed using a Ludlum Model 2224 portable scaler/ratemeter with a Ludlum 43-1-1 alpha/beta scintillator probe or equivalent.

As discussed in Regulatory Guide 8.30, beta evaluations may be substituted for surveys using radiation survey instruments based on two figures provided in the Regulatory Guide. These beta evaluations are based on curves that represent the increase of the beta dose rate over time due to the ingrowth of protactinium-234 and thorium-234 (Regulatory Guide 8.30, Figure 1) and the decrease of beta dose as the distance from the source increases (Regulatory Guide 8.30, Figure 2).

Section 5.7.2.1 was revised to include this detail on beta evaluations.

5-7. Airborne Radiation Monitoring Program (Section 5.7.3)

The applicant has not provided sufficient information regarding the airborne radiation monitoring program. Specifically, the following information should be provided:

a. The location of airborne particulate and radon daughter sampling are depicted in Figure 5.7-1 of the technical report. However, according to Figure 5.7-1, no airborne particulate monitoring will be performed in the control/lunch room or the ion exchange area. Explain why airborne particulate monitoring is not necessary in the control/lunch room and ion exchange area.

b. Describe the frequency of airborne particulate sampling in the plant.

   Response:

   Section 5.7.3.1 was revised to reflect that samples will be obtained using area samplers on a monthly frequency.

c. Describe the plans for documentation of radiation exposures and how they will be consistent with the requirements of 10 CFR 20.2102, 20.2103, 20.2106, and 20.2110.

   Response:

   See next response.

5-8. Exposure Calculations (Section 5.7.4)

Provide more information regarding the statements in Sections 5.7.4.1 and 5.7.4.2 of the Technical Report, "The results of periodic time studies for each classification of worker or 100% occupancy time will be used to determine routine worker exposure times." More specifically, please describe what is meant by "results of periodic time studies for each classification of worker" and "100% occupancy time will be used to determine routine worker exposure times."

Response:

In general, 100% occupancy time will be used to determine exposures. Using this method, each classification of worker is assumed to have spent their entire work shift in the survey area(s). Note that the length of work shifts may vary by worker classification. Plant operators will generally be working on a shift schedule to provide full time coverage and this may result in some variation from the standard 40-hour week schedule. Maintenance, wellfield, and part-time workers may not spend a full shift in the restricted area(s). The occupancy time determinations will be based on the actual scheduled time in the restricted area for each occupational group.

This approach generally results in a conservative (i.e., higher than actual) estimate of internal exposure to airborne natural uranium because it does not account for time the employee may have spent outside the work area, such as during breaks and meals. Alternatively, the RSO may perform a time study to determine the average time of exposure for each classification of worker. Under this approach, the RSO will have a representative population of each classification of worker track their time spent in different areas of the facility. The time study will be performed for an extended period (usually one month) and will provide the RSO with a percentage of time spent in each area for each classification of worker. If time studies are employed to determine time of exposure, they will be updated annually to account for any changes.

Sections 5.7.4.1 and 5.7.4.2 were revised providing this additional information on 100% occupancy time.

5-9. Bioassay Program (Section 5.7.5)

The applicant has not described the reporting and record keeping for occupational doses as suggested in Regulatory Guide 8.7. Please provide that information.

Response:

For employees that are monitored for internal and/or external exposure, recording and reporting of monitoring results is required in 10 CFR §20.2106(a) and §20.2206(b), respectively. Records of exposure monitoring results will be maintained for each monitored individual on an NRC Form 5 or equivalent.

In addition, 10 CFR §20.2104 requires a determination of the individual's current year dose at other facilities. EMC will obtain prior dose histories for all employees. EMC will obtain an NRC Form 4 signed by the individual to be monitored, or a written statement that includes the names of all facilities that monitored the individual for occupational exposure to radiation during the current year and an estimate of the dose received. EMC will attempt to verify the information provided by the individual. EMC will also attempt to obtain records of the individual's lifetime cumulative occupational radiation dose. This lifetime dose may be based on a written estimate or an up-to-date NRC Form 4 signed by the individual.

In accordance with 10 CFR §19.13(b), monitored employees will be advised in writing on an annual basis of their calculated TEDE. Additionally, any employee may request a written report of their exposure history at any time. These reports will be provided within 30 days of the request and will provide the information outlined in 10 CFR §19.13.

Section 5.7.4.5 was developed to include the above information on reporting and record keeping for occupational doses.

It should be noted that bioassays are not used for exposure determination and that a response in accordance with Reg Guide 8.7 is not appropriate in this section. Additional text was added to Section 5.7.5 to point out that the bioassay program confirms the air monitoring and internal exposure determinations discussed in Section 5.7.4.1.

5-10. Contamination Control Program (Section 5.7.6)

The applicant has not provided sufficient information regarding the contamination control program. Specifically, the following information should be provided:

a. Describe the reporting and record keeping for occupational doses as suggested in Regulatory Guide 8.7.

   Response:

   See Previous Response.

b. Describe in more detail the contamination control for maintenance activities that may involve the release of interior surfaces of pipes, drain lines, or duct work as well as equipment or scrap.

   Response:

   Employees that enter a restricted area will be required to sign in on an access log and note their name and the time entered. Upon leaving the restricted area, employees will be required to monitor themselves for radioactive contamination or take a shower and change their clothing in accordance with Regulatory Guide 8.30. The monitoring will consist of a visual examination to detect any visible yellowcake and an instrument survey to ensure that any suspected contamination is below the acceptable limits. If the contamination limit is exceeded, personnel must decontaminate their skin and/or clothing, repeat the survey, and notify the RSO. The RSO will investigate of the cause of the contamination and take corrective action, if appropriate. Employees will be trained during initial radiation safety training to self-monitor using a rate meter with an alpha scintillation detector. The results of the personnel survey will be recorded on the access log at the survey station. The RSO will routinely observe employees leaving the restricted area to ensure that proper personnel contamination survey methods are employed. Restricted areas include the central plant and drum storage areas as shown on Figure 2.1-3. All wellfield areas will be controlled areas as defined in 10 CFR §20.1003. Wellfield areas are shown on Figures 2.1-2 and 3.1-2

   Section 5.7.6 was updated with this additional information on contamination control.

c. Describe, and show on a map or maps, any restricted or controlled areas on the site and discuss access and egress procedures.

   Response:

   See previous response maps of restricted or controlled areas and for access and egress procedures.

5-11. Airborne Effluent and Environmental Monitoring Program (Section 5.7.7)

The applicant has not provided sufficient information regarding the airborne effluent and environmental monitoring program. Specifically, the following information should be provided:

a. Regulatory Guide 4.14 states that for air, radon monitoring should be conducted at five or more locations and these locations should be the same locations as for air particulate monitoring. From Figure 5.7-2, it does not appear that all of the air particulates (triangle symbols) are the same location as the radon monitoring. Please demonstrate that at least five air particulate monitoring locations are within the same proximity as the radon monitoring locations. Also, identify in Figure 5.7-2, which location is the control location.

Response:

Baseline radon monitoring station locations were selected prior to placement of air particulate monitoring stations. Air particulate station locations 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 radon stations do not exactly coincide with air particulate station locations, in each case there is one or more radon station reasonably close by each air particulate station. The radon monitoring portion of Section 5.7.7 was revised to reflect selection of monitoring stations described above.

There were no known residences within 10 km of the site so a fifth air particulate station was not considered applicable according to the protocols outlined in Table 1 of Regulatory Guide 4.14. Also, the control/background air particulate location was chosen to be on site rather than at a location "remote from the site". This is consistent with footnote (c) to Table 1 which states a need for the background location to be representative of site conditions. That footnote also states that the background air particulate station should be upwind of the site. Because of the large amount of area included within the boundaries of this ISR site, it seemed reasonable to place the background station within site boundaries, but at considerable distance upwind of operational areas (it is currently located at least 1 mile west/southwest of the plant location and wellfield areas). This also seemed to be a practical background location as it is readily accessible and hard line electrical power was available.

The control/background air particulate and radon monitoring stations are represented by ID numbers MRA-4 and MR-1 (as respectively shown in Fig. 2.9-25 and 5.7-2). Again, these locations are generally upwind of the plant location based on annual prevailing wind directions presented in the earlier response to comment 2.10 (d).

Regulatory Guide 4.14 calls for a minimum of 5 radon sampling stations, each located at the five recommended air particulate sampling stations. Because of the very large size of the site, 10 radon monitoring stations were used instead of the recommended 5 stations. Furthermore, each air particulate sampling station has at least 1 radon monitoring station in the general vicinity. Baseline Rn-222 results indicated a relatively minor degree of spatial variability in radon concentrations across the site. Because additional radon monitoring stations are placed in many locations around the site, any significant localized changes in conditions due to ISR operations should be detected and can be compared against pre-operational baseline data and where applicable, against data from the nearest air monitoring station or other stations.

Additionally, a description of operational air particulate environmental monitoring was inadvertently omitted from the original application. The following description of operational air particulate monitoring was added to Section 5.7.7:

> 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 2.9.6. Sampling locations are shown on Figure 5.7-2. 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 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.

b. The application does not address soil sampling during operations. Discuss the soil sampling program during operations. Include a description of subsurface soil sampling. Identify the sampling locations, including addressing the suggestion in Regulatory Guide 4.14 that they be taken at the same locations that air particulate monitoring is conducted?

Response:

Operational soil sampling will be conducted on an annual basis. Locations will include each of the 4 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. Regulatory Guide 4.14 does not indicate subsurface sampling during operational phases of the site.

The surface and subsurface soil portions of Section 5.7.7 was updated to reflect operational soil monitoring described above.

c. The applicant states that it will use environmental dosimeters and exchange them quarterly. Please identify the type of environmental dosimeter to be used for direct radiation and its lower limit of detection.

Response:

The environmental dosimeter used for direct radiation measurements will be the InLight dosimeter from Landauer. The InLight has a lower limit of detection of 0.1mrem. The direct radiation monitoring in Section 5.7.7 was revised to include type of dosimeter and the lower limit of detection.

5-12. Groundwater and Surface Water Monitoring Programs (Section 5.7.8)

The groundwater and surface water monitoring programs have not been sufficiently described to determine if they will detect an excursion from the ISL operations in an effective and timely manner. Please provide the following information:

a. A corrected groundwater model which uses the true unconfined conditions in the "70 sand" to determine the location of monitoring wells in the production zone monitoring well ring.

   Response:

   This information will be submitted with the next RAI response package.

b. The number and location of monitoring wells in the "60 sand" which will be the underlying aquifer in Wellfield 2, based on the communication of the 70 and 68 sands in a large section of this wellfield.

   Response:

   In the areas of Wellfield 2 where a confining unit exists between the 70 and 68 sands, monitor wells will be placed in the 68 sand at the spacing described in this section (1 per 4 acres). Additional monitor wells may be placed around the area where the two sands coalesce to provide increased monitoring of any potential impacts to areas of the 68 sand outside of the coalescing area. 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 final number and location of these underlying wells will be determined during final wellfield planning and submitted to the WDEQ-LQD in the Wellfield Package.

   Section 5.7.8 was revised to include this information.

c. A justification for the use of chloride, conductivity and total alkalinity for excursion indicators in the overlying "72 sand" which may have elevated values similar to the production mining zone as a consequence of CBM produced water infiltration. Otherwise, please provide an alternate set of other constituents to be used as excursion indicators for the "72 sand."

   Response:

   As demonstrated in the previous response for 2-5(b), Infiltration from CBNG produced water and subsequent elevation of potential excursion indicators in the 72 sand is not apparent at this time. Hence, the use of chloride, conductivity and total alkalinity is appropriate given baseline groundwater quality characteristics.

d. A discussion of how EMC will conduct pumping tests to establish that each wellfield production zone is in communication with the monitoring well ring given the reduced drawdown in the unconfined aquifer which may not stress the production zone sufficiently to see communication.

Response:

This information will be submitted with the next RAI response package.

e. A statement that EMC will also submit all wellfield hydrologic testing packages to NRC for review and approval before mining begins as EMC does not have a record of performance with NRC.

Response:

A response to this RAI will be submitted with the next RAI response package.

f. A standard operating procedure for sampling of the monitoring and private wells to ensure sampling is consistent for all wells during operations.

Response:

Groundwater samples are critical to meeting environmental protection goals at ISR uranium mines. The results of these samples are used to monitor operational environmental protection efforts and to determine whether restoration activities are successful. In order to ensure the accuracy of these monitoring efforts, strict compliance with groundwater sampling procedures is necessary. This section provides instructions on water level determination, proper well sampling techniques, sample preservation and documentation, and QA/QC requirements. These requirements will be followed for all samples obtained from private wells and monitor wells.

The accurate determination of the static water level in monitor wells provides important information concerning aquifer conditions. Well static water levels are monitored using an electrical measuring line (an "e-line"). An e-line is a device that measures electrical conductance with two electrodes contained in a shielded probe. The probe is mounted to a graduated strip to allow measurement of water levels. The probe is slowly lowered into the well. When the probe contacts the water surface in the well, the circuit is completed and an audible device is actuated. The sampler will take water level readings of all wells before sampling.

It is generally not possible to measure water level in existing private wells without disassembly of pumping and piping systems. If possible, the water level will be measured. If it is not possible to measure water level, the well will be purged for at least five minutes to evacuate any lines or existing pressure tanks of stagnant water. If any particulate matter is identified in the water, the well will be allowed to flow until it no longer contains any particulate.

During regional well sampling, all readings should be reported to within at least one tenth of a foot and preferably to within a hundredth of a foot. It is important to check the e-line length by measuring with a steel tape after the line has been used for a long time, when the length has been altered due to repairs, or after it has been pulled hard in an attempt to free the line. If an e-line's length is altered by these causes, a correction factor should be written on the side of the e-line so readings may be properly adjusted.

Water that remains in the well casing between samples may not be representative of the formation water quality. The quality of water left in the casing between samples may be changed by sorption or desorption from casing materials, oxidation, or biological activity. Purging is required to remove this stagnant water and allow formation water into the well screen.

The well must have a sufficient volume of water removed to induce the flow of formation water through the well screen. Two approaches to purging are provided in ASTM Guide D 4448. The first approach requires purging a large volume of water. ASTM Guide D 4448 recommends that three to five casing volumes be purged for the high volume method, while one casing volume may be acceptable if a lower purge rate near the recharge rate of the well is used. The second approach recommended in ASTM D 4448 requires the removal of stagnant casing water until one or more indicator parameters are stable. Stabilization is considered achieved when the measurements of all parameters are stable within a predetermined range. Parameters that EMC will monitor include pH, temperature, and specific conductivity.

For high and medium yield wells, EPA recommends a minimum purge volume of three casing volumes. For low yield wells, EPA also allows a smaller minimum purge volume of one casing volume if the flow is near the recharge rate of the aquifer.

The Wyoming LQD in Guideline 8, Section IV.A.4.b requires withdrawing at least two casing volumes of water prior to sampling. The sampler will document the pumping rate and the purging time. The LQD alternatively allows purging the well until pH, conductivity, temperature, and water level readings remain constant. The field sampler will document the changes in each field parameter against time in a tabular form. If recharge cannot match minimal pumping rates in a low permeability aquifer, then a sample can be retrieved by pumping the well dry once and then bailing the water that subsequently enters the well.

Accurate records of well purging will be maintained to document the number of casing volumes purged from the well before sampling. These records will include the casing volume (gallons), the pumping rate (gpm), and pumping start and stop times. The pumping rate can be determined with a flowmeter or by timing how long it takes to fill a 5-gallon bucket or other container of a known volume.

The following formula will be used to calculate the number of gallons contained in one casing volume:

$$\textit{Casing Volume (Gals)} = (\textit{Height of water in well in ft}) \times (\textit{Radius of the well}^2 \textit{ in inches}) \times (\pi) \times (0.052)$$

Where: $\pi = 3.1416$

The height of the water in the well = the total depth (TD) of the well in feet minus the depth to water in feet.

Field meters will be used to measure pH, specific conductance, and temperature of water samples. The use, calibration, and care of these meters will be in accordance with the owner's manual recommendations.

The groundwater sample will be taken as soon as the well is adequately purged. If the well was pumped dry during purging, the sample will be obtained as soon as adequate formation water is present in the casing. The sampler will record the following sampling data on a field sampling sheet:

- Identification of the well;
- Well depth;
- Static water level depth and measurement techniques;
- Well yield;
- Purge volume, pumping rate and volume per casing volume;
- Time well purged;
- Collection methods (bail or pump);
- Field observations (such as well condition, sample color, sample smell, sound);
- Name of collector; and
- Climatic conditions, including air temperature.

Once a water sample has been taken, the quality of the sample begins to degrade with time. Because of this, all samples will be kept cool and some must be preserved in order to lengthen the acceptable holding time. The contract laboratory will be consulted when determining proper preservation techniques for samples that require off site analysis. Samples to be analyzed for dissolved metals will be filtered to < 0.45 microns to remove suspended solids that may affect the results.

Preservative (acid) will be added to sample containers either before or immediately after collection and filtration, if required, of samples. The following Table provides a summary of the sampling and preservation recommendations for analytes typically of concern in groundwater. Field sampling personnel will consult the bottle and preservation list provided by the contract laboratory to ensure that the appropriate sample preservation method is used.

Parameter	Volume Required (mls)	Preservative	Holding Time
Dissolved Metals	250	Filter (0.45 μm), then add HNO_3 to ph<2	6 months
Total Metals	250	HNO_3 to ph<2	6 months
Alkalinity	100	Cool, 4°C	14 days
Chloride	50	None Required	28 days

Parameter	Volume Required (mls)	Preservative	Holding Time
Conductance	100	Cool, 4°C	28 days
Fluoride	50	None Required	28 days
Ammonia as N	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate + Nitrite	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate	50	Cool, 4°C	48 hours
Nitrite	50	Cool, 4°C	48 hours
pH	25	None Required	Analyze immediately
TDS	500	Cool, 4°C	7 days
TSS	500	Cool, 4°C	7 days
Sulfate	100	Cool, 4°C	28 days
Lead-210	1000	HNO_3 to ph<2	6 months
Polonium-210	1000	HNO_3 to ph<2	6 months
Radium-226	1000	HNO_3 to ph<2	6 months
Uranium	1000	HNO_3 to ph<2	6 months

Chain of Custody (COC) forms will accompany every sample sent to off-site contract laboratories. The chain of custody will contain at a minimum the type of sample, the sample identification number, the preservation techniques (if any), the name of the sampler, the date and time the sample was taken, the name(s) of individuals who handled the sample and when they passed it on to another person, and the required analysis.

This information on well sampling methods was added to Section 5.7.8.2

g. The location of the surface water sampling points and description of surface water sampling methods.

Response:

The locations of operational surface water sampling points are shown on Figure 2.7-1.

Surface water samples are collected using methods similar to groundwater. Samples are collected in the appropriate container(s) and field measurements for pH and conductivity are performed and documented using the techniques described in groundwater sampling methods.

The sample bottle must be rinsed with the sample water. The bottle is then filled with the mouth of the sample bottle pointed down stream to prevent collecting debris. If samples involve analysis that requires filtration, collect water in a clean bucket for transfer to the filter apparatus. Treatment of sample containers, preservation techniques, holding times, and shipping techniques are identical to those used for groundwater samples previously described.

Section 5.7.8.2 was revised to include the surface water sampling methods described above.

h. The location and permitted volume of CBM discharge at all surface water sampling points.

Response:

The previous responses to RAIs 2-4.c and 2-8.a detail locations and permitted volumes for CBNG discharges in the license area.

5-13 Quality Assurance (Section 5.7.9)

The applicant has stated that it will implement a quality assurance program but has not provided any details of that program. The applicant must propose a quality assurance program applicable to all radiological, effluent, and environmental monitoring programs.

Response:

Section 5 was revised to include the general Uranium One Quality Assurance Plan for Wyoming ISR Operations, which is provided in Addendum 5-A.

6-1. Plans and Schedules for Groundwater Quality Restoration (Section 6.1)

The plans and schedules for groundwater quality restoration have not been sufficiently described to determine if they will achieve the required goals of restoration. Please provide the following information:

a. Demonstrate that the applicant will be able to return the groundwater quality to the NRC required restoration standard of baseline water quality or the standards listed in Criterion 5B(5)(b) of Appendix A to 10 CFR Part 40.

   Response:

   EMC believes that the standard of baseline water quality or the standards listed in Criterion 5B(5)(b) of Appendix A to 10 CFR 40 are not appropriate criteria to demonstrate adequate restoration.

   WDEQ-LQD Rules and Regulations Chapter 11, Section 5 (ii), states that contents of the Reclamation Plan should include "the information necessary to demonstrate that the operation will achieve the standard of returning all affected groundwater to the premining class of use or better using Best Practical Technology". Section 6.1 of the Moore Ranch Application currently provides a description of restoration success in returning groundwater quality to the class of use as required by Wyoming Statutes using best practical technology, and has also demonstrated restoration to baseline for several parameters.

b. In Wellfield 2, the "70 sand" production zone and the "68 sand" coalesce in a large section of almost 1000 linear feet on cross section E-E'. Given the total absence of a confining layer between these sands, explain how lixiviant and restoration fluids will be prevented from moving freely from the "70 sand" into the "68 sand". Also, explain how the 68 sand in this region will be restored if it becomes apparent during operations that the 68 sand has been significantly affected by lixiviant.

   Response:

   Wellfield balance will be maintained in the area where these sands coalesce as it would be maintained during normal operations. This will maintain flow into the wellfield. Therefore, the affected pore volume is anticipated to be the same as if a confining unit was present. If portions of the 68 sand are impacted through normal operations in the area where the 70 and 68 sands coalesce, then the impacted portion of the 68 sand will be restored using proposed restoration methods. The proposed monitoring in this area should be sufficient to detect impacts to the 68 sand.

c. A description of biological reduction method to be used to achieve restoration for targeted constituents in the proposed wellfield mining zone including: the efficacy of the chosen method; additives and rates; how progress with be monitored; estimates of pore volumes required when using biological reductants; and how the stability of water quality in zones treated with biological reductants will be monitored and established.

Response:

The biological reduction method has not been determined at this time. Biological reduction has been successful in trial use at other ISR sites. Further evaluation is needed to determine the biological reduction method and field implementation for the Moore Ranch Project.

d. An explanation of how the restoration methods proposed for Moore Ranch which have only been applied to confined aquifers will be successful in an unconfined aquifer like the "70 sand" production zone at Moore Ranch. Address issues including how to ensure contact of restoration fluids with all parts of the mined region including dewatered zones, predicting the behavior of each constituent in an unsaturated environment where oxygen will be present, and methods to ensure representative sampling. The applicant must address these issues and any others to ensure that the proposed restoration methods are suited to the unconfined aquifer setting and will achieve the primary restoration standard of return to baseline water quality for the entire production zone.

Response:

This information will be submitted with the next RAI response package.

e. Report the specific pore volume for each well field and show the calculations and assumptions. In Wellfield 2, if you determine that the "68 sand" must be included in the production zone (see b. above); the pore volume estimate should include both the "70 sand" and the "68 sand" which coalesce in a large section in the center of the wellfield.

Response:

Response:

This information will be submitted with the next RAI response package.

f. Justify in detail the six pore volumes estimate for each of the wellfields, which appears very low, using a basis of comparable field experience or revise the estimate. Reported field case pore volumes from the similarly situated COGEMA Irigaray ISL Units 1-9 ranged from 9.5 to 18.4 with an average of 14.6 to achieve restoration. If the applicant retains the estimate of six pore volumes, it should provide a substantial justification using analytical methods or numerical modeling. These estimates should also take into account unique issues presented by the unconfined aquifer setting at Moore Ranch and address any difference in pore volumes needed if biological reductants are used. Provide a new schedule for restoration if the estimated number of pore volumes for restoration is revised. (See also RAI 6-6.)

Response:

This information will be submitted with the next RAI response package.

g. Provide a description of how the mining zone will be monitored during restoration to track the success of any restoration phase or techniques such as the addition of chemical or biological reductants.

Response:

The mining zone will monitored on a frequent basis adequate enough to determine success of restoration, optimize efficiency of restoration techniques, and determine any areas of the wellfield that need additional attention. Samples will be monitored for all of the parameters shown in Table 6.1-1 at the start of restoration and all or selected parameters through restoration as needed.

Section 6.1.7.2 was revised with this information.

h. Describe the deep disposal wells to be installed, the number of wells, their locations, their design, injection zone, and their capacity. Provide an estimate, with supporting analysis of how much waste water would be produced during restoration and the ability of the disposal wells to handle the rates and volumes. In addition, describe how waste fluids will be handled if any or all of the disposal wells became inoperable. (See also RAI 4-2).

Response:

See response to RAI 4-2.

i. Address how EMC will detect and clean up spills of waste fluids from lines to the deep disposal wells in a safe, effective, and timely manner.

Response:

The wells will be equipped with a high-level shutoff switch on the injection tubing to prevent operation of the pumps at pressures greater than the Limiting Surface Injection Pressure. In addition, the wells will be equipped with a low-pressure shut-down switch on the surface injection line that will deactivate the injection pump in the event of a surface leak. Finally, the wells will include a high/low pressure shutdown switch with a pressure sensor on the tubing/casing annulus. This switch will stop the injection pump in the event of either (1) a tubing leak or (2) a casing, packer, or wellhead leak. This information was added to Section 4.2.3.3.

See response to RAI 4-2(g) for clean of spills.

j. Provide a justification for the selection of a six month stability monitoring time period to determine restoration success. Additionally, provide the criteria which will be used to establish that the water quality in the restored zone is stable (e.g., no increasing trends that would threaten ground water quality if left unabated).

Response:

The six month stability monitoring period is specified in WDEQ-LQD Guideline 4. The criteria to establish restoration stability will be based on wellfield averages for water quality. A determination of aquifer stability should be made upon the "trends" in the data; i.e., a stable aquifer should not exhibit rapid upward or downward trends or be oscillating back and forth over a wide range of values. The data is evaluated against baseline quality and variability to determine if the restoration goal is met and if the water is restored at a minimum to within the class of use.

Section 6.1.7.2 was revised to include the above information.

6-2. Plans for Reclaiming Disturbed Lands (Section 6.2)

The plans for reclaiming disturbed lands have not been sufficiently described to determine if they will achieve the required goals of reclamation. Please provide the following information:

a. A discussion of the pre-reclamation radiological survey regarding how it and the baseline survey will be used to identify potential contamination areas.

Response:

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.

b. A reference a pre-operations topographic map in Section 6.2.4. In addition, EMC should provide additional discussion on the development of a post reclamation topographic map or provide an explanation of why one is not needed.

Response:

As stated in Section 6.2.4, no major changes in the topography will result from the proposed mining operation. Therefore, a final contour map is not required As a result, the pre-operations contour shown on Figure 2.1-2 will generally show post-mining contour. The reference to Figure 2.1-2 was added to Section 6.2.4.

c. A discussion of plans for decommissioning non-radiological hazardous constituents as required by 10 CFR Part 40, Appendix A, Criterion 6 (7).

Response:

All waste that could pose a threat to human health and the environment will disposed of offsite. This will effectively control, minimize, or eliminate post-closure escape of nonradiological hazardous constituents, leachate, contaminated rainwater or waste composition products to the ground or surface waters, or to the atmosphere.

Section 6.3.2 was revised to include the above information.

d. The EMC QA program discussed in Section 6.4.4 addresses only the need to require the soil testing laboratory to have a QA program. EMC should discuss or reference its own QA/QC program that needs to address all aspects of decommissioning, including procedures and confidence intervals.

Response:

See response to RAI 5-13

6-3. Removal and Disposal of Structures, Waste Material, and Equipment (Section 6.3)

The applicant needs to provide the following additional information related to the removal and disposal of structures, waste material, and equipment:

a. Provide the details of a waste disposal agreement for 11e.(2) byproduct material disposal at an NRC or Agreement State licensed facility. The agreement should include commitments to notify NRC within 7 days if it is terminated and to submit a new agreement for NRC approval within 90 days of expiration or termination. (See also RAI 4-3).

   Response:

   See response to RAI 4-3

b. EMC needs to include in its survey and decontamination procedures, a commitment that radioactivity along the interior surfaces of pipes, drain lines, and duct work will be determined by measurements at traps or other access points, and a commitment that pieces or equipment that are too big to scan will be considered contaminated in excess of the limits.

   Response:

   This commitment was added to Section 6.3.2.1.

6-4. Methodologies for Conducting Post Reclamation and Decommissioning Radiological Surveys (Sections 6.4 & 6.5)

The applicant needs to provide the following additional information related to the methodologies for conducting post reclamation and decommissioning radiological surveys:

a. Discuss how the background radiological characteristic data from Section 2.9 will be used in the post reclamation and decommissioning surveys.

Response:

Please see response to 6-2 (a.)

b. In Section 6.4.1.3, Uranium Chemical Toxicity Assessment, it states, "No intake of contaminated food through the aquatic or milk pathways was considered probable. The applicant included all food pathways, but not the aquatic and milk pathway. Provide an explanation for why the milk and aquatic pathways were not considered probable and thus not included in the RESRAD calculations provided in Appendix C.

Response:

Intake of contaminated food through aquatic pathways is not likely since surface water bodies on the site are ephemeral in nature and do not support aquatic species. Intake of contaminated milk is likewise not likely as no dairy livestock are located within or near the permit boundaries. Thus, these pathways were not included in the RESRAD calculations.

c. In Section 6.4.3, the applicant indicates that cleanup of surface soils will be restricted to a few areas where there are known spills and, potentially, small spills near wellheads. The applicant should justify why other areas where there may be small, unknown spills, are not considered for soil cleanup. Describe in more detail the surface soil cleanup verification and sampling in known contaminated areas and potentially contaminated areas, including more information about the gamma action level and how it will be demonstrated that other areas are not contaminated. In addition, the discussion should also include those well fields where no spills are known. Please discuss the type of radiation surveys and sampling that will be conducted in these areas.

Response:

Pre-reclamation surveys will also be conducted as described in Section 6.2.1 in areas where known contamination has occurred or the potential for unknown soil contamination exists. This statement was added to Section 6.4.3.

Also, See previous response to 6-2(a).

6-5. Financial Assurance (Section 6.6)

The applicant needs to provide the following additional information related to financial assurance:

a. The financial assurance cost estimate should be presented in 2008 dollars or provide an adjustment for inflation from the 2006 dollar value currently used in the tables.

   Response:

   Appendix D has been updated with a new reclamation cost estimate in 2008 dollars.

b. The financial assurance funding mechanism (i.e., surety bond, cash deposit, certificate of deposit, deposit of government securities, etc.) that EMC plans on using for the Moore Ranch project should be identified.

   Response:

   The financial assurance funding mechanism will be in the form of an Irrevocable Letter of Credit. Section 6.6 was updated to include the anticipated surety mechanism.

c. EMC needs to provide indication in Section 6.6 that it will 1) automatically extend the existing surety amount if the NRC has not approved the extension at least 30 days prior to the expiration date; 2) revise the surety arrangement within 3 months of NRC approval of a revised closure (decommissioning) plan, if estimated costs exceed the amount of the existing financial surety; 3) update the surety to cover any planned expansion or operational change not included in the annual surety update at least 90 days prior to beginning associated construction; and 4) provide NRC a copy of the State's surety review and the final surety arrangement.

   Response:

   Section 6.6 was revised to include the statements requested above.

6-6. Financial Assurance Spreadsheets (Appendix D)

The following items in the Financial Assurance spreadsheets in Appendix D of the application need to be discussed, explained, or calculated further:

a. Provide the justification for using 6 pore volumes total. This number appears to assume that the well field is at the end of its productive life. Provide the required number of pore volumes to restore while the mine unit is still active. (See also RAI 6-1.f.)

   Response:

   This information will be submitted with the next RAI response package.

b. Provide the justification for the flare factor, including discussion of why the value used for other sites is appropriate for the Moore Ranch site.

   Response:

   This information will be submitted with the next RAI response package.

c. The $20,000 per year for spare parts does not appear to be carried through the equations in the cost estimate.

   Response:

   Appendix D has been updated with a new reclamation cost estimate in 2008 dollars.

d. Groundwater Restoration, Table 1, of Appendix D, Total number of wells in wellfield – The total estimated number of wells should at least be equal to the current number of wells (i.e., 60 and not 55).

   Response:

   Appendix D has been updated with a new reclamation cost estimate in 2008 dollars based on current design and number of wells.

e. Groundwater Restoration, Table 1, of Appendix D, Item VII, Total Building Utility Cost does not sum from the correct row.

   Response:

   Appendix D has been updated with a new reclamation cost estimate in 2008 dollars providing new building utility costs.

f. Groundwater Restoration, Table 1, of Appendix D – The current spreadsheet is based on 2.5 years of restoration, regardless of the amount of water treated (i.e., the number of pore volumes). The duration of restoration is a factor of the number of pore volumes needed. Provide the basis of tying the estimated number of pore volumes to duration. If the duration exceeds 2.5 years, the following time related costs need to be tied into the longer duration of restoration: V - Estimated restoration period, stability period, VII – building utility costs number of months, VIII – Vehicle Operating Costs average number of years, IX –Labor Costs number of years (current assumption is 6 months longer than restoration period).

Response:

Appendix D has been updated with a new reclamation cost estimate in 2008 dollars. Estimated restoration duration is tied to the number of pore volumes.

g. Provide additional explanation of the elution costs (in Groundwater Restoration, Table 1, of Appendix D, Item IV), i.e., whether they fixed costs or are they tied to the duration and/or number of pore volumes. If they are tied to the duration and/or the number of pore volumes, these costs need to be recalculated.

Response:

Appendix D has been updated with a new reclamation cost estimate in 2008 dollars including updated CPP operation costs based on ISL operating experience.

h. Either provide costs in the surety for MIT testing and gamma surveys for the reclaimed areas or explain why those costs do not need to be included.

Response:

Appendix D has been updated with a new reclamation cost estimate in 2008 dollars including MIT costs during restoration and for gamma surveys for decontamination.

7-1. Accidents

Provide the information requested in Section C.6 of Regulatory Guide 3.5. This includes an evaluation of various potential accidents, measures to be implemented to prevent accidents, and emergency plans and training:

Response:

An evaluation of potential accidents is contained in Section 7.5.

2 SITE CHARACTERISTICS

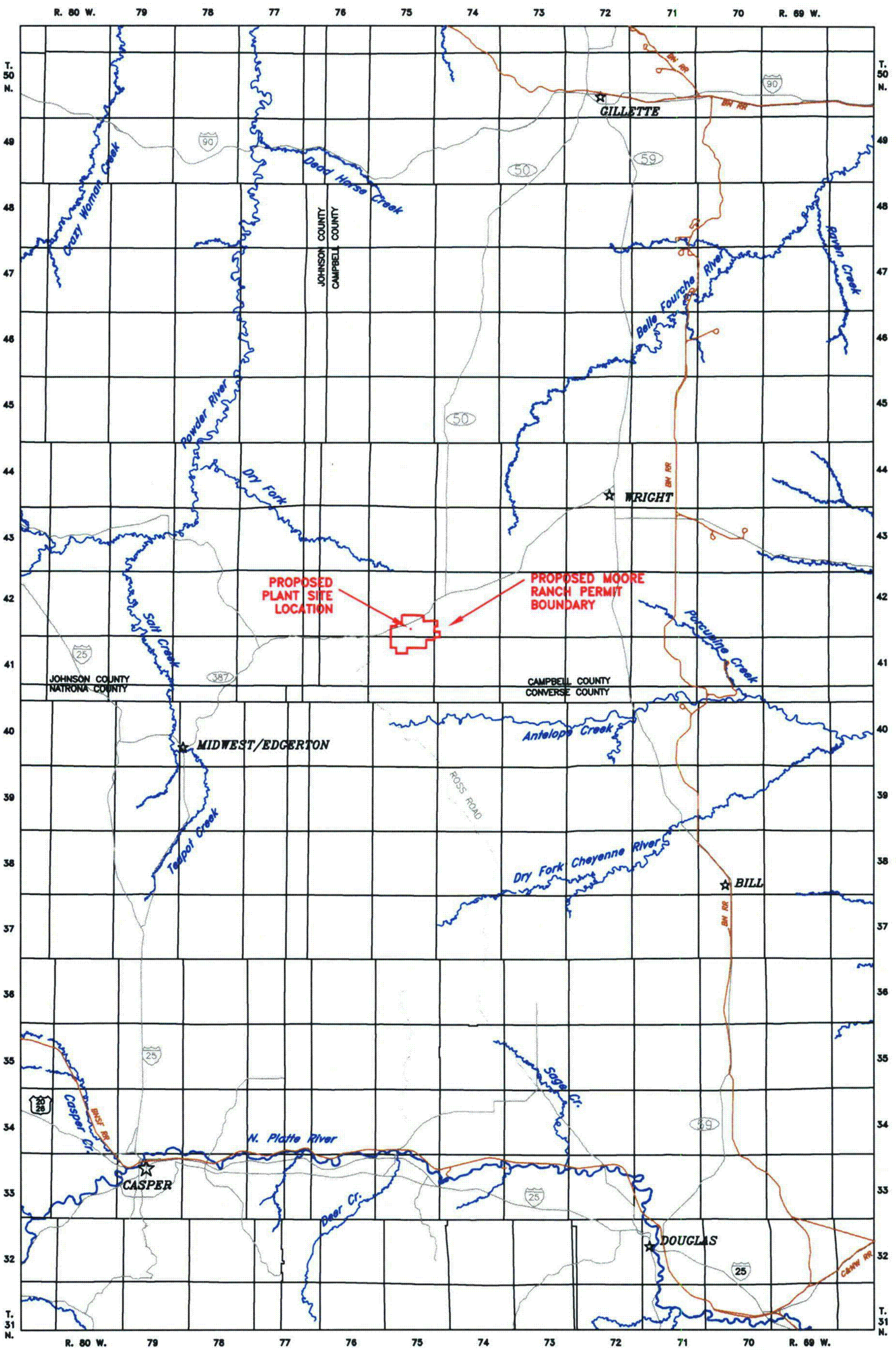
2.1 SITE LOCATION AND LAYOUT

The location of the proposed Moore Ranch Uranium Project is in Township 42 North, Range 75 West, Sections 26, 27, 33, 34, 35, 36 and Township 41 North, Range 75 West, Sections 1, 2, 3, and 4, and Township 42 North, Range 74 West, Section 31. Coordinates for the Central Plant are Easting 3827510 and Northing 12715235. Figure 2.1-1 shows the general location of the site in the Powder River Basin area in relation to surrounding population centers, interstates and highways, and County boundaries. Population centers around the Moore Ranch Project area include Casper (approximately 57 miles south-southwest), Gillette (approximately 54 miles north-northeast), Wright (approximately 25 miles northeast), and Midwest/Edgerton (approximately 24 miles southwest). Section 2.3 provides more information on surrounding population and Figure 2.3-1 shows population and distances to population centers within a 50-mile (80 km) radius.

Access to the site from the east is on State Highway 59 or State Highway 50 to State Highway 387. Access from the west is from I-25 to State Highway 259 to State Highway 387. The main access road to the plant facilities and wellfields is located off Highway 387 in T42N, R75W, Section 27. The access road runs south through Section 34 and forks to the east through Section 35 and also continues south through the permit boundary. This existing access road will provide the primary access to all currently planned wellfields and facilities. Secondary roads for wellfield headerhouses and facility access will fork off of the existing primary access road.

The maps used in this section and other sections of this application were derived from USGS 7.5 minute topo quad maps from Topo Depot® software and geo spatial data from the Wyoming Geographic Information Science Center. These are CAD/GIS drawings where each road, stream, and contour line are individual entities. This base map was then used for each of the figures prepared for this document with the addition of the pertinent information for that figure.

Figure 2.1-2 shows the proposed license boundaries, general topography, project site layout, topography, site drainage, access, and facility areas including the Central Plant (restricted area), Warehouse/Shop, and Office building areas, the potential wellfield boundaries (control areas). The total area within the proposed license boundaries is 7,110 acres. Other site right of ways such as electrical transmission lines, water pipelines, and oil and gas pipelines are shown on Figure 7.2-1 in Section 7.2. Drainage, surface water features, and waterways are shown on Figure 2.7.1-1 in Section 2.7. Figure 2.1-3 shows the main processing area facilities layout, topography, site drainage, and access.



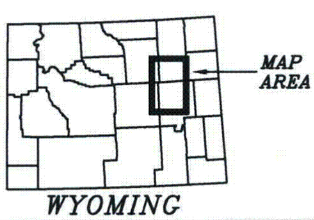


FIGURE 2.1-1

0 KM 10 KM
0 MILES 3 6 MILES

ENERGY METALS CORPORATION, US

139 West 2nd St. Casper, WY 82601 307-234-8235

REVISIONS			MOORE RANCH URANIUM PROJECT
NO.	DATE	BY	SITE LOCATION MAP
1	07/16/07	JT	PORTIONS OF CONVERSE, NATRONA, JOHNSON & CAMPBELL COUNTIES

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED: DRAWING NO.: FIGURE 2.1-2, "MOORE RANCH URANIUM PROJECT SITE LAYOUT"

WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT DRAWING NO. FIGURE 2.1-2

D-01

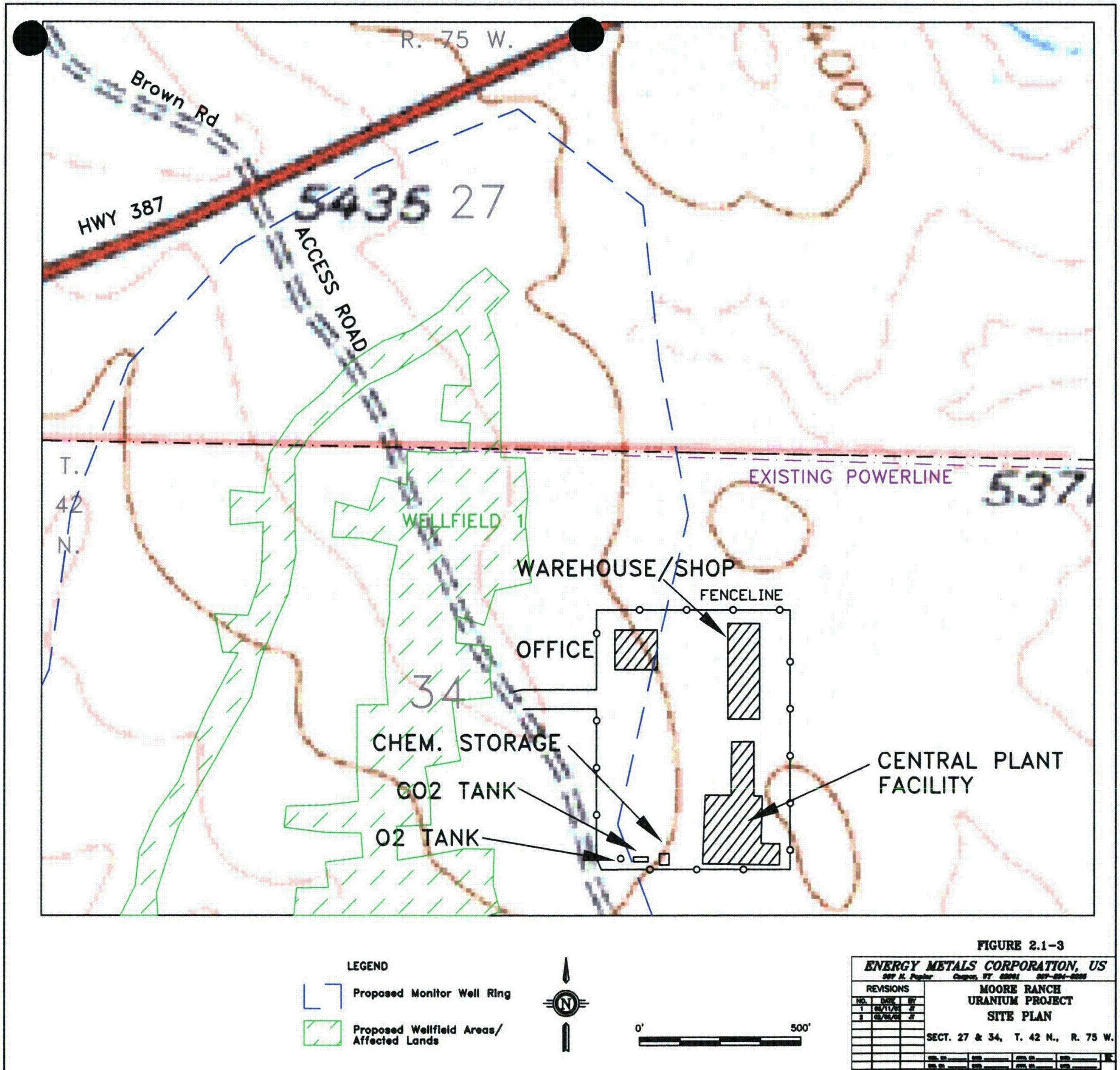

R. 75 W.
Brown Rd
HWY 387
5435
27
ACCESS ROAD
T.
42
N.
EXISTING POWERLINE
WELLFIELD 1
WAREHOUSE/SHOP
FENCELINE
OFFICE
34
CHEM. STORAGE
CO2 TANK
O2 TANK
CENTRAL PLANT FACILITY
LEGEND
Proposed Monitor Well Ring
Proposed Wellfield Areas/ Affected Lands
N
0'
500'
ENERGY METALS CORPORATION, US
REVISIONS
NO.
1
2
MOORE RANCH
URANIUM PROJECT
SITE PLAN
SECT. 27 & 34, T. 42 N., R. 75 W.

FIGURE 2.1-3

2.5 METEOROLOGY

2.5.1 Introduction

The proposed Moore Ranch Project is located in a semi-arid or steppe climate. The region is characterized seasonally by cold harsh winters, hot dry summers, relatively warm moist springs and cool autumns. Temperature extremes range from roughly -25° F in the winter to 100° F in the summer. The "last freeze" occurs during late May and the "first freeze" mid-to-late September.

Yearly precipitation totals are typically near 10 inches. The region is prone to severe thunderstorm events throughout the spring and early summer months and much of the precipitation is attributed to these events. In a typical year, the area will see 4 or 5 severe thunderstorm events (as defined by the National Weather Service criteria) and 40 to 50 thunderstorm days. Autumn stratiform rain events also contribute to precipitation totals, but to a lesser degree than those before mentioned. Snow frequents the region throughout winter months (40-50 in / year), but provides much less moisture than rain events.

Windy conditions are fairly common to the area. Nearly 5% of the time hourly wind speed averages exceed 25 mph. The predominant wind direction is west/southwest with the wind blowing out of that direction 20% of the time. A north/northwest secondary mode is also present. Surface wind speeds are relatively high all year-round, with hourly averages 11 - 15 mph. Higher average wind speeds are encountered during the winter months while summer months experience lower average wind speeds.

Meteorological data has been compiled for ten sites surrounding the Moore Ranch project. Data has been acquired through the Western Regional Climate Center (WRCC, 2007) for eight COOP and ASOS stations operated by the National Weather Service (NWS) including Casper AP, Douglas, Dull Center 1SE, Glenrock 5 ESE, Kaycee, Lance Creek 3 WNW, Midwest, and Reno. In addition, Glenrock Coal Company (GCC) and Antelope Coal Company (ACC) meteorological data have been obtained through Inter-Mountain Laboratories (IML) located in Sheridan Wyoming. The latter two mentioned sites are operated in compliance with regulations set forth by the Wyoming Air Quality Division (AQD) for air quality monitoring. IML has maintained the sites and archived the data for nearly 20 years. Baseline meteorological information for the Moore Ranch Project was collected by IML and subsequently reported to EMC and is described in this Section. Table 2.5-1 provides the station identification, coordinates, and period of operation for each site.

The Antelope Coal (ACC) and Glenrock Coal (GCC) mines were both analyzed in the site specific analysis due to their proximity to the permitted region and to provide perspective from both a ridge top and drainage. The GCC site is located on the western slope just below the peak of a ridge and ACC is situated on the eastern slope of a small drainage. ACC data is chosen over GCC as most representative of the proposed project area, for several reasons. The ACC site, like the proposed project area, extends from the eastern slope of a ridge downward into a drainage. GCC lies slightly higher in elevation and is on the opposite facing slope. GCC's location leads to slightly higher wind speeds since ACC is slightly sheltered from the predominant winds. ACC experiences greater temperature extremes than GCC, which may also be related to terrain. Lastly, ACC is approximately 10 miles closer to the project area than GCC.

Table 2.5-1 Meteorological Stations Included in Climate Analysis.

Name	Agency	X	Y	Z(ft)	Years_Operation
Antelope Coal Company	IML	474179	4816180	4675	1986-2006
Glenrock Coal Company	IML	431649	4767610	4910	1996-2006
Casper AP (112)	NWS	380229	4750539	5338	1948-2005
Douglas (118)	NWS	468655	4732910	4820	1909-2005
Dull Center 1SE (71)	NWS	503239	4806131	4420	1926-2005
Glenrock 5 ESE (117)	NWS	436247	4742017	4950	1941-2005
Kaycee (58)	NWS	368677	4840739	4660	1900-2005
Lance Creek 3 WNW (77)	NWS	528436	4782869	4340	1962-1984
Midwest (59)	NWS	396362	4806926	4820	1939-2005
Reno (68)	NWS	458891	4836243	5080	1963-1983

The ten sites collectively have been analyzed to provide a regional climatic temperature and precipitation analysis of the proposed project area. Only the Casper AP, GCC, and ACC sites will be analyzed for the regional wind summaries. The eight NWS sites will be incorporated into the snowfall discussion as neither mine site records snowfall data. No on-site data is available for the proposed area and the combination of the ACC and GCC sites will be substituted as the nearest representative available data sets for the site specific analysis. GCC and ACC lie in similar terrain as that seen in the proposed project area. Figure 2.5-1 shows the ten sites in relation to the project permit boundary. As can be seen in the figure, ACC and GCC are the closest available sites with wind data. The closest NWS operated station which continuously records all weather parameters is the Casper AP site which lies some 55-60 miles to the southwest.

A regional overview will be presented first. The section will include a discussion of the maximum and minimum temperature, relative humidity, annual precipitation including snowfall estimates, and a short wind speed and direction summary. ACC, GCC and the Casper AP provide the only wind data for the region. Casper AP will be incorporated into the regional overview and ACC and GCC will be analyzed for the site specific analysis. The last portion of the regional analysis will include a general climate data summary from Casper.

The site specific analysis will follow with much of the data based on the ACC, and GCC meteorological data with many of the same parameters listed previously. An in-depth wind analysis will be comprised of summaries including wind speed and direction averages, joint frequency distributions to characterize the wind data for the site by stability class, and wind speed distributions to provide insight into the wind speed relative frequencies. A seasonal data discussion is included for the temperature and wind parameters. The seasonal classification does not follow the general calendar dates. The seasons are classified in three month intervals as follows; January – March for winter, April-June for spring, July – September for summer, and October – December for fall. No site specific general climate data will be included as the regional evaluation is deemed adequate.

The ACC and GCC meteorological stations were also proposed to the NRC for use in baseline data collection for the Allemand-Ross Project by High Plains Uranium, Inc. (HPU) in August of 2006. Since that time, HPU was acquired by Energy Metals Corporation. In a letter from the NRC to HPU dated September 14, 2006, the NRC states that the meteorological stations at the Antelope and Glenrock mines meet the standards identified in NRC Regulatory Guide 3.63, *Onsite Meteorological Measurement Program for Uranium Recovery Programs- Data Acquisition and Reporting,* and can be recognized as "standard installations" per NUREG-1569. Therefore, data from these stations may be used in place of NWS Station Data. As described above, the ACC and GCC stations are closer to the Moore Ranch Project than the nearest NWS station and lie in very similar terrain. As a result, EMC believes that data from the ACC and GCC stations is representative of expected long term conditions at the Moore Ranch site. The ACC site has similar topographic features and is about 25 miles from the project site. Both sites are characterized by mildly rolling hills covered with grass and sparse shrubs. The nearest mountain ranges are:

- the Bighorn Mountains, approximately 50 miles from the Moore Ranch project site and 75 miles from ACC
- the Black Hills, approximately 60 miles from ACC and 85 miles from the Moore Ranch

- the northern Laramie Range, approximately 50 miles south of Moore Ranch and 65 miles southwest of ACC

Due to these large distances, neither the ACC site nor the Moore Ranch site experiences significant wind channeling or shielding from any of the three mountain ranges. Also, there are no major bodies of water affecting the meteorology of these two sites. The ACC site is several hundred feet lower in elevation than Moore Ranch. Both, however, are situated on the southeasterly side of the hydrologic divide with a similar vertical relationship to the divide.

Because of the extensive surface coal mining that has developed over the last 30 years, the PRB airshed is one of the most heavily monitored in the country. Coal production in the PRB grew from a few million tons in 1973 to over 400 million tons in 2006. The Clean Air Act and the Surface Mining Control and Reclamation Act of the 1970's prompted a parallel growth in ambient air quality monitoring throughout the PRB. This has led to over 100 particulate monitoring samplers and more than 20 meteorological monitoring towers, all configured to support air quality permitting, compliance and research objectives.

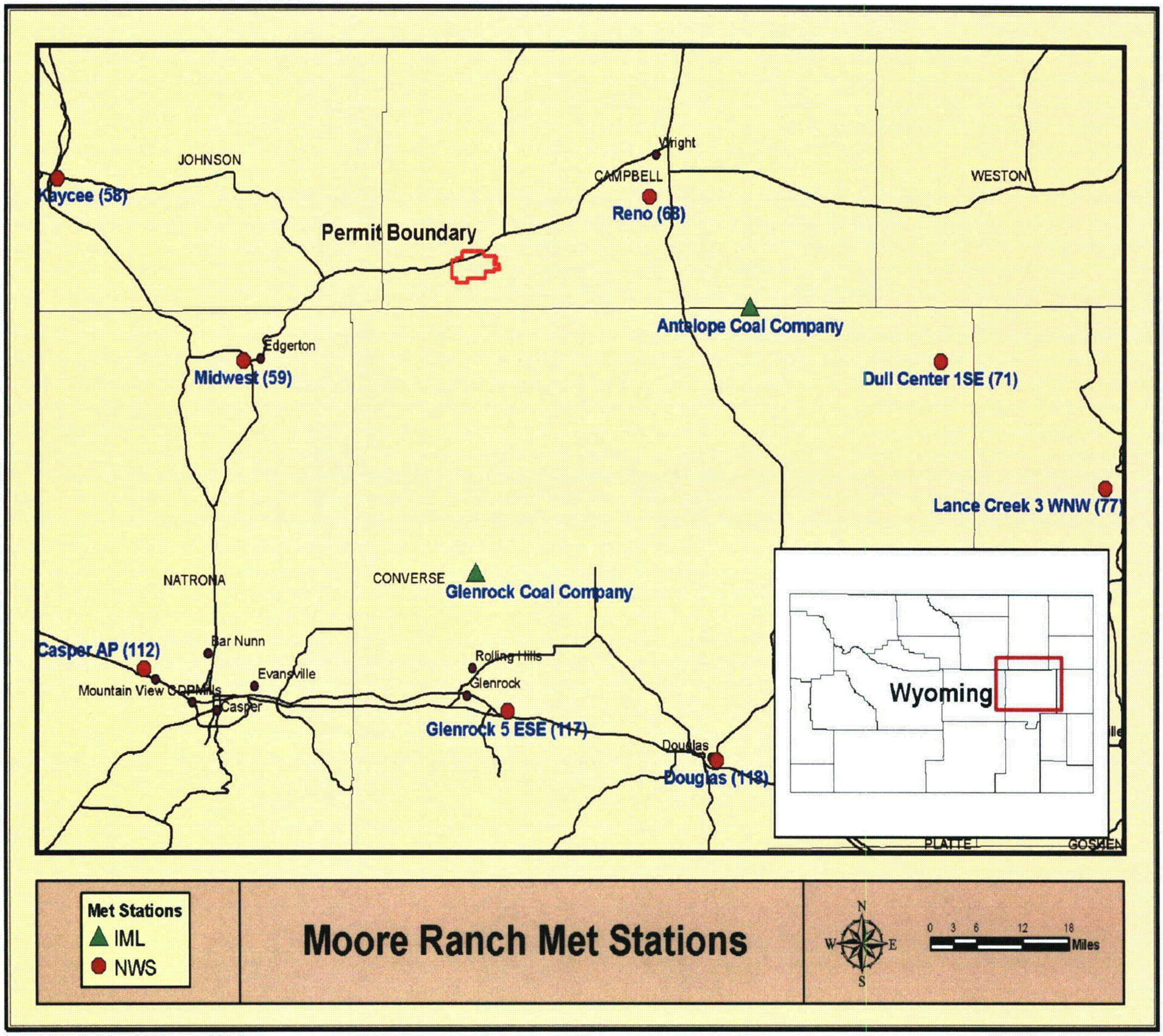
The monitoring programs at these sites meet the Wyoming Department of Environmental Quality requirements for land and air quality permit compliance. Methods used in collecting and validating these data adhere to EPA's "On-Site Meteorological Program Guidance For Regulatory Modeling Applications." Hourly average values for various parameters are generated by field instruments and recorded by continuous data loggers, all operated and maintained by IML Air Science. Data recovery has typically exceeded 95%. Depending on the mine, meteorological parameters logged include wind speed, wind direction, sigma theta, ambient temperature, barometric pressure, solar radiation and precipitation. All hourly data are downloaded to IML Air Science's relational database. The database software provides for quality assurance, invalidation of suspect or erroneous data, and various forms of data presentation.

Table 2.5-2 lists the meteorological instruments employed at the Antelope (ACC) and Glenrock (GCC) mines. The coordinates and elevations of both sites are presented, along with instrument models, accuracy specifications, and instrument heights above the ground.

Table 2.5-2 Meteorological Stations Included in Climate Analysis.

Antelope	10m tower	CR10X Data Logger		Lat: 43° 28' 08.92" Elev. 4,680 ft Long: -105° 20' 57.56"	
Parameter	**Instrument**	**Range**	**Accuracy**	**Threshold**	**Instrument Height**
Wind Speed	RM Young Wind Monitor AQ	0-112 mph	±0.4 mph or 1% of reading	0.9 mph	10 meters
Wind Dir	RM Young Wind Monitor AQ	0-360°	±3°	1.0 mph	10 meters
Temp	Fenwall Electronics Model 107	-35°- 50° C	±0.5° C @ given Range	--	2 meters
Precip	Met One 12" tip	Temp: -20° - 50° C	±0.5% @ 0.5 in/hr rate	--	1 meter
Bar Press	Vaisala PTB 101B	600 -1060 mb	±0.5 mb @ 20°C	--	2 meters
Glenrock	10m tower	CR10 Data Logger		Lat: 43° 03' 36" Elev. 4,910 ft Long: -105° 50' 24"	
Parameter	**Instrument**	**Range**	**Accuracy**	**Threshold**	**Instrument Height**
Wind Speed	RM Young Wind Monitor AQ	0-112 mph	±0.4 mph or 1% of reading	0.9 mph	10 meters
Wind Dir	RM Young Wind Monitor AQ	0-360°	±3°	1.0 mph	10 meters
Temp	Fenwall Electronics Model 107	-35°- 50° C	±0.5° C @ given Range	--	2 meters
Precip	Met One 8" tip	Temp: -20° - 50° C	±0.5% @ 0.5 in/hr rate	--	1 meter

Figure 2.5-1 NWS and Coal Mine Meteorological Stations.



2.5.2 Regional Overview

2.5.2.1 Temperature

The annual average temperature for the region is 46° F. The graph (Figure 2.5-2) shows monthly average temperatures for the two mine sites and the Casper AP. As illustrated, there is very little difference exhibited between the three sites. July shows the highest average monthly temperatures followed by August. January and December record the lowest average temperatures for the year. Table 2.5-3 below compares the monthly average temperatures for the three sites. The slight differences in average temperatures could be attributed to the small change in elevation between the stations. ACC has the highest average temperature of the three and the lowest elevation while Casper has the lowest average temperature and is the highest in elevation.

The proposed project region has annual average maximum temperatures of 58.5° F and average minimum temperatures of 32.5° F. July has the highest maximum temperatures with averages near 90° F while the lowest minimum temperatures are observed in January with averages near 10° F. Annual average minimum and maximum temperatures are shown in Figures 2.5-3 and 2.5-4, respectively.

Large diurnal temperature variations are found in the region due in large part to its altitude and low humidity. Figure 2.5-5 depicts the seasonal diurnal temperature variations for the two mine sites. The site specific monthly values are shown in Table 2.5-3 spring and summer daily variations of 15° - 25° F are common with maximum temperature variations of 30 - 40° F observed during extremely dry periods. Less daily variation is observed during the cooler portions of the year as fall and winter have variations of 10° - 15° F.

The lesser variation in daily temperature can be attributed to the more stable environment the region is exposed to during the fall and winter months. Stable periods have much lower mixing heights and accompanying lapse rates allowing for less temperature variation. The graphs also show ACC having larger diurnal variations than GCC. This may be attributed to the major soil type/surface each site is exposed too. ACC is an active coal mine with much bare soil (coal) exposed and little vegetation in the areas surrounding the meteorological station. GCC, on the other hand, has been in reclaim for an extended period with the meteorological station located in the middle of rolling prairie with native grasses and scattered scrub brush present. The vegetated region will "hold" more moisture and moderate temperatures to a greater extent as more energy is applied to latent heating rather than to sensible heating.

Table 2.5-3 Annual and Monthly Average Temperatures for ACC, GCC, and Casper AP

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Casper	23.4	27.1	33.6	42.8	52.7	62.9	70.9	69.2	58.5	46.6	33.2	25.3	45.5
Glenrock	26.1	26.7	32.5	41.7	51.1	60.7	70.8	68.1	57.9	45.7	33.7	26.1	46.1
Antelope	26.0	27.2	34.4	43.7	53.4	63.9	71.5	69.9	58.7	45.4	33.5	26.1	47.8

Figure 2.5-2 Average Monthly Temperatures for ACC, GCC, and Casper AP

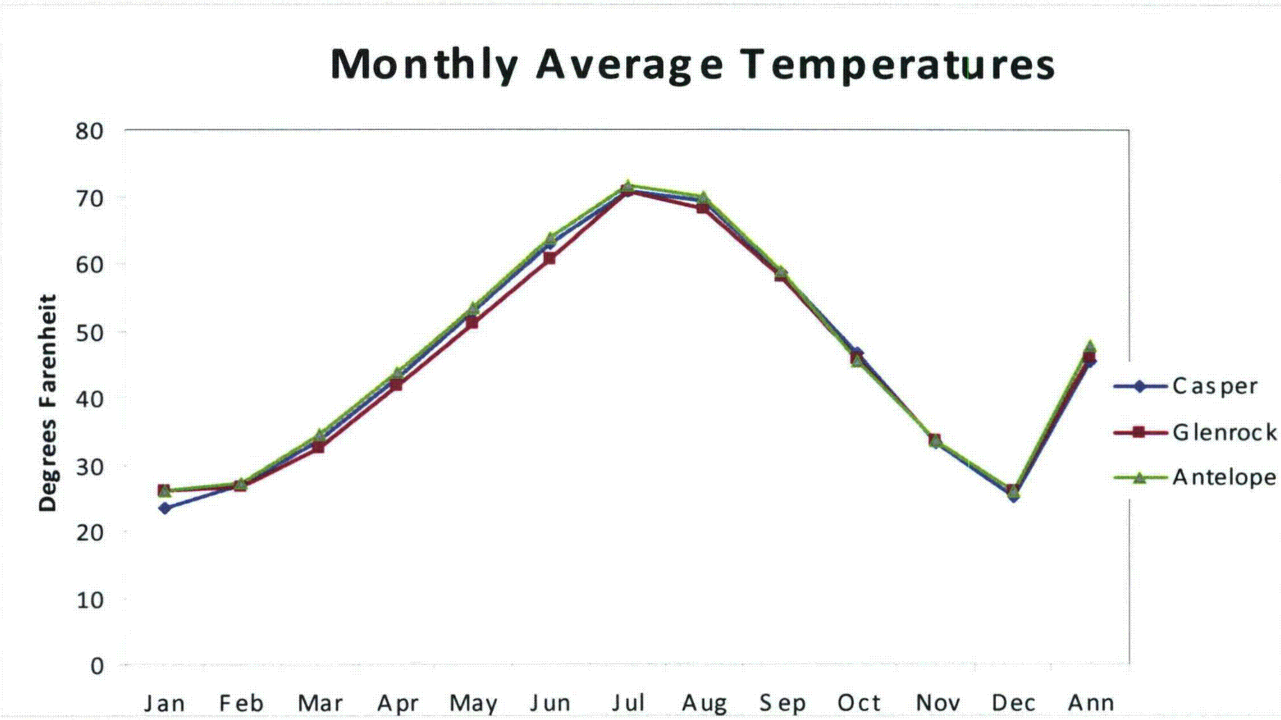


Figure 2.5-3 Regional Annual Average Minimum Temperatures.

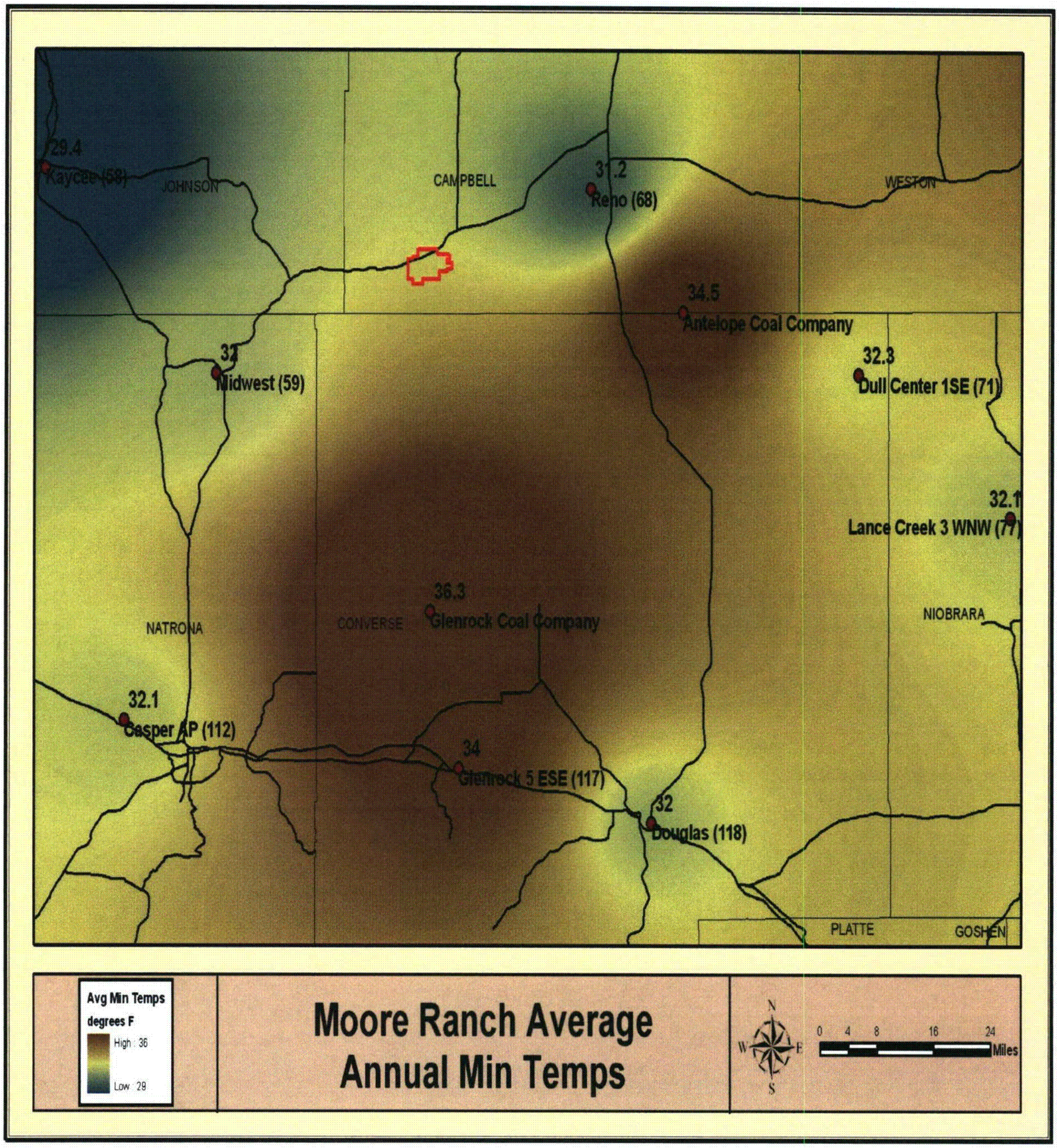


Figure 2.5-4 Regional Annual Average Maximum Temperatures.

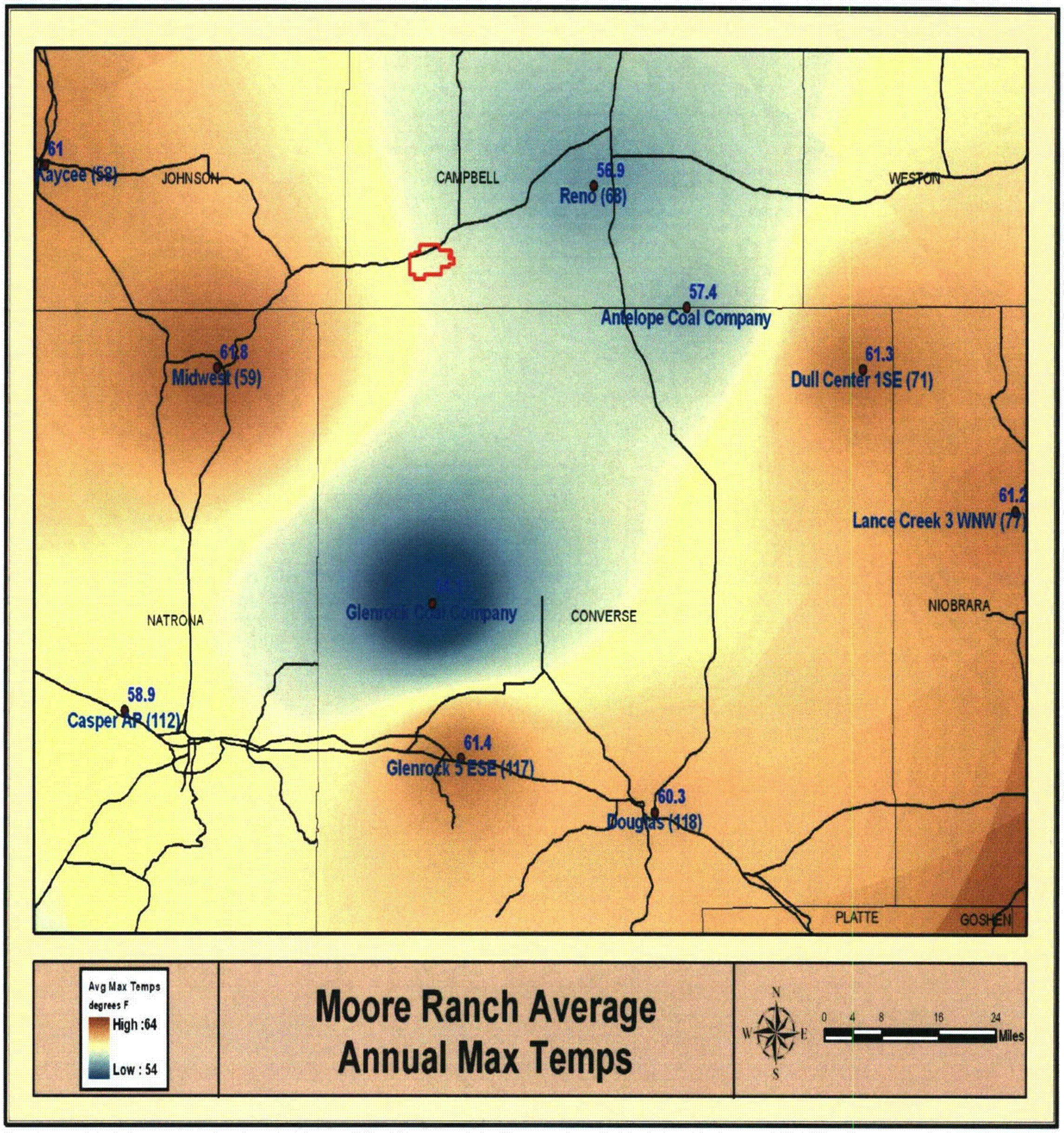
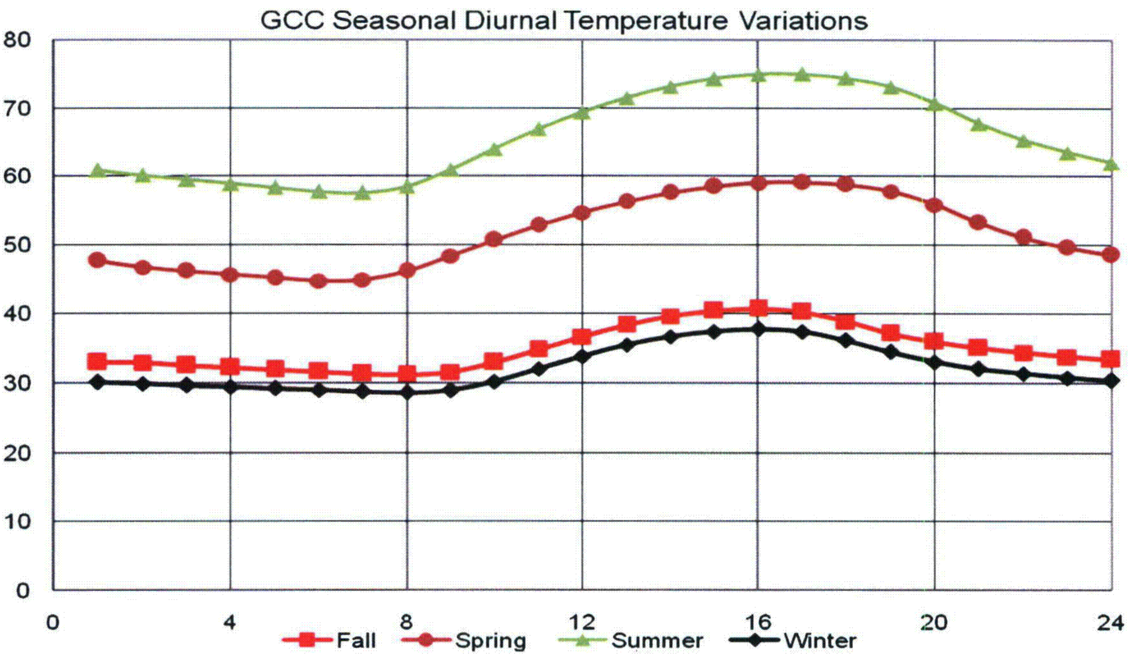
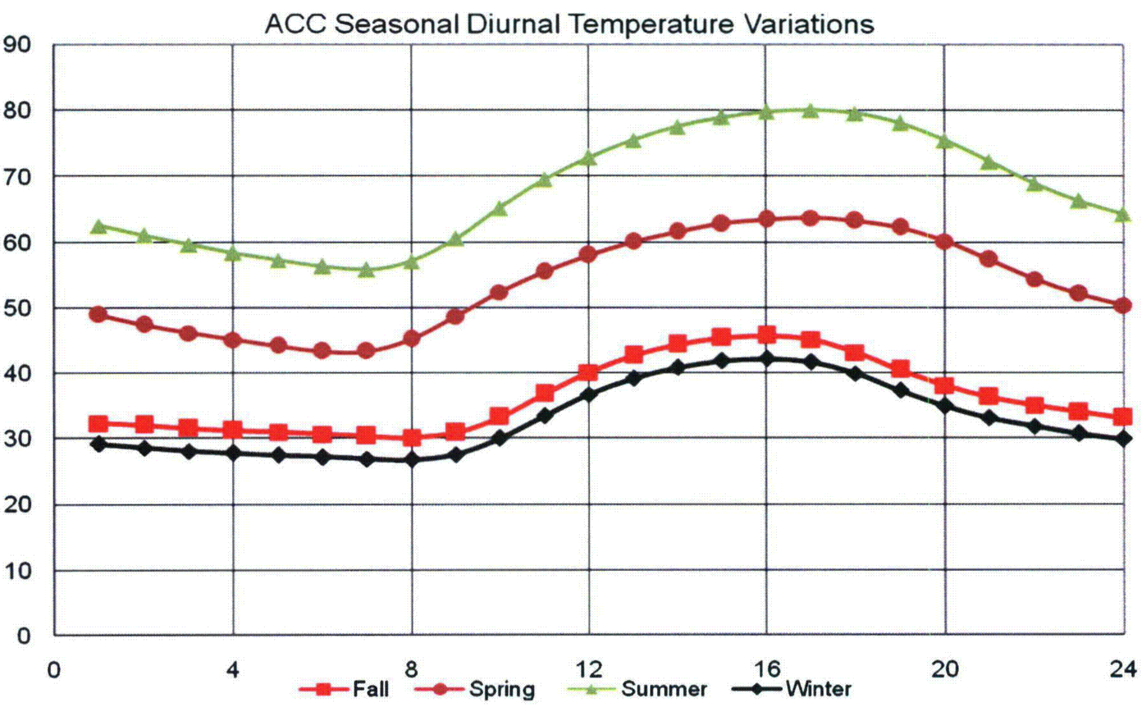


Figure 2.5-5 GCC (top) and ACC (bottom) Seasonal Diurnal Temperature Variations

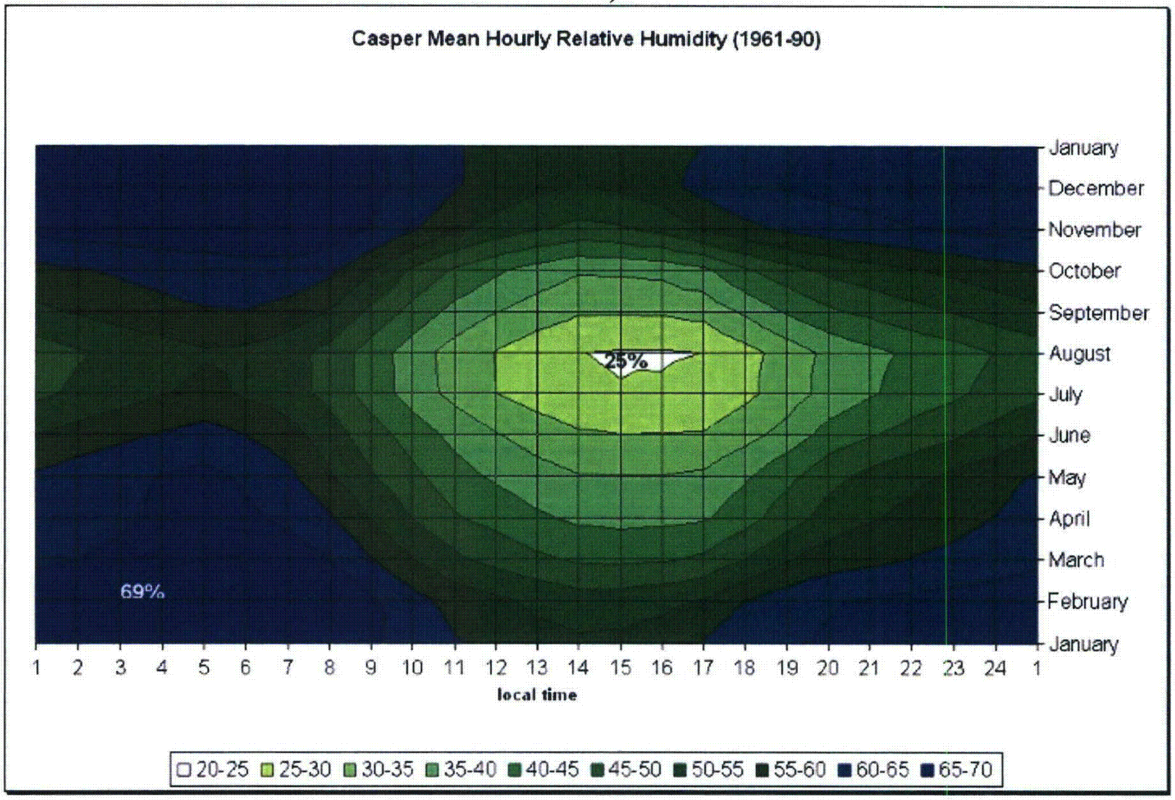




2.5.2.2 Relative Humidity

The Casper AP is the only site included in the analysis that records relative humidity (dew point) data. The graph shown in Figure 2.5-6 presents data taken from the Wyoming Climate Atlas (WRDS, 2007). The graph shows the mean hourly relative humidity (%) by time of day and month. It can be seen here that July is the "driest" month of the year followed by August and June. It also shows the winter months of December and January are the "wettest" portions of the year. The extreme values are stenciled on the graph where 25% is the lowest mean hourly value while 69% is the highest mean hourly value.

Figure 2.5-6 Mean Monthly and Hourly Relative Humidity for Casper AP (WRDS, 2007)



Relative humidity maximums occur more frequently in mornings (5:00 am) while minimums typically occur during the afternoon (5:00 pm). The average annual readings are 70% and 43% for mornings and afternoons, respectively. Mean monthly afternoon values range from 24% in August to 62% in December while morning mean values range from 66% in August to 77% in May. There is a much greater variation in the afternoon values which coincides with the greater temperature variations which occur during that time. Relative humidity is a temperature based calculation which shows the fraction of moisture present versus the amount of moisture for saturated air at that temperature.

2.5.2.3 Precipitation

The region is characterized by extremely dry conditions. On average, the region experiences only 40-60 days with measurable (>0.01 in) precipitation (WRCC, 2007). The proposed project region has an annual average in the 11 – 11.5 inch category based on the interpolated values (Figure 2.5-7). Annual averages across the region range from 9 – 13 inches. Spring and early summer (May-July) thunderstorms produce the majority of the precipitation, 45%. May is typically the wettest month of the year; all stations have monthly averages greater than 2 inches for that time as can be seen in Figure 2.5-8 below. January, on the contrary, is the driest month of the year as values are generally one half inch or less. The winter months (Dec-Feb) typically account for only 10% of the yearly totals. A secondary minimum is also evident during August as warm conditions have persisted over the course of the summer months. This promotes extremely stable conditions and light precipitation amounts as convective activity is limited.

Severe weather does arise throughout the region, but is limited to 4-5 severe events per year. These severe events are generally split between hail and damaging wind events. Tornadoes can occur but on rare occasions, with less than one tornado per county per year (Martner, 1986).

Major snowstorms (more than 6 in/day) also frequent the region. The region surrounding Casper experiences one to two snowstorms per year. Casper AP has the highest annual snowfall of all the sites with an average of nearly 80 inches. This value is sharply contrasted by three sites having annual averages of 20 – 25 inches. The great disparity between the sites can attributed to Casper's proximity to Casper Mountain. The site is located at the base of the northern slopes of the mountains and is influenced by snow events which occur as a result of orographic lifting. The interpolated values (Figure 2.5-9) show the project region having averages near 40 inches. This value agrees well with the Wyoming Climate Atlas (Martner, 1986) which lists averages for southwestern Campbell County at 40-50 inches. Substantial monthly averages (more than 3 in/month) occur for half the year and "measurable" averages (>1 in/month) for 2/3 of the year (Figure 2.5-10).

Figure 2.5-7 Regional Annual Average Precipitation

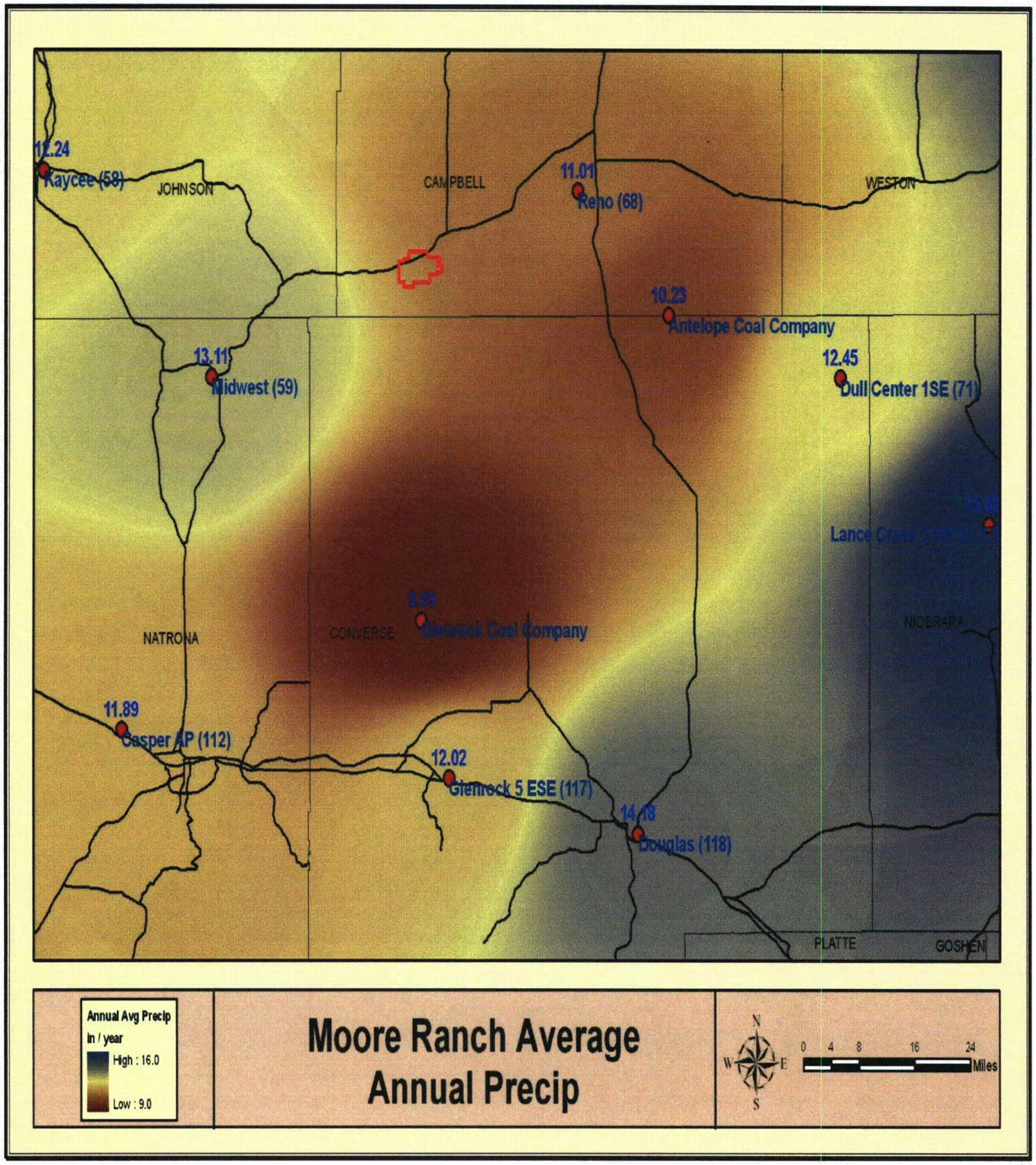


Figure 2.5-8 NWS Station Monthly Precipitation Averages (NCDC, 2007)

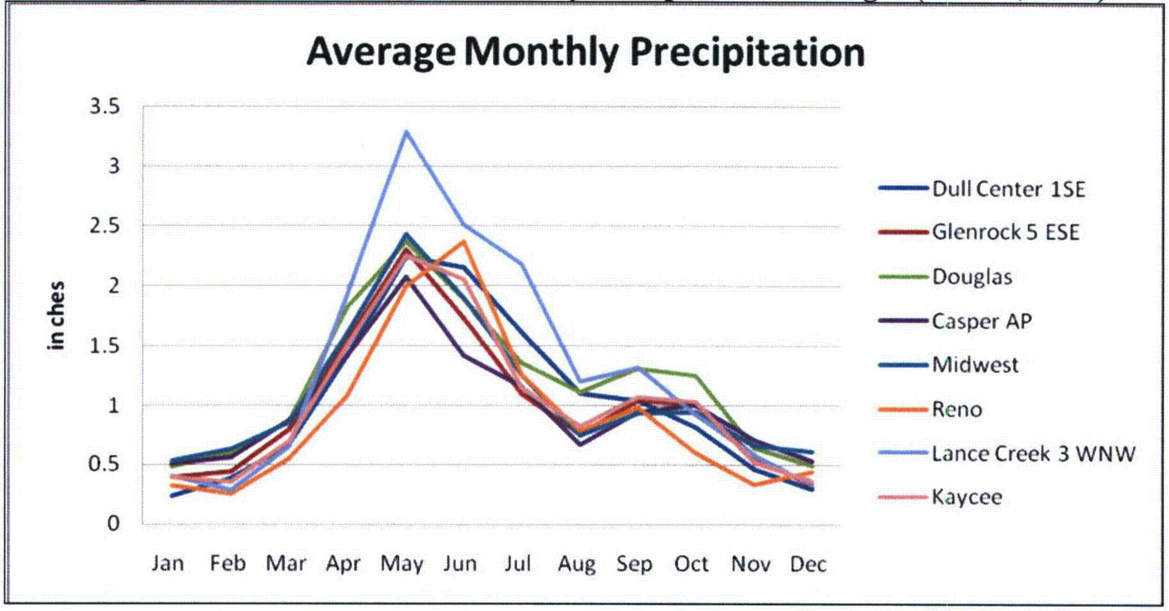


Figure 2.5-9 Regional Annual Average Snowfall

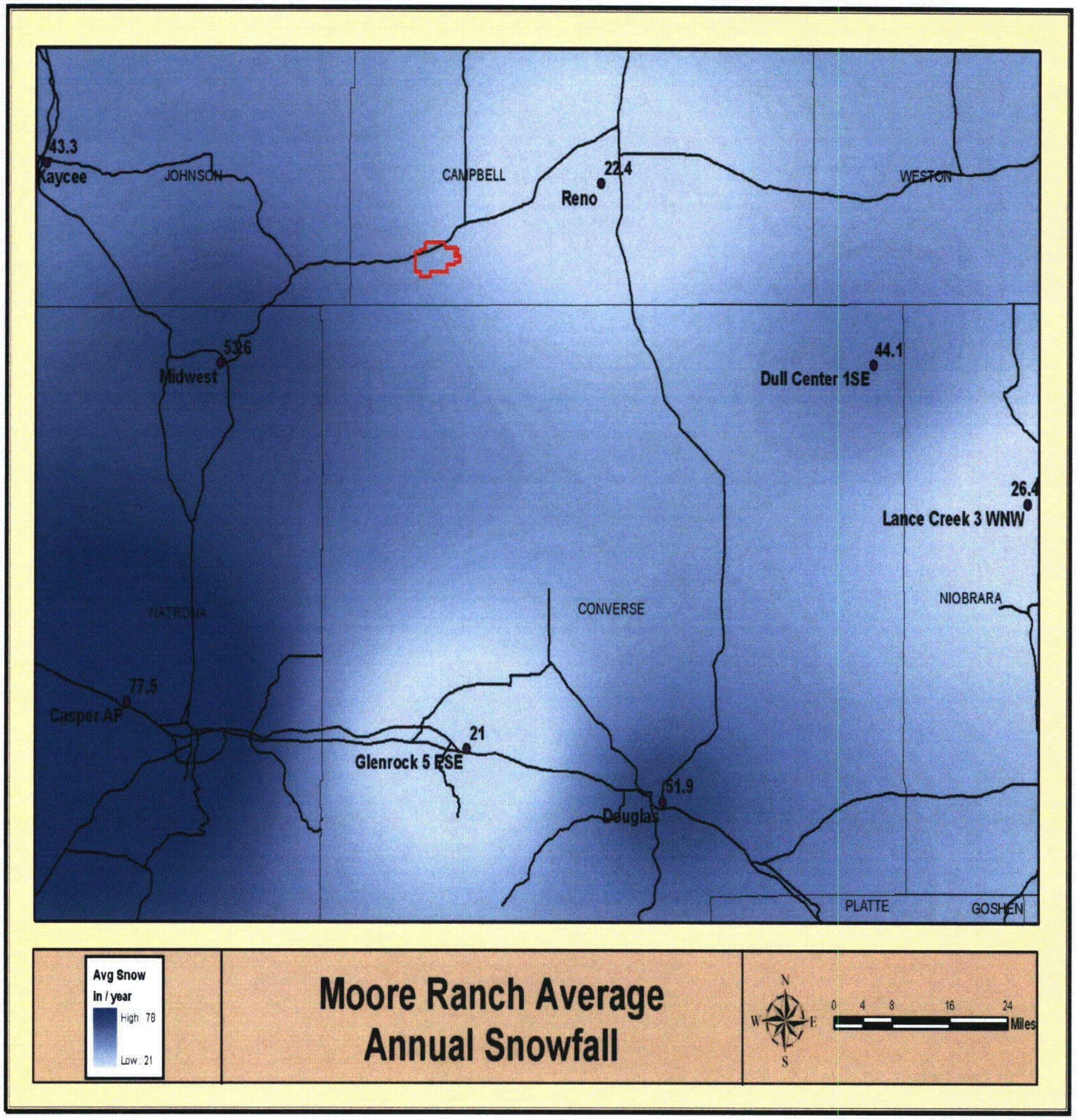
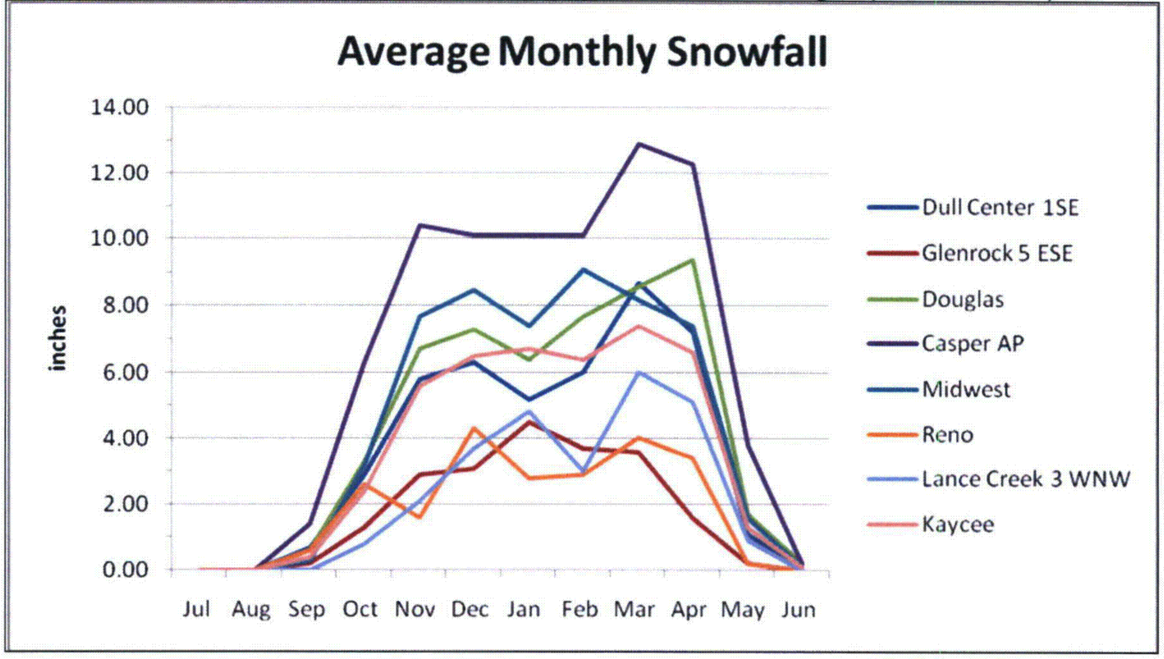


Figure 2.5-10 NWS Station Monthly Snowfall Averages (NCDC, 2007)



2.5.2.4 Wind Patterns

The Casper AP site averaged 12.8 mph for the 50+ years included in its climate database. The wind patterns throughout the region show very little variability. Strong west/southwesterly winds frequent the region. More than 40% of the time the wind direction is from the southwest to west sectors and accompanying wind speeds are generally fairly high with averages greater than 12 mph nearly 75% of the time. Mean monthly values from the Casper AP show July having the lowest value of 10.1 mph and January the highest at 16.3 mph. (Table 2.5-4) shows the monthly wind speed and direction averages along with monthly gust values. NWS direction data are summarized to the nearest 10 degrees. High wind events are a regular event as gust data from the Casper AP shows every month recording wind gusts greater than 60 mph. Little change is evident in the predominant seasonal wind directions. Spring and summer show west/southwest as the predominant direction, with southwest winds dominating fall and winter.

Table 2.5-4 Casper AP Monthly Wind Parameters Summary (WRCC, 2007)

	Wind Speed	Wind Direction	Wind Gust
JAN	16.3	SW	67
FEB	15.0	SW	64
MAR	13.8	SW	63
APR	12.6	WSW	60
MAY	12.6	WSW	64
JUN	11.0	WSW	64
JUL	10.1	WSW	60
AUG	10.3	SW	62
SEP	10.9	WSW	63
OCT	12.0	SW	62
NOV	14.4	SW	60
DEC	16.0	SW	66
ANN	**12.8**	**SW**	**67**

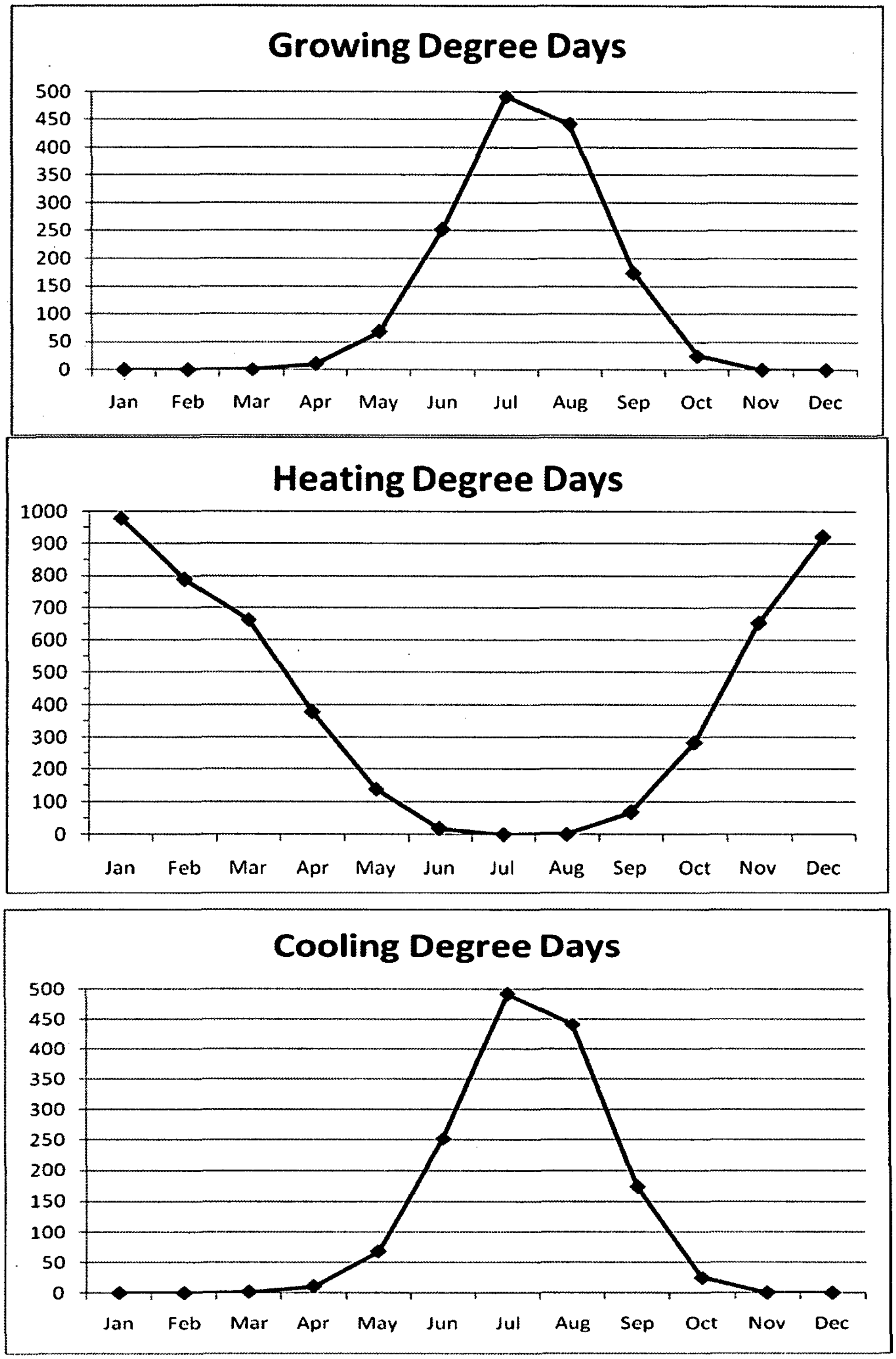
2.5.2.5 Cooling, Heating, and Growing Degree Days

The graphs shown on the next page (Figure 2.5-11) summarize the cooling, heating, and growing degree days for Casper. The data are assumed to be indicative of the region as the other meteorological parameters for the various sites track very closely.

The heating and cooling degree days are included to show deviation of the average daily temperature from a predefined base temperature. In this case, 55° F has been selected as the base temperature. The number of heating degree days is computed by taking the average of the high and low temperature occurring that day and subtracting it from the base temperature. The calculation for computing growing and cooling degree days is the same. The number of days is computed in the opposite fashion as the base temperature is subtracted from the average of the high and low temperature for the day. Negative values are disregarded for both calculations.

As expected, the heating degree days and cooling degree days are inversely proportional and the number of growing and cooling degree days are identical when the same base temperature is chosen. The maximum number of heating degree days occurs in January, 980 degree days, which coincides with January having the lowest minimum average temperature. Conversely, July registers the most cooling/growing degree days with 492, which also corresponds to July having the highest maximum average temperature.

Figure 2.5-11 Casper AP Cooling, Heating, and Growing Degree Days (WRCC, 2007).



2.5.3 Site Specific Analysis

The site specific discussion will be limited to the meteorological data from the two mine sites, Glenrock Coal (GCC) and Antelope Coal (ACC). These two sites were chosen as surrogate sites based on their proximity and similar topographic features to the permitted region. The region is characterized by high plains, rolling hills and minor ridges. Both sites are included to provide a depiction of the differences experienced between the ridge tops and lower drainages. The vegetation types are mainly confined to native grasses with some sage brush and very sparse woody coverage. Each mine's meteorological station is surrounded by rolling hills covered with native grasses.

2.5.3.1 Temperature

The annual average site temperature is 46.5 °F with temperatures for each site experiencing a maximum exceeding 98° F and minimum falling below -25° F. Figure 2.5-12 shows the seasonal average temperatures for both sites, which are nearly identical. The accompanying Table 2.5-5 provides the maximum, minimum and average seasonal temperatures for both mine sites. Average temperatures range from 30° F in the winter to 65° in the summer.

Tables 2.5-6 and 2.5-7 provide meteorological summaries for the two surrogate sites. The averages, maximums, and minimums are specified for each parameter recorded at the site along with the recovery rate for each. The recovery rates are greater than 90% for all parameters at both sites with the exception of sigma theta at GCC which had a recovery rate of 89%.

Table 2.5-5 ACC and GCC Max, Min, and Average Seasonal Temps (°F)

	ACC			GCC		
	Avg	**Max**	**Min**	**Avg**	**Max**	**Min**
Winter	29.2	76.2	-35.7	28.5	70	-25
Spring	53.4	98.5	3.6	51.6	92.7	0
Summer	66.7	102.1	21.7	65.7	97.4	21.7
Fall	34.9	84.4	-39.9	35.3	78.7	-18.9

Figure 2.5-12. ACC and GCC Seasonal Average Temperatures °F

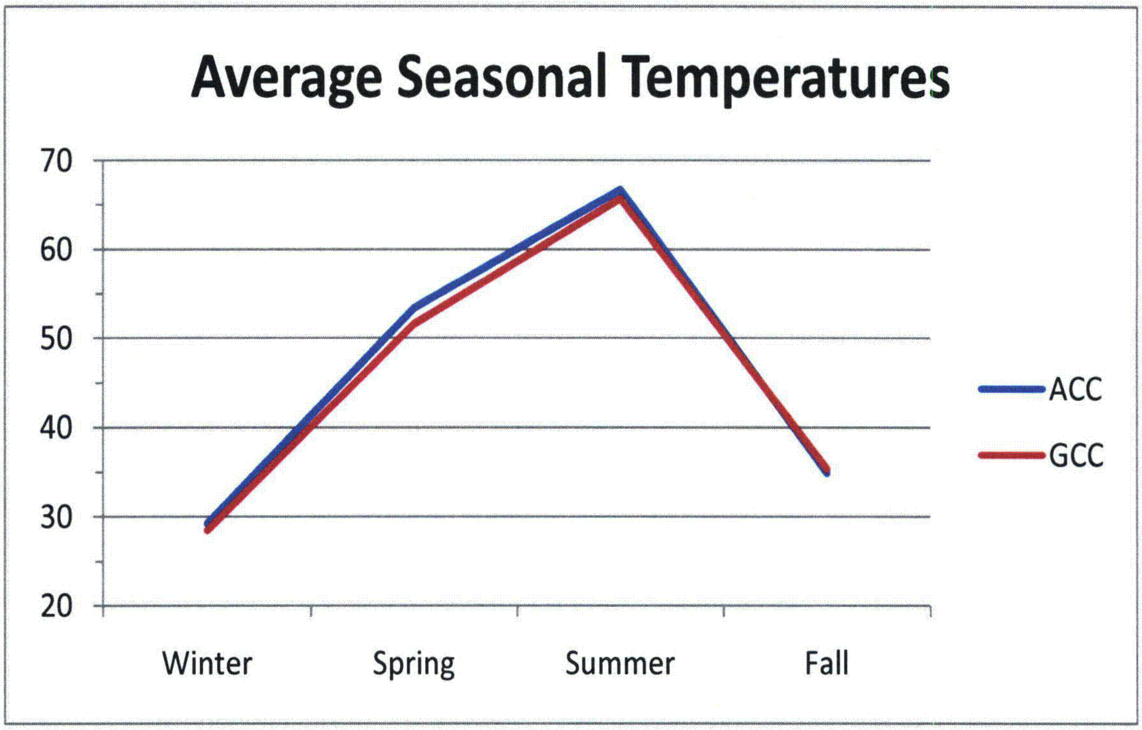


Table 2.5-6 ACC Meteorological Summary for January 1997-December 2006

Hourly Data

	Average/Total	Max	Min
Wind Speed (mph)	11.2	50.6	0.0
Sigma-Theta (°)	16.3	82.0	0.4
Temperature (F)	47.5	102.1	-33.8
Precipitation (in)	102.34	1.48	

Predominant wind direction was from the W sector, accounting for 15.2% of the possible winds

Data Recovery

Parameter	**Possible** (hours)	**Reported** (hours)	**Recovery**
Wind Speed	87648	81938	93.49%
Wind Direction	87648	81951	93.50%
Sigma-Theta	87648	81951	93.50%
Temperature	87648	83702	95.50%
Precipitation	87648	83705	95.50%

Table 2.5-7 GCC Meteorological Summary for January 1997-December 2006

Hourly Data

	Average/Total	Max	Min
Wind Speed (mph)	14.8	57.6	0.0
Sigma-Theta (°)	11.0	79.3	0.0
Temperature (F)	46.1	97.4	-25.0
Precipitation (in)	89.92	1.56	

Predominant wind direction was from the W/SW sector, accounting for 20.0% of the possible winds

Data Recovery

Parameter	Possible (hours)	Reported (hours)	Recovery
Wind Speed	87648	81406	92.88%
Wind Direction	87648	81406	92.88%
Sigma-Theta	87648	78171	89.19%
Temperature	87648	81376	92.84%
Precipitation	87648	82827	94.50%

2.5.3.2 Wind Patterns

Figure 2.5-13 and Figure 2.5-14 show the seasonal wind roses for GCC and ACC, respectively. The GCC predominant wind direction is west/southwest and the ACC predominant wind direction is west with a secondary maximum of west/southwest. High pressure located over the southwestern United States is the culprit for the strong west/southwesterly winds which frequent the region. Spring experiences the greatest variability in wind direction with secondary modes from the southeast/east and northerly directions. The modes are a result of the synoptic scale transition period that occurs during this time. Low pressure regions develop on the lee side of the Rockies bringing southeast/easterly winds during development. As the low pressure systems form and move off with the general atmospheric flow, winds switch to a northerly direction.

The monthly and seasonal wind speeds are summarized in Figures 2.5-15 and 2.5-16. The graphs show a pronounced difference between the winter and summer averages. GCC experiences higher wind speeds, but the seasonal changes seem to mirror each other. Late fall and winter time averages are in the upper teens while summer time averages dip into the upper single digits to low teens. Overall, sites see differences of 3-4 mph from summer to winter months.

The site average for GCC is 14.8 mph for the entire ten year period analyzed and 11.1 mph for ACC. A closer look at the wind speed, summarized in the ACC and GCC wind summaries (Table 2.5-9 and Table 2.5-10), shows the west/southwesterly component average wind speed is 19.4 mph for GCC and 15.8 mph for ACC. The values suggest that the predominant wind direction is comprised of high, sustained wind speeds. Maximum hourly averages of greater 50 mph have been recorded at both mine sites. Figure 2.5-17 shows the cumulative frequency wind speed distributions for ACC and GCC. It is clearly evident from the graphs that light wind speeds are a rare occurrence.

The Joint Frequency Distributions are included for GCC (Table 2.5-11) and ACC (Table 2.5-12). The distributions show the frequencies of average wind speed for each direction based on stability class. Seventy percent of all winds at GCC and better than 56% at ACC fall into stability class D which represents near neutral to slightly unstable conditions. The light winds which accompany stable environments can be seen by the stability class F summaries (stable) as neither site has wind speed averages greater than 6 knots (6.9 mph).

2.5.3.3 Average Inversion and Mixing Layer Heights

The nearest upper-air data available from the National Weather Service are from Riverton, Wyoming or Rapid City, South Dakota. In both cases, the large distance from the southern PRB and the proximity to prominent mountain ranges make them ill suited to represent the Moore Ranch project site.

The Air Quality Division of the Wyoming Department of Environmental Quality (WDEQ-AQD) has provided statewide mixing heights to be used in dispersion modeling with the Industrial Source Complex (ISC3) model. These are based on the methods of Holsworth (1972) as applied to Lander, located in central Wyoming. For modeling purposes, the annual average mixing heights are assigned according to stability class as follows:

Class A	3,450 meters
Class B	2,300 meters
Class C	2,300 meters
Class D	2,300 meters
Class E	10,000 meters
Class F	10,000 meters

Stability classes E and F are given an arbitrarily high number to indicate the absence of a distinct boundary in the upper atmosphere.

In August of 2000, IML Air Science conducted Sound Detection and Ranging (SODAR) monitoring at the Black Thunder Mine, located approximately 20 miles north of the Antelope Mine. The purpose of this monitoring was to support a comprehensive study of NO_x dispersion characteristics following overburden and coal blasting events. The SODAR instrument provided 3D wind speeds, wind directions, temperatures, temperature gradients, and other atmospheric parameters as a function of height above the ground. The vertical range of the SODAR was 1,500 meters, with a sounding performed every 15 minutes. Each sounding resulted in a calculated "inversion height / mixing height" (the two terms are used interchangeably by the SODAR system supplier). For purposes of response to NRC, these mixing heights were downloaded into a database and queried, with results shown in Table 2.5-8. Morning and afternoon time intervals were taken from EPA modeling guidance.

Table 2.5-8 Average Mixing/Inversion Heights from Black Thunder Mine SODAR Monitoring

Time Period (Filtered)	Number of Data Points	Average Mixing / Inversion Height
Morning (2 am – 6 am)	193	641 meters
Afternoon (12 pm – 4 pm)	152	1,052 meters

Since the SODAR definition of mixing height appears somewhat ambiguous, and these measurements were all from August, it is not known whether they would qualify as typical baseline conditions or meteorological inputs to the MILDOS model.

Figure 2.5-13. GCC Seasonal Wind Roses

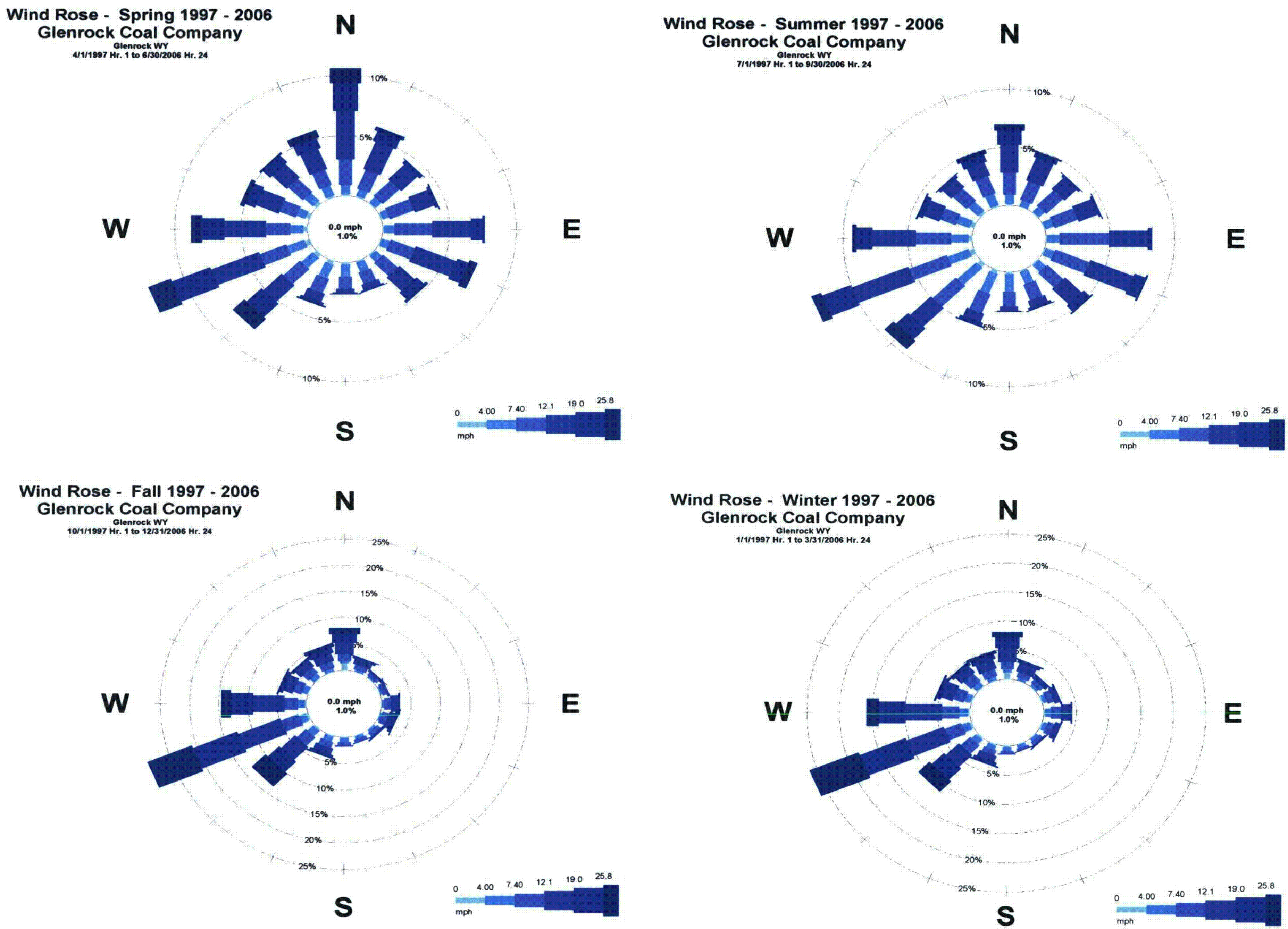
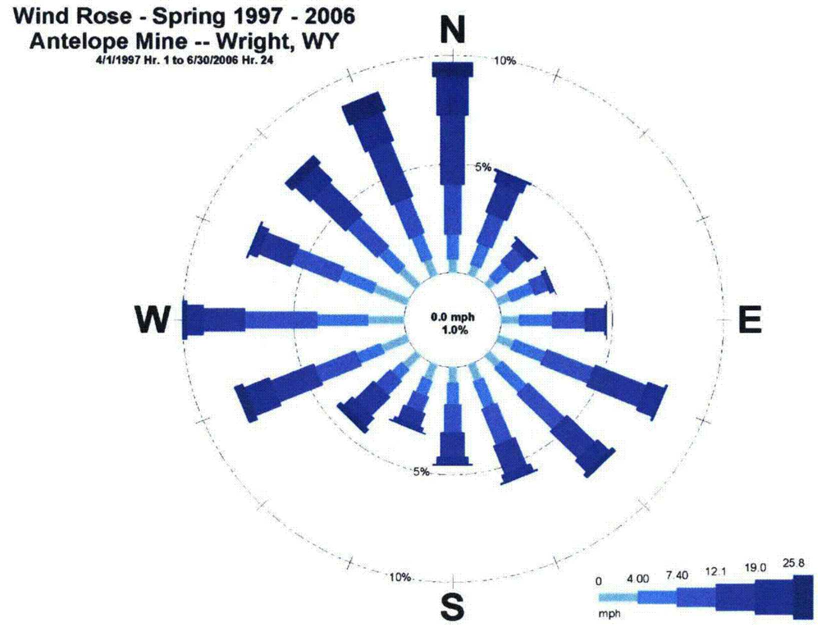
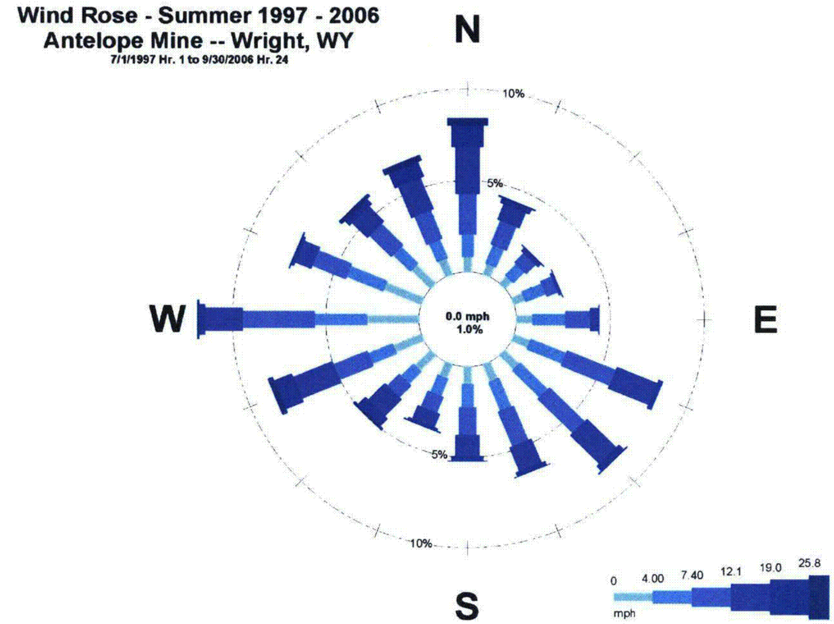
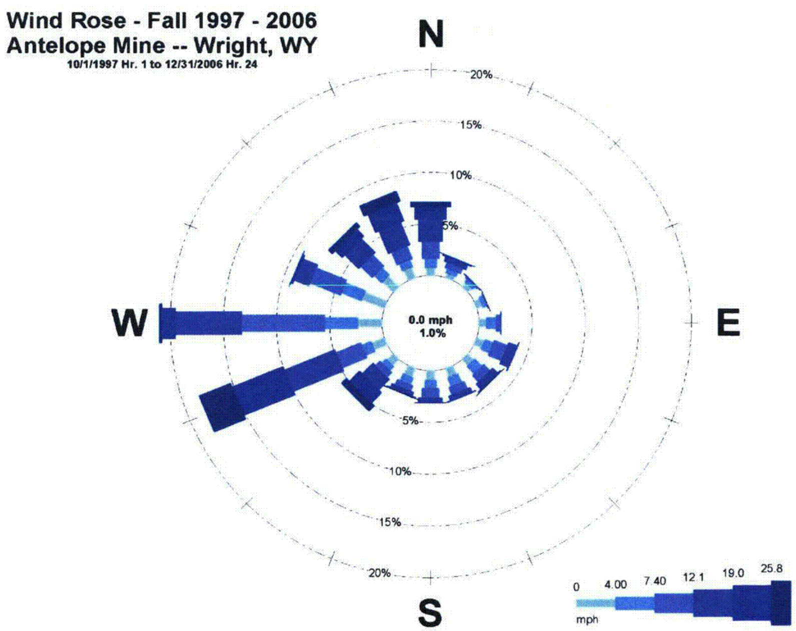


Figure 2.5-14. ACC Seasonal Wind Roses







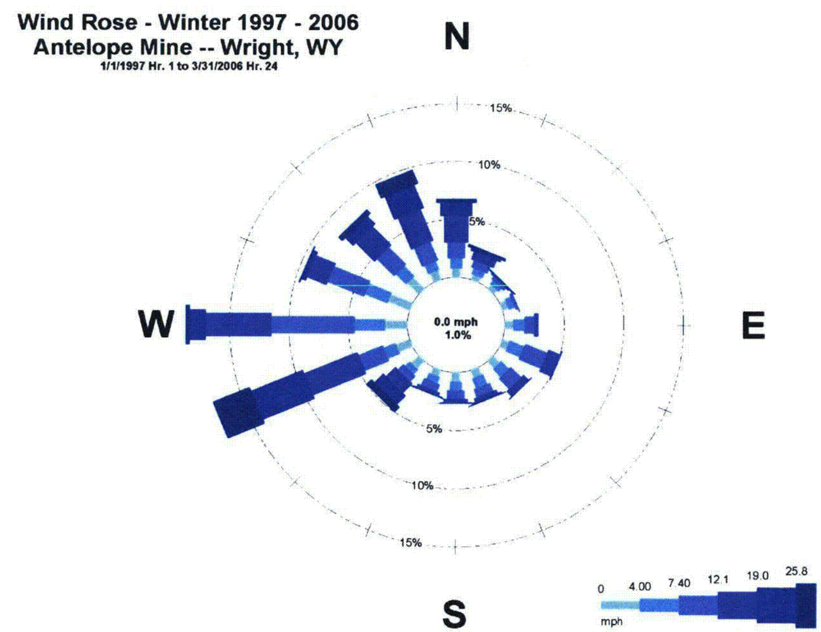


Figure 2.5-15 Monthly Wind Speed Averages for ACC and GCC.

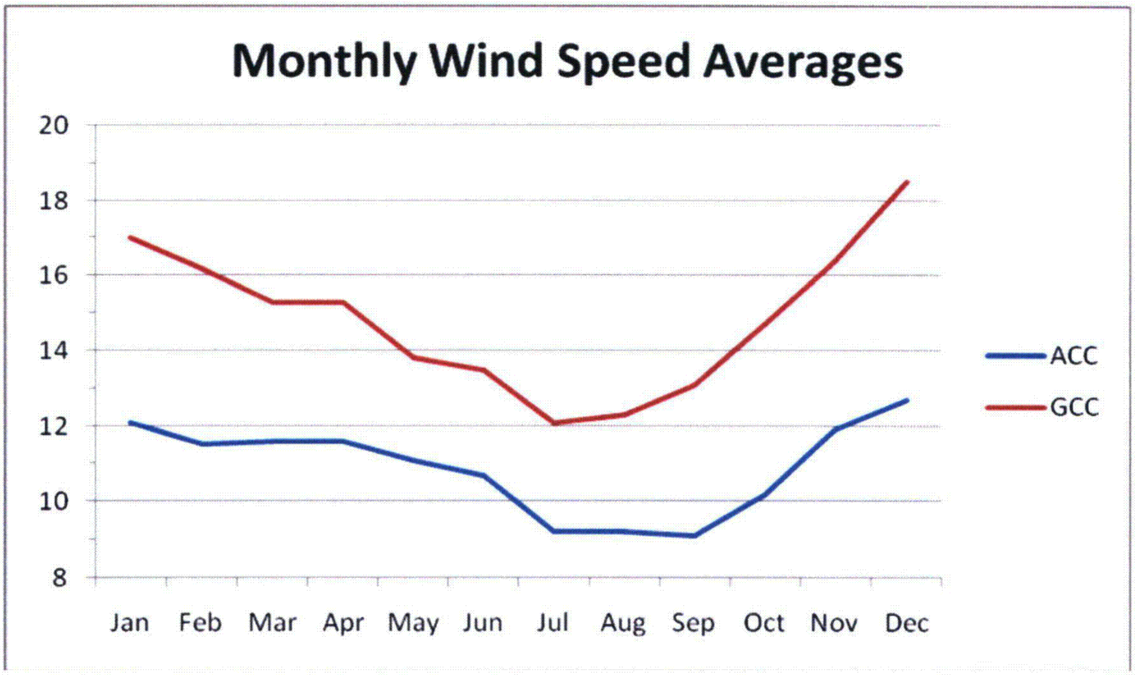


Figure 2.5-16 Seasonal Wind Speed Averages for ACC and GCC

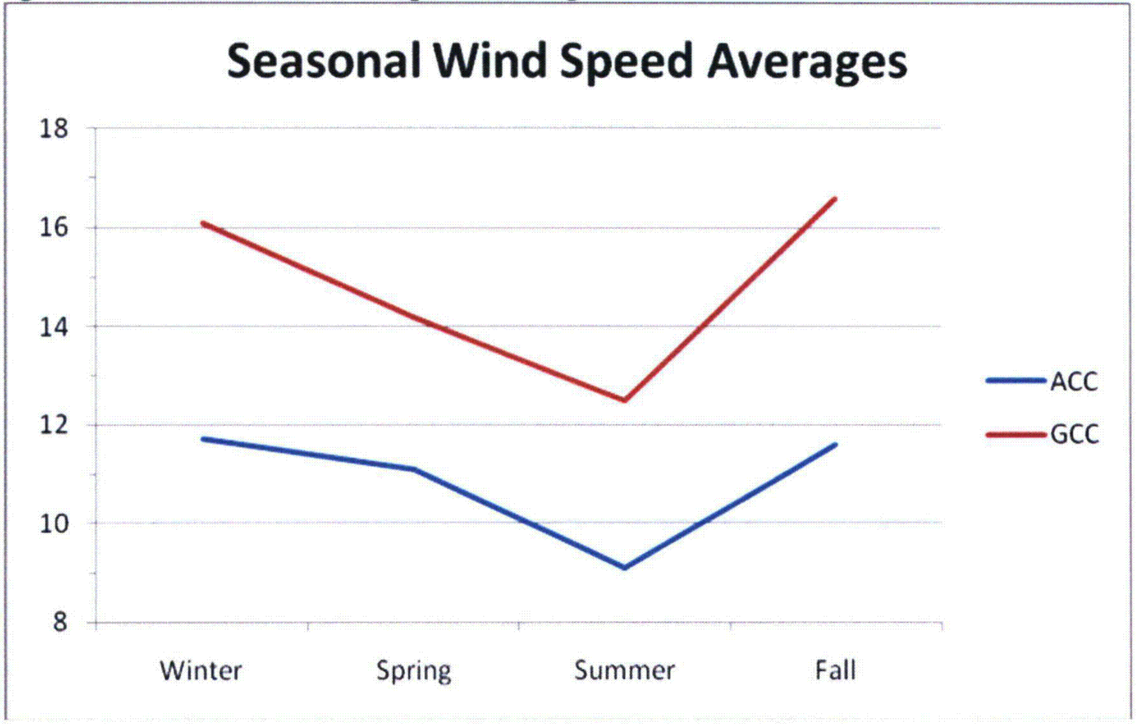


Table 2.5-9 ACC Wind Summary

Antelope Mine

Wind Data Summary

1/1/1997 - 12/31/2006

Hourly Data

	Average	Max	Min
Wind Speed (mph)	11.14	50.60	-
Sigma Theta (°)	16.15	78.50	0.35
Wind Direction			
N	13.26	47.32	0.30
NNE	10.55	39.25	0.58
NE	7.38	37.61	0.38
ENE	6.09	27.41	0.60
E	7.34	28.30	0.56
ESE	9.94	33.86	0.50
SE	9.78	35.52	0.50
SSE	8.98	33.57	0.40
S	8.89	32.30	0.69
SSW	8.33	36.90	0.57
SW	12.64	41.99	-
WSW	15.79	50.60	0.09
W	10.27	37.90	0.30
WNW	8.39	37.40	0.30
NW	11.48	45.10	0.30
NNW	14.49	43.50	-

Predominant wind direction was from the W sector, accounting for 15.7% of the winds, the average wind direction was 217°.

Data Recovery

	Possible (hours)	Reported (hours)	Recovery
Wind Speed	87648	79756	91.00%
Sigma Theta	87648	39657	45.25%
Wind Direction	87648	39657	45.25%

Table 2.5-10 GCC Wind Summary

Glenrock Coal Company

Wind Data Summary

1/1/1997 - 12/31/2006

Hourly Data

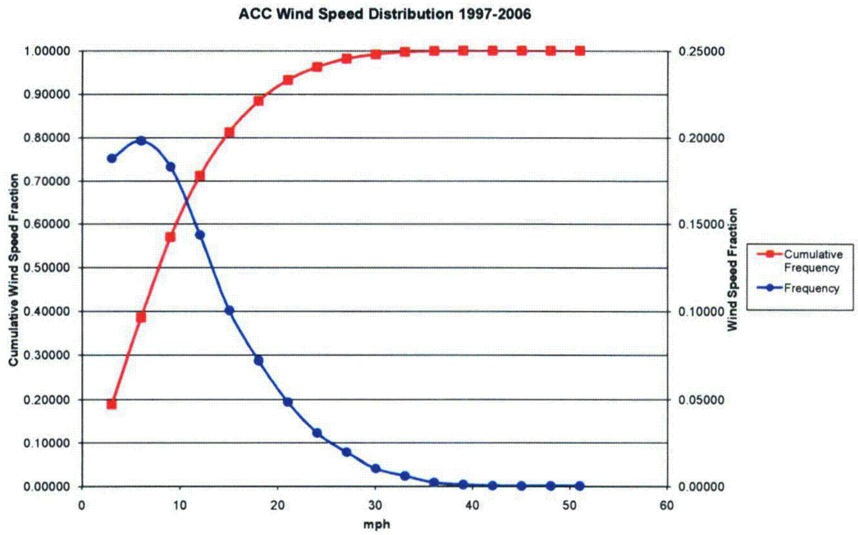
	Average	Max	Min
Wind Speed (mph)	14.82	57.60	-
Sigma Theta (°)	10.96	79.30	-
Wind Direction			
N	15.36	46.29	-
NNE	13.52	38.22	-
NE	11.32	30.90	-
ENE	11.14	29.80	-
E	11.92	37.15	0.10
ESE	13.52	38.80	-
SE	12.37	39.44	-
SSE	9.05	33.30	0.10
S	8.16	34.50	-
SSW	10.99	37.46	-
SW	17.09	55.58	-
WSW	19.36	57.60	-
W	15.89	48.21	-
WNW	12.69	39.44	0.10
NW	11.88	38.49	0.30
NNW	14.64	44.07	-

Predominant wind direction was from the WSW sector, accounting for 20% of the winds, the average wind direction was 205°.

Data Recovery

	Possible (hours)	Reported (hours)	Recovery
Wind Speed	87648	81406	92.88%
Sigma Theta	87648	78171	89.19%
Wind Direction	87648	81406	92.88%

Figure 2.5-17 ACC and GCC Wind Speed Frequency Distributions



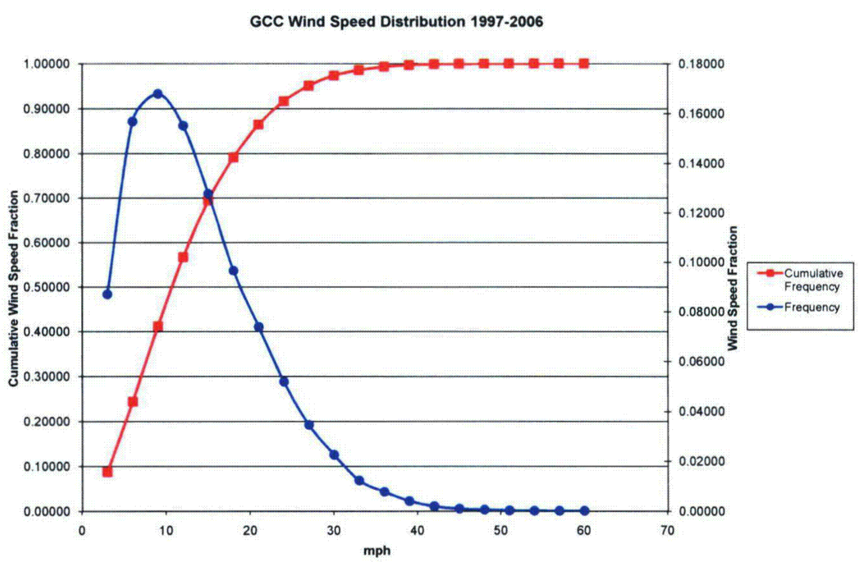


Table 2.5-11 GCC Joint Frequency Distribution for 1997 -2006

Glenrock Coal Company	Frequency Distribution	IML Air Science
Rolling Hills, Wyoming	Hourly Average Wind Speed, Wind Direction and Sigma	Sheridan, WY
Calm Readings 334	Total Readings 78171 Possible Readings 87648	Data Capture 89.2%
	From 1/1/1997 To 12/31/2006	

Stability Class A — **Wind Speed (Knots)**

Direction	**0.6 - 3.0**	**4 - 6**	**7 - 10**	**11-16**	**17 - 21**	**> 21**	**Row Total**
E	0.00023	0.00148	0.00127	0.00006	0.00001		0.00306
ENE	0.00030	0.00117	0.00069	0.00008	0.00001		0.00225
ESE	0.00031	0.00122	0.00101	0.00014			0.00269
N	0.00026	0.00166	0.00159	0.00017	0.00001		0.00369
NE	0.00026	0.00136	0.00109	0.00001		0.00001	0.00274
NNE	0.00015	0.00116	0.00128	0.00015			0.00275
NNW	0.00037	0.00222	0.00127	0.00017	0.00003	0.00001	0.00407
NW	0.00046	0.00216	0.00189	0.00040	0.00001	0.00001	0.00493
S	0.00026	0.00167	0.00089	0.00022	0.00003		0.00306
SE	0.00024	0.00105	0.00093	0.00014			0.00236
SSE	0.00027	0.00143	0.00110	0.00010			0.00290
SSW	0.00048	0.00207	0.00112	0.00024			0.00391
SW	0.00045	0.00230	0.00204	0.00045	0.00001		0.00525
W	0.00045	0.00170	0.00247	0.00069	0.00009	0.00003	0.00542
WNW	0.00055	0.00170	0.00182	0.00030	0.00001	0.00001	0.00439
WSW	0.00048	0.00216	0.00227	0.00060	0.00006		0.00558
Sum	0.00551	0.02649	0.02275	0.00393	0.00028	0.00008	0.05905

Table 2.5-11 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class B — **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00008	0.00026	0.00049	0.00024			0.00107
ENE	0.00005	0.00018	0.00057	0.00009			0.00089
ESE	0.00009	0.00018	0.00084	0.00024			0.00135
N	0.00003	0.00024	0.00095	0.00039	0.00003	0.00008	0.00171
NE	0.00006	0.00012	0.00049	0.00009			0.00076
NNE	0.00003	0.00026	0.00085	0.00019			0.00132
NNW	0.00004	0.00027	0.00110	0.00060	0.00005		0.00207
NW	0.00012	0.00044	0.00094	0.00072	0.00004		0.00225
S	0.00010	0.00037	0.00031	0.00021	0.00001	0.00001	0.00101
SE	0.00006	0.00026	0.00075	0.00030		0.00001	0.00137
SSE	0.00004	0.00039	0.00041	0.00023	0.00001		0.00108
SSW	0.00012	0.00048	0.00066	0.00058	0.00004		0.00186
SW	0.00023	0.00059	0.00116	0.00119	0.00019	0.00005	0.00342
W	0.00017	0.00054	0.00168	0.00177	0.00019	0.00008	0.00443
WNW	0.00014	0.00037	0.00096	0.00100	0.00010		0.00258
WSW	0.00022	0.00051	0.00130	0.00167	0.00021	0.00005	0.00396
Sum	0.00157	0.00545	0.01344	0.00952	0.00087	0.00028	0.03113

Table 2.5-11 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class C **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00008	0.00044	0.00087	0.00081			0.00220
ENE	0.00008	0.00028	0.00062	0.00040		0.00001	0.00139
ESE	0.00003	0.00045	0.00094	0.00132	0.00003		0.00276
N	0.00009	0.00032	0.00154	0.00297	0.00135	0.00099	0.00726
NE	0.00003	0.00015	0.00089	0.00044			0.00150
NNE	0.00003	0.00030	0.00099	0.00118	0.00001		0.00251
NNW	0.00006	0.00058	0.00140	0.00161	0.00037	0.00013	0.00415
NW	0.00013	0.00048	0.00131	0.00209	0.00049	0.00009	0.00459
S	0.00010	0.00066	0.00051	0.00042	0.00010	0.00001	0.00181
SE	0.00008	0.00054	0.00117	0.00131	0.00006	0.00001	0.00317
SSE	0.00009	0.00045	0.00062	0.00045	0.00003	0.00001	0.00164
SSW	0.00013	0.00075	0.00104	0.00091	0.00037	0.00006	0.00326
SW	0.00026	0.00091	0.00189	0.00297	0.00143	0.00027	0.00772
W	0.00022	0.00080	0.00164	0.00441	0.00159	0.00035	0.00901
WNW	0.00012	0.00050	0.00121	0.00276	0.00067	0.00015	0.00541
WSW	0.00026	0.00089	0.00247	0.00511	0.00226	0.00059	0.01158
Sum	0.00176	0.00848	0.01910	0.02916	0.00876	0.00269	0.06995

Table 2.5-11 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class D **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00033	0.00190	0.00957	0.02189	0.00403	0.00075	0.03848
ENE	0.00033	0.00112	0.00550	0.01107	0.00141	0.00026	0.01970
ESE	0.00027	0.00202	0.00903	0.02149	0.00591	0.00281	0.04154
N	0.00032	0.00258	0.00951	0.02536	0.01484	0.01046	0.06307
NE	0.00014	0.00119	0.00497	0.01015	0.00161	0.00026	0.01832
NNE	0.00013	0.00134	0.00545	0.01611	0.00495	0.00203	0.03000
NNW	0.00040	0.00247	0.00641	0.01381	0.00714	0.00641	0.03664
NW	0.00067	0.00375	0.00723	0.01043	0.00365	0.00175	0.02748
S	0.00040	0.00335	0.00325	0.00166	0.00039	0.00008	0.00912
SE	0.00008	0.00238	0.00567	0.00879	0.00384	0.00119	0.02194
SSE	0.00035	0.00258	0.00353	0.00245	0.00076	0.00022	0.00989
SSW	0.00075	0.00445	0.00579	0.00523	0.00132	0.00078	0.01832
SW	0.00082	0.00561	0.00949	0.01742	0.01382	0.02167	0.06885
W	0.00068	0.00567	0.01377	0.03848	0.02288	0.01382	0.09530
WNW	0.00053	0.00412	0.00763	0.01314	0.00501	0.00244	0.03288
WSW	0.00107	0.00624	0.01566	0.05036	0.04394	0.05395	0.17122
Sum	0.00726	0.05077	0.12247	0.26785	0.13550	0.11888	0.70274

Table 2.5-11 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class E **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00049	0.00257	0.01188				0.01494
ENE	0.00019	0.00164	0.00686				0.00870
ESE	0.00037	0.00159	0.00609				0.00806
N	0.00030	0.00143	0.00313				0.00486
NE	0.00019	0.00153	0.00443				0.00615
NNE	0.00014	0.00141	0.00446				0.00601
NNW	0.00031	0.00184	0.00356				0.00570
NW	0.00028	0.00218	0.00373				0.00619
S	0.00055	0.00425	0.00376				0.00857
SE	0.00026	0.00140	0.00376				0.00542
SSE	0.00039	0.00283	0.00352				0.00673
SSW	0.00082	0.00433	0.00380				0.00895
SW	0.00072	0.00398	0.00420				0.00890
W	0.00060	0.00224	0.00424				0.00708
WNW	0.00046	0.00199	0.00265				0.00510
WSW	0.00089	0.00298	0.00403				0.00790
Sum	0.00696	0.03820	0.07412				0.11927

Table 2.5-11 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class F **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00045	0.00077					0.00122
ENE	0.00050	0.00067					0.00117
ESE	0.00039	0.00054					0.00093
N	0.00033	0.00040					0.00073
NE	0.00036	0.00046					0.00082
NNE	0.00027	0.00050					0.00077
NNW	0.00031	0.00059					0.00090
NW	0.00051	0.00068					0.00119
S	0.00041	0.00067					0.00108
SE	0.00040	0.00053					0.00093
SSE	0.00042	0.00046					0.00089
SSW	0.00039	0.00054					0.00093
SW	0.00068	0.00060					0.00128
W	0.00072	0.00103					0.00175
WNW	0.00077	0.00077					0.00154
WSW	0.00071	0.00103					0.00173
Sum	0.00762	0.01024					0.01786

Table 2.5-12 ACC Joint Frequency Distribution for 1997-2006

Antelope Coal Company | Frequency Distribution | IML Air Science
Wright, Wyoming | Hourly Average Wind Speed, Wind Direction and Sigma | Sheridan, WY
Calm Readings 28 | Total Readings 81938 | Possible Readings 87648 | Data Capture 93.5%
From 1/1/1997 To 12/31/2006

Stability Class A — **Wind Speed (Knots)**

Direction	**0.6 - 3.0**	**4 - 6**	**7 - 10**	**11-16**	**17 - 21**	**> 21**	**Row Total**
E	0.00226	0.00203	0.00076	0.00001			0.00505
ENE	0.00193	0.00214	0.00039	0.00006			0.00452
ESE	0.00192	0.00212	0.00088	0.00016			0.00508
N	0.00259	0.00260	0.00193	0.00013	0.00005		0.00730
NE	0.00175	0.00204	0.00070	0.00009			0.00457
NNE	0.00183	0.00264	0.00098	0.00005	0.00002		0.00552
NNW	0.00261	0.00278	0.00173	0.00021	0.00001		0.00735
NW	0.00316	0.00316	0.00217	0.00028			0.00878
S	0.00164	0.00273	0.00125	0.00016			0.00577
SE	0.00175	0.00295	0.00133	0.00009	0.00001		0.00613
SSE	0.00165	0.00289	0.00138	0.00012			0.00604
SSW	0.00134	0.00236	0.00111	0.00006	0.00002		0.00490
SW	0.00172	0.00205	0.00131	0.00031	0.00010	0.00011	0.00559
W	0.00271	0.00333	0.00206	0.00032	0.00002	0.00002	0.00847
WNW	0.00342	0.00360	0.00225	0.00032	0.00001		0.00960
WSW	0.00190	0.00282	0.00193	0.00031	0.00010	0.00001	0.00707
Sum	0.03417	0.04225	0.02215	0.00266	0.00035	0.00015	0.10173

Table 2.5-12 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class B **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00042	0.00048	0.00049	0.00004			0.00142
ENE	0.00027	0.00024	0.00038	0.00004			0.00093
ESE	0.00026	0.00039	0.00095	0.00018			0.00178
N	0.00023	0.00055	0.00164	0.00063	0.00002	0.00001	0.00309
NE	0.00021	0.00024	0.00055	0.00006			0.00106
NNE	0.00015	0.00049	0.00088	0.00017	0.00001		0.00170
NNW	0.00024	0.00057	0.00139	0.00077	0.00002	0.00004	0.00304
NW	0.00061	0.00070	0.00154	0.00082	0.00002	0.00002	0.00371
S	0.00024	0.00055	0.00089	0.00028	0.00002		0.00199
SE	0.00033	0.00079	0.00134	0.00033			0.00280
SSE	0.00023	0.00078	0.00120	0.00032	0.00001		0.00254
SSW	0.00020	0.00031	0.00059	0.00021	0.00001		0.00131
SW	0.00016	0.00039	0.00054	0.00048	0.00009	0.00005	0.00170
W	0.00066	0.00110	0.00183	0.00096	0.00004		0.00459
WNW	0.00087	0.00090	0.00166	0.00101	0.00006	0.00002	0.00453
WSW	0.00039	0.00054	0.00128	0.00127	0.00015	0.00010	0.00372
Sum	0.00546	0.00902	0.01714	0.00757	0.00046	0.00024	0.03990

Table 2.5-12 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class C **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00026	0.00063	0.00052	0.00043			0.00184
ENE	0.00017	0.00043	0.00037	0.00016			0.00112
ESE	0.00023	0.00093	0.00137	0.00096	0.00002		0.00352
N	0.00016	0.00051	0.00266	0.00454	0.00147	0.00084	0.01018
NE	0.00010	0.00042	0.00043	0.00022	0.00001		0.00117
NNE	0.00005	0.00054	0.00125	0.00096	0.00006	0.00002	0.00288
NNW	0.00012	0.00066	0.00226	0.00418	0.00101	0.00035	0.00858
NW	0.00037	0.00096	0.00226	0.00294	0.00060	0.00013	0.00726
S	0.00010	0.00073	0.00137	0.00099	0.00009	0.00001	0.00328
SE	0.00021	0.00089	0.00251	0.00198	0.00009		0.00568
SSE	0.00015	0.00100	0.00214	0.00183	0.00011		0.00523
SSW	0.00013	0.00034	0.00085	0.00085	0.00011		0.00230
SW	0.00017	0.00029	0.00076	0.00160	0.00054	0.00050	0.00386
W	0.00057	0.00232	0.00309	0.00396	0.00068	0.00016	0.01078
WNW	0.00052	0.00165	0.00236	0.00286	0.00048	0.00007	0.00794
WSW	0.00012	0.00073	0.00136	0.00365	0.00151	0.00077	0.00814
Sum	0.00343	0.01304	0.02554	0.03211	0.00678	0.00287	0.08376

Table 2.5-12 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class D **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00074	0.00620	0.00678	0.00411	0.00032	0.00004	0.01819
ENE	0.00059	0.00354	0.00265	0.00087	0.00005	0.00001	0.00770
ESE	0.00077	0.00685	0.01279	0.01637	0.00275	0.00032	0.03985
N	0.00034	0.00421	0.01107	0.01977	0.01002	0.00448	0.04990
NE	0.00015	0.00227	0.00321	0.00171	0.00037	0.00011	0.00781
NNE	0.00022	0.00289	0.00608	0.00751	0.00241	0.00116	0.02027
NNW	0.00052	0.00380	0.00941	0.01935	0.01261	0.00955	0.05524
NW	0.00046	0.00438	0.01044	0.01425	0.00632	0.00420	0.04006
S	0.00052	0.00270	0.00504	0.00645	0.00170	0.00039	0.01680
SE	0.00063	0.00531	0.00905	0.01156	0.00287	0.00084	0.03026
SSE	0.00079	0.00352	0.00614	0.00752	0.00186	0.00033	0.02016
SSW	0.00052	0.00182	0.00364	0.00413	0.00109	0.00037	0.01156
SW	0.00043	0.00139	0.00424	0.01034	0.00708	0.00414	0.02762
W	0.00128	0.01170	0.03427	0.03327	0.00778	0.00226	0.09055
WNW	0.00096	0.00802	0.01688	0.01012	0.00215	0.00048	0.03862
WSW	0.00048	0.00360	0.01284	0.03002	0.02392	0.02084	0.09170
Sum	0.00942	0.07220	0.15454	0.19734	0.08327	0.04951	0.56628

Table 2.5-12 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class E **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00096	0.00250	0.00167				0.00514
ENE	0.00055	0.00142	0.00044				0.00241
ESE	0.00105	0.00328	0.00534				0.00967
N	0.00052	0.00162	0.00122				0.00337
NE	0.00042	0.00078	0.00027				0.00147
NNE	0.00042	0.00088	0.00118				0.00248
NNW	0.00088	0.00117	0.00112				0.00317
NW	0.00101	0.00149	0.00148				0.00398
S	0.00103	0.00167	0.00237				0.00507
SE	0.00121	0.00289	0.00370				0.00780
SSE	0.00100	0.00271	0.00276				0.00647
SSW	0.00077	0.00150	0.00133				0.00360
SW	0.00105	0.00095	0.00094				0.00294
W	0.00267	0.00523	0.01179				0.01969
WNW	0.00233	0.00315	0.00286				0.00834
WSW	0.00129	0.00206	0.00359				0.00695
Sum	0.01717	0.03332	0.04206				0.09254

Table 2.5-12 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class F **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00363	0.00131					0.00493
ENE	0.00244	0.00081					0.00325
ESE	0.00372	0.00151					0.00524
N	0.00346	0.00110					0.00455
NE	0.00220	0.00071					0.00291
NNE	0.00250	0.00079					0.00330
NNW	0.00446	0.00125					0.00570
NW	0.00750	0.00138					0.00888
S	0.00509	0.00156					0.00665
SE	0.00458	0.00162					0.00620
SSE	0.00481	0.00151					0.00632
SSW	0.00479	0.00153					0.00631
SW	0.00581	0.00190					0.00772
W	0.01356	0.00380					0.01736
WNW	0.01183	0.00272					0.01455
WSW	0.00939	0.00253					0.01192
Sum	0.08976	0.02603					0.11579

2.5.4 References

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Western Region Climate Center, 2007: *Local Climate Data Summaries*. Available: http://www.wrcc.dri.edu/summary/lcd.html [2006, Jan 28].

are taken after sufficient well recovery. Accurate records of well purging are maintained to document the number of casing volumes purged from the well before sampling.

Groundwater field measurements and samples are taken as soon as the well is adequately purged. Sampling container(s) are completely filled, so all air is excluded from the container. Field measurements including pH, conductivity, and temperature are taken and recorded. Meters used to take field measurements are calibrated daily.

Section 2.7.2.2 (Figure 2.7.2-5) provides a description of the hydraulic gradient of the Moore Ranch Project Area. In general, groundwater flow direction for the wells shown on Figure 2.9-34 is predominantly to the north. Therefore, wells on south side of the proposed development areas are up gradient and those wells on the north side are down gradient. Dates of all groundwater sampling and results can be found on Tables 2.7.3-17 through 2.7.3-21.

2.9.8.2 Groundwater Sampling Radiological Results

Results to date for dissolved radiological groundwater parameters are shown in Table 2.9-15. Parameters in suspended form were also evaluated, but all were below analytical reporting limits and are not presented here (those data, reporting limits, and other details can be found in Section 2.7.3 of the application pertaining specifically to groundwater).

Table 2.9-15: Analytical results to date for radiological parameters in groundwater samples collected during 2007 baseline surveys. Values with less-than qualifiers were all below analytical reporting limits.

Well No.	Gross Alpha pCi/L	Gross Beta pCi/L	Pb-210 pCi/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	Th-230 pCi/L	Uranium pCi/L*
MR-PW-1	627	78.9	10	<1.0	82.6	2.1	<0.2	126
MR-OMW-1	3.5	20.4	<1.0	<1.0	0.8	2.8	<0.2	6.7
MR-UMW-1	13.3	25	<1.0	<1.0	0.8	<1.0	<0.2	6.4
MR-MW-2	1050	327	31	51	138	<1.0	<0.2	495
MR-OMW-2	9.6	8.6	<1.0	<1.0	1.1	2.5	1	1.8
MR-UMW-2	83.3	36.8	<1.0	1.8	1	<1.0	<0.2	75
MR-MW-3	370	162	69	34	280	<1.0	<0.2	56
MR-UMW-3	1.8	13.6	<1.0	<1.0	1.1	9.5	<0.2	0.9
MR-MW-4	201	53.8	<1.0	<1.0	45.7	1.7	<0.2	87
MR-OMW-4	3.5	14.4	<1.0	<1.0	1.8	2	<0.2	0.5
MR-UMW-4	53.4	18.4	<1.0	<1.0	1	3.3	<0.2	46
MR-MW-6	17	13.6	<1.0	<1.0	1.3	<1.0	<0.2	6.7
MR-MW-7	21.2	11.4	<1.0	1.6	1.1	<1.0	<0.2	6.7
MR-MW-9	47.1	24.6	<1.0	2	2.5	<1.0	<0.2	39
MR-MW-11	156	47.3	<1.0	<1.0	26	3.5	0.9	69
MR-885	293	147	41	31	309	1.8	<0.2	51
MR-1808	30.9	12.8	<1.0	<1.0	9.1	<1.0	0.4	0.8
MR-8-3	3.6	12.9	<1.0	<1.0	0.8	3	<0.2	1.3
Stockwell #1	68.2	24	<1.0	<1.0	0.8	1.6	<0.2	6.7
Stockwell #2	2	7.9	<1.0	<1.0	0.9	3.9	<0.2	6.7
Stockwell #3	24.3	16.5	<1.0	<1.0	3.3	3.5	<0.2	6.7
Stockwell #4	5.9	5.5	<1.0	<1.0	<0.2	<1.0	0.9	4.8

*Converted from units of mg/L to activity units of pCi/L using a conversion factor of 670 pCi/mg

2.9.9.1 Methods

Surface water samples are collected in the appropriate containers provided by the contract laboratory. Field meters were used to measure pH, specific conductance, and temperature of water samples and calibrated before each day's use as discussed in the Owner's Manual. Sample containers are flushed with the sample water in order to remove potential contaminants from the container. The bottle is then filled directly from the stream or pond with the with the sample bottle in a manner to prevent collecting debris or filled by using an alternate clean container. All samples analyzed by a contract laboratory are accompanied by a chain of custody to ensure proper analysis is performed and the sample is tracked.

2.9.9.2 Surface Water Sampling Results

Select results to date for dissolved radiological groundwater parameters are shown in Table 2.9-17. Parameters in suspended form were also evaluated, but virtually all were below analytical reporting limits and are not presented here (those data, reporting limits, and other details can be found in Section 2.7.3 of the application pertaining specifically to surface water)

Table 2.9-17: Analytical results to date for radiological parameters in surface water samples collected during 2007 baseline surveys. Values with less-than qualifiers were all below analytical reporting limits.

Surface Water Sampling ID	Sampling Date	Gross Alpha pCi/L	Gross Beta pCi/L	Pb-210 pCi/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	Th-230 pCi/L	Uranium pCi/L*
MRSW-1	11/3/2006	6.8	21.8	170	<0.2	<0.2	<1.0	<0.2	3.5
	3/23/2007	1	10.3	<1.0	<1.0	<0.2	<1.0	<0.2	0.5
MRSW-2	10/25/2006	3	14	<1.0	<1.0	<0.2	<1.0	<0.2	13.4
	3/23/2007	1.5	9.7	<1.0	<1.0	<0.2	<1.0	<0.2	0.3
MRSW-3	10/25/2006	12.7	13.5	<1.0	<1.0	<0.2	<1.0	<0.2	8.7
	3/22/2007	7.9	9.7	<1.0	<1.0	<0.2	<1.0	<0.2	8.0
MRSW-4	10/25/2006	5.6	11.9	<1.0	<1.0	<0.2	<1.0	<0.2	4.6
	3/27/2007	2.5	7.6	<1.0	<1.0	<0.2	<1.0	<0.2	2.3
MRSW-5	11/3/2006	11	32.7	9.9	<1.0	<0.2	<1.0	<0.2	0.7
	3/22/2007	2.4	11	<1.0	<1.0	1.5	<1.0	<0.2	1.9
MRSW-6	3/22/2007	1.1	6.9	<1.0	<1.0	<0.2	<1.0	<0.2	<0.2
MRSW-7	10/25/2006	5.4	13.1	<1.0	<1.0	<0.2	<1.0	<0.2	0.4
MRSW-8	10/25/2006	4.3	20.9	<1.0	<1.0	<0.2	<1.0	<0.2	2.7
	3/23/2007	2.4	10.1	<1.0	<1.0	<0.2	<1.0	<0.2	0.6
MRSW-9	3/21/2007	1.7	3.9	8.6	<1.0	<0.2	<1.0	<0.2	1.1

*Converted from units of mg/L to activity units of pCi/L using a conversion factor of 670 pCi/mg

Locations MRSW-10 and MRSW-11 as shown in Figure 2.9-37 have not been sampled because surface water has yet to be observed in these impoundments. Most sample results to date for

3 DESCRIPTION OF PROPOSED FACILITY

The Moore Ranch Project will be developed by constructing wellfields and mining support facilities, as well as a central process facility to provide chemical makeup of recovery solutions, recovery of uranium by ion exchange, resin loading/unloading, elution and precipitation circuits, yellowcake drying capabilities, and groundwater restoration capabilities.

The proposed License Area for the Moore Ranch property contains approximately 7,110 acres. The total surface area to be affected by the proposed operation is within the License Area and will total less than 150 acres. The wellfields, central plant/offices/shop facilities, and two wastewater disposal wells are the primary surface features associated with the proposed ISR operations. There are no evaporation or holding ponds planned for the Moore Ranch Project at this time.

The proposed wellfield area to be used for the injection and recovery operations over the ten-year mine life will encompass approximately 150 acres. The wellfield areas will be fenced to limit access by livestock.

Other mineralized trends exist within the current proposed license area, but have not been extensively explored. If future exploration shows potential for development of these other existing trends, then appropriate baseline evaluations will be made at that time and submitted the NRC for approval.

3.1 IN SITU RECOVERY PROCESS

Production of uranium by ISR techniques involves a mining step and a uranium recovery step. Mining is accomplished by installing a series of injection wells through which the recovery solution is pumped into the ore body. Corresponding recovery wells and pumps promote flow through the ore body and allow for the collection of uranium-rich recovery solution. Uranium is removed from the recovery solution by ion exchange, and then from the ion exchange resin by elution. The recovery solution can then be reused for mining purposes. The elution liquid containing the uranium (the "pregnant" eluant) is then processed by precipitation, dewatering, and drying to produce a transportable form of uranium.

3.1.1 Orebody

The targeted mineralized zone for in situ uranium recovery at Moore Ranch is the 70 Sandstone at a depth that varies from 180 feet to 250 feet. The overall width of the mineralized area varies from 100 feet to 1000 feet. The orebody ranges in grade from less than 0.05% to greater than 0.5% U3O8, with an average grade estimated at 0.1% U3O8. Additional mining targets may exist in the area at greater depths. Additional future delineation will be needed to fully define any deeper targets.

Typical stratigraphic intervals to be mined are shown in the geologic cross sections contained in Section 2.6. For ISR wellfields, the production zone is the geological sandstone unit where the recovery solutions are injected and produced.

3.1.2 Well Construction and Integrity Testing

3.1.2.1 Well Materials of Construction

The well casing material will be polyvinyl chloride (PVC) with schedule 40 wall thickness and a nominal 5-inch outside diameter. However, if a larger pump size is necessary, larger diameter casing may be utilized. The table below shows the range of casing sizes that could be used at Moore Ranch, and the corresponding drill hole size to ensure adequate annular sealing. Each joint of the PVC casing will normally have a length of approximately 20 feet. Each joint will be connected either with glue and self-tapping screws or joined mechanically (with pipe threads or a water tight o-ring seal with a high strength nylon spline).

Casing	I.D.	O.D.	Bit size
4.5"	4.454	4.950	7-7/8
5.0"	5.047	5.563	8-3/4
6.0"	6.065	6.625	9-7/8

3.1.2.2 Well Construction Methods

Pilot holes for monitor, recovery, and injection wells are drilled to the bottom of the target completion interval with a small rotary drilling unit using native mud and a small amount of commercial drilling fluid additive for viscosity control. The hole is logged, reamed, casing set, and cemented to isolate the completion interval from all other aquifers. The cement is placed by pumping it down the casing and forcing it out the bottom of the casing and back up the casing-drill hole annulus. The pilot holes will be large enough in diameter to provide at least three inches of annulus space.

Typical well completion schematics for recovery wells, injection wells, and monitor wells are shown on Figure 3.1-1.

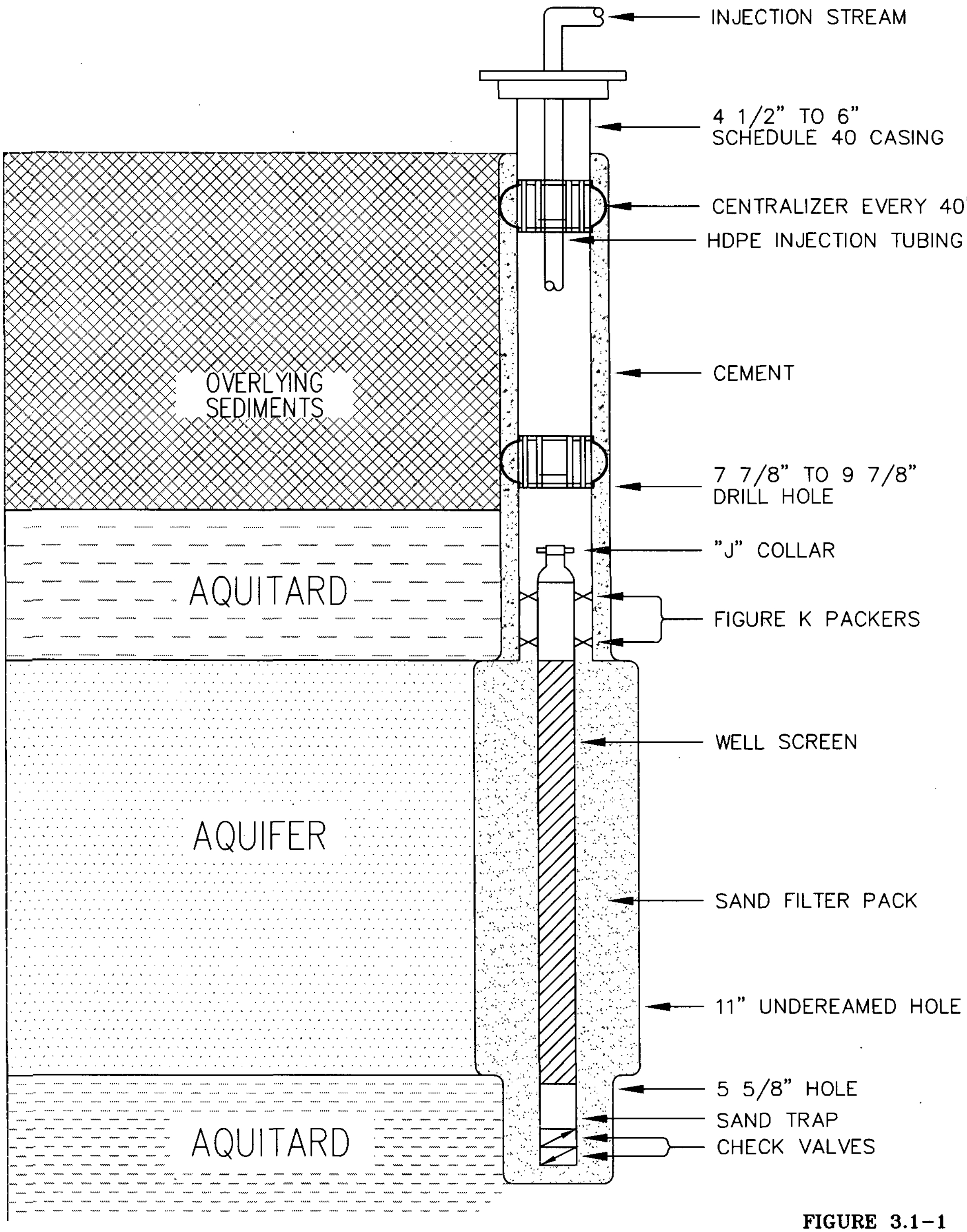

FIGURE 3.1-1

ENERGY METALS CORPORATION, US

139 W. 2nd, Suite 1C Casper, Wyoming 82601 [illegible]

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NO.	DATE	BY

MOORE RANCH URANIUM PROJECT

TYPICAL WELL COMPLETION

CAMPBELL COUNTY, WYOMING

GEOL. BY:	DATE: [illegible]	APPR. BY:	DATE:	SHT. NO.
ENG. BY:	DATE:	APPR. BY:	DATE:	
DRAFT. BY:	DATE:	SCALE:	FILE:	

Casing centralizers, located approximately every 40 feet above the casing shoe, are normally run on the casing to ensure it is centered in the drill hole. Effective sealing materials shall consist of neat cement slurry, sand-cement grout, or bentonite clay mixtures meeting State requirements described in Section 6, Chapter 11 of the Wyoming Land Quality Division (LQD) Non Coal Rules and Regulations or equivalent. The purpose of the cement or other sealing materials is to stabilize and strengthen the casing and plug the annulus of the hole to prevent vertical migration of solutions. The volume of cement used in each well is determined by estimating the volume required to fill the annulus and ensure cement returns to the surface. In almost all cement jobs, returns to the surface are observed. In rare instances, however, the drilling may result in a larger annulus volume than anticipated and cement may not return all the way to the surface. In these cases the upper portion of the annulus will be cemented from the surface to backfill as much of the well annulus as possible and stabilize the wellhead. This procedure may be performed by placement of a tremie pipe from the surface as far down into the annulus as possible to the nearest centralizer (40 feet), or by simply backfilling from the surface if use of a tremie pipe is impractical. Cement is pumped into the annulus until return to the surface is observed.

After the well is cemented to the surface and the cement has set, the well is drilled out and completed either as an open hole or it is fitted with a screen assembly (slotted liner), which may have a sand filter pack installed between the screen and the underreammed formation. The well is then air lifted to remove any remaining drilling mud and/or cuttings until well fluids are clear. A small submersible pump is frequently run in the well for final clean-up and sampling (where necessary).

A well completion report is completed on each well. These data are kept available on-site for review or submitted to the Land Quality Division upon request.

3.1.2.3 Well Development

Following construction (and before baseline water quality samples are taken for restoration and monitoring wells), the wells must be developed to restore the natural hydraulic conductivity and geochemical equilibrium of the aquifer. All wells are initially developed immediately after construction using air lifting, swabbing or other accepted development techniques. Well development removes water and drilling fluids from the casing and borehole walls along the screened interval. The primary goal for well development is to allow formation water to enter the well screen. This process is necessary to allow representative samples of groundwater to be collected, and to ensure efficient injection and recovery operations.

Before obtaining baseline samples from monitor or restoration wells, the well must be further developed to ensure that representative formation water is available for sampling.

Final development is performed by pumping the well or swabbing for an adequate period to ensure that stable formation water is present. Monitoring for pH and conductivity is performed during this process to ensure that development activities have been effective. The field parameters must be stable at representative formation values before baseline sampling will begin.

3.1.2.4 Well Integrity Testing

Field-testing of all (i.e., injection, recovery, and monitor) wells is performed to demonstrate the mechanical integrity of the well casing. This mechanical integrity test (MIT) is performed using pressure-packer tests. In the MIT, the bottom of the casing adjacent to or below the confining layer above the production zone is sealed with a plug, downhole packer, or other suitable device. The top of the casing is then sealed in a similar manner or with a threaded cap, and a calibrated pressure gauge is installed to monitor the pressure inside the casing. The pressure in the sealed casing is then increased to 120% of the maximum operating pressure. A well must maintain 90% of this pressure for 10 minutes to pass the test. EMC will test all well casings at a pressure of 150 psi (maximum operating pressure) plus the 20% safety factor, for a total test pressure of 180 psi.

If there are obvious leaks, or the pressure drops by more than 10% during the 10 minute period, the seals and fittings on the packer system will be reset and/or checked and another test is conducted. If the pressure drops less than 10% the well casing is considered to have demonstrated acceptable mechanical integrity.

If a well casing does not meet the MIT criteria, the well will be taken out of service and the casing may be repaired and the well re-tested or plugged and abandoned. The WDEQ-LQD will be notified of any well that fails the MIT. If a repaired well passes the MIT, it will be employed in its intended service following approval from the LQD Administrator that the well has demonstrated mechanical integrity. If the well defect occurs at depth, the well may be plugged back and re-completed for use in a shallower zone provided it passes the MIT. If an acceptable test cannot be obtained after repairs, the well will be plugged and abandoned.

In addition to the initial testing after well construction, a MIT will be conducted on any well after any repair where a downhole drill bit or underreaming tool is used. Any injection well with evidence of suspected subsurface damage will require a new MIT prior to the well being returned to service. In accordance with WDEQ and EPA requirements, MITs are repeated once every five years for all wells.

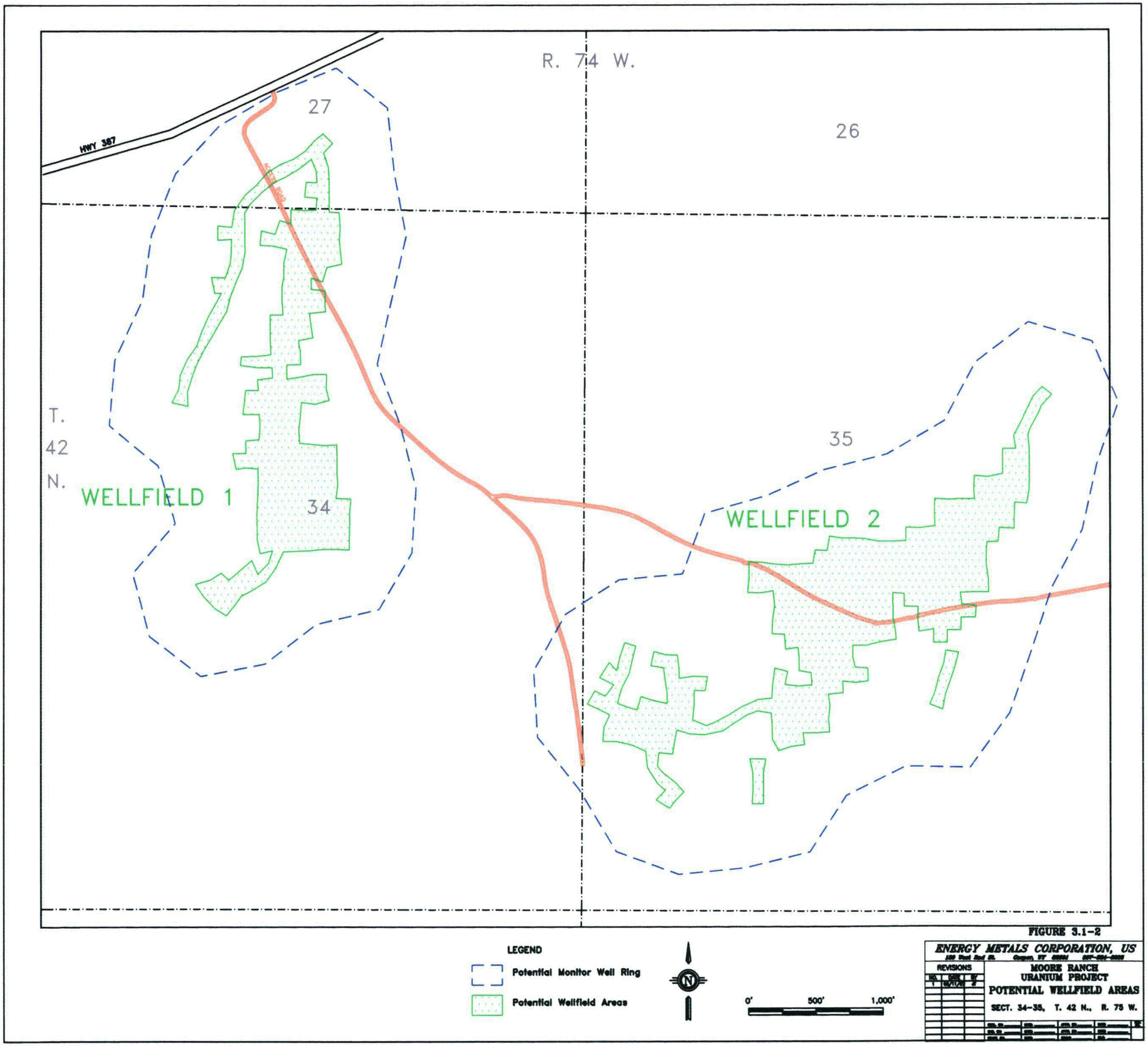
The MIT of a well will be documented to include the well designation, date of the test, test duration, beginning and ending pressures, and the signature of the individual responsible for conducting the test. Results of the MITs are maintained on site and are available for inspection by NRC and WDEQ. In accordance with WDEQ and EPA requirements, the results of MITs are reported to the WDEQ on a quarterly basis.

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 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."


R. 74 W.
HWY 387
27
26
T.
42
N.
35
WELLFIELD 1
34
WELLFIELD 2
LEGEND
Potential Monitor Well Ring
Potential Wellfield Areas
N
0'
500'
1,000'
FIGURE 3.1-2
ENERGY METALS CORPORATION, US
REVISIONS
MOORE RANCH
URANIUM PROJECT
POTENTIAL WELLFIELD AREAS
SECT. 34-35, T. 42 N., R. 75 W.

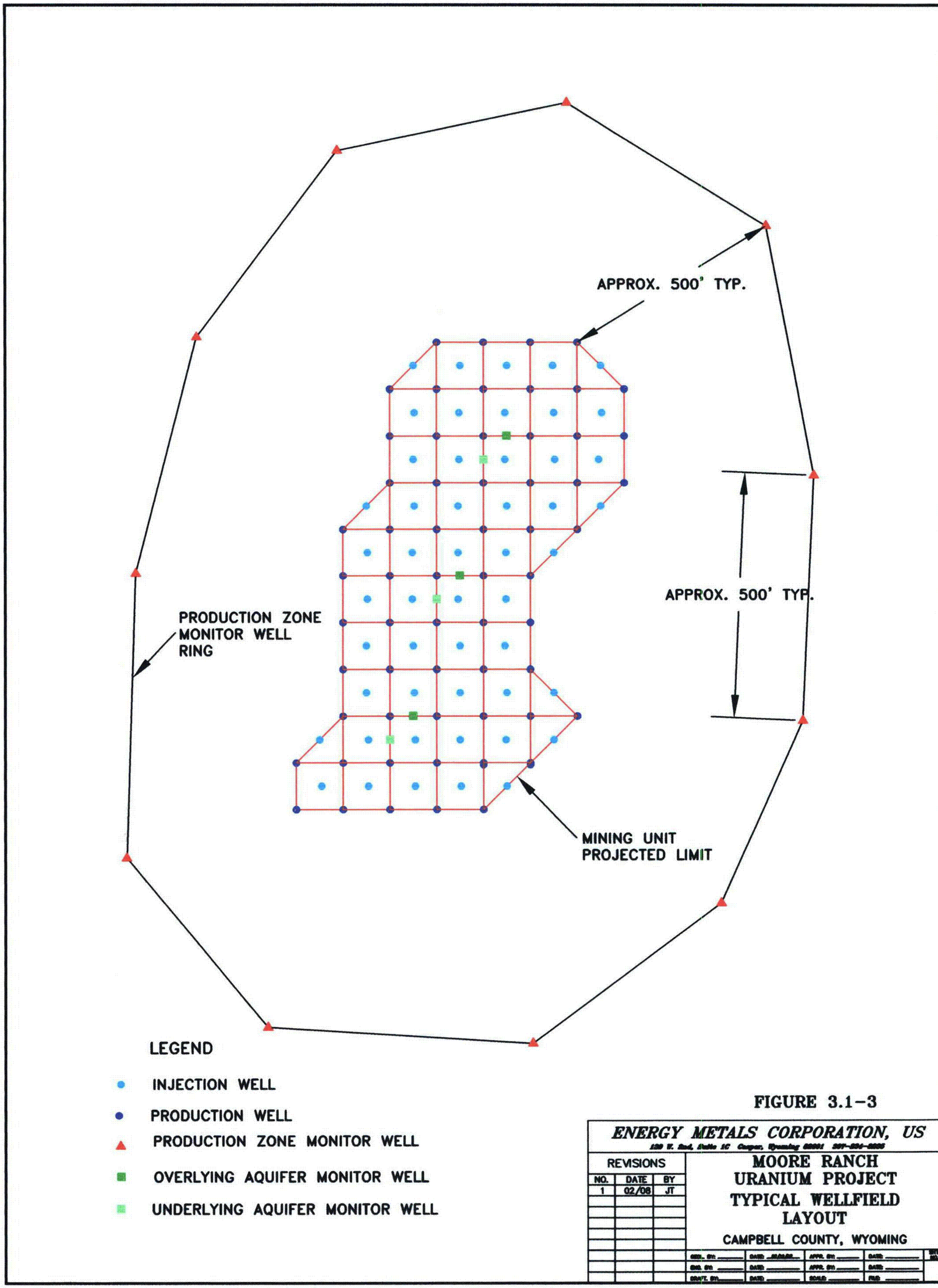
The minimum over production or bleed rates will be a nominal 0.5% of the total wellfield production rate and the maximum bleed rate typically approaches 1.5%. Bleed rates will be adjusted as necessary to ensure that the wellfield cone of depression is maintained.

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. Header houses will be used to distribute injection fluid to injection wells and collect production solution from recovery wells. Each header house will be connected to two trunk lines, one for receiving injection fluid from the processing plant and one for conveying recovery fluids to the processing plant. The header house includes manifolds, valves, flow meters, pressure meters, booster pumps and oxygen for incorporation into the injection lixiviant, if and when required. Each header house will service approximately 40 to 60 wells (injection and recovery). Figure 3.1-3A illustrates a plan view of a typical headerhouse. Currently, approximately 8 headerhouses are planned to be constructed for Wellfield 1 and 11 are planned for Wellfield 2.

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.



APPROX. 500' TYP.
APPROX. 500' TYP.
PRODUCTION ZONE MONITOR WELL RING
MINING UNIT PROJECTED LIMIT
LEGEND
INJECTION WELL
PRODUCTION WELL
PRODUCTION ZONE MONITOR WELL
OVERLYING AQUIFER MONITOR WELL
UNDERLYING AQUIFER MONITOR WELL
ENERGY METALS CORPORATION, US
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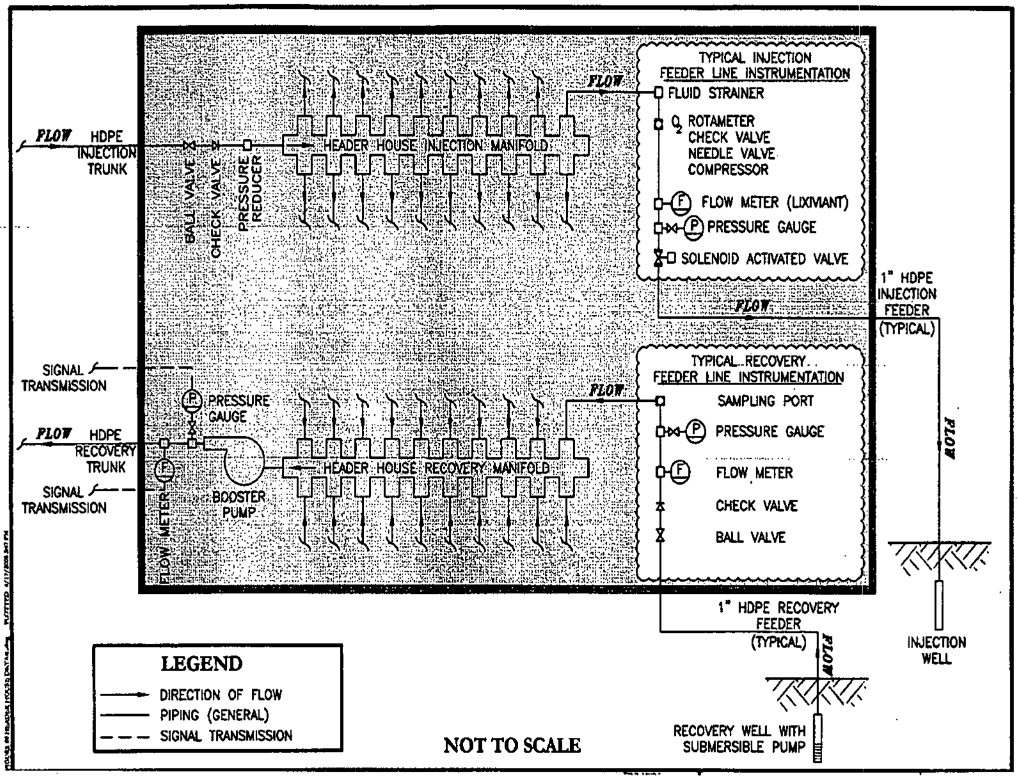
MOORE RANCH URANIUM PROJECT
TYPICAL WELLFIELD LAYOUT
CAMPBELL COUNTY, WYOMING

FIGURE 3.1-3

Figure 3.1-3A Headerhouse Design



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. The location of these wells is shown on Figure 3.1-4A.

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.

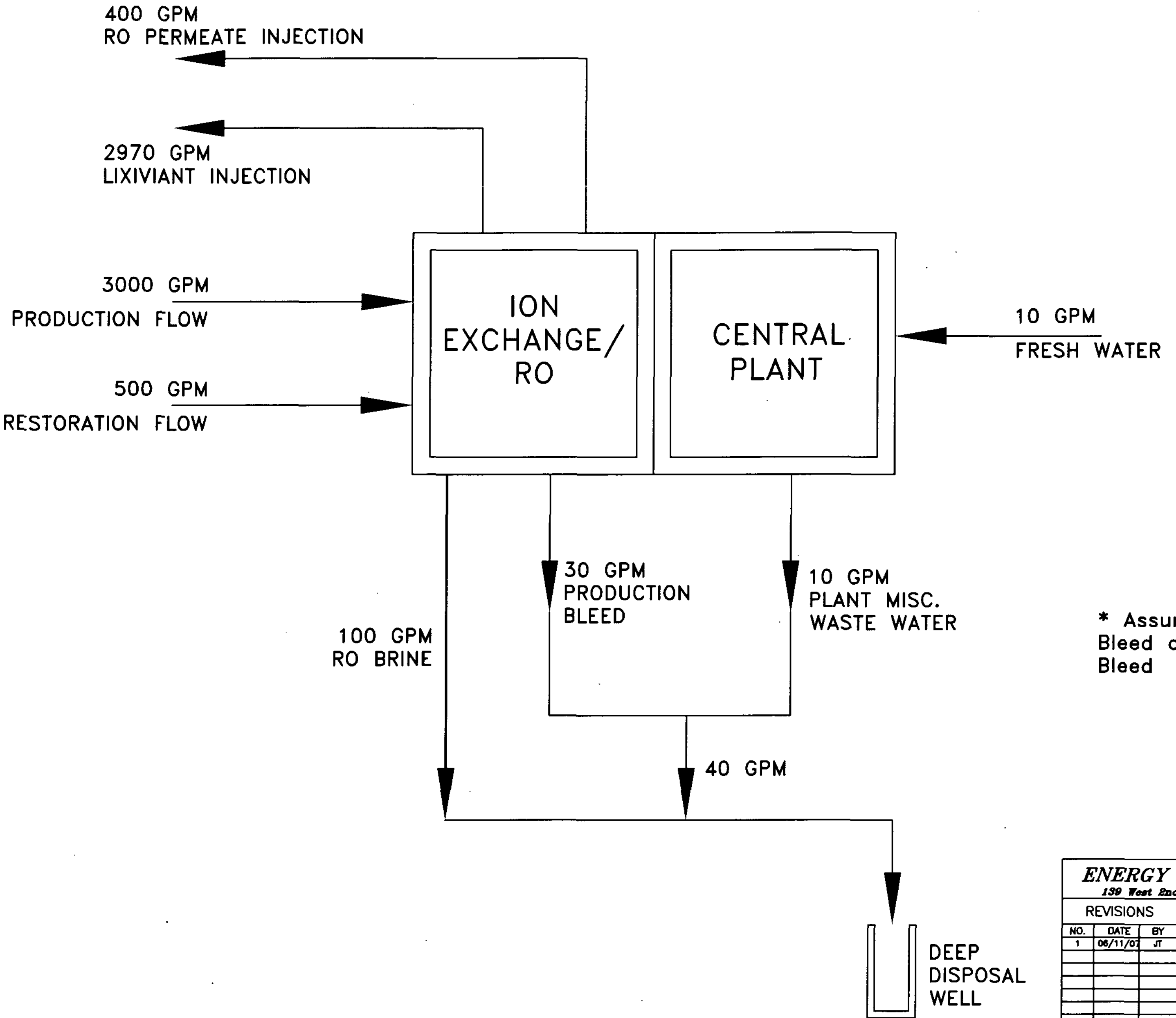
Downhole injection pressures will be maintained below the formation fracture pressure. The formation fracture pressure gradient commonly used is 1.0 psi for every 1 foot of depth[1] to the top of the screened interval. At Moore Ranch, the depth to the top of the anticipated screened interval varies from 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.

3.1.3.1 Wellfield Operational Monitoring

As discussed in Section 5.7 of this Technical Report, an extensive water-sampling program will be conducted prior to, during and following mining operations at the Moore Ranch project to identify any potential impacts to water resources of the area. The groundwater monitoring program is designed to establish baseline water quality prior to mining; detect excursions of lixiviant either horizontally or vertically outside of the production zone during mining; and determine when the production zone aquifer has been adequately restored following mining.

Injection well and production well flow rates and pressures are monitored at the headerhouse in order that injection and production can be balanced for each pattern and the entire wellfield. The flow rate of each production and injection well is continuously monitored by monitoring individual electronic flow meters in each wellfield headerhouse. The pressure of each production and injection trunk line will be monitored at the headerhouse with electoronic pressure gauges. The flow meters and pressure gauges will be tied into the headerhouse control panel, which will be in communication with the central plant control room.

High and low pressure and flow alarms will be in place to alert wellfield and plant operators if specified ranges are exceeded in conjunction with automatic shutoff valves to stop flow if significant changes in flow or pressure occur.



* Assuming 1% Production Bleed and 20% Restoration Bleed

FIGURE 3.1-4

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MOORE RANCH URANIUM PROJECT
WATER BALANCE

SECT. 34-35, T. 42 N., R. 75 W.

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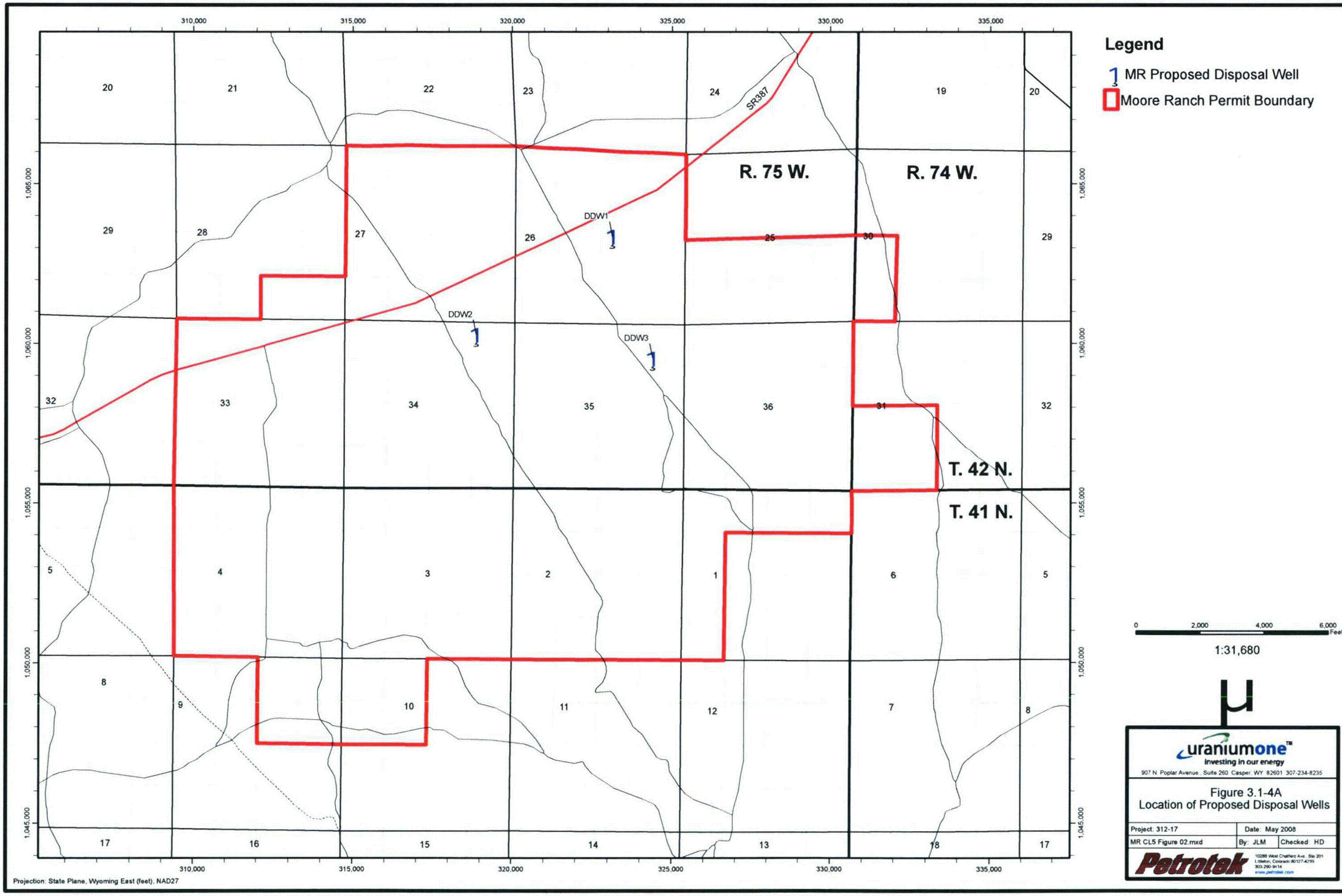
SHT. NO.



Legend
MR Proposed Disposal Well
Moore Ranch Permit Boundary
R. 75 W.
R. 74 W.
T. 42 N.
T. 41 N.
SR387
DDW1
DDW2
DDW3
0 2,000 4,000 6,000 Feet
1:31,680
uraniumone
investing in our energy
907 N. Poplar Avenue, Suite 260 Casper, WY 82601 307-234-8235
Figure 3.1-4A
Location of Proposed Disposal Wells
Project: 312-17
Date: May 2008
MR CL5 Figure 02.mxd
By: JLM
Checked: HD
Petrotek
Projection: State Plane, Wyoming East (feet), NAD27

3.1.4 Process Description

Uranium in situ recovery is a process that takes place underground, or in-place, by injecting lixiviant (recovery) solutions into the ore body and then recovering these solutions when they are rich in uranium. The uranium rich solutions (pregnant lixiviant) are then pumped from recovery wells (production wells) to the central plant ion exchange system for extraction. The uranium recovery process utilizes the following steps:

1. Injection of lixiviant: oxidation and complexation of the uranium underground;
2. Loading of uranium complexes onto an ion exchange resin;
3. Reconstitution of the recovery solution by addition of carbon dioxide and/or sodium bicarbonate and an oxidant;
4. Elution of uranium complexes from the resin;
5. Precipitation of uranium.

3.1.4.1 In Situ Reactions

The lixiviant is the recovery solution which is used to solubilize the uranium from the ore deposit. The composition is designed to reverse the natural geochemical conditions which led the to original uranium deposition. The project will use a carbonate/or bicarbonate recovery solution consisting of varying concentrations and combinations of sodium carbonate (Na_2CO_3), sodium bicarbonate ($NaHCO_3$), oxygen, and carbon dioxide (CO_2) added to the native groundwater to promote the dissolution of uranium as a uranyl carbonate complex. The lixiviant is typically made up on a batch basis in the plant and added continuously to the injection stream. The expected or typical lixiviant concentration and composition is shown in Table 3.1-1.

The chemistry of in situ recovery involves an oxidation step to convert the uranium in the solid state to a form that is easily dissolved by the recovery solution. The reactions representing these steps at a neutral or slightly alkaline pH are:

Oxidation: $UO_{2\,(solid)} + \frac{1}{2} O_{2\,(in\ solution)} + 2H^{+} \longrightarrow UO_{3\,(at\ solid\ surface)}$

Dissolution: $UO_3 + 2\,HCO_3^{-1} \longrightarrow UO_2(CO_3)_2^{-2} + H_2O$

$$UO_3 + CO_3^{-2} + 2HCO_3^{-1} \longrightarrow UO_2(CO_3)_3^{-4} + H_2O$$

The principal uranyl carbonate ions formed as shown above are uranyl dicarbonate, $UO_2(CO_3)_2^{-2}$, (UDC), and uranyl tricarbonate $UO_2(CO_3)_3^{-4}$, (UTC). The relative abundance of each is a function of pH and total carbonate strength.

3.1.4.2 Uranium Extraction

The process flow sheet depicting the uranium extraction process as planned for the central plant is shown in Figure 3.1-5. The recovery of uranium from the pregnant lixiviant in the Moore Ranch Facility will take place in the ion exchange columns. The uranium bearing recovery solution enters the pressurized downflow ion exchange column and passes through the resin bed. A uranium specific ion exchange resin, such as Dowex 21K or equivalent, is used. The uranium complexes in solution are loaded onto the ion exchange resin in the column. This loading process is represented by the following chemical reaction:

$$2\,R\,HCO_3 + UO_2(CO_3)_2^{-2} \longrightarrow R_2UO_2(CO_3)_2 + 2HCO_3^{-1}$$

$$2\,RCl + UO_2(CO_3)_2^{-2} \longrightarrow R_2UO_2(CO_3)_2 + 2Cl^{-}$$

$$R_2SO_4 + UO_2(CO_3)_2^{-2} \longrightarrow R_2UO_2(CO_3)_2 + SO_4^{-2}$$

As shown in the reaction, loading of the uranium complex results in simultaneous displacement of chloride, bicarbonate or sulfate ions.

The now barren lixiviant passes from the ion exchange columns to be reinjected into the formation. The solution is refortified with the sodium carbonate/bicarbonate based lixiviant as required and pumped to the wellfield for reinjection into the formation.

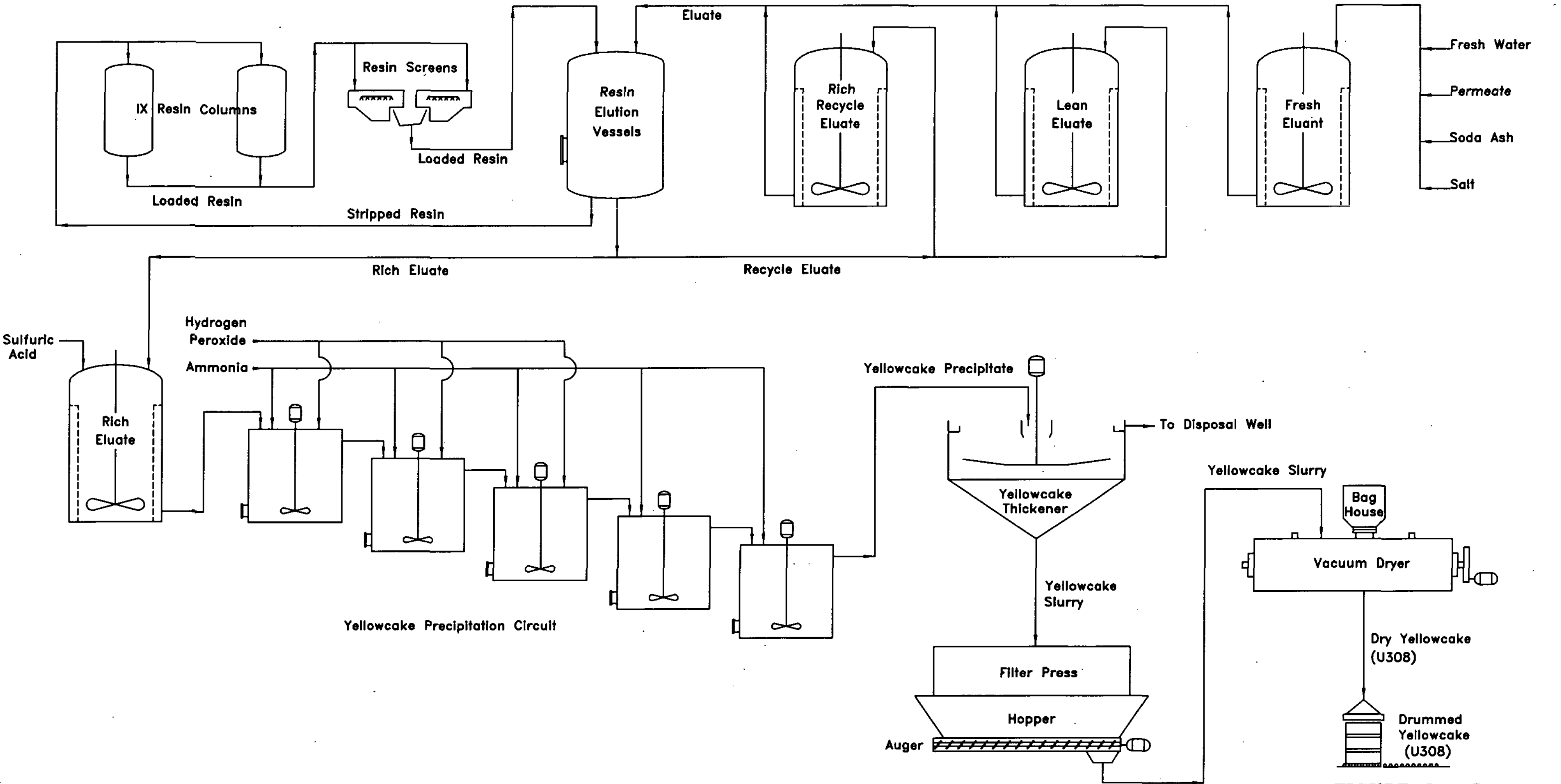


FIGURE 3.1-5

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MOORE RANCH
URANIUM PROJECT
PROCESS FLOW DIAGRAM

SECT. 34-35, T. 42 N., R. 75 W.

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1	07/13/07	JT

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Table 3.1-1: Typical Lixiviant Concentrations

SPECIES	RANGE (mg/L)	
	Low	High
Na	≤ 400	6000
Ca	≤ 20	500
Mg	≤ 3	100
K	≤ 15	300
CO_3	≤ 0.5	2500
HCO_3	≤ 400	5000
Cl	≤ 200	5000
SO_4	≤ 400	5000
U_3O_8	≤ 0.01	500
V_2O_5	≤ 0.01	100
TDS	≤ 1650	12000
pH	< 6.0	8.0

* All values in mg/l except pH (units).

NOTE: The above values represent the concentration ranges that could be found in barren lixiviant or pregnant lixiviant and would include the concentration normally found in "injection fluid".

3.1.4.3 Resin Transfer and Elution

Once the ion exchange resin in an IX column is loaded to capacity with uranium complexes, the column will be taken out of service. The resin loaded with uranium will be transferred from the IX column to the elution circuit. Once the resin has been stripped of the uranium by the process of elution, the resin will be returned to the appropriate column for reuse in the ion exchange circuit. In the elution circuit the loaded resin will be stripped of uranium by a process based on the following chemical reaction:

$$R_2UO_2(CO_3)_2 + 2Cl^- + CO_3^{-2} \longrightarrow 2\ RCl + UO_2(CO_3)_3^{-2}$$

After the uranium has been stripped from the resin, the resin may be rinsed with a sodium bicarbonate solution. This rinse removes the high chloride eluant physically entrained in the resin and partially converts the resin to bicarbonate form. In this way, chloride ion buildup in the lixiviant can be controlled.

3.1.4.4 Precipitation

When a sufficient volume of pregnant eluant is held in storage, it is acidified with either sulfuric acid to break the uranyl carbonate complex ion and liberate carbonate ions as carbon dioxide. The solution is agitated to assist in removal of the resulting CO_2. The decarbonization can be represented as follows:

$$UO_2(CO_3)_3^{-4} + 6H^+ \longrightarrow UO_2^{++} + 3\ CO_2\uparrow + 3H_2O$$

Anhydrous ammonia is then added to raise the pH to a level conducive for precipitating uranium crystals.

Hydrogen peroxide is then added to the solution to precipitate the uranium according to the following reaction:

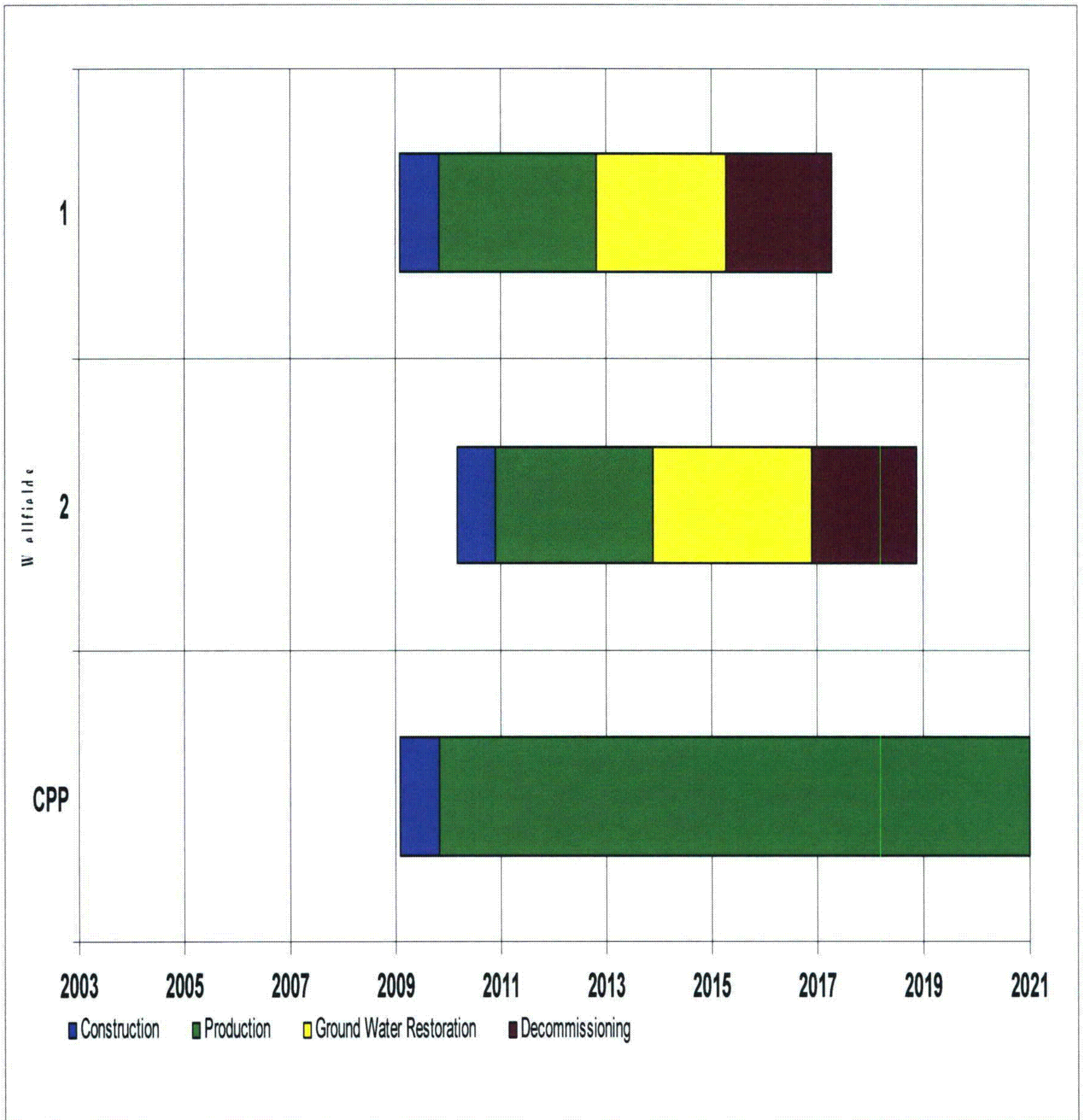
$$UO_2^{++} + H_2O_2 + 2H_2O \xrightarrow{NH_3} UO_4 \bullet 2H_2O + 2H^+$$

The precipitated uranyl peroxide slurry is pH adjusted, allowed to settle, and the clear solution decanted. The decant solution is recirculated back to the barren makeup tank, sent to fresh salt brine makeup, or sent to waste. The thickened uranyl peroxide "slurry" is further dewatered and washed. The solids discharge is either sent to the vacuum dryer for drying before shipping or is sent to storage for shipment as slurry to a licensed recovery or conversion facility.

3.1.5 Proposed Operating Schedule

The proposed Moore Ranch mine schedule is shown in Figure 3.1-6. The mine schedule is preliminary based on EMC's current knowledge of the area and the installation of three wellfields. As the Moore Ranch Project is developed, the mine schedule will be updated accordingly.

Figure 3.1-6: Proposed Moore Ranch Operations Schedule



3.2 CENTRAL PLANT AND CHEMICAL STORAGE FACILITIES; EQUIPMENT USED AND MATERIAL PROCESSED

The uranium recovery process described in the preceding section will be accomplished in several steps. Uranium recovery from the solution by ion exchange, subsequent processing of the loaded ion exchange resin to remove the uranium (elution), the precipitation of uranium, and the dewatering and packaging of solid uranium (yellowcake) will be performed at the central plant.

The central plant will not only serve production from Moore Ranch ISR operations, but is also planned to process resin from other potential EMC satellite projects in the area, or potential tolling arrangements with other in situ operations licensed under a different operator. The central plant will be initially designed and constructed to produce 2 million pounds of U_3O_8 per year (see Figure 3.2-1 for layout). Capacity is expected to be expanded to 4 million pounds per year as these other potential satellite projects are licensed and production increases (see Figure 3.2-2 for expanded facility layout).

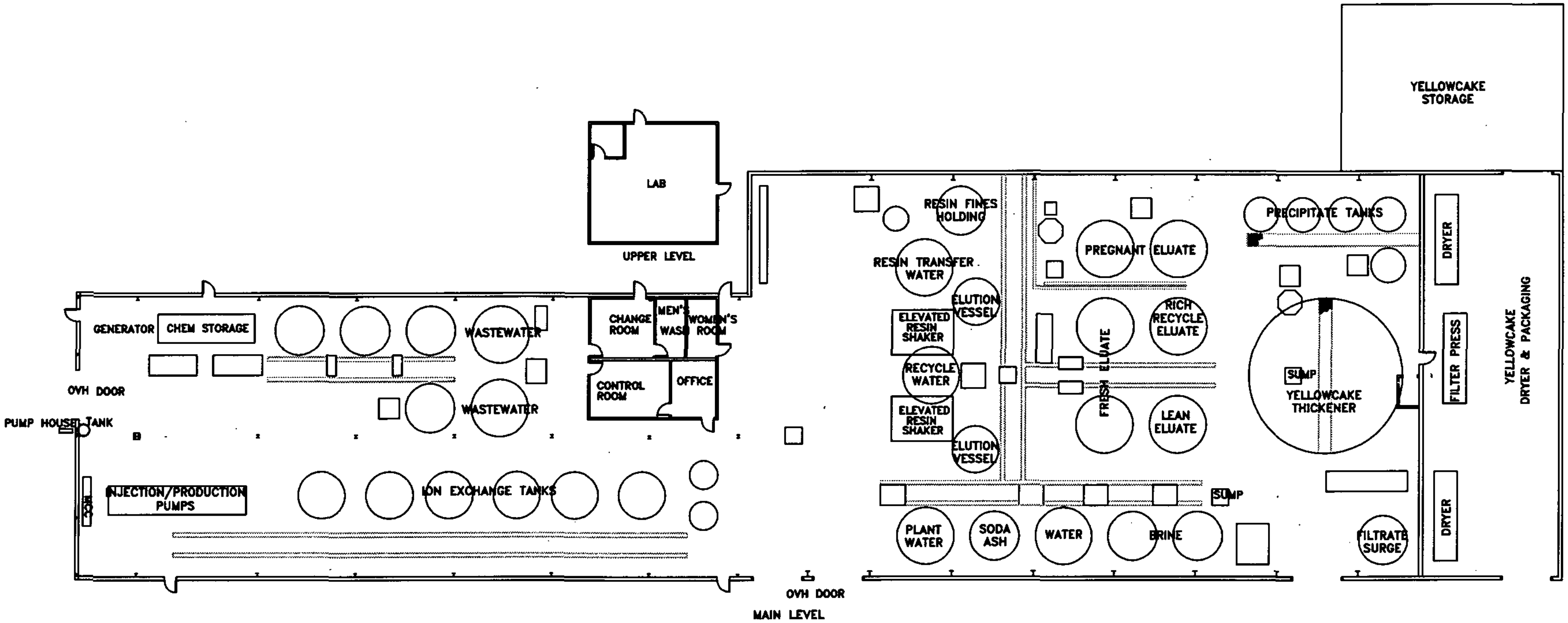


FIGURE 3.2-1

ENERGY METALS CORPORATION, US

139 West 2nd St. Casper, WY 82601 307-234-8235

MOORE RANCH URANIUM PROJECT

CENTRAL PLANT LAYOUT

SECT. 34-35, T. 42 N., R. 75 W.

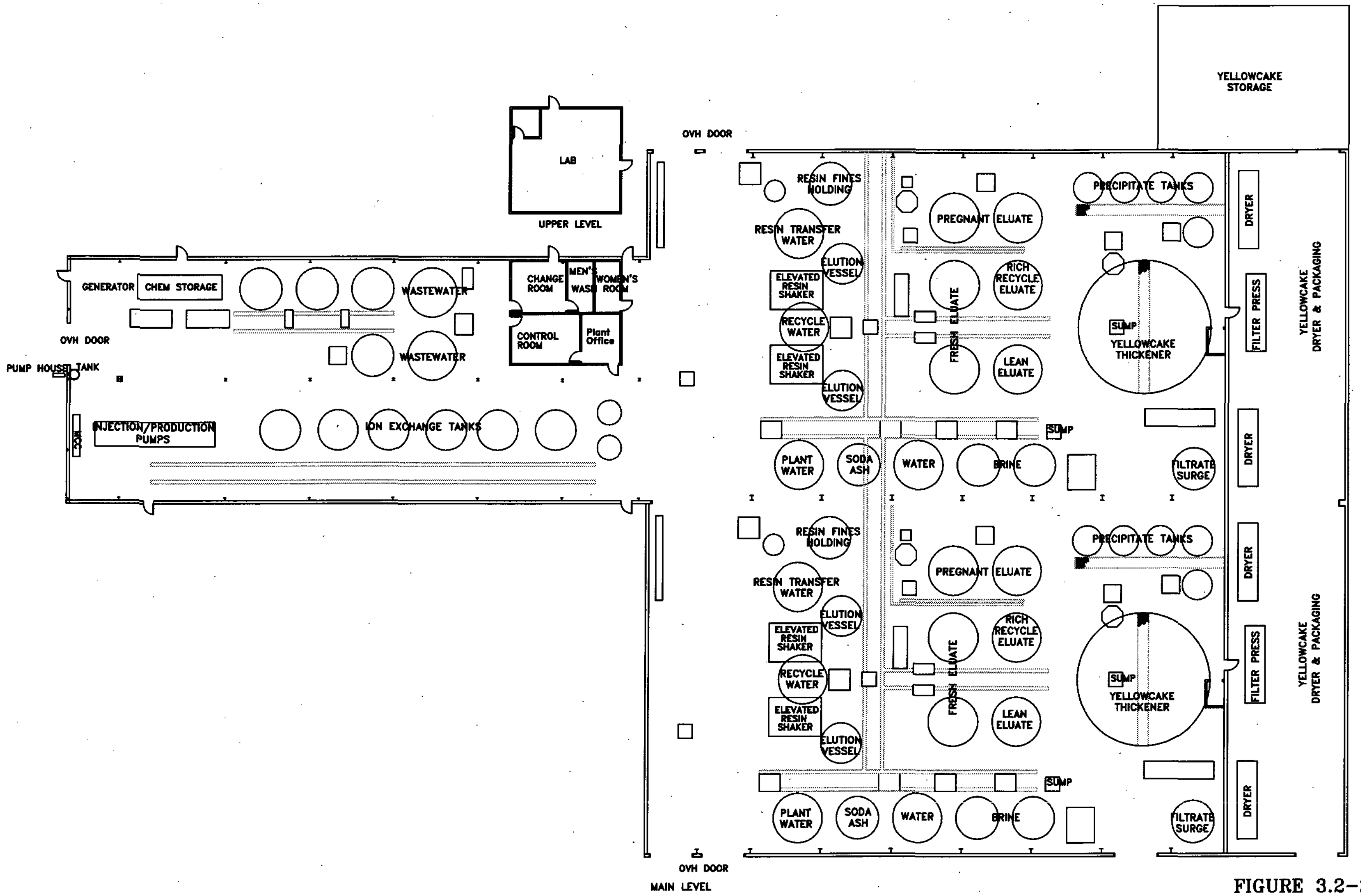


FIGURE 3.2-2

ENERGY METALS CORPORATION, US
139 West 2nd St. Casper, WY 82601 307-234-8235

MOORE RANCH URANIUM PROJECT

EXPANDED CENTRAL PLANT LAYOUT

SECT. 34-35, T. 42 N., R. 75 W.

REVISIONS

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3.2.1 Moore Ranch Central Plant Equipment

The initial Moore Ranch central plant facilities will be housed in a building approximately 350 feet long by 100 feet wide. The building width (with the exception of the ion exchange area) will likely double to accommodate the future planned expansion. The central plant includes the following systems:

- Ion exchange;
- Resin transfer
- Chemical addition
- Filtration
- Elution Circuit
- Precipitation Circuit
- Product Filtering, Drying and Packaging, and
- Liquid Waste Stream Circuit.

Based on preliminary design and site geotechnical evaluations, the Moore Ranch central plant will be located within an 11 acre fenced area in the NW ¼¼, Section 34, T42N, R75W. This area will also contain the deep disposal well and chemical storage areas. Figure 3.2-2 shows the plan view of the expanded central plant.

3.2.1.1 Flow and Material Balance – Ion Exchange

The uranium-bearing solution or pregnant lixiviant pumped from the wellfield is piped to the ion exchange plant for extraction of the uranium by use of ion exchange units. The ion exchange system consists of eight fixed bed ion exchange vessels. The ion exchange vessels will be operated as three sets of two vessels in series with two vessels available for restoration. The ion exchange system is designed to process recovered solution at a rate of 3,000 gpm with each vessel sized for 500 cubic feet of resin operated in a pressurized downflow mode. As the solution passes through the IX resin in the IX vessels the uranyldicarbonate and uranyltricarbonate are preferentially removed from the solution. The barren solutions leaving the ion exchange units normally contain less than 2 mg/l of uranium.

After the barren lixiviant leaves the ion exchange vessels, carbon dioxide and/or carbonate/bicarbonate is added as necessary to return the carbonate/bicarbonate concentration to the desired operating level. The solution is then pumped back to the wellfield, with the oxidant (O_2 gas) added either as it leaves the central plant, or just before the solution is re-injected into the production zone.

Loaded resin from potential future EMC satellite operations or other projects will be transported to the central plant via tanker truck. A pressurized transfer system will be used to transfer resin from the truck to the plant.

3.2.1.2 Flow and Material Balance – Elution System

Using a three stage elution circuit, approximately 33,000 gallons of eluate will contact 500 cubic feet of resin. The first elution stage generates approximately 1,500 ft^3 (11,220 gallons) of pregnant eluate containing 10 to 20 grams per liter U_3O_8. Approximately 1,500 ft^3 (11,220 gallons) of fresh eluate will be required per elution batch. The fresh eluate is prepared by mixing the proper quantities of a saturated sodium chloride (salt) solution and saturated sodium carbonate (soda ash) solution and water to form a solution that is approximately 9% NaCl and 2% Na_2CO_3. The saturated salt solution will be generated in a brine generator and the saturated soda ash solution will be prepared by passing warm water (>105° F) through a bed of soda ash. The eluate is passed through a bank of 10 micron bag filters to remove entrained particulates prior to contacting the resin beds in the elution vessels.

In the three stage elution, the rich eluate is first passed through the elution vessels which contain the IX resin. The rich eluate strips approximately 84% of the uranyl carbonate ions from the resin and becomes pregnant eluate, which then contains approximately 15,500 mg/l of U_3O_8. Next, lean eluate is contacted with the resins and removes approximately 68% of the remaining uranyl carbonate to become rich eluate. Finally, fresh eluate is passed through the resins in the elution vessels and removes approximately 35% of the remaining uranyl carbonate from the resins. This final flush is the lean eluate. At this point, the resins have a residual uranyl carbonate concentration of approximately 3.33%. The resins are washed with fresh water and/or sodium bicarbonate rinse and transferred back to the appropriate vessel or to a resin transfer trailer for transport back to any off-site satellite mining areas. Each batch of eluate will be transferred from the respective eluate storage tank through the elution vessel at a rate of approximately 210 gpm.

3.2.1.3 Flow and Material Balance – Precipitation System

Approximately 210 gallons of hydrochloric or sulfuric acid is added to the pregnant eluate to break the uranyl carbonate complex, which liberates carbon dioxide and frees uranyl ions to form a uranyl sulfate ion complex. The acidic, uranium rich fluid is pumped to the first of five agitated tanks arranged in series. The fluid flows by gravity from one tank to the next. Hydrogen peroxide is added to the first two tanks to form an insoluble uranyl peroxide compound. Sodium Hydroxide (or possibly anhydrous ammonia) is then diffused into solution, with compressed air, in the third tank. Sodium hydroxide (or ammonia) and air are also diffused into solution into the final tank in series. The addition of sodium hydroxide (or ammonia) raises the pH of the precipitate solution to near neutral for optimum crystal growth and settling. Whether sodium hydroxide or ammonia is used (as well as hydrochloric or sulfuric acid) will be determined by the economics of the chemicals at the time of operation. The uranium precipitate solution is then pumped from the final precipitation tank to a 38-foot diameter gravity thickener.

3.2.1.4 Yellowcake Drying

The thickened yellowcake will be pumped into a plate and frame filter press. The yellowcake is washed by pumping fresh water through the solids in the filter press. Washing removes excess chlorides and other soluble contaminants from the yellowcake. The filtered yellowcake, which is approximately 60% solids, drops from the filter press into a live bottom hopper with a screw auger to move the pressed yellowcake slurry to a sump where a moyno-type positive displacement pump transfers the yellowcake to an indirect fired rotary vacuum dryer. Water is added to the yellowcake in the live bottom hopper to facilitate pumping the solids to the dryer.

The yellowcake will be dried at approximately 250°F. The off gases generated during the drying cycle are filtered through a baghouse, which is located on the top of the dryer, to remove particles down to approximately a 1 micron size fraction. The gases are then cooled and scrubbed in a surface condenser to further remove the smaller size fraction particulates and the water vapor during the drying process. Two rotary vacuum dryers (potentially 4 vacuum dryers after future plant expansion) will be located in a separate building attached to the central plant which will contain the dryers, the baghouses on the dryers and a condenser scrubber and vacuum pump system for each dryer. The dryers will be approximately 20 feet in length and 5 feet in diameter. The dryers will be heated with a heat transfer fluid (Dow-Therm® or equivalent) that circulates through the shell and the rotating central shaft, to which plows are affixed. The plows stir and mix the material in the dryer to facilitate even drying of the solids in the chamber. The heat transfer fluid (HTF) will be heated by two natural gas or propane fired HTF heaters, each provided with HTF pumps for circulating the HTF though the shell and central shaft of the dryer. The HTF heaters and pumps will be located in a shed structure attached to the back of the dryer building. The water-sealed vacuum pumps will provide the vacuum source while the dryer is being loaded and while the yellowcake is unloaded into drums. The major components of the system are described below:

1. Drying Chamber: A horizontal 316 stainless steel vessel heated externally and fitted with rotating plows to stir the yellowcake. The chamber will have a top port for loading the wet yellowcake and a bottom port for unloading the dry powder. A third port will be provided for the venting through the baghouse during the drying procedure.

2. Bag House: This air and vapor filtration unit will be mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house will be heated to prevent condensation of water vapor during the drying cycle. It will be kept under negative pressure by the vacuum system.

3. Condenser: This unit will be located downstream of the bag house and will be water cooled. It will be used to remove the water vapor from the non-condensable gases coming from the drying chamber. The gases are moved through the condenser by the vacuum system. Dust passing through the bag filters is wetted and entrained in the condensing moisture within this unit.

4. Vacuum Pump: The vacuum pump will be a rotary water sealed unit that provides a negative pressure on the entire system during the drying cycle. It will also be used to provide negative pressure during transfer of the dry powder from the drying chamber to fifty-five (55) gallon drums. The water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams.

5. Packaging: The system will be operated on a batch basis. When the yellowcake is dried sufficiently, it will be discharged from the drying chamber through a bottom port into drums. A level gauge, a weigh scale, or other suitable device will be used to determine when a drum is full. Particulate capture will be provided by a sealed hood that fits on the top of the drum, which will be vented through a sock filter to the condenser and the vacuum pump system when the powder is being transferred.

6. Heating: The heat for drying will be supplied by indirect HTF such as Dow-Therm® or other suitable heat transfer fluids. The drying will be accomplished under 250°F and at pressures less than atmospheric.

7. Effluent Monitoring: The vacuum pump discharges to the atmosphere. The water that is collected from the condenser will be recycled to the precipitation circuit, eluant makeup or disposed with other process water. Room air will be monitored routinely for airborne dust.

8. Controls: The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures.

3.2.2 Yellowcake Packaging, Storage, and Shipment

The dried yellowcake will be removed from the rotary vacuum dryer by passing through a rotary valve into 55-gallon steel drums, which are placed under a hood for the drum loading. The vacuum pump for the dryer will be connected to the loading hood to minimize particulate emissions during drum loading.

The dried yellowcake product in the steel drums will be stored for shipment within a restricted storage area and shipped by truck to other licensed facilities for further processing. An enclosed warehouse, adjacent to the yellowcake drying area, will be provided for the storage of yellowcake. Onsite inventory of drummed yellowcake typically will be less than 200,000 lbs. However, in periods of inclement weather or other interruptions in product shipments, all production will be stored on-site in designated restricted storage areas.

The drummed yellowcake will be shipped by exclusive use transport to another licensed facility for further processing. All yellowcake shipments will be made in compliance with applicable DOT and NRC regulations.

A discussion of the areas in the proposed plant facility where fumes or gases could be generated can be found in Section 7.3. The potential sources are minimal in the ion exchange process area since the mining solutions contained in the process equipment are maintained under a positive pressure. Building ventilation in the process equipment area will be accomplished by the use of an exhaust system that draws in fresh air and sweeps the plant air out to the atmosphere.

3.2.3 Chemical Storage Facilities

Chemical storage facilities at the Moore Ranch Project will include both hazardous and non-hazardous material storage areas. Bulk hazardous materials, which have the potential to impact radiological safety, will be stored outside and segregated from areas where licensed materials are processed and stored. Bulk storage of hazardous chemicals will be located as to provide adequate separation to avoid mixing of incompatible materials. Also, bulk hazardous materials will be stored outside in areas to provide adequate distance from facilities to minimize hazards to people during an accidental release. Other non-hazardous bulk process chemicals (e.g., sodium carbonate) that do not have the potential to impact radiological safety may be stored within the central plant facilities.

3.2.3.1 Process Related Chemicals

Process-related chemicals stored in bulk at the Moore Ranch Central Plant will potentially include carbon dioxide, oxygen, sodium sulfide, sodium hydroxide and/or ammonia, hydrochloric acid and/or sulfuric acid, and hydrogen peroxide. Risk assessments completed by the NRC in NUREG-6733[2] for in situ recovery facilities identified anhydrous ammonia and bulk acid (sulfuric and hydrochloric) storage as the most hazardous chemicals with the greatest potential for impacts to chemical and radiological safety. Uranium One plans to use sodium hydroxide instead of anhydrous ammonia in the precipitation cycle, but the choice will be determined by the economics of each chemical at the time of operations.

- Carbon Dioxide

Carbon dioxide will be stored adjacent to the central plant where it will be added to the lixiviant prior to leaving the central plant.

- Oxygen

Oxygen is typically stored near the central plant or within wellfield areas, where it is centrally located for addition to the injection stream in each headerhouse. Since oxygen readily supports combustion, fire and explosion are the principal hazards that must be controlled. The oxygen storage facility will be located a safe distance from the central plant and other chemical storage areas for isolation. The storage facility will be designed to meet industry standards in NFPA-50[3].

Oxygen service pipelines and components must be clean of oil and grease since gaseous oxygen will cause these substances to burn if ignited. All components intended for use with the oxygen distribution system will be properly cleaned using recommended methods in CGA G-4.1[4]. The design and installation of oxygen distribution systems is based on CGA-4.4[5].

- Chemical Reductants

Hazardous materials typically used during groundwater restoration activities include the addition of a chemical reductant (i.e., sodium sulfide or hydrogen sulfide gas). To minimize the potential for accidents involving process chemicals to impact areas where licensed material is handled, these materials are stored outside of process areas. Sodium sulfide may be used as a chemical reductant during groundwater restoration. The material consists of a dry flaked product and is typically purchased on pallets of 55-pound bags or super sacks of 1,000 pounds. The bulk inventory will be stored outside of process areas in a cool, dry, clean environment to prevent contact with any acid, oxidizer, or other material that may react with the product. There are no current plans to use hydrogen sulfide gas at the Moore Ranch Project. However, in the event that EMC determines that use of hydrogen sulfide as a chemical reductant is necessary, proper chemical safety precautions will be taken.

- Sodium Hydroxide or Anhydrous Ammonia

As previously stated, EMC plans to use sodium hydroxide (caustic soda) to raise the pH levels during the precipitation phase of the process at the Antelope Central Plant. However, depending upon economics, it could be more cost effective to use anhydrous ammonia for the same purpose. If sodium hydroxide is used, the bulk tank will be stored adjacent to the plant building.

If used, the anhydrous ammonia storage and distribution system at the proposed Moore Ranch Central Plant will have an initial capacity of approximately 90,000 lbs with potential to double after expansion of the central plant. Administrative controls will limit ammonia storage in the tank to 80% of maximum capacity. Strict unloading procedures will be utilized to ensure that this limit is not exceeded and that other safety controls are in place during the transfer of anhydrous ammonia. Process safety controls will be in place at the central plant where anhydrous ammonia is added to the precipitation circuit. These safety controls include the installation of a process area ammonia detector and alarm and emergency shut off solenoid for isolation of the ammonia distribution system in the event of a major release.

The ammonia system at the central plant will be covered under the EPA's Risk Management Program (RMP) regulations. The RMP regulations require certain actions by covered facilities to prevent accidental releases of hazardous chemicals and minimize potential impacts to the public and environment. These actions include measures such as accidental release modeling, documentation of safety information, hazard reviews, operating procedures, safety training, and emergency response preparedness. Storage and operation of the anhydrous ammonia system will be conducted in compliance with RMP regulations.

Additionally, anhydrous ammonia will have total storage exceeding the screening threshold contained in Appendix A of 6 CFR 27, Chemical Facility Anti-terrorism Final Interim Standards, Department of Homeland Security. As a result, EMC will be obligated to undergo initial screening requirements as required by the rule.

- Acid Storage

The sulfuric and/or hydrochloric acid storage and distribution systems at the central plant will have an initial capacity of approximately 6,000 gallons. Future capacity will double after expansion of the central plant. Strict unloading procedures are utilized to ensure that safety controls are in place during the transfer of these acids. Process safety controls are also in place at the central plant where sulfuric or hydrochloric acid is added to the precipitation circuit.

Initial anticipated hydrochloric acid storage (6,000 gallons) does not exceed the screening threshold (11,250 lbs) contained in Appendix A of 6 CFR 27, Chemical Facility Anti-terrorism Final Interim Standards, Department of Homeland Security. However, the threshold will be exceeded if capacity is doubled after plant expansion. As a result, EMC will be obligated to undergo initial screening requirements for hydrochloric acid as required by the rule at that time.

- Hydrogen Peroxide

Hydrogen peroxide will be stored outside in a 6,000-gallon tank constructed of aluminum during initial operations. This capacity will double after expansion of the central plant. The storage tank will be stored away from flammable sources, organic materials, and incompatible chemicals (including ammonia) to avoid adverse chemical reactions.

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.

The Moore Ranch design includes the use of hydrogen peroxide at a concentration of 50 percent contained in a hydrogen peroxide tank with an initial capacity of 6,000 gallons. With the design hydrogen peroxide concentration and capacity, EMC will not be subject to the aforementioned regulatory programs.

3.2.3.2 Non-Process Related Chemicals

Non-process related chemicals that will be stored at the Moore Ranch Central Plant include petroleum (gasoline, diesel) and propane. Due to the flammable and/or combustible properties of these materials, all bulk quantities will be stored outside of process areas at the plant. All gasoline and diesel storage tanks are located above ground and within secondary containment structures to meet EPA requirements.

3.3 INSTRUMENTATION AND CONTROL

The piping and metering system for production and injection solutions consists of buried trunk lines between the recovery plant and the operating wellfield areas with metering and flow distribution headers in the wellfield headerhouses. The individual well flows and pressures are adjusted and controlled within the headerhouses. Wellfield instrumentation will be provided to measure total production and injection flow. In addition, instrumentation will be provided to indicate the pressure which is being applied to the injection wells. Wellfield headerhouses will be equipped with water sensors and alarms to detect the presence of liquids in the wellfield headerhouses.

Instrumentation will be provided to monitor the total recovery flow into the central plant, the total injection flow leaving the plant, and the total waste flow leaving the plant. Instrumentation will be provided on each injection and production well to record an alarm in the event of a change in flow that might indicate a leak or rupture in the system. In the process areas, tank levels are measured in chemical storage tanks as well as process tanks.

Handheld radiation detection instruments and portable samplers will be used to monitor radiological conditions at the central plant. Specifications/ for this equipment are discussed in further detail in Section 5. The location of monitoring points and monitoring frequency for in-plant radiation safety is also discussed in Section 5.

3.4 REFERENCES

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[1] Driscoll, F.G., *Groundwater and Wells, Second Edition*, (Johnson Division, 1986).

[2] Center for Nuclear Waste Regulatory Analyses, NUREG/CR–6733, *A Baseline Risk-Informed, Performance-Based Approach for In Situ Leach Uranium Extraction Licenses*, 2001.

[3] National Fire Protection Association, NFPA-50, *Standard for Bulk Oxygen Systems at Consumer Sites*, (NFPA, 1996)

[4] Compressed Gas Association, CGA G-4.1, *Cleaning Equipment for Oxygen Service*, (CGA, 2000)

[5] Compressed Gas Association, CGA G-4.4, *Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems*, (CGA, 1993)

4 EFFLUENT CONTROL SYSTEMS

This section describes the effluent control systems used at the Moore Ranch Uranium Project. The effluents of concern at ISR operations include the release or potential release of radon gas (radon-222) and dried yellowcake. Yellowcake processing and drying operations will be conducted at the central plant.

The yellowcake drying facilities at the central plant will be comprised of vacuum dryers. By design, vacuum dryers do not discharge any uranium when operating. Effluent controls for yellowcake drying at the Moore Ranch Central Plant are discussed in this section and in detail in the process description in Section 3.1 of this Technical Report.

4.1 GASEOUS AND AIRBORNE PARTICULATES

The primary radioactive airborne effluent at the Moore Ranch Facility will be radon-222 gas. Radon-222 is found in the pregnant lixiviant that comes from the wellfield into the facility for separation of uranium. The uranium will be separated from the groundwater by passing the solution through fixed bed ion exchange (IX) units operated in a pressurized downflow mode. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted to atmosphere outside the building via an induced draft fan. Venting any released radon-222 gas to atmosphere outside the plant minimizes employee exposure. 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 are minimal radon gas releases on an infrequent basis. The exhaust system in the plant will further reduce employee exposure. The air in the plant is sampled for radon daughters (see Section 5.0) to assure that concentration levels of radon and radon daughters are maintained as low as reasonably achievable (ALARA).

This section describes the gaseous effluent control systems that will be installed in the Moore Ranch Facility.

4.1.1 Gaseous Effluents-Tank and Process Vessel, and Work Area Ventilation Systems

A separate ventilation system will be installed for all indoor non-sealed process tanks and vessels where radon-222 or process fumes would be expected. The system will consist of an air duct or piping system connected to the top of each of the process tanks. Redundant exhaust fans will direct collected gases to discharge piping that will exhaust fumes to the outside atmosphere. The design of the fans will be such that the system will be capable of limiting employee exposures with the failure of any single fan. Discharge stacks will be located on the leeward side of the building and ventilation intakes will be on the upwind side of the building to ensure exausted radon is not taken back into the facility from prevailing winds. as recommended in Regulatory Guide 8.31[1]. Airflow through any openings in the vessels will be from the process area into the vessel and into the ventilation system, controlling any releases that occur inside the vessel. Separate ventilation systems may be used as needed for the functional areas within the plant. Tank ventilation systems of this type have been successfully utilized at other ISR facilities and have proven to be an effective method for minimizing employee exposure.

The work area ventilation system will be designed to force air to circulate within the plant process areas. The ventilation system will exhaust outside the building, drawing fresh air in. The work area ventilation system will consist of 4 fans with a capacity 10,000 gpm. 2 fans will be located in the ion exchange area, one fan will be located in the resin transfer area, and one fan will be located in the precipitation area. The air exchange rate of the four fans is approximately 1.25 air exchanges per hour. During favorable weather conditions, open doorways and convection vents in the roof will provide satisfactory work area ventilation. During extreme cold outdoor temperatures, the ventilation system will provide adequate work area ventilation if doorways need to be shut. Buildings will be heated during winter months to maintain temperatures in the plant area. The design of the ventilation system will be adequate to ensure that radon daughter concentrations in the facility are maintained below 25 percent of the derived air concentration (DAC) from 10 CFR Part 20.

Other emissions to the air are limited to exhaust and dust from limited vehicular traffic. Impacts from potential emissions from process chemicals that will be used at the plant is described in Section 7. There are no significant combustion related emissions from the process facility as commercial electrical power is available at the site.

4.1.2 Air Particulate Effluents

Potential radiological air particulate effluents consist primarily of dried yellowcake in the drying and processing areas of the central plant. The yellowcake drying facilities at the Moore Ranch Central Plant will be comprised of vacuum dryers. By design, vacuum dryers do not discharge any uranium when operating. The vacuum drying system is proven technology, which is being used successfully in several ISR sites where uranium oxide is being produced. Air particulate controls of the vacuum drying system include a bag house, condenser, vacuum pump, and packaging hood.

The bag house is an air and vapor filtration unit mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house is heated to prevent condensation

The bag house is an air and vapor filtration unit mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house is heated to prevent condensation of water vapor during the drying cycle. It is kept under negative pressure by the vacuum system.

The condenser unit is located downstream of the bag house and is water cooled. It is used to remove the water vapor from the non-condensable gases coming from the drying chamber. The gases are moved through the condenser by the vacuum system. Any particulates that pass through the bag filters are wetted and entrained in the condensing moisture within this unit.

The vacuum pump is a rotary water sealed unit that provides a negative pressure on the entire system during the drying cycle. It is also used to provide ventilation during transfer of the dry powder from the drying chamber to fifty-five (55) gallon drums. The water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams.

The packaging system is operated on a batch basis. When the yellowcake is dried sufficiently, it is discharged from the drying chamber through a bottom port into drums. A level gauge, a weigh scale, or other suitable device will be used to determine when a drum is full. Particulate capture is provided by a sealed hood that fits on the top of the drum, which is vented through a sock filter to the condenser and the vacuum pump system when the powder is being transferred.

The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures. The system will alarm if there is an indication that the emission control system is not performing within operational specifications. If the system is alarmed due to the emission control system, the operator will follow standard operating procedures to recover from the alarm condition, and the dryer will not be unloaded as part of routine operations, if currently loaded, or reloaded, if currently empty, until the emission control system is returned to service within specified operational conditions.

To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signal an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is checked and documented during dryer operations. In the event this system fails, the operator will perform and document checks of the differential pressure or vacuum every four (4) hours. Additionally, during routine operations, the air pressure differential gauges for other emission control equipment is observed and documented at least once per shift during dryer operations.

4.2 LIQUID WASTE

4.2.1 Sources of Liquid Waste

As a result of in-situ recovery mining, there are several sources of liquid waste that are collected. The potential water sources that exist at the Moore Ranch Facility include the following.

4.2.1.1 Liquid Process Waste

The operation of the ion exchange process generates production bleed, the primary source of liquid waste as previously discussed in Section 3.0. This bleed will be routed to the deep disposal well(s) for disposal. Other liquid waste streams from the central plant include plant wash down water and bleed stream from the elution and precipitation circuits. However, these other liquid waste streams make up a very small portion of the total liquid waste stream. The anticipated liquid waste stream is non-hazardous under the Resource Conservation and Recovery Act. The anticipated water chemistry of the injected waste stream is presented in Table 4-1. Minor concentrations of corrosion inhibitors, scale inhibitors, and/or biocides may be used as needed to maintain the well in optimum condition. These waste streams are benefication wastes, exempt from RCRA regulation under the Bevill Amendment found in 40 CFR 261.4(b)(7).

Table 4-1 Summary of Anticipated Waste Stream Water Quality

	Estimated Range of URANIUM ONE	
	Waste Stream Water Quality	
Chemical	Minimum Maximum	
Species	(mg/l) (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

4.2.1.2 Aquifer Restoration

Following mining operations, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan consists of three activities:

1. Groundwater Transfer,
2. Groundwater Sweep, and
3. Groundwater Treatment.

Only the groundwater sweep and groundwater treatment activities will generate wastewater.

During groundwater sweep, water is extracted from the mining zone without injection, causing an influx of baseline quality water to sweep the affected mining area. The extracted water must be sent to the wastewater disposal system during this activity.

Groundwater treatment activities involve the use of process equipment to lower the ion concentration of the groundwater in the affected mining area. A reverse osmosis (RO) unit will be used to reduce the total dissolved solids of the groundwater. The RO unit produces clean water (permeate) and brine. The permeate is injected back into the formation and the brine is sent to the wastewater disposal system. Chemical reducing agents such as sodium sulfide, hydrogen sulfide or biological reducing agents may also be employed during the groundwater treatment phase.

4.2.1.3 Water Collected from Wellfield Releases

This water is injection lixiviant or recovery fluids recovered from areas where a liquid release has occurred from a well or pipeline. The water will be placed into the wastewater disposal system for deep well injection.

4.2.1.4 Stormwater Runoff

A final source of water is storm runoff. Stormwater management is controlled under NPDES permits issued by the WDEQ-WQD. Facility drainage will be designed to route storm runoff water away or around the plant, ancillary building and parking areas, and chemical storage. The design of the Moore Ranch facilities and procedural and engineering controls contained in a Best Management Practices (BMP) Plan will be implemented such that runoff is not considered to be a potential source of pollution.

4.2.2 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,Three disposal wells are planned for the Moore Ranch Project. The location of these wells is shown on Figure 3.1-5A. These proposed wells will be permitted for a capacity of 125 gpm per well, giving a total of 375 gpm of disposal capacity. The estimated depth of the disposal wells and target zone is approximately 6,400 feet. As shown in Figure 3.1-5, anticipated disposal during operations is approximately 40gpm and during restoration could be as high as 140 gpm. A minimum of Two disposal wells will be constructed for the first several years of operation (40 gpm) which will provide capacity of 125 gpm each. One well will handle all disposal flow from operations during this period. If a well becomes inoperable for a short time during maintenance or integrity testing, then the additional well will provide adequate disposal capacity. A third disposal well may be constructed to provide a backup well once restoration disposal flows commence.

EMC believes that permanent deep disposal is preferable to evaporation in evaporation ponds or land application methods for the following reasons: (1) Liquid waste disposed of through deep wells is secluded from human contact eliminating risk to human health; (2) large evaporation ponds have the potential for leaks and impacts to the environment and much larger volume of 11(e)(2) byproduct is created through use of evaporation ponds; (3) land application methods have the potential to impact surface media from prolonged discharge and would require extensive treatment to meet land application standards. All compatible liquid wastes at the Moore Ranch Facility will be disposed in the planned deep wells. The application for the proposed deep disposal wells at Moore Ranch was submitted to the WDEQ-WQD on May 12, 2008 and is currently under review..

4.2.2.1 Liquid Waste Monitoring and Reporting

A composite sample of the waste stream will be collected quarterly, or when process change occurs that could significantly alter the chemical composition of the waste stream. Samples will be collected upstream of the high-pressure injection pump. Analyses will be performed using approved methods and in accordance with WDEQ Rules and Regulations, Chapter VIII, Section 7. The proposed parameter list follows:

Ra-226 (pCi/l)
Uranium (mg/l)
TDS (mg/l)
PH (units)
Total Alkalinity (mg/l)

It is understood that WDEQ recently has been requesting an EPA 624 Analysis for the waste stream. If this standard should be required by the WDEQ, Uranium One will comply.

Monitoring records will be submitted to WDEQ quarterly (within 30 days after the end of the quarter) and will include:

1) Date, location and time of sampling
2) Name(s) of sampling personnel
3) Date(s) of analysis
4) Analytical laboratory and name(s) of analytical technician(s)
5) Analytical procedures or methods used

It is understood that WDEQ recently has been requesting an EPA 624 Analysis for the waste stream. If this standard should be required by the WDEQ, Uranium One will comply.

Monitoring records will be submitted to WDEQ quarterly (within 30 days after the end of the quarter) and will include:

1) Date, location and time of sampling
2) Name(s) of sampling personnel
3) Date(s) of analysis
4) Analytical laboratory and name(s) of analytical technician(s)
5) Analytical procedures or methods used
6). Analytical results

Reporting will include injection and annulus pressures. Further, the average reservoir pressure will be determined once per year by conducting a pressure falloff test on one of the Uranium One wells.

4.2.2.2 Disposal Well Mechanical Integrity

After completion of deep disposal well construction, Part I mechanical integrity will be demonstrated for each well before injection commences, in accordance with the procedures specified by WDEQ.

Part II integrity will be demonstrated prior to injection by either (1) a Radioactive Tracer Log and Temperature Survey coupled with a casing pressure check, or (2) an oxygen activation log. Part II MIT will also be demonstrated (1) if any abnormal annulus pressures are observed, (2) every five years at a minimum, and (3) any time the tubing and packer are removed from the well.

4.2.3 Potential Pollution Events Involving Liquid Waste

Although there are a number of potential sources of pollution present at the Moore Ranch facility, existing regulatory requirements from the NRC and WDEQ, and provisions of EMC's Environmental Management Programs have established a framework that significantly reduces the possibility of an occurrence. Extensive training of all personnel is standard policy for EMC operations and will be implemented at the Moore Ranch Facility. Frequent inspections of waste management facilities and systems will be conducted. Detailed procedures will be included in EMC's Environmental Management Programs., which will be adapted for use at the Moore Ranch Facility.

Potential sources of pollution include the following:

4.2.3.1 Spills from Wellfield Buildings, Pipelines, and Well Heads

Wellfield buildings or pipelines are not considered to be a potential source of pollutants during normal operations, as there will be no process chemicals or effluents stored within them. The only instance in which these wellfield features could contribute to pollution would be in the event of a release of injection or recovery solutions due to pipe or well failure. The possibility of such an occurrence is considered to be minimal as the piping will be leak checked first. In addition, the flows through the pipe will be at a relatively low pressure and can quickly be stopped, thus any release would not migrate far. Wellfield headerhouses will also be equipped with wet alarms for early detection of leaks. Piping from the wellfields will generally be buried, minimizing the possibility of an accident. Large leaks in the pipe would quickly become apparent to the plant operators due to a decrease in flow and pressure, thus any release could be mitigated rapidly. All piping will be leak checked prior to operation.

In general, piping from the plant, to and within the wellfield will be constructed of PVC or high density polyethylene pipe (HDPE) with butt welded joints or the equivalent. All pipelines will be pressure tested before final operation. It is unlikely that a break would occur in a buried section of line because no additional stress is placed on the pipes. In addition, underground pipelines will be protected from a major cause of potential failure which is vehicles driving over the lines causing breaks. Typically, the only exposed pipes will be at the central plant, at the wellheads, and in the headerhouses in the wellfield. Trunkline flows and manifold pressures will be monitored for process control.

Engineering and administrative controls will be in place at the Central Plant to prevent both surface and subsurface releases to the environment, and to mitigate the effects should an accident occur.

Should a leak in the wellfield buildings, pipelines, or at wellheads occur, the primary health and safety hazards presented by the spilled mining solutions would be ingestion or inhalation of the spilled liquid or dried residue, direct gamma exposure, and release of radon gas. These hazards would primarily apply to EMC personnel responding to the spill. Section 5 discusses in detail the administrative controls that will be implemented by EMC to maintain radiological exposures as low as reasonably achievable, including employee training and the use of standard operating procedures (SOPs) or radiation work permits (RWPs). All employees will receive training in the proper response to solution spills during radiation worker training. SOPs and/or RWPs will specify worker monitoring and protective equipment requirements for spill response.

Spilled mining solutions will contain elevated concentrations of uranium, radium-226, and trace metals. Although these concentrations are not high enough to present a significant health and safety risk when absorbed in soil, they could present an increased hazard in areas where spilled solutions may pond or build up over time. All cleanup of spilled material will be performed with proper protective equipment. If soil cleanup of a spill area is necessary due to the exceedance of the soil concentration limits in 10 CFR Part 40, Appendix A, engineering controls will be used to minimize the generation of dust. Direct gamma radiation exposure is not expected to be a significant hazard from solution spills due to the low concentrations of gamma-emitting radionuclides in the mining solution. Radon may be a hazard in enclosed spaces (e.g., within a headerhouse) but this hazard can be controlled through the use of ventilation.

4.2.3.2 Central Plant

The central plant will serve as a central hub for the mining operations in the Moore Ranch Project. Therefore, the central plant area will have the greatest potential for spills or accidents resulting in the release of potential pollutants. Spills could result from a release of process chemicals from bulk storage tanks, piping failure, or a process storage tank failure.

The design of the central plant building will be such that any release of liquid waste would be contained within the structure. A concrete curb will be built around the entire process building. This pad will be designed to contain the contents of the largest tank within the building in the event of a rupture. In the event of a piping failure, the pump system will immediately shut down, limiting any release. Liquid inside the building, both from a spill or from washdown water, will be drained through a sump and pumped to the liquid waste system.

The potential health and safety hazards from spills within the Central Plant are similar to those discussed in section 4.1.1.1 above. However, the Central Plant will be equipped to handle liquid spills. The building will include sumps that will recover spilled solutions and direct them to the wastewater system. Building ventilation will control the radon released by spilled solutions.

4.2.3.3 Spills from Deep Well Pumphouses, Lines, and Wellheads

The design of the deep well pumphouses and wellheads will be such that any release of liquids will be contained within the building or in a bermed containment area surrounding the facilities. Liquid inside the building will be contained and managed as appropriate.

The wells will be equipped with a high-level shutoff switch on the injection tubing to prevent operation of the pumps at pressures greater than the Limiting Surface Injection Pressure. In addition, the wells will be equipped with a low-pressure shut-down switch on the surface injection line that will deactivate the injection pump in the event of a surface leak. Finally, the wells will include a high/low pressure shutdown switch with a pressure sensor on the tubing/casing annulus. This switch will stop the injection pump in the event of either (1) a tubing leak or (2) a casing, packer, or wellhead leak.

The potential health and safety hazards from spills within the deep well pumphouses and at the wellheads are similar to those discussed in section 4.1.1.2 above.

4.2.3.4 Domestic Liquid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the State of Wyoming. These systems are in common use throughout the United States and the effect of the system on the environment is known to be minimal.

4.3 TRANSPORTATION VEHICLES

The release of pollutants to the environment could occur due to accidents involving transportation vehicles. This could involve either vehicles delivering bulk chemical products, transport of resin to the Moore Ranch facility from satellite plants, transport of radioactive contaminated waste from Moore Ranch to an approved disposal site, or from vehicles carrying yellowcake slurry or dried yellowcake product from Moore Ranch Central Plant.

All chemicals and products delivered to or transported from the site will be transported in accordance with DOT regulations. Emergency response procedures will be developed and implemented as part of EMC's Environmental Management Programs to insure a rapid response to the situation. All appropriate personnel will be trained to the level required in the emergency response procedures to facilitate proper response from EMC employees.

4.4 SOLID WASTE AND CONTAMINATED EQUIPMENT

Solid waste generated at the site is expected to include spent resin, resin fines, empty reagent containers, miscellaneous pipe, pumps and fittings, and domestic trash, construction debris, and is separated into the following two categories.

4.4.1 Uncontaminated Solid Waste

Waste which is not contaminated with radioactive material or which can be decontaminated and re-classified as uncontaminated waste includes solid waste, piping, valves, instrumentation, equipment and any other items that are not contaminated or which may be successfully decontaminated. If decontamination of waste material is possible, surveys for residual surface contamination will be made before releasing the material. Decontaminated materials must have activity levels lower than those specified in NRC guidance[2]. Methods for decontamination and release of contaminated equipment are discussed in further detail in Section 5.

EMC estimates that the proposed Moore Ranch Project will produce approximately 2,000 cubic yards (yd^3) of uncontaminated solid waste per year. Uncontaminated solid waste will be collected on the site on a regular basis and disposed of in the nearest sanitary landfill.

4.4.2 Byproduct Material

All contaminated items that cannot be decontaminated to meet release criteria will be properly packaged, transported, and disposed at a disposal site licensed to accept 11e.(2) byproduct material. Solid wastes generated by this project that may become contaminated with radioactive materials consist of items such as rags, trash, packing material, worn or replaced parts from equipment, piping, filters, protective clothing, and solids removed from process pumps and vessels. Radioactive solid waste that has a contamination level requiring controlled disposal will be isolated in drums or other suitable containers. EMC estimates that the proposed Moore Ranch Project will produce approximately 100 yd^3 of 11e.(2) byproduct material per year. These materials will be stored on site inside the restricted area until such time that a full shipment can be shipped to a licensed waste disposal site or mill tailings facility.

4.4.3 Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the WDEQ for Class V UIC wells. Disposal of solid materials collected in septic systems must be performed in accordance with WDEQ Solid Waste Management rules and regulations.

4.4.4 Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). In the State of Wyoming, hazardous waste is governed by WDEQ Hazardous Waste Rules and Regulations. Based on preliminary waste determinations conducted by EMC in consideration of the processes and materials that will be used on the project, EMC will likely be classified as a Conditionally Exempt Small Quantity Generator (CESQG), defined as a generator that generates less than 100 kg of hazardous waste in a calendar month and that complies with all applicable hazardous waste program requirements. EMC expects that only used waste oil and universal hazardous wastes such as spent batteries will be generated at Moore Ranch.

4.4.5 Soil Contaminated as a Result of Wellfield Releases

All piping from the Moore Ranch Central 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 header houses where injection and production wells will be continuously monitored for pressure and flow. Individual wells, along with main trunk lines, may have high and low flow alarm limits set in the header house. 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).

Occasionally, leaks (typically small) at pipe joints and fittings in the wellhouses or at the wellheads may occur. Reporting of site releases is discussed in Section 4.4.6.. Until remedied, these leaks may drip process solutions onto the underlying soil. Surface and subsurface soil at a solution mine may become contaminated by leaks and spills of process solutions. Although the specific concentration of radionuclides in these process solutions is relatively low, the concentration of contamination in the soil may exceed regulatory limits if the solution is confined to a small area or if there are multiple spills in the same location. Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic (at a minimum of daily) inspections of each wellfield that is in service or in restoration. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination above cleanup standards. Following repair of a leak, Uranium One will require that the affected soil be surveyed for contamination and the area of the spill documented as required by the NRC. The soils potentially impacted by a spill of injection or production fluid are typically sampled and scanned for gamma radiation. The surface extent of any spill will be delineated horizontally by use of a field GPS system. If contamination is detected by gamma surveys, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed immediately if concentrations exceed regulatory requirements or left in place and documented for future clean up (if necessary) during the decommissioning phase of site closure.

In the event of a minor spill where the amount of fluid is limited with minimal chance of significant infiltration of the fluid, samples may be obtained at only the 0-6 inch depth. In the case of significant pooling of fluid, soil samples may be necessary at the 0-6 inch and 6-12 inch intervals. The first steps after a release is discovered will be to immediately stop the source of the leak and limit the horizontal migration of released fluid then initiate the process of recovering any free standing fluids.

The cleanup of surface and subsurface soils is governed by the limits in 10 CFR Part 40, Appendix A. Those limits for the concentration of Ra-226 in soil are 5 pCi/gm above background for the first 15 cm surface layer, averaged over not more than 100 m^2 and 15 pCi/gm above background for each successive 15 cm subsurface layer, averaged over not more than 100 m^2. Soil clean up and survey methods will be designed to meet current requirements of the USNRC and will be described in the Decommissioning Plan required by NRC License Condition.

All site release information and survey results will be maintained as a component of the decommissioning records as required by 10 CFR §20.2103. Documentation of annual releases from the site will be provided with a Map to the WDEQ-LQD in the annual Mine Permit report.

4.4.6 Reporting Procedures

Reporting of excursions and corrective actions will be conducted as described in Section 5.7.8.

The WDEQ-LQD will be verbally notified (per telephone or email) within 24 hours of discovery of a spill of ISR process fluids exceeding 420 gallons. A written report will be provided to the WDEQ-LQD within 5 days of discovery containing the information described in WDEQ-LQD Rules and Regulations, Chapter 11, Section 12(a)(B)(ii).

The NRC will be verbally notified (per telephone or email) within 48 hours of discovery of a spill of ISR process fluids fluids reportable to the WDEQ-LQD. . A written report will be provided to the NRC within 30 days of discovery containing the information required per NRC License Conditions.

Other unanticipated spills of reportable quantities from chemicals bulk storage areas will be reported to the WDEQ in accordance WDEQ-WQD, Rules and Regulations, Chapter 17, Part E and 40 CFR 302 (CERCLA).

Other operational reporting and applicable requirements include the following:

- Corrective Actions and Compliance Schedules- WDEQ-LQD Rules and Regulations, Section 13 and NRC License Conditions.
- Quarterly Monitoring Reports- WDEQ-LQD Rules and Regulations, Section 15.
- Annual Operations Reports- WDEQ-LQD Rules and Regulations, Section 15.
- Well Abandonment Reports- WDEQ-LQD Rules and Regulations, Section 15
- Deep Disposal Well Monitoring Reports- Done in accordance with UIC injection well permit issued by the WDEQ-LQD.
- NRC Semi-Annual Report- Done in accordance with NRC License Conditions.

4.5 REFERENCES

[1] U. S. Nuclear Regulatory Commission, Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002).

[2] U. S. Nuclear Regulatory Commission, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source or Special Nuclear Material* (May 1987).

5 OPERATIONS

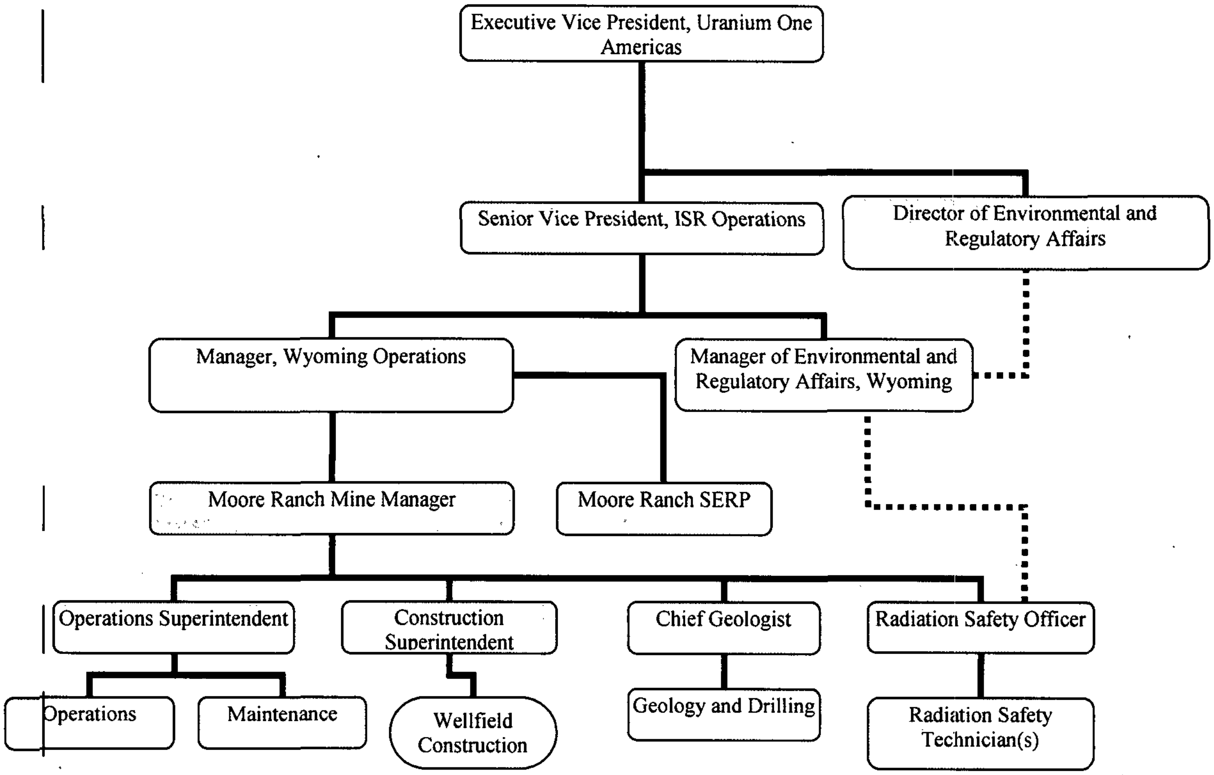
Energy Metals Corporation, US (EMC) is committed to conducting all operations in conformance with applicable laws, regulations and requirements of the various regulatory agencies. The responsibilities described below have been designed to ensure compliance and further implement EMC's policy for providing a safe working environment with cost effective incorporation of the philosophy of maintaining radiation exposures as low as is reasonably achievable (ALARA).

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

EMC will maintain a performance-based approach to the management of the environment and employee health and safety, including radiation safety. Figure 5.1-1 is a partial organization chart for EMC with respect to the operation of the Moore Ranch Uranium Project and associated operations and represents the management levels that play a key part in the Radiation Protection Program (RPP). The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, programs, environmental and groundwater monitoring programs as well as routine and non-routine maintenance activities. These individuals may also serve a functional part of the Safety and Environmental Review Panel (SERP) described under Section 5.2.5.

Specific responsibilities in the organization are provided below.

Figure 5.1-1: EMC Moore Ranch Organizational Chart



5.1.1 Board of Directors

The Board of Directors has the ultimate responsibility and authority for radiation safety and environmental compliance for EMC. The Board of Directors sets corporate policy and provides procedural guidance in these areas. The Board of Directors provides operational direction to the Chief Operating Officer of EMCExecutive Vice President through the Chief Operating Officer.

5.1.2 Chief Operating OfficerExecutive Vice President

The Chief Operating Officer (COO)Executive Vice President (EVP) is responsible for interpreting and acting upon the Board of Director's policy and procedural decisions. The COO EVP is empowered by the Board of Directors to havehas the responsibility and authority for the radiation safety and environmental compliance programs at all EMC Uranium One Americas facilities. The COO EVP is directly responsible for ensuring that EMC personnel comply with industrial safety, radiation safety, and environmental protection programs as established in the EMC Program. The COO EVP is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The COOEVP has the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees or public health, the environment, or potentially a violation of state or federal regulations.

5.1.3 Senior Vice President, ISR Operations

The Senior Vice President (Sr. VP) is responsible for management of all company in situ recovery (ISR) operations including those in Wyoming. In this role, the Sr. VP has the responsibility and authority for the radiation safety and environmental compliance programs at ISR operations. The Sr. VP is responsible for ensuring that EMC personnel comply with industrial safety, radiation safety, and environmental protection programs as established in the EMC Program. The Sr. VP is also responsible for compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The Sr. VP has the responsibility and authority to terminate immediately any activity that is determined to be a threat to employees or public health, the environment, or potentially a violation of state or federal regulations.

5.1.4 Director of Environmental and Regulatory Affairs

The Director of Environmental and Regulatory Affairs is responsible for all radiation protection, health and safety, and environmental programs for EMC. The Director is responsible for ensuring that all company operations comply with all applicable regulatory requirements. The Director of Environmental and Regulatory Affairs reports directly to the Executive Vice President. This position is responsible for the development and review of radiological, health and safety, and environmental protection programs.

5.1.45.1.5 Manager of Wyoming Operations

The Manager of Wyoming Operations is responsible for all ISR uranium production activity at the Wyoming project sites. All site operations, maintenance, construction, environmental, health and safety, and support groups report directly to the Manager of Wyoming Operations. In addition to production activities, the Manager of Wyoming Operations is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with Wyoming operations. The Manager of Wyoming Operations is authorized to immediately implement any action to correct or prevent hazards. The Manager of Wyoming Operations has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Manager of Wyoming Operations reports directly to the Senior Vice President.

5.1.5Director of Environmental and Regulatory Affairs

The Director of Environmental and Regulatory Affairs is responsible for all radiation protection, health and safety, and environmental programs for EMC. The Director is responsible for ensuring that all company operations comply with all applicable regulatory requirements. The Director of Environmental and Regulatory Affairs reports directly to the Senior Vice President. This position is responsible for the development and review of radiological, health and safety, and environmental protection programs.

5.1.6 Manager of Environmental and Regulatory Affairs, Wyoming

The Manager of Environmental and Regulatory Affairs, Wyoming is responsible for all radiation protection, health and safety, and environmental programs at ISR operations in the State of Wyoming as stated in the EMC Program and for ensuring that EMC complies with all applicable regulatory requirements. The Manager of Environmental and Regulatory Affairs, Wyoming reports directly to the Manager of Wyoming OperationsSenior Vice President and supervises advises the Radiation Safety Officer (RSO) to ensure that the radiation safety and environmental monitoring and protection programs are conducted in a manner consistent with regulatory requirements. This position assists in the development and review of radiological and environmental sampling and analysis procedures and is responsible for routine auditing of the programs.

5.1.7 Moore Ranch Mine Manager

The Moore Ranch Mine Manager (Mine Manager) is responsible for all uranium production activity at the Moore Ranch project site. All site operations, maintenance, construction, environmental health and safety, and support groups report directly to the Mine Manager as shown in Figure 5.1-1. In addition to production activities, the Mine Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with Moore Ranch operations. The Mine Manager is authorized to immediately implement any action to correct or prevent hazards. The Mine Manager has the responsibility and the authority to suspend, postpone or modify, immediately if necessary, any activity that is determined to be a threat to employees, public health, the environment, or potentially a violation of state or federal regulations. The Mine Manager cannot unilaterally override a decision for suspension, postponement or modification if that decision is made by the RSO. The Mine Manager reports directly to the Manager of Wyoming Operations.

5.1.75.1.8 Radiation Safety Officer

The RSO is responsible for the development, administration, and enforcement of all radiation safety programs. The RSO is authorized to conduct inspections and to immediately order any change necessary to preclude or eliminate radiation safety hazards and/or maintain regulatory compliance. The RSO is responsible for the implementation of all on-site environmental programs, including emergency procedures. The RSO inspects facilities to verify compliance with all applicable requirements in the areas of radiological health and safety. The RSO works closely with all supervisory personnel to review and approve new equipment and changes in processes and procedures that may affect radiological safety and to ensure that established programs are maintained. The RSO is also responsible for the collection and interpretation of employee exposure related monitoring, including data from radiological safety. The RSO makes recommendations to improve any and all radiological safety related controls. The RSO has no production-related responsibilities. The RSO reports directly to the Mine Manager of Environmental and Regulatory Affairs, Wyoming.

5.1.85.1.9 Radiation Safety Technician

The Radiation Safety Technician (RST) assists the RSO with the implementation of the radiological and industrial safety programs. The RST is responsible for the orderly collection and interpretation of all monitoring data, to include data from radiological safety and environmental programs. The RST reports directly to the RSO.

5.1.10 Site Department Supervisors

The Moore Ranch department supervisors will include the Operations Superintendent, Construction Superintendent, and Chief Geologist. These positions are responsible for the direct supervision of site activities including construction, operation and maintenance of the central processing plant and wellfields. The department supervisors will be responsible for enforcing compliance with all aspects of the RPP and SOPs to control exposure to ionizing radiation and radioactive materials in accordance with the EMC ALARA Program. Department supervisors will perform and document an annual review of each SOP within their area of responsibility to ensure continued accuracy and relevance. These individuals report directly to the Mine Manager.

5.1.95.1.11 ALARA Program Responsibilities

The purpose of the ALARA (As Low As Reasonably Achievable) Program is to keep exposures to all radioactive materials and other hazardous material as low as possible and to as few personnel as possible, taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.

In order for an ALARA Program to correctly function, all individuals including management, supervisors, health physics staff, and workers, must take part in and share responsibility for keeping all exposures as low as reasonably achievable. This policy addresses this need and describes the responsibilities of each level in the organization.

5.1.105.1.12 Management Responsibilities

Consistent with Regulatory Guide 8.31[1], EMC senior management is responsible for the development, implementation, and enforcement of applicable rules, policies, and procedures as directed by regulatory agencies and company policies. These responsibilities include the following:

1. The development of a strong commitment to and continuing support of the implementation and operations of the ALARA program;
2. An Annual Audit Program which reviews radiation monitoring results, procedural, and operational methods;
3. A continuing evaluation of the Radiological Protection Program including adequate staffing and support; and
4. Proper training and discussions that address the ALARA program and its function to all facility employees and, when appropriate, to contractors and visitors.

5.1.10.15.1.12.1 Radiation Safety Officer ALARA Responsibility

The RSO is responsible for ensuring the technical adequacy of the radiation protection program, implementation of proper radiation protection measures, and the overall surveillance and maintenance of the ALARA program. The RSO is assigned the following:

1. The responsibility for the development and administration of the ALARA program;
2. Enforcement of regulations and administrative policies that affect the Radiological Protection Program;
3. Assist with the review and approval of new equipment, process changes or operating procedures to ensure that the plans do not adversely affect the Radiological Protection Program;
4. Maintain equipment and surveillance programs to assure continued implementation of the ALARA program;
5. Assist with conducting an Annual ALARA Audit as discussed in Section 5.3.2 to determine the effectiveness of the program and make any appropriate recommendations or changes as may be dictated by the ALARA philosophy;
6. Review annually all existing operating procedures involving or potentially involving any handling, processing, or storing of radioactive materials to ensure the procedures are ALARA and do not violate any newly established or instituted radiation protection practices; and

7. Conduct daily inspections of pertinent facility areas to observe that general radiation control practices, hygiene, and housekeeping practices are in line with the ALARA principle.

5.1.10.25.1.12.2 Supervisor Responsibility

Supervisors have front line responsibility for implementing all safety programs including the ALARA program. Each supervisor will be trained and instructed in the general radiation safety practices and procedures. Their responsibilities include:

1. Adequate training to implement the general philosophy behind the ALARA program;
2. Provide direction and guidance to subordinates in ways to adhere to the ALARA program;
3. Enforcement of rules and policies as directed by the Radiological Protection Program, which implement the requirements of regulatory agencies and company management; and
4. Seek additional help from management and the RSO should radiological problems be deemed by the supervisor to be outside their sphere of training.

5.1.10.35.1.12.3 Worker Responsibility

Because success of both the radiation protection and ALARA programs are contingent upon the cooperation and adherence to those policies by the workers themselves, the facility employees must be responsible for certain aspects of the program in order for the program to accomplish its goal of keeping exposures as low as possible. Worker responsibilities include:

1. Adherence to all rules, notices, and operating procedures as established by management and the RSO through the Radiological Protection Program;
2. Making valid suggestions which might improve the radiation protection and ALARA programs;
3. Reporting promptly, to immediate supervisor, any malfunction of equipment or violation of procedures which could result in an unacceptable increased radiological hazard;
4. Proper use of protective equipment;
5. Proper performance of required contamination surveys.

5.2 MANAGEMENT CONTROL PROGRAM

5.2.1 Operating Procedures

EMC will develop procedures consistent with the corporate policies and standards and regulatory requirements to implement these management controls. The Radiological Protection Program will consist of written operating procedures for all process activities including those activities involving radioactive materials for the Moore Ranch Uranium Project. Where radioactive material handling is involved, pertinent radiation safety practices will be incorporated into the operating procedure. Additionally, written operating procedures will be developed for non-process activities including environmental monitoring, radiological protection procedures, emergency procedures, and industrial safety.

The procedures will provide pertinent radiation safety procedures to be followed. A copy of the written procedure will be kept in the area where it is used. All procedures involving radiation safety will be reviewed and approved in writing by the RSO or another individual with similar qualifications prior to being implemented. The RSO will also perform a documented review of the operating procedures annually.

5.2.2 Radiation Work Permits

In the case that employees are required to conduct activities of a nonroutine nature where there is the potential for significant exposure to radioactive materials and for which no operating procedure exists, a Radiation Work Permit (RWP) will be required. The RWP will describe the scope of the work, precautions necessary to maintain radiation exposures to ALARA, and any supplemental radiological monitoring and sampling to be conducted during the work. The RWP shall be reviewed and approved in writing by the RSO (or qualified designee in the absence of the RSO) prior to initiation of the work.

The RSO may also issue Standing Radiation Work Permits (SRWPs) for periodic tasks that require similar radiological protection measures (e.g., maintenance work on a specified plant system). The SRWP will describe the scope of the work, precautions necessary to maintain radiation exposures to ALARA, and any supplemental radiological monitoring and sampling to be conducted during the work. The SRWP shall be reviewed and approved in writing by the RSO (or qualified designee in the absence of the RSO) prior to initiation of the work.

5.2.3 Record Keeping and Retention

Specific iInstructions for the proper maintenance, control, and retention of records will be developed and will be consistent with the requirements of 10 CFR 20 Subpart L and 10 CFR §40.61 (d) and (e). The following specific records will be permanently maintained and retained until license termination:

- Records of disposal of byproduct material on site through the deep disposal wells as required in 10 CFR §20.2002 and transfers or disposal off site of source or byproduct material;
- Records of surveys, calibrations, personnel monitoring, and bioassays as required in 10 CFR §20.2103;
- , transfers or disposal of source or byproduct material, and transportation accidents will be maintained on site until license termination. Records containing information pertinent to decommissioning and reclamation such as descriptions of spills, excursions, contamination events, etc. including the dates, locations, areas, or facilities affected, assessments of hazards, corrective and cleanup actions taken, and potential locations of inaccessible contamination;
- Records of as well as information related to site and aquifer characterization and background radiation levels will be maintained on site until license termination.;
- As-built drawings and photographs of structures, equipment, restricted areas, well fields, areas where radioactive materials are stored, and any modifications showing the locations of these structures and systems; and
- Records of the radiation protection program including program revisions, standard operating procedures, radiation work permits, training and qualification records, SERP proceedings, and audits.

The RSO will be responsible for ensuring that the required records are maintained and controlled. Hard copies of all records will be maintained on site All records will be maintained onsite in a controlled areaenvironment to protect them from damage or deterioration and will be available for NRC inspection. Electronic copies may be maintained in addition to hard copies with backup protection. Duplicates of all significant records will be maintained in the corporate office or other offsite location(s).

5.2.4 Performance Based License Condition

With this license application EMC is requesting a Performance Based License (PBL). Under a license containing a PBL Condition, EMC will be allowed, without prior NRC approval or the need to obtain a License Amendment, to:

1. Make changes to the facility or process, as presented in the license application (as updated).
2. Make changes in the procedures presented in the license application (as updated).
3. Conduct tests or experiments not presented in the license application (as updated).

A License Amendment and/or NRC approval will be necessary prior to implementing a proposed change, test or experiment if the change, test or experiment would:

1. Result in any appreciable increase in the frequency of occurrence of an accident previously evaluated in the license application (as updated);
2. Result in any appreciable increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the license application (as updated);
3. Result in any appreciable increase in the consequences of an accident previously evaluated in the license application (as updated);
4. Result in any appreciable increase in the consequences of a malfunction of an SSC previously evaluated in the license application (as updated);
5. Create a possibility for an accident of a different type than any previously evaluated in the license application (as updated);
6. Create a possibility for a malfunction of an SSC with a different result than previously evaluated in the license application (as updated);
7. Result in a departure from the method of evaluation described in the license application (as updated) used in establishing the final safety evaluation report (FSER) or the environmental assessment (EA) or technical evaluation reports (TERs) or other analysis and evaluations for license amendments.
8. For purposes of this paragraph as applied to this license, SSC means any SSC that has been referenced in a staff SER, TER, EA, or environmental impact statement (EIS) and supplements and amendments thereof.

Additionally, EMC will be required to obtain a license amendment unless the change, test, or experiment is consistent with the NRC conclusions, or the basis of, or analysis leading to, the conclusions of actions, designs, or design configurations analyzed and selected in the site or facility SER, TERs, and EIS or EA. This would include all supplements and amendments, and TERs, EAs, and EISs issued with amendments to the license.

5.2.5 Safety and Environmental Review Panel (SERP)

A Safety and Environmental Review Panel (SERP) will make the determination of compliance concerning the conditions discussed in Section 5.2.4. The SERP will consist of a minimum of three individuals. One member of the SERP will have expertise in management and will be responsible for managerial and financial approval for changes; one member will have expertise in operations and/or construction and will have expertise in implementation of any changes; and one member will be the Radiation Safety Officer (RSO), or equivalent. Other members of the SERP may be utilized as appropriate, to address technical aspects of the change, experiment or test, in several areas, such as health physics, groundwater hydrology, surface water hydrology, specific earth sciences, and others. Temporary members, or permanent members other than the three identified above, may be consultants.

The SERP will be responsible for monitoring any proposed change in the facility or process, making changes in procedures, and conducting tests or experiments not contained in the current NRC license. As such, the SERP will be responsible for insuring that any such changes result in no degradation in the essential safety or environmental commitments of EMC.

5.2.5.1 Safety and Environmental Review Panel Review Procedures

The EMC SERP will implement the following review procedures for the evaluation of all appropriate changes to the facility operations. The SERP may delegate any portion of these responsibilities to a committee of two or more members of the SERP. Any committees so constituted will report their findings to the full SERP for a determination of compliance with Section 5.2.4 of this chapter. In their documented review of whether a potential change, test, or experiment (hereinafter called the change) is allowed under the PBL (or Performance Based License Condition (PBLC)) without a license amendment, the SERP will consider the following:

- Current NRC License Requirements

The SERP will conduct a review of the most current NRC license conditions to assess which, if any, conditions will have an impact on or be impacted by the potential SERP action. If the SERP action will conflict with a specific license requirement, then a license amendment will be necessary before initiating the change. This review will include information included in the approved license application.

- Ability to Meet NRC Regulations

The SERP will determine if the change, test, or experiment conflicts with applicable NRC regulations (example: 10 CFR Parts 20 and 40 requirements). If the SERP action conflicts with NRC regulations, a license amendment will be necessary.

- Licensing Basis

The SERP will review whether the change, test, or experiment is consistent with NRC's conclusions regarding actions analyzed and selected in the licensing basis. Documents that the SERP must review in conducting this evaluation include any SERs, TERs, EAs, or EISs prepared to support issuance of or amendments to the license. The RSO will maintain a current copy of all pertinent documents for review by the SERP during these evaluations.

- Financial Surety

The SERP will review the proposed action to determine if any adjustment to the financial surety arrangement or approved amount is required. If the proposed action will require an increase to the existing surety amount, the financial surety instrument must be increased accordingly. The surety estimate must be approved through a license amendment by the NRC.

- Essential Safety and Environmental Commitments

The SERP will assure that there is no degradation in the essential safety or environmental commitment in the license application.

5.2.5.2 Documentation of SERP Review Process

After the SERP conducts the review process for a proposed action, it will document its findings, recommendations, and conclusions in a written report format. All members of the SERP shall sign concurrence on the final report. If the report concludes that the action meets the appropriate PBL or PBLC requirements and does not require a license amendment, the proposed action may then be implemented. If the report concludes that a license amendment is necessary before implementing the action, the report will document the reasons why, and what course EMC plans to pursue. The SERP report shall include the following:

- A description of the proposed change, test, or experiment (proposed action);
- A listing of all SERP members conducting the review and their qualifications (if a consultant or other member not previously qualified);
- The technical evaluation of the proposed action including all aspects of the SERP review procedures listed above;

- Conclusions and recommendations;
- Signatory approvals of the SERP members; and
- Any attachments such as all applicable technical, environmental, or safety evaluations, reports, or other relevant information including consultant reports.

All SERP reports and associated records of any changes made pursuant to the PBL or PBLC shall be maintained through termination of the NRC license.

On an annual basis, EMC will submit a report to the NRC that describes all changes, tests, or experiments made pursuant to the PBL or PBLC. The report will include a summary of the SERP evaluation of each change. In addition, EMC will annually submit replacement pages of the License Application or supplementary information. Each replacement page will include both a change indicator for the area of change, (e.g., bold marking vertically in the margin adjacent to the portion actually change), and a page change identification, (date of change or change number, or both).

5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAM

The following internal inspections, audits and reports will be performed for the Moore Ranch Uranium Project operations.

5.3.1 Radiation Safety Inspections

5.3.1.1 Daily Inspections

The RSO, RST or a qualified designee will conduct a daily walkthrough inspection of the plant. The inspection will entail a visual examination of compliance or other problems, which will reviewed with the Manager, Wyoming Operations.

5.3.1.2 Weekly RSO Inspections

On a weekly basis, the RSO and Manager, Wyoming Operations (or designees in their absence) will conduct an inspection of all facility areas to observe general radiation control practices and review required changes in procedures and equipment.

5.3.1.3 Monthly RSO Reports

The RSO will provide a written summary of the month's radiological activities at the Moore Ranch Uranium Project facilities. The report will include a review of all monitoring and exposure data for the month, a summary of worker protection activities, a summary of all pertinent radiation survey records, a discussion of any trends in the ALARA program, and a review of adequacy of the implementation of the NRC license conditions. Recommendations will be made for any corrective actions or improvements in the process or safety programs.

5.3.2 Annual ALARA Audits

EMC will conduct annual audits of the radiation safety and ALARA programs. The Director of Environmental and Regulatory Affairs may conduct these audits. Alternatively, EMC may use qualified personnel from other uranium recovery facilities or an outside radiation protection auditing service to conduct these audits. The purpose of the audits will be to provide assurance that all radiation health protection procedures and license condition requirements are being conducted properly at the Moore Ranch Uranium Project. Any outside personnel used for this purpose will be qualified in radiation safety procedures as well as environmental aspects of solution mining operations. Whether conducted internally or through the use of an independent audit service, the auditor will meet the minimum qualifications for education and experience for the RSO as described in Section 5.4.

The audit of the radiation protection and ALARA program will be conducted in accordance with the recommendations contained in Regulatory Guide 8.31. A written report of the results will be submitted to corporate management. The RSO may accompany the auditor but may not participate in the conclusions.

The annual ALARA audit report will summarize the following data:

1. Employee exposure records
2. Bioassay results
3. Inspection log entries and summary reports of mine and process inspections
4. Documented training program activities
5. Applicable safety meeting reports
6. Radiological survey and sampling data
7. Reports on any overexposure of workers
8. Operating procedures that were reviewed during this time period

The ALARA audit report will specifically discuss the following:

1. Trends in personnel exposures
2. Proper use, maintenance and inspection of equipment used for exposure control
3. Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

The ALARA audit report will be submitted to and reviewed by the Senior Vice President and the Manager, Wyoming Operations. Implementations of the recommendations to further reduce employee exposures, or improvements to the ALARA program, will be reviewed with the ALARA auditor.

An audit of the Quality Assurance/Quality Control (QA/QC) program will also be conducted on an annual basis. An individual qualified in analytical and monitoring techniques who does not have direct responsibilities in the areas being audited will perform the audit. The results of the QA/QC audit will be documented with the ALARA Audit.

5.4 RADIATION SAFETY STAFF QUALIFICATIONS

The EMC project staff is highly experienced in the management of uranium project development, mining and operations. The following minimum personnel specifications and qualifications for the radiation safety staff will be strictly adhered to.

5.4.1 Radiation Safety Officer Qualifications

The minimum qualifications for the Radiation Safety Officer (RSO) are as follows:

- Education - A Bachelor's Degree or an Associate Degree in the physical sciences, industrial hygiene, environmental technology or engineering from an accredited college or university or an equivalent combination of training and relevant experience in uranium mill/solution mining radiation protection. Two years of relevant experience are generally considered equivalent to 1 year of academic study. For example, an RSO candidate with an Associates Degree would also require an additional 4 years of relevant experience to meet this education requirement.

- Health Physics Experience - A minimum of 1 year of work experience relevant to uranium mill/solution mining operations in applied health physics, radiation protection, industrial hygiene or similar work.

- Specialized Training - A formalized, specialized course(s) in health physics specifically applicable to uranium milling/solution mining operations, of at least 4 weeks duration. The RSO attends refresher training on uranium mill health physics every two years.

- Specialized Knowledge - The RSO, through classroom training and on-the-job experience, possesses a thorough knowledge of the proper application and use of all health physics equipment used in the operation, the procedures used for radiological sampling and monitoring, methods used to calculate personnel exposures to uranium and its daughters, and a thorough understanding of the solution mining process and equipment used and how hazards are generated and controlled during the process.

5.4.2 Radiation Safety Technician Qualifications

The RST will have one of the following combinations of education, training and experience:

1. Education - An associate degree or 2 years or more of study in the physical sciences, engineering or a health-related field, or high school diploma and a combination of experience and training.

   Training - At least a total of 4 weeks of generalized training in radiation health protection applicable to uranium mills/solution mining operations.

   Experience - One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium mill/solution mining operation.

□2. Education - A high school diploma.

   Training - A total of at least 3 months of specialized training in radiation protection relevant to uranium mills of which up to 1 month may be on-the-job training.

   Experience - Two years of relevant work experience in applied radiation protection.

5.5 RADIATION SAFETY TRAINING

All site employees and contractor personnel at the Moore Ranch Uranium Project will participate in a training program covering radiation safety, radioactive material handling, and radiological emergency procedures. The training program will be administered in keeping with standard radiological protection guidelines and the guidance provided in USNRC Regulatory Guide 8.29[2], USNRC Regulatory Guide 8.31, and USNRC Regulatory Guide 8.13[3]. The technical content of the training program will be under the direction of the RSO. The RSO or a qualified designee will conduct all radiation safety training.

5.5.1 Radiation Safety Training Program Content

5.5.1.1 Visitors

Visitors to the Moore Ranch Uranium Project facilities who have not received training will be escorted by on site personnel properly trained and knowledgeable about the hazards of the facility. At a minimum, visitors will be instructed specifically on what they should do to avoid possible hazards in the area of the facilities that they are visiting.

5.5.1.2 Contractors

Any contractors having work assignments at the Moore Ranch Uranium Project will be given appropriate radiation safety training. Contract workers who will be performing work on heavily contaminated equipment will receive the same training normally required of Moore Ranch workers as discussed in Section 5.5.1.3.

5.5.1.3 Radiation Worker Training

All EMC employees (and some contractors as noted in Section 5.5.1.2) will receive training as radiation workers. The program will incorporate the following topics recommended in USNRC Regulatory Guide 8.31:

<u>Fundamentals of health protection</u>

- Using respirators when appropriate.
- Eating, drinking and smoking only in designated areas.
- Using proper methods for decontamination.

<u>Facility-provided protection</u>

- Cleanliness of working space.
- Safety designed features for process equipment.
- Ventilation systems and effluent controls.

- Standard operating procedures.
- Security and access control to designated areas.

Health protection measurements

- Measurements of airborne radioactive material.
- Bioassay to detect uranium (urinalysis and in vivo counting).
- Surveys to detect contamination of personnel and equipment.
- Personnel dosimetry.

Radiation protection regulations

- Regulatory authority of NRC, OSHA and state.
- Employee rights in 10 CFR Part 19.
- Radiation protection requirements in 10 CFR Part 20.

Emergency procedures

All new workers, including supervisors, will be given instruction on the health and safety aspects of the specific jobs they will perform. This instruction is done in the form of individualized on-the-job training. Retraining is performed annually and documented.

5.5.2 Testing Requirements

A written test with questions directly relevant to the principals of radiation safety and health protection in the facility covered in the training course is given to each worker. The instructor reviews the test results with each worker and discusses incorrect answers to the questions with the worker until worker understanding is achieved. Workers who fail the exam are retested and test results remain on file.

5.5.3 On-The-Job Training

5.5.3.1 Health Physics Technician

On-the-job training will be provided to RSTs in radiation exposure monitoring and exposure determination programs, instrument calibration, plant inspections, posting requirements, respirator programs and radiation safety procedures.

5.5.4 Refresher Training

Following initial radiation safety training, all permanent employees and long-term contractors will receive on-going radiation safety training as part of the annual refresher training program and, if determined necessary by the RSO, during monthly safety meetings. This on-going training will be used to discuss problems and questions that have arisen, any relevant information or regulations that have changed, exposure trends and other pertinent topics.

5.5.5 Training Records

Records of training will be kept until license termination for all employees trained as radiation workers (i.e., occupationally exposed employees).

5.6 SECURITY

EMC is committed to:

- Providing employees with a safe, healthful, and secure working environment;
- Maintaining control and security of NRC licensed material;
- Ensuring the safe and secure handling and transporting of hazardous materials; and
- Managing records and documents that may contain sensitive and confidential information.

The NRC requires licensees to maintain control over licensed material (i.e., natural uranium ("source material") and byproduct material defined in 10 CFR §40.4). 10 CFR 20, Subpart I, *Storage and Control of Licensed Material*, requires the following:

§20.1801 Security of Stored Material

The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

§20.1802 Control of Material not in Storage

The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Stored material at the Moore Ranch Uranium Project would include uranium packaged for shipment from the facility or byproduct materials awaiting disposal. Examples of material not in storage would include yellowcake slurry or loaded ion exchange resin removed from the restricted area for transfer to other areas.

5.6.1 License Area and Plant Security

The active mining areas will be controlled with fences and appropriate signs. All areas where source or byproduct materials are handled will be fenced. The main access road will be equipped with a locking gate. A 24-hour per day 7-day per week staff will be on duty at the Moore Ranch facility.

Plant operators will perform an inspection to ensure the proper storage and security of licensed material at the beginning of each shift. The inspection will determine whether all licensed material is properly stored in a restricted area or, if in controlled or unrestricted areas, is properly secured. In particular, operators will ensure that loaded ion exchange resin, slurry, drummed yellowcake, and byproduct material is properly secured. If licensed material is found outside a restricted area, the operator will ensure that it is secured, locked, moved to a restricted area, or kept under constant surveillance by direct observation by site personnel. The results of this inspection will be properly documented.

There will be a reception area located at the main entrance into the office building. All other entrances will be locked during off-shift hours. Visitors entering the office will be greeted by a receptionist. All visitors will be required to sign the access log and indicate the purpose of their visit and the employee to be visited. The person being visited will be responsible to supervise the visitor(s) at all times when they are on site. Visitors will only be allowed at the facility during regular working hours unless prior approval is obtained from the Manager, Wyoming Operations or the Manager of Environmental and Regulatory Affairs, Wyoming.

5.6.2 Transportation Security

EMC will routinely receive, store, use, and ship hazardous materials as defined by the U.S. Department of Transportation (DOT). In addition to the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations (HMR), 49 CFR 172, Subpart I, *Security Plans*, requires that persons that offer for transportation or transport certain hazardous materials develop a Security Plan. Shipments may qualify for this DOT requirement under the following categories:

> §172.800(b)(4) A shipment of a quantity of hazardous materials in a bulk package having a capacity equal to or greater than 13,248 L (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids;
>
> §172.800(b)(5) A shipment in other than a bulk packaging of 2,268 kg (5,000 pounds) gross weight or more of one class of hazardous material for which placarding of a vehicle, rail car, or freight container is required;
>
> §172.800(b)(7) A quantity of hazardous material that requires placarding under the provisions of subpart F.

DOT requires that Security Plans assess the possible transportation security risks and evaluate appropriate measures to address those risks. All hazardous materials shippers and transporters subject to these standards must take measures to provide personnel security by screening applicable job applicants, prevent unauthorized access to the hazardous materials or vehicles being prepared for shipment, and provide for en route security. Companies must also train appropriate personnel in the elements of the Security Plan.

Transport of licensed/hazardous material by EMC employees will generally be restricted to moving ion exchange resin from a Satellite facility to the Moore Ranch Central Plant or transferring contaminated equipment between company facilities. This transport will generally occur over short distances through remote areas. Therefore, the potential for a security threat during transport by EMC vehicle is minimal. The goal of the driver, cargo, and equipment security measures is to ensure the safety of the driver and the security and integrity of the cargo from the point of origin to the final destination by:

- Clearly communicating general point-to-point security procedures and guidelines to all drivers and non-driving personnel;
- Providing the means and methods of protecting the drivers, vehicles, and customer's cargo while on the road; and

- Establishing consistent security guidelines and procedures that shall be observed by all personnel.

For the security of all tractors and trailers, the following will be adhered to:

- If material is stored in the vehicle, access must be secured at all openings with locks and/or tamper indicators;
- Off site tractors will always be secured when left unattended with windows closed, doors locked, the engine shut off, and no keys or spare keys in or on the vehicle;
- The unit is to be kept visible by an employee at all times when left unattended outside a restricted area.

The security guidelines and procedures apply to all transport assignments. All drivers and non-driving personnel will be expected to be knowledgeable of, and adhere to, these guidelines and procedures when performing any load-related activity.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

EMC has a strong corporate commitment to and support for the implementation of the radiological control program at the Moore Ranch Uranium Project facilities. This corporate commitment to maintaining personnel exposures as low as reasonably achievable (ALARA) will be incorporated into the radiation safety controls and monitoring programs described in the following sections.

5.7.1 Effluent Control Techniques

5.7.1.1 Gaseous and Airborne Particulate Effluents

5.7.1.1.1 Radon Gas

Under routine operations, the only radioactive effluent at the Moore Ranch facility will be radon-222 gas from the production solutions. Final processing of uranium to produce yellowcake will be performed in a vacuum dryer. As described in Section 4, there are no emissions from these systems.

The radon-222 is found in the pregnant lixiviant that will come from the wellfield into the Moore Ranch facility. The production flow will be directed to the process plant for separation of the uranium. The uranium will be separated by passing the recovery solution through pressurized downflow ion exchange units. The vents from the individual vessels will be connected to a manifold that will be exhausted outside the plant building through the plant stack.

Venting radon gas to the atmosphere outside of the plant building minimizes personnel exposure. Small amounts of radon-222 may be released in the plant building during solution spills, filter changes, ion exchange resin transfer operations and maintenance activities. The plant building will be equipped with exhaust fans to remove any radon that may be released in the building. No significant personnel exposure to radon gas is expected based on operating experience from similar facilities. Ventilation and effluent control equipment will be inspected for proper operation as recommended in USNRC Regulatory Guide 3.56[4]. Ventilation and effluent control equipment inspections will be conducted during radiation safety inspections as discussed in Section 5.3.1.

Monitoring for combined plant and wellfield releases at the site airborne monitoring stations will be accomplished through the use of Track-Etch radon cups as discussed in Section 5.7.7. Monitoring for radon gas releases from the plant building and ventilation discharge points is not practicable. 10 CFR §20.1302 allows demonstration by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from licensed operations does not exceed the annual dose limit of 100 mrem. Regulatory Guide 8.37, section 3.3 notes that where monitoring effluents points is not practicable, a licensee should estimate the magnitude of these releases and include these estimated releases in demonstrating compliance with the annual dose limit.

As discussed in Section 7.3, EMC has used MILDOS-Area to model the dose from facility operations resulting from releases of radon gas. The central plant will include pressurized downflow ion exchange columns, which do not routinely release radon gas except during resin transfer and column backwashing. In these systems, the majority of radon released to the production fluid stays in solution and is not released. The radon which is released is generated by occasional venting of process vessels and tanks, small unavoidable leaks in ion exchange equipment, and maintenance of equipment. For the purposes of determining the source term for MILDOS-Area, radon gas release was estimated as 10% of the radon-222 in the production fluid from the wellfields and an additional 10% in the ion exchange circuit in the central plant. Release of radon-222 at this concentration did not result in significant public dose. The maximum TEDE of 0.8 mrem/yr. was located at the northwest property boundary and is 0.8 percent of the public dose limit of 100 mrem. The closest resident to the Moore Ranch facility received an estimated TEDE of 0.7 mrem/yr, which is 0.7 percent of the regulatory limit.

5.7.1.1.2 Airborne Particulates

Final processing of uranium to produce yellowcake will be performed in a vacuum dryer. As described in Section 4, there are no emissions from these systems.
By design, vacuum dryers do not discharge any uranium when operating. The vacuum drying system is proven technology, which is being used successfully in several ISR sites where uranium oxide is being produced. Air particulate controls of the vacuum drying system include a bag house, condenser, vacuum pump, and packaging hood.

The bag house is an air and vapor filtration unit mounted directly above the drying chamber so that any dry solids collected on the bag filter surfaces can be batch discharged back to the drying chamber. The bag house is heated to prevent condensation of water vapor during the drying cycle. It is kept under negative pressure by the vacuum system.

The condenser unit is located downstream of the bag house and is water cooled. It is used to remove the water vapor from the non-condensable gases coming from the drying chamber. The gases are moved through the condenser by the vacuum system. Any particulates that pass through the bag filters are wetted and entrained in the condensing moisture within this unit.

The vacuum pump is a rotary water sealed unit that provides a negative pressure on the entire system during the drying cycle. It is also used to provide ventilation during transfer of the dry powder from the drying chamber to fifty-five (55) gallon drums. The water seal of the rotary vacuum pump captures entrained particulate matter remaining in the gas streams.

The packaging system is operated on a batch basis. When the yellowcake is dried sufficiently, it is discharged from the drying chamber through a bottom port into drums. A level gauge, a weigh scale, or other suitable device will be used to determine when a drum is full. Particulate capture is provided by a sealed hood that fits on the top of the drum, which is vented through a sock filter to the condenser and the vacuum pump system when the dried yellowcake is being transferred.

The system will be instrumented sufficiently to operate automatically and to shut itself down for malfunctions such as heating or vacuum system failures. The system will alarm if there is an indication that the emission control system is not performing within operational specifications. If the system is alarmed due to the emission control system, the operator will follow standard operating procedures to recover from the alarm condition. If the dryer is loaded, yellowcake will not be packaged until the emission control system is returned to service within specified operational conditions. Similarly, if the dryer is empty, it will not be reloaded until the emission control system is returned to service.

To ensure that the emission control system is performing within specified operating conditions, instrumentation will be installed that signal an audible alarm if the air pressure (i.e. vacuum level) falls below specified levels, and the operation of this system is checked and documented during dryer operations. In the event this system fails, the operator will perform and document checks of the differential pressure or vacuum every four (4) hours. Additionally, during routine operations, the air pressure differential gauges for other emission control equipment will be observed and documented at least once per shift during dryer operations.

During dryer maintenance, all work will normally be performed under an RWP unless a standard operating procedure has been prepared and approved. The RWP will specify control measures to minimize the release of airborne particulates, including but not limited to removal of yellowcake from system components and establishing airborne radioactivity areas before maintenance is begun.

During emergency situations such as fire or severe weather, the yellowcake dryers will be shut down in a safe configuration until the emergency has passed. Vacuum systems will be left in operation and the dryer room(s) will be closed as potential airborne radioactivity areas.

5.7.1.1.3 Laboratory Emissions

Laboratory areas will be used for the analysis of groundwater and process samples. Most of the analytical load for the laboratory will consist of routine semimonthly analysis of monitor well samples for chloride, conductivity, and total alkalinity. In laboratory areas where reagents are in use or fumes could be generated by the analytical method in use, laboratory fume hoods will be used to control emissions. Process samples will be analyzed within the restricted area and fumes hoods will be used as necessary to control emissions.

5.7.1.2 Liquid Effluents

The liquid effluents from the Moore Ranch Uranium Project facilities can be classified as follows:

- Liquid Process Waste

The operation of the ion exchange process generates production bleed, the primary source of liquid waste as previously discussed in Section 3.0. This bleed is routed to the deep disposal well for disposal. Other liquid waste streams from the central plant include plant wash down water and bleed stream from the elution and precipitation circuits. However, these other liquid waste streams make up a very small portion of the total liquid waste stream.

- Aquifer Restoration

Following mining operations, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan consists of four activities:

1. Groundwater Transfer,
2. Groundwater Sweep,
3. Groundwater Treatment, and
4. Wellfield Circulation.

Only the groundwater sweep and groundwater treatment activities will generate wastewater.

During groundwater sweep, water is extracted from the mining zone without injection, causing an influx of baseline quality water to sweep the affected mining area. The extracted water must be sent to the wastewater disposal system during this activity.

Groundwater treatment activities involve the use of process equipment to lower the ion concentration of the groundwater in the affected mining area. A reverse osmosis (RO) unit will be used to reduce the total dissolved solids of the groundwater. The RO unit produces clean water (permeate) and brine. The permeate is either injected into the formation or disposed of in the waste disposal system. The brine is sent to the wastewater disposal system. Chemical reducing agents such as sodium sulfide or biological reducing agents may also be employed during the groundwater treatment phase.

EMC proposes to handle liquid effluents from the Moore Ranch Uranium Project using deep well injection.

5.7.1.3 Spill Contingency Plans

The RSO will be charged with the responsibility to develop and implement appropriate procedures to handle potential spills of radioactive materials. Personnel representing the engineering and operations functions of the Moore Ranch Uranium Project facility will assist the RSO in this effort. Basic responsibilities will include:

- Assignment of resources and manpower.
- Responsibility for materials inventory.
- Responsibility for identifying potential spill sources.
- Establishment of spill reporting procedures and visual inspection programs.
- Review of past incidents of spills.
- Coordination of all departments in carrying out goals of containing potential spills.
- Establishment of employee emergency response training programs.
- Responsibility for program implementation and subsequent review and updating.
- Review of new construction and process changes relative to spill prevention and control.

Spills can take two forms within an in-situ uranium mining facility: 1) surface spills such as tank failures, piping ruptures, transportation accidents, etc., and 2) subsurface releases such as a well excursion, in which process chemicals migrate beyond the wellfield resulting in a subsurface release.

Engineering and administrative controls will be in place to prevent both surface and subsurface releases to the environment and to mitigate the effects should a release occur.

- <u>Surface Releases</u>

  Failure of process tanks - Potential failures of process tanks will be contained within the central plant building. The entire plant building will drain to a sump that will allow transfer of the spilled solutions to appropriate tankage or the waste disposal system.

Surface Releases - The most common form of surface releases from in-situ mining operations occurs from breaks, leaks, or separations within the piping system that transfers mining fluids between the central plant and the wellfield. These are generally small releases due to engineering controls that detect pressure changes in the piping systems and alert the Plant Operators through system alarms.

In general, piping within the wellfield will be constructed of PVC or high-density polyethylene (HDPE) pipe with butt welded joints or an equivalent. All pipelines will be pressure tested at operating pressures prior to operation. It is unlikely that a break would occur in a buried section of line because no additional stress is placed on the pipes. In addition, underground pipelines will be protected from vehicles driving over the lines, which could cause breaks. The only exposed pipes will be at the wellheads and in the headerhouses. Trunkline flows and wellhead pressures will be monitored for process control. Spill response will be specifically addressed in Emergency Procedures.

- Releases Associated With Transportation

EMC will prepare an emergency action plan for responding to a transportation accident involving a radioactive materials shipment. The plan will provide instructions for proper packaging, documentation, driver emergency and accident response procedures and cleanup and recovery actions.

- Sub-surface releases

Well Excursions - Mining fluids are normally maintained in the production aquifer within the immediate vicinity of the wellfield. The function of the monitor well ring will be to detect any mining solutions that may migrate away from the production area due to fluid pressure imbalance. This system has been proven to function satisfactorily over many years of operating experience with ISR mining. At Moore Ranch, an undetected excursion will be highly unlikely. A ring of perimeter monitor wells located no further than 500 feet from the wellfield and screened in the ore-bearing aquifer will surround all wellfields. Additionally, shallow monitor wells will be placed in the first overlying and underlying aquifers for each wellfield segment. Sampling of these wells will be done on a biweekly basis. Past experience at other ISR mining facilities has shown that this monitoring system is effective in detecting lixiviant migration. The total effect of the close proximity of the monitor wells, the low flow rate from the well patterns, and over-production of leach fluids (production bleed) makes the likelihood of an undetected excursion extremely remote.

Migration of fluids to overlying and underlying aquifers has also been considered. Several controls will be in place to prevent this. EMC will plug all exploration holes to prevent commingling of the ore zone, overlying, and underlying aquifers and to isolate the mineralized zone. In addition, prior to placing a well in service, a well mechanical integrity test (MIT) will be performed. This requirement of the WDEQ UIC Program ensures that all wells be constructed properly and capable of maintaining pressure without leakage. Finally, monitor wells completed in the overlying and underlying aquifer will be sampled on a regular basis for the presence of recovery solution.

In addition to the spills described above, the accumulation of sediment or erosion of existing soils can lead to potential releases of pollutants. The likelihood of significant sediment or erosion problems is greatest during construction activities. If rain, producing runoff, occurs during construction a small amount of the fill may be carried away from the construction area. Significant precipitation during plant facility construction may also produce the same effect. Plant cover for erosion control will be established as soon as possible on exposed areas. Little additional suspendable material should be produced during mining operations and restoration activities. Site reclamation in the future with grading the plant site and replacing the topsoil will also expose unsecured soil for suspension in runoff waters. The sediment load as a result of precipitation during future construction or reclamation activities should not significantly affect the quality of any watercourses since the projected plant location is not crossed by any streams.

Runoff from precipitation events should be controlled to minimize any exposure to pollutants on the site. Runoff should not be a major issue given the engineering design of the facilities as well as engineering and administrative controls. Should there be high runoff concurrent with a pipeline failure, some contamination could be spread depending upon the relative saturation of the soils beneath the leaking area. In any event, only minimal releases of solutions would occur in the event of a pipeline failure and migration of pollutants due to runoff would be minimal.

5.7.2 EXTERNAL RADIATION EXPOSURE MONITORING PROGRAM

5.7.2.1 Gamma Surveys

External gamma radiation surveys will be performed routinely at the Moore Ranch Uranium Project. The required frequency will be quarterly in designated Radiation Areas and semiannually in all other areas of the plant. Surveys will be performed at worker occupied stations and areas of potential gamma sources such as tanks and filters. EMC will establish a Radiation Area if the survey indicates that gamma radiation levels exceed the action level of 5.0 mRem per hour for worker occupied stations. An investigation will be performed to determine the probable source and survey frequency for areas exceeding 5.0 mRem per hour is increased to quarterly. Records will be maintained of each investigation and the corrective action taken. If the results of a gamma survey identified areas where gamma radiation is in excess of levels that delineate a "radiation area", access to the area will be restricted and the area will be posted as required in 10 CFR §20.1902 (a).

External gamma surveys will be performed with survey equipment that meets the following minimum specifications:

1. Range - Lowest range not to exceed 100 microRoentgens per hour (μR/hr) full-scale with the highest range to read at least 5 milliRoentgens per hour (mR per hour) full scale;

2. Battery operated and portable;

Examples of satisfactory instrumentation that meets these requirements are the Ludlum Model 3 survey meter with a Ludlum 44-38 probe or equivalent. Gamma survey instruments will be calibrated at the manufacturer's suggested interval or at least annually and will be operated in accordance with the manufacturer's recommendations. Instrument checks will be performed each day that an instrument is used.

Gamma exposure rate surveys will be performed in accordance with standard operating procedures. Proposed survey locations for the Moore Ranch Central Plant are shown on Figure 5.7-1. The proposed survey locations were selected based on experience with external exposure rates at operating ISR facilities. Areas where elevated gamma exposure rates are typically found include the ion exchange columns, filter housings that remove solid materials from the production and injection streams, and tank bottoms where solid material may collect. These solids historically contain elevated concentrations of radium-

226, which results in elevated gamma exposure rates. In some cases, the gamma dose rates from these components may exceed 5 mrem per hour and may require posting as Radiation Areas. Radiation Areas are not usually encountered in wellfield areas of ISR facilities unless filtration equipment is installed in headerhouses, which is not proposed for Moore Ranch.

Gamma survey instruments will be checked each day of use in accordance with the manufacturer's instructions. Surveys will be performed in accordance with the guidance contained in USNRC Regulatory Guide 8.30[5].

Beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake are recommended in USNRC Regulatory Guide 8.30, Section 1.4. The beta dose rate on the surface of yellowcake just after separation from ore is negligible. Over a period of several months, the beta dose from aged yellowcake increases due to the ingrowth of protactinium-234 and thorium-234. EMC plans to ship yellowcake on a schedule that minimizes the dose from aged yellowcake.

EMC will perform beta surveys at least once for each operation and whenever there is a change in procedures or equipment that may affect the beta dose. Beta surveys will be performed using a Ludlum Model 2224 portable scaler/ratemeter with a Ludlum 43-1-1 alpha/beta scintillator probe or equivalent.

As discussed in Regulatory Guide 8.30, bBeta evaluations may be substituted for surveys using radiation survey instruments based on two figures provided in the Regulatory Guide. These beta evaluations are based on curves that represent the increase of the beta dose rate over time due to the ingrowth of protactinium-234 and thorium-234 (Regulatory Guide 8.30, Figure 1) and the decrease of beta dose as the distance from the source increases (Regulatory Guide 8.30, Figure 2).

5.7.2.2 Personnel Dosimetry

10 CFR §20.1502 (a)(1) requires exposure monitoring for "Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in §20.1201 (a)". Ten percent of the dose limit would correspond to a Deep Dose Equivalent (DDE) of 0.500 Rem.

EMC will determine monitoring requirements in accordance with the guidance contained in USNRC Regulatory Guide 8.34[6]. Based on the experience of other ISR operations, EMC believes that it is not likely that any employee working at the Moore Ranch Plant will exceed 10 percent of the regulatory limit (i.e., 500 mrem/yr).

- The typical wellfield dose rate will not exceed background gamma exposure rates except immediately adjacent to wellheads and headerhouses, where scale formed on the inside surfaces of piping may contain radium-226, resulting in increased gamma exposure rates. Experience at operating ISR facilities indicates that annual doses for wellfield workers generally do not exceed 1 percent of the regulatory limit (i.e., 50 mrem/yr.).
- Process plant workers will be exposed to elevated gamma exposure rates during operations and maintenance activities in the central plant including work in Radiation Areas. Experience at operation ISR facilities indicates that annual doses to process plant workers are generally less than 10 percent of the regulatory limit.

□Although monitoring of external exposure may not be required in accordance with §20.1201(a) due to the low exposure rates typically encountered at ISR facilities, EMC will issue dosimetry to all process plant employees and will exchange them on a quarterly basis.

Dosimeters will be provided by a vendor that is accredited by National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology as required in 10 CFR § 20.1501. The dosimeters will have a range of 1 mR to 1000 R. Dosimeters will be exchanged and read on a quarterly basis.

Results from personnel dosimetry will be used to determineprovide the individual Deep Dose Equivalent (DDE) for use in determining Total Effective Dose Equivalent (TEDE). The TEDE is defined in Regulatory Guide 8.30 as the sum of the DDE and the committed effective dose equivalent (CEDE) for internal exposures. Determination of the CEDE is discussed in further detail in Section 5.7.4.

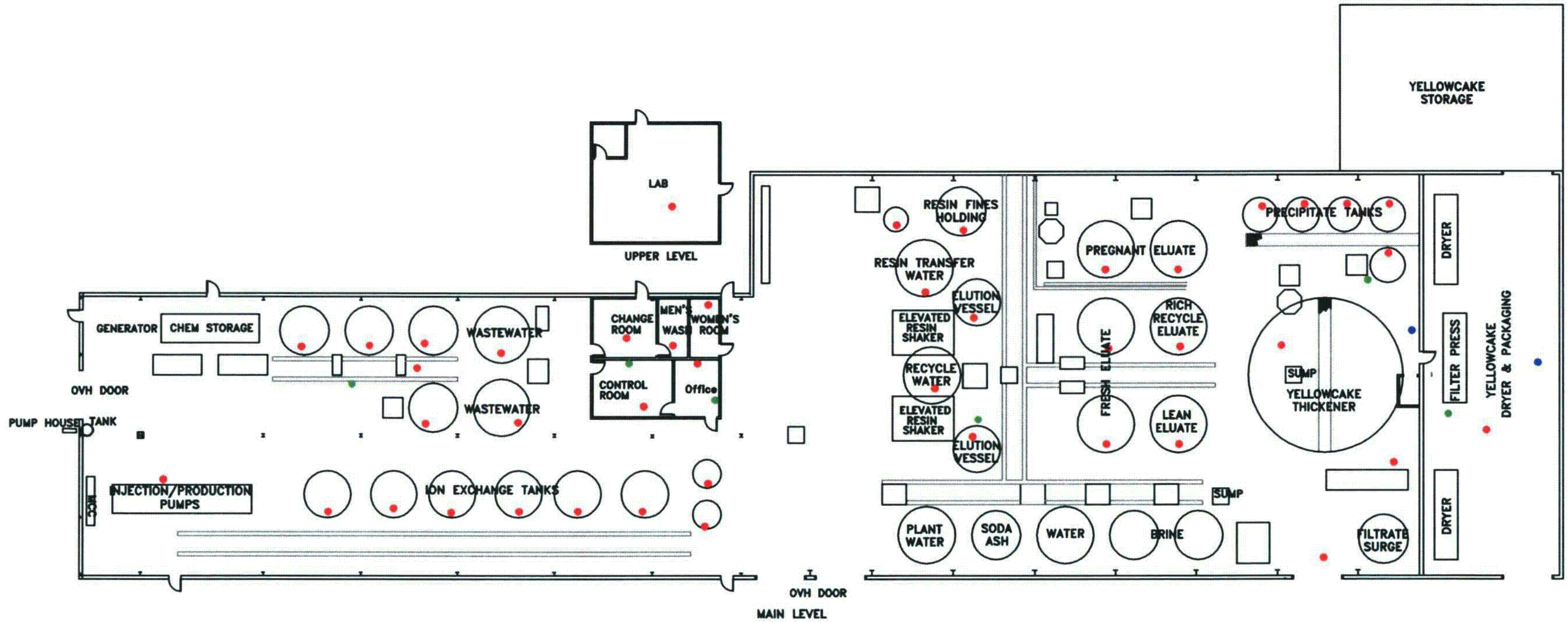


FIGURE 5.7-1

LEGEND

- RADON TESTING LOCATIONS
- GAMMA SURVEY LOCATIONS
- AIR PARTICULATE MONITORING LOCATIONS

ENERGY METALS CORPORATION, US
139 West 2nd St. Casper, WY 82601 307-234-8235

MOORE RANCH
URANIUM PROJECT
CENTRAL PLANT
RADIOLOGICAL SURVEY
LOCATIONS
SECT. 34-35, T. 42 N., R. 75 W.

REVISIONS		
NO.	DATE	BY

5.7.3 IN-PLANT AIRBORNE RADIATION MONITORING PROGRAM

5.7.3.1 Airborne Uranium Particulate Monitoring

Airborne particulate levels at solution mines that employ vacuum dryers are very low since there are no emissions. The primary potential source of airborne uranium is during yellowcake packaging. This operation will be confined to the dryer room. The room will be closed and posted as an airborne radioactivity area during packaging. The proposed airborne uranium sampling locations for the Moore Ranch Central Plant are shown on Figure 5.7-1. Samples will be obtained using area samplers on a monthly frequency.

Area samples will be taken in accordance with standard operating procedures. These procedures will implement the guidance contained in USNRC Regulatory Guide 8.25[7]. Samples will be taken with a glass fiber filter and a regulated air sampler such as an Eberline RAS-1 or equivalent. Sample volume will be adequate to achieve the lower limits of detection (LLD) for uranium in air. Samplers will be calibrated at the manufacturer's suggested interval or semiannually with a digital mass flowmeter or other primary calibration standard.

Breathing zone sampling will be performed to determine individual exposure to airborne uranium during certain operations. Sampling will be performed with a lapel sampler or equivalent. The air filters will be counted and compared to the Derived Air Concentration (DAC) using the same method used for area sampling. Air samplers will be calibrated at the manufacturer's recommended frequency or at least every six months using a primary calibration standard. Air sampler calibration will be performed in accordance with standard operating procedures.

Measurement of airborne uranium will be performed by gross alpha counting of the air filters using an alpha scaler such as a Ludlum Model 2000 or equivalent. The DAC for soluble (D classification) natural uranium of $5x10^{-10}$ μCi/ml from Appendix B to 10 CFR §§20.1001 - 20.2401 will be used. This is a conservative method because the gross alpha results include Uranium-238 and several of its daughters (notably Ra-226 and Th-230), which are also alpha emitters. An action level of 25% of the DAC for soluble natural uranium will be established at the Moore Ranch Plant. If an airborne uranium sample exceeds the DAC, the RSO will investigate the cause.

The results of airborne uranium particulate monitoring will be used to determine the committed effective dose equivalent (CEDE) or internal exposure as described in detail in Section 5.7.4.1.

5.7.3.2 Radon Daughter Concentration Monitoring

Surveys for radon daughter concentrations will be conducted in the operating areas of the Moore Ranch Plant on a monthly basis. Sampling locations will be determined in accordance with the guidance contained in USNRC Regulatory Guide 8.25. Proposed radon daughter sampling locations for the Moore Ranch Plant are shown on Figure 5.7-1.

Samples will be collected with a low volume air pump (e.g., lapel sampler) and then analyzed with an alpha scaler using the Modified Kusnetz method described in ANSI-N13.8-1973. Routine radon daughter monitoring will be performed in accordance with standard operating procedures. Samplers will be calibrated at the manufacturer's suggested interval or semiannually with a digital mass flowmeter or other primary calibration standard. Air sampler calibration will be performed in accordance with standard operating procedures.

Results of radon daughter sampling are expressed in Working Levels (WL) where one WL is defined as any combination of short-lived radon-222 daughters in one liter of air without regard to equilibrium that emit 1.3×10^5 MeV of alpha energy. The DAC limit from Appendix B to 10 CFR §§ 20.1001 - 20.2402 for radon-222 with daughters present is 0.33 WL. EMC will establish an action level of 25% of the DAC or 0.08 WL. Radon daughter results in areas with an average concentration in excess of the action level will result in an investigation of the cause and an increase in the sampling frequency to weekly until the radon daughter concentration levels do not exceed the action level for four consecutive weeks.

The results of radon daughter concentration monitoring will be used to determine the committed effective dose equivalent (CEDE) or internal exposure as described in detail in Section 5.7.4.2.

5.7.3.3 Respiratory Protection Program

Respiratory protective equipment will be supplied by EMC for activities where engineering controls may not be adequate to maintain acceptable levels of airborne radioactive materials or toxic materials. Use of respiratory equipment at Moore Ranch Uranium Project will be in accordance with a respiratory protection program designed to implement the guidance contained in USNRC Regulatory Guide 8.15[8] and USNRC

Regulatory Guide 8.31. The respirator program will administered by the RSO as the Respiratory Protection Program Administrator (RPPA).

5.7.4 EXPOSURE DETERMINATION AND RECORDSCALCULATIONS

Employee exposure to radiation will be monitored and recorded in accordance with 10 CFR §20.1001 to §20.2401 and Regulatory Guides 8.30 and 8.34. Routine employee external exposures are determined and recorded for those employees likely to receive more than 10% of the allowable occupational dose limit (i.e., 0.5 rem). External exposures will be determined using personnel dosimetry as discussed in Section 5.7.2.2. Routine employee internal exposures will be determined and recorded for those employees likely to receive more than 10% of the Annual Limit of Intake (ALI) for internal exposure from radon daughters or uranium.

Employee internal exposure to airborne radioactive materials at the Moore Ranch Plant will be determined based upon the requirements of 10 CFR § 20.1204 and the guidance contained in USNRC Regulatory Guides 8.30 and 8.7[9].
Following is a discussion of the exposure calculation determination methods and documentation of results.

5.7.4.1 Natural Uranium Internal Exposure

Exposure calculations for airborne natural uranium will be perfromedperformed using the intake method from USNRC Regulatory Guide 8.30, Section 2. The intake is calculated using the following equation:

$$I_u = b\sum_{i=1}^{n}\frac{X_i \times t_i}{PF}$$

where:

I_u	=	uranium intake, μg or μCi
t_i	=	time that the worker is exposed to concentrations X_i (hr)

X_i	=	average concentration of uranium in breathing zone, $\mu g/m^3$, $\mu Ci/m^3$
b	=	breathing rate, 1.2 m^3/hr
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the week or quarter

The intake for uranium will be calculated and recorded. The intakes will be totaled and entered onto each employee's Occupational Exposure Record.

The data required to calculate internal exposure to airborne natural uranium will be determined as follows:

<u>Time of Exposure Determination</u>

The results of periodic time studies for each classification of worker or 100% occupancy time will be used to determine routine worker exposures. In general, 100% occupancy time will be used to determine exposures. Using this method, each classification of worker is assumed to have spent their entire work shift in the survey area(s). Note that the length of work shifts may vary by worker classification. Plant operators will generally be working on a shift schedule to provide full time coverage and this may result in some variation from the standard 40-hour week schedule. Maintenance, wellfield, and part-time workers may not spend a full shift in the restricted area(s). The occupancy time determinations will be based on the actual scheduled time in the restricted area for each occupational group.

This approach generally results in a conservative (i.e., higher than actual) estimate of internal exposure to airborne natural uranium because it does not account for time the employee may have spent outside the work area, such as during breaks and meals. Alternatively, the RSO may perform a time study to determine the average time of exposure for each classification of worker. Under this approach, the RSO will have a representative population of each classification of worker track their time spent in different areas of the facility. The time study will be performed for an extended period (usually one month) and will provide the RSO with a percentage of time spent in each area for each classification of worker. If time studies are employed to determine time of exposure, they will be updated annually to account for any changes. Exposures during non-routine work (i.e., work requiring an RWP) will be based upon actual time.

Airborne Uranium Activity Determination

Airborne uranium activity will be determined from surveys performed as described in Section 5.7.3.1.

Exposures to airborne uranium will be compared to the DAC for the "D" solubility class for natural uranium from Appendix B of 10 CFR §§20.1001 - 20.2401 (i.e., $5x10^{-10}$ µCi/ml).

5.7.4.2 Radon Daughter Internal Exposure

Exposure calculations for airborne radon daughters will be performed using the intake method from USNRC Regulatory Guide 8.30, Section 2. The radon daughter intake will be calculated using the following equation:

$$I_r = \frac{1}{170} \sum_{i=1}^{n} \frac{W_i \times t_i}{PF}$$

where:

I_r	=	radon daughter intake, working-level months
t_i	=	time that the worker is exposed to concentrations W_i (hr)
W_i	=	average number of working levels in the air near the worker's breathing zone during the time (t_i)
170	=	number of hours in a working month
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the year

The data required to calculate exposure to radon daughters will be determined as follows:

Time of Exposure Determination

The results of periodic time studies for each classification of worker or 100% occupancy time will be used to determine routine worker exposure times. In general, 100% occupancy time will be used to determine exposures. Using this method, each classification of worker is assumed to have spent their entire work shift in the survey area(s). Note that the length of work shifts may vary by worker classification. Plant operators will generally be working on a shift schedule to provide full time coverage and this may result in some variation from the standard 40-hour week schedule. Maintenance, wellfield, and part-time workers may not spend a full shift in the restricted area(s). The occupancy time determinations will be based on the actual scheduled time in the restricted area for each occupational group.

This approach generally results in a conservative (i.e., higher than actual) estimate of internal exposure to airborne natural uranium because it does not account for time the employee may have spent outside the work area, such as during breaks and meals. Alternatively, the RSO may perform a time study to determine the average time of exposure for each classification of worker. Under this approach, the RSO will have a representative population of each classification of worker track their time spent in different areas of the facility. The time study will be performed for an extended period (usually one month) and will provide the RSO with a percentage of time spent in each area for each classification of worker. If time studies are employed to determine time of exposure, they will be updated annually to account for any changes. Exposures during non-routine work (i.e., work requiring an RWP) will be based upon actual time.

Radon Daughter Concentration Determination

Radon-222 daughter concentrations will be determined from surveys performed as described in Section 5.7.3.2. The working-level months for radon daughter exposure will be calculated and recorded. The working-level months will be totaled and entered onto each employee's Occupational Exposure Record.

Exposures to radon daughters will be compared to the DAC for radon daughters from Appendix B of 10 CFR §§20.1001 - 20.2401 (i.e., 0.33 WL).

5.7.4.3 External Exposure

Occupational exposure to external gamma and beta radiation will be measured using personnel dosimeters such as Thermoluminescent Dosimeters (TLD) or Optically Stimulated Luminescence (OSL) dosimeters as discussed in Section 5.7.2.2. Consistent with 10 CFR §20.1502 and Regulatory Guide 8.34, occupational exposure to external radiation will be used to determine the TEDE for employees whose work locations or functions may be expected to exceed 10% of the occupational exposure limits. The RSO will use historical and current monitoring and survey data to ensure that external radiation exposures are less than 10% of the occupational dose limit for all unmonitored workers. The results of the external radiation monitoring program will be recorded and reviewed annually by the RSO to ensure that unmonitored employees have not exceeded 10% of the dose limit.

5.7.4.35.7.4.4 Prenatal and Fetal Exposure

10 CFR §20.1208 requires that licensees ensure that the dose to an embryo/fetus during the entire pregnancy from occupational exposure of a declared pregnant woman does not exceed 0.5 Rem (500 mRem). Licensees are also required to make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman that would satisfy the 0.5 Rem limit. The dose to the embryo/fetus is calculated as the sum of (1) the deep-dose equivalent to the declared pregnant woman and (2) the dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

The dose equivalent to the embryo/fetus is determined by the monitoring of the declared pregnant woman. 10 CFR §20.1502(a)(2) requires monitoring the exposure of a declared pregnant woman when the external dose to the embryo/fetus is likely to exceed a dose from external sources in excess of 10% of the embryo/fetus dose limit (i.e., 0.05 Rem/yr). 10 CFR 20.1502(b)(2) also requires that the licensee monitor the occupational intakes of radioactive material for the declared pregnant woman if her intake is likely to exceed a committed effective dose equivalent in excess of 0.05 Rem/yr. Based on this 0.05 Rem threshold, the dose to the embryo/fetus must be determined if the intake is likely to exceed 1% of ALI during the entire period of gestation.

Prior to declaration of pregnancy, the woman may not have been subject to monitoring based on the conditions specified in 10 CFR §20.1502. In this case, EMC will estimate the exposure during the period monitoring was not provided, using any combination of surveys or other available data (e.g., air monitoring, area monitoring, and bioassay). Exposure calculations will be performed as recommended in USNRC Regulatory Guide 8.36[10]:

- External Dose to the Embryo/Fetus

The deep-dose equivalent to the declared pregnant woman during the gestation period will be taken as the external dose for the embryo/fetus. The determination of external dose will consider all occupational exposures of the declared pregnant woman since the estimated date of conception and will be based on the methods discussed in Section 5.7.2.

- Internal Dose to the Embryo/Fetus

The internal dose to the embryo/fetus will consider the exposure to the embryo/fetus from radionuclides in the declared pregnant woman and in the embryo/fetus. The dose to the embryo/fetus will include the contribution from any radionuclides in the declared pregnant woman (body burden) from occupational intakes occurring prior to conception. The intake for the declared pregnant woman will be determined as discussed in Sections 5.7.3.1 and 5.7.3.2.

5.7.4.5 Exposure Recording and Reporting

For employees that are monitored for internal and/or external exposure, recording and reporting of monitoring results is required in 10 CFR §20.2106(a) and §20.2206(b), respectively. Records of exposure monitoring results will be maintained for each monitored individual on an NRC Form 5 or equivalent.

In addition, 10 CFR §20.2104 requires a determination of the individual's current year dose at other facilities. EMC will obtain prior dose histories for all employees. EMC will obtain an NRC Form 4 signed by the individual to be monitored, or a written statement that includes the names of all facilities that monitored the individual for occupational exposure to radiation during the current year and an estimate of the dose received. EMC will attempt to verify the information provided by the individual. EMC will also attempt to obtain records of the individual's lifetime cumulative occupational radiation dose. This lifetime dose may be based on a written estimate or an up-to-date NRC Form 4 signed by the individual.

In accordance with 10 CFR §19.13(b), monitored employees will be advised in writing on an annual basis of their calculated TEDE. Additionally, any employee may request a written report of their exposure history at any time. These reports will be provided within 30 days of the request and will provide the information outlined in 10 CFR §19.13.

5.7.5 BIOASSAY PROGRAM

EMC will implement a urinalysis bioassay program at the Moore Ranch Uranium Project that meets the guidelines contained in USNRC Regulatory Guide 8.22[11]. The primary purpose of the program will be to detect uranium intake in employees who are regularly exposed to uranium and to confirm the results of the airborne uranium particulate monitoring program (discussed in Section 5.7.3.1) and the internal exposure determination (discussed in Section 5.7.4.1). The bioassay program will consist of the following elements:

1. Prior to assignment to the facility, all new employees will be required to submit a baseline urinalysis sample. Upon termination, an exit bioassay will be required from all employees.

2. During operations, urine samples will be collected from workers on a quarterly basis. Employees who have the potential for exposure to dried yellowcake will submit bioassay samples on a monthly basis or more frequently as determined by the RSO. Samples will be analyzed for uranium content by a contract analytical laboratory. Blank and spiked samples will also be submitted to the laboratory with employee samples as part of the Quality Assurance program. The minimum measurement sensitivity for the analytical laboratory will be 5 μg/l.

3. Action levels for urinalysis will be established based upon Table 1 in USNRC Regulatory Guide 8.22.

Elements of the quality assurance requirements for the Bioassay Program will be based upon the guidelines contained in USNRC Regulatory Guide 8.22. These elements include the following:

1. Each batch of samples submitted to the analytical laboratory will be accompanied by two blind control samples. The control samples will be from persons that have not been occupationally exposed and are spiked to a uranium concentration of 10 to 20 μg/l and 40 to 60 μg/l. Alternatively, synthetic control samples may be used. The results of analysis for these samples are required to be within ± 30% of the spiked value

2. The analytical laboratory spikes 10 to 30% of all samples received with known concentrations of uranium and the recovery fraction is determined. Results will be reported to EMC.

5.7.6 CONTAMINATION CONTROL PROGRAM

EMC will perform surveys for surface contamination in operating and clean areas of the Moore Ranch Plant in accordance with the guidelines contained in USNRC Regulatory Guide 8.30. Surveys for total alpha contamination in clean areas will be conducted weekly. In designated clean areas, such as lunchrooms, offices, change rooms, and respirator cabinets, the target level of contamination is nothing detectable above background. If the total alpha survey indicates contamination that exceeds 250 dpm/100 cm^2 (i.e., 25% of the removable limit) a smear survey will be performed to assess the level of removable alpha activity. If smear test results indicate removable contamination greater than 250 dpm/100 cm^2, the area will be promptly cleaned and resurveyed.

All personnel leaving the restricted area will be required to perform and document alpha contamination monitoring. In addition, personnel who could come in contact with potentially contaminated solutions outside a restricted area such as in the wellfields will be required to monitor themselves prior to leaving the area. All personnel will receive training in the performance of surveys for skin and personal contamination. All contamination on skin and clothing is considered removable, so the limit of 1,000 dpm/100 cm^2 will be applied to personnel monitoring. Personnel will also be allowed to conduct contamination monitoring of small, hand-carried items for use in wellfield and controlled areas as long as all surfaces can be reached with the instrument probe and the item does not originate in yellowcake areas. All other items are surveyed as described below.

Employees that enter a restricted area will be required to sign in on an access log and note their name and the time entered. Upon leaving the restricted area, employees will be required to monitor themselves for radioactive contamination or take a shower and change their clothing in accordance with Regulatory Guide 8.30. The monitoring will consist of a visual examination to detect any visible yellowcake and an instrument survey to ensure that any suspected contamination is below the acceptable limits. If the contamination limit is exceeded, personnel must decontaminate their skin and/or clothing, repeat the survey, and notify the RSO. The RSO will investigate of the cause of the contamination and take corrective action, if appropriate. Employees will be trained during initial radiation safety training to self-monitor using a rate meter with an alpha scintillation detector. The results of the personnel survey will be recorded on the access log at the survey station. The RSO will routinely observe employees leaving the restricted area to ensure that proper personnel contamination survey methods are employed. Restricted areas include the central plant and drum storage areas as shown on Figure 2.1-3. All wellfield areas will be controlled areas as defined in 10 CFR §20.1003. Wellfield areas are shown on Figures 2.1-2 and 3.1-2

The RSO, the radiation safety staff, or properly trained employees will perform surveys of all items removed from the restricted areas with the exception of small, hand-carried items described above. The release limits will be set as specified in *"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct or Source Materials"*, USNRC, May 1987.

Surveys will be performed with the following equipment:

1. Total surface activity will be measured with an appropriate alpha survey meter. A Ludlum Model 2241 scaler or a Ludlum Model 177 Ratemeter with a Model 43-65 or Model 43-5 alpha scintillation probe, or equivalent, will be used for the surveys.

2. Portable GM survey meter with a beta/gamma probe with an end window thickness of not more than 7 mg/cm^2, a Ludlum Model 3 survey meter with a Ludlum 44-38 probe or equivalent.

3. Swipes for removable contamination surveys as required.

Survey equipment will be calibrated annually or at the manufacturer's recommended frequency, whichever is more frequent. Surface contamination instruments will be checked daily when in use. Alpha survey meters for personnel surveys will be response checked before each use.

As recommended in USNRC Regulatory Guide 8.30, EMC will conduct quarterly unannounced spot checks of personnel to verify the effectiveness of the surveys for personnel contamination. The purpose of the spot check surveys is to ensure that employees are adequately surveying and decontaminating themselves prior to exiting the restricted areas.

Contamination control during maintenance or other nonroutine activities will be controlled through the use of an RWP unless standard operating procedures have been developed. In preparing an RWP, the RSO will assess the potential hazard to workers from loose and fixed contamination. In general, any work on pumps, piping, tankage, containers, or associated equipment will be evaluated for an RWP by the RSO. This would include any nonroutine maintenance or repairs in the drying and packaging facilities; sandblasting, welding, or grinding on any contaminated metal surfaces; and chipping or drilling concrete in plant buildings where contamination may be present. The RWP will contain requirements for specific contamination control techniques suited to the maintenance task. In most instances, some method of decontamination prior to performing maintenance work will be required. Methods typically employed at ISR facilities have included pressure washing surfaces or performing decontamination with a mild solution of muriatic acid to reduce contamination levels to a minimum. In some cases, work that may involve generation of dust that may contain radioactive materials will be performed under wet conditions.

5.7.7 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

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 2.9.6. Sampling locations are shown on Figure 5.7-2. 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 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. 5.7-2. This location is at least one mile west/southwest (i.e., upwind) of the plant location and wellfield areas.

The radon gas effluent released to the environment will be monitored at the same air monitoring locations (MR-1 through MR-10) that were used for baseline determination of radon concentrations as described in Section 2.9. Sampling locations are shown on Figure

5.7-2. 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 7.3 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. Surface soil has been sampled as described in Section 2.9.3. Surface soil samples will be taken at the monitoring locations described in Section 2.9.3 following conclusion of operations and will be compared to the results of the preoperational monitoring program.

Surface soil will also be sampled at the plant location as described in Section 2.9. Post operational surface soil samples will be taken following conclusion of operations and will be compared to the results of the preoperational monitoring program.

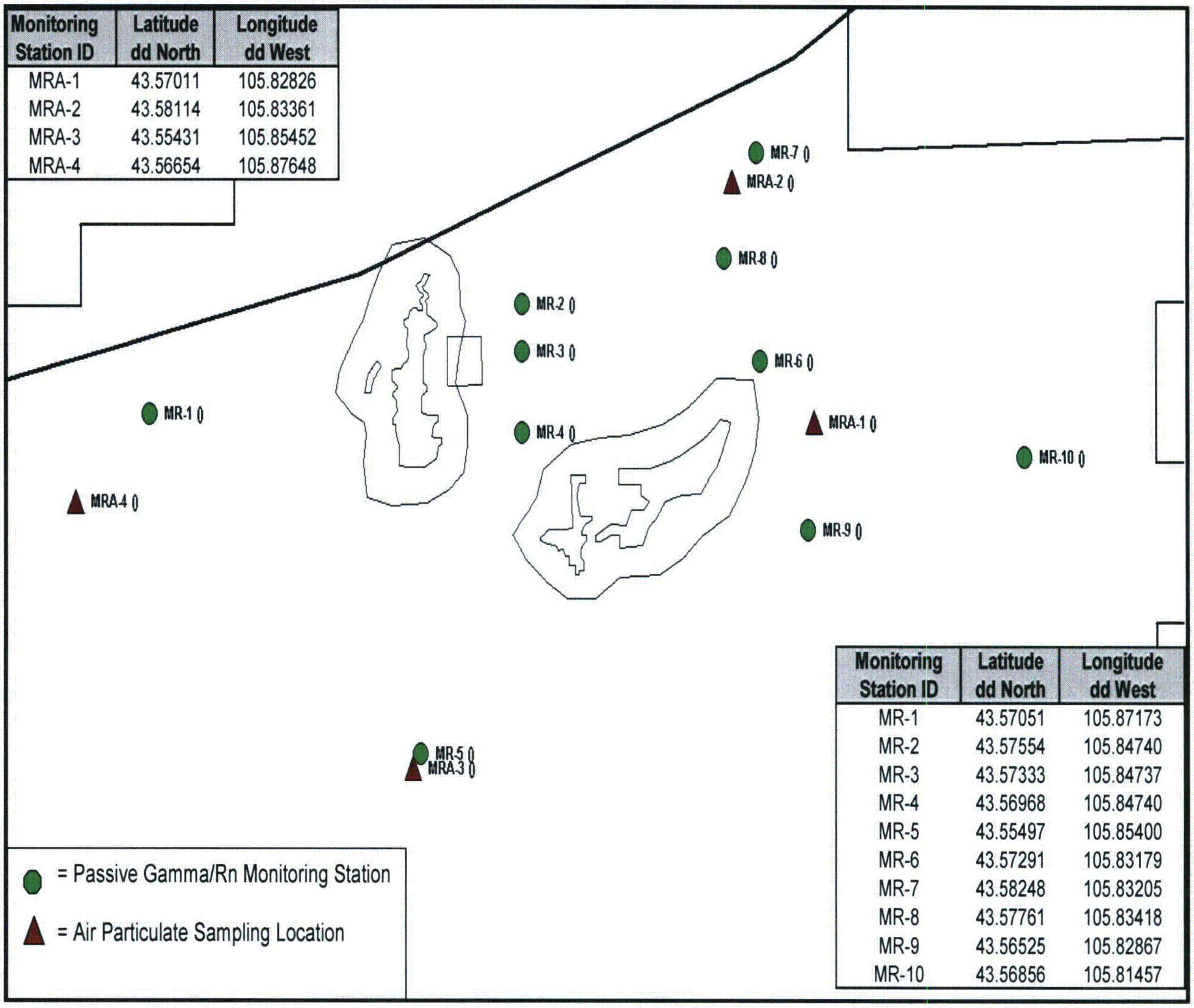
Subsurface Soil

Regulatory Guide 4.14 does not indicate subsurface soil sampling during operational phases of the site. Subsurface soil will be sampled at the plant location as described in Section 2.9. 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 5.7-2

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



Monitoring Station ID	Latitude dd North	Longitude dd West
MR-1	43.57051	105.87173
MR-2	43.57554	105.84740
MR-3	43.57333	105.84737
MR-4	43.56968	105.84740
MR-5	43.55497	105.85400
MR-6	43.57291	105.83179
MR-7	43.58248	105.83205
MR-8	43.57761	105.83418
MR-9	43.56525	105.82867
MR-10	43.56856	105.81457

Vegetation

Preoperational vegetation samples from the Moore Ranch Uranium Project site were collected in 2007 at the locations describedlocations described in Section 2.9.

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[12], 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 7.3.

Direct Radiation

Environmental gamma radiation levels will be monitored continuously at the air monitoring stations (MRA-1 through MRA-104). 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. 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 1V Underground Injection Control Permit(s) issued by the Wyoming Department of Environmental Quality-Water Quality Division.

5.7.8 GROUNDWATER/SURFACE WATER MONITORING PROGRAM

5.7.8.1 Program Description

During operations at the Moore Ranch Uranium Project, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. EMC's operational water monitoring program will include the evaluation of groundwater on a regional basis, groundwater within the licensed area, and surface water on a regional and site specific basis.

5.7.8.2 Groundwater Monitoring

The groundwater monitoring program is designed to detect excursions of lixiviant outside of the wellfield under production and into the overlying and/or underlying water bearing strata.

- Private Well Monitoring

All private wells within one kilometer of the wellfield area boundary will be sampled on a quarterly basis with the landowner's consent. Groundwater samples will be analyzed for natural uranium and radium-226.

- Wellfield Baseline Sampling

Production zone wells (injection and production pattern area) will be sampled four times with a minimum of 2 weeks between samplings during baseline characterization. Wells will be selected based on a density of one well per three acres of mine unit. The first and second sample events will include analyses for all WDEQ LQD Guideline 8, Appendix 1, parts III and IV parameters as shown in Table 5.7-1. The third and fourth sampling events will be analyzed for a reduced list of parameters as defined by the results of the previous sample events. If certain elements are not detected during the first and second sampling events, then those elements will not be analyzed during the third and fourth sample events.

Data for each parameter are averaged. If the data collected for the entire mine unit indicate that waters of different underground water classes (WDEQ-WQD Rules and Regulations, Chapter VIII) exist together, the data are not averaged together, but treated as sub-zones. Data within specific sub-zones are averaged. Boundaries of sub-zones, where required, are delineated at half-way between the sets of sampled wells which define the sub-zones. The Restoration Target Values (RTV's) are determined from the baseline water quality data and are used to assess the effectiveness of ground water restoration activities. The average and range of baseline values determined for the wells completed in the Production Zone within the wellfield area constitute the RTV's.

- Well Sampling Methods

Groundwater samples are critical to meeting environmental protection goals at ISR uranium mines. The results of these samples are used to monitor operational environmental protection efforts and to determine whether restoration activities are successful. In order to ensure the accuracy of these monitoring efforts, strict compliance with groundwater sampling procedures is necessary. This section provides instructions on water level determination, proper well sampling techniques, sample preservation and documentation, and QA/QC requirements. These requirements will be followed for all samples obtained from private wells and monitor wells.

The accurate determination of the static water level in monitor wells provides important information concerning aquifer conditions. Well static water levels are monitored using an electrical measuring line (an "e-line"). An e-line is a device that measures electrical conductance with two electrodes contained in a shielded probe. The probe is mounted to a graduated strip to allow measurement of water levels. The probe is slowly lowered into the well. When the probe contacts the water surface in the well, the circuit is completed and an audible device is actuated. The sampler will take water level readings of all wells before sampling.

It is generally not possible to measure water level in existing private wells without disassembly of pumping and piping systems. If possible, the water level will be measured. If it is not possible to measure water level, the well will be purged for at least five minutes to evacuate any lines or existing pressure tanks of stagnant water. If any particulate matter is identified in the water, the well will be allowed to flow until it no longer contains any particulate.

During regional well sampling, all readings should be reported to within at least one tenth of a foot and preferably to within a hundredth of a foot. It is important to check the e-line length by measuring with a steel tape after the line has been used for a long time, when the length has been altered due to repairs, or after it has been pulled hard in an attempt to free the line. If an e-line's length is altered by these causes, a correction factor should be written on the side of the e-line so readings may be properly adjusted.

Water that remains in the well casing between samples may not be representative of the formation water quality. The quality of water left in the casing between samples may be changed by sorption or desorption from casing materials, oxidation, or biological activity. Purging is required to remove this stagnant water and allow formation water into the well screen.

The well must have a sufficient volume of water removed to induce the flow of formation water through the well screen. Two approaches to purging are provided in ASTM Guide D 4448. The first approach requires purging a large volume of water. ASTM Guide D 4448 recommends that three to five casing volumes be purged for the high volume method, while one casing volume may be acceptable if a lower purge rate near the recharge rate of the well is used. The second approach recommended in ASTM D 4448 requires the removal of stagnant casing water until one or more indicator parameters are stable. Stabilization is considered achieved when the measurements of all parameters are stable within a predetermined range. Parameters that EMC will monitor include pH, temperature, and specific conductivity.

For high and medium yield wells, EPA recommends a minimum purge volume of three casing volumes. For low yield wells, EPA also allows a smaller minimum purge volume of one casing volume if the flow is near the recharge rate of the aquifer.

The Wyoming LQD in Guideline 8, Section IV.A.4.b requires withdrawing at least two casing volumes of water prior to sampling. The sampler will document the pumping rate and the purging time. The LQD alternatively allows purging the well until pH, conductivity, temperature, and water level readings remain constant. The field sampler will document the changes in each field parameter against time in a tabular form. If recharge cannot match minimal pumping rates in a low permeability aquifer, then a sample can be retrieved by pumping the well dry once and then bailing the water that subsequently enters the well.

Accurate records of well purging will be maintained to document the number of casing volumes purged from the well before sampling. These records will include the casing volume (gallons), the pumping rate (gpm), and pumping start and stop times. The pumping rate can be determined with a flowmeter or by timing how long it takes to fill a 5-gallon bucket or other container of a known volume.

The following formula will be used to calculate the number of gallons contained in one casing volume:

Casing Volume (Gals) = (Height of water in well in ft) x (Radius of the well^2 in inches) x (π) x (0.052)

Where: $\pi = 3.1416$
The height of the water in the well = the total depth (TD) of the well in feet minus the depth to water in feet.

Field meters will be used to measure pH, specific conductance, and temperature of water samples. The use, calibration, and care of these meters will be in accordance with the owner's manual recommendations.

The groundwater sample will be taken as soon as the well is adequately purged. If the well was pumped dry during purging, the sample will be obtained as soon as adequate formation water is present in the casing. The sampler will record the following sampling data on a field sampling sheet:

- Identification of the well;
- Well depth;
- Static water level depth and measurement techniques;
- Well yield;
- Purge volume, pumping rate and volume per casing volume;
- Time well purged;
- Collection methods (bail or pump);
- Field observations (such as well condition, sample color, sample smell, sound);
- Name of collector; and
- Climatic conditions, including air temperature.

Once a water sample has been taken, the quality of the sample begins to degrade with time. Because of this, all samples will be kept cool and some must be preserved in order to lengthen the acceptable holding time. The contract laboratory will be consulted when determining proper preservation techniques for samples that require off site analysis. Samples to be analyzed for dissolved metals will be filtered to < 0.45 microns to remove suspended solids that may affect the results.

Preservative (acid) will be added to sample containers either before or immediately after collection and filtration, if required, of samples. The following Table provides a summary of the sampling and preservation recommendations for analytes typically of concern in groundwater. Field sampling personnel will consult the bottle and preservation list provided by the contract laboratory to ensure that the appropriate sample preservation method is used.

Parameter	Volume Required (mls)	Preservative	Holding Time
Dissolved Metals	250	Filter (0.45 μm), then add HNO_3 to ph<2	6 months
Total Metals	250	HNO_3 to ph<2	6 months
Alkalinity	100	Cool, 4°C	14 days
Chloride	50	None Required	28 days
Conductance	100	Cool, 4°C	28 days
Fluoride	50	None Required	28 days
Ammonia as N	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate + Nitrite	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate	50	Cool, 4°C	48 hours
Nitrite	50	Cool, 4°C	48 hours
pH	25	None Required	Analyze immediately
TDS	500	Cool, 4°C	7 days
TSS	500	Cool, 4°C	7 days
Sulfate	100	Cool, 4°C	28 days
Lead-210	1000	HNO_3 to ph<2	6 months
Polonium-210	1000	HNO_3 to ph<2	6 months
Radium-226	1000	HNO_3 to ph<2	6 months
Uranium	1000	HNO_3 to ph<2	6 months

Chain of Custody (COC) forms will accompany every sample sent to off-site contract laboratories. The chain of custody will contain at a minimum the type of sample, the sample identification number, the preservation techniques (if any), the name of the sampler, the date and time the sample was taken, the name(s) of individuals who handled the sample and when they passed it on to another person, and the required analysis.

- Monitor Well Baseline Water Quality

Monitor well ring wells are installed within the Production Zone, outside the mineralized portion of the ore zone and production pattern area in a "ring" around the mine area. These wells are used to obtain baseline water quality data and characterize the area outside the production pattern area. Upper Control Limits (UCL's) are determined for these wells from the baseline water quality data used in operational excursion monitoring.

As determined from the modeling described in Addendum 5.7-A, the distance between these monitor wells will be no more than 500 feet and the distance between these monitor wells and the production patterns will be approximately 500 feet. The acceptable distance between the monitor wells and the production patterns was determined using a ground water flow model and estimated hydraulic properties for the proposed production area. The acceptable distance between monitor wells and the production patterns also took into account the demonstration that if an excursion were to occur, production fluids could be controlled within 60 days, as required by WDEQ requirements.

Monitor wells will be installed within the overlying aquifer (72-Sand) and underlying aquifer (68-sand) at a density of one well per every four acres of pattern area. These wells will be used to obtain baseline water quality data to be used in the development of UCL's for these zones.

In the areas of Wellfield 2 where a confining unit exists between the 70 and 68 sands, monitor wells will be placed in the 68 sand at the spacing described in this section (1 per 4 acres). Additional monitor wells may be placed around the area where the two sands coalesce to provide increased monitoring of any potential impacts to areas of the 68 sand outside of the coalescing area. 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 final number and location of these underlying wells will be determined during final wellfield planning and submitted to the WDEQ-LQD in the Wellfield Package.

After completion, wells will be developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appears to be stable and consistent with the anticipated water quality of the area. After development, wells will be sampled to obtain baseline water quality. Wells will be purged before sample collection to ensure that representative water is obtained. All monitor wells including ore zone and overlying and underlying monitor wells will be sampled four times at least two weeks apart. The first sample will be analyzed for the parameters shown in Table 5.7-1. Subsequent samples will be analyzed for the UCL parameters only (i.e., chloride, conductivity, and total alkalinity). Results from the samples will be averaged arithmetically to obtain a baseline mean value determination of upper control limits for excursion detection. If the data collected for the monitor well ring unit indicate that waters of different underground water classes (WDEQ-WQD Rules and Regulations, Chapter VIII) exist together, the data are not averaged together, but treated as sub-zones. Data within specific sub-zones are averaged. Boundaries of sub-zones, where required, are delineated at half-way between the sets of sampled wells which define the sub-zones.

Table 5.7-1
Baseline Water Quality Parameters
WDEQ LQD Guideline 8

Constituents (reported in mg/l unless noted)	*Analytical Method*
Ammonia Nitrogen as N	EPA 350.1
Nitrate + Nitrite as N	EPA 353.2
Bicarbonate	EPA 310.1/310.2
Boron	EPA 212.3/200.7
Carbonate	EPA 310.1/310.2
Fluoride	EPA 340.1/340.2/340.3
Sulfate	EPA 375.1/375.2
Total Dissolved Solids (TDS) @ 180°F	EPA 160.1/SM2540C
Dissolved Arsenic	EPA 206.3/200.9/200.8
Dissolved Cadmium	EPA 200.9/200.7/200.8
Dissolved Calcium	EPA 200.7/215.1/215.2
Dissolved Chloride	EPA 300.0
Dissolved Chromium	EPA 200.9/200.7/200.8
Total and Dissolved Iron	EPA 236.1/200.9/200.7/200.8
Dissolved Magnesium	EPA 200.7/242.1
Total Manganese	EPA 200.9/200.7/200.8/243.1/243.2
Dissolved Molybdenum	EPA 200.7/200.8
Dissolved Potassium	EPA 200.7/258.1
Dissolved Selenium	EPA 270.3/200.9/200.8
Dissolved Sodium	EPA 200.7/273.1
Dissolved Zinc	EPA 200.9/200.7/200.8
Radium-226 (pCi/l)	DOE RP450/EPA 903.1/SM 7500-R-AD
Radium-228 (pCi/l)	SM 7500-R-AD
Gross Alpha (pCi/l)	DOE RP710/CHEMTA-GP B1/EPA 900
Gross Beta (pCi/l)	DOE RP710/CHEMTA-GP B1/EPA 900
Uranium	DOE MM 800/EPA 200.8
Vanadium	EPA 286.1/286.2/200.7/200.8

- Wellfield Hydrologic Data Package

Following completion of the field data collection, the Wellfield Hydrologic Data Package is assembled and submitted to the WDEQ for review. In accordance with NRC Performance Based Licensing requirements, the Wellfield Hydrologic Data Package is reviewed by a Safety and Environmental Review Panel (SERP) to ensure that the results of the hydrologic testing and the planned mining activities are consistent with technical requirements and do not conflict with any requirement stated in NRC regulations or in the NRC license. A written SERP evaluation will evaluate safety and environmental concerns and demonstrate compliance with applicable NRC license requirements as previously discussed in Section 5.2.4. The written SERP evaluation will be maintained at the site.

The Wellfield Hydrologic Data Package contains the following:

1. A description of the proposed mine unit (location, extent, etc.).

2. A map(s) showing the proposed production patterns and locations of all monitor wells.

3. Geologic cross-sections and cross-section location maps.

4. Isopach maps of the Production Zone sand, overlying confining unit and underlying confining unit.

5. Discussion of how the hydrologic test was performed, including well completion reports.

6. Discussion of the results and conclusions of the hydrologic test including pump test raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and when appropriate, directional transmissivity data and graphs.

7. Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns.

8. Baseline water quality information including proposed UCLs for monitor wells and average production zone/restoration target values.

9. Any other information pertinent to the area tested will be included and discussed.

- Operational Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, upper control limits (UCLs) are set for chemical constituents which would be indicative of a migration of lixiviant from the well field. The constituents chosen for indicators of lixiviant migration and for which UCLs will be set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during mining. Water levels are obtained and recorded prior to each well sampling. However, water levels are not used as an excursion indicator. Upper control limits will be set at the baseline mean concentration plus five standard deviations for each excursion indicator. For chloride with a low baseline mean and little noted variation during baseline sampling, the UCL may be determined by adding 15 mg/l to the baseline mean if that value is greater than the baseline mean plus five standard deviations.

Operational monitoring consists of sampling the monitor wells at least twice monthly and at least 10 days apart and analyzing the samples for the excursion indicators chloride, conductivity, and total alkalinity. EMC requests that in the event of certain situations such as inclement weather, mechanical failure, or other factors that may result in placing an employee at risk or potentially damaging the surrounding environment, NRC allow a delay in sampling of no more than five days. In these situations, EMC will document the cause and the duration of any delays.

To assure that water within the well casing has been adequately displaced and/or formation water is sampled, wells will be purged before sample collection to ensure that representative water is obtained. Samples will be taken when field water quality parameters such as pH and specific conductivity appear to be stable and consistent with the anticipated water quality of the area. Low flow purging may also be used in certain instances to prevent pulling of mining fluids to the monitor well from excessive purging and ensure only formation water is sampled.

Water level and analytical monitoring data for the UCL parameters are reported to the WDEQ-LQD on a quarterly basis. This data is retained on site for review by the NRC.

- Excursion Verification and Corrective Action

During routine sampling, if two of the three UCL values are exceeded in a monitor well, , the well is resampled within 24 hours of the determination that a sample has exceeded two of the three UCL values and analyzed for the excursion indicators. The verification sample is split and analyzed in duplicate to assess analytical error. If results of the confirmatory sampling are not complete within 30 days of the initial sampling event, then the excursion will be considered confirmed for the purpose of meeting the reporting requirements described below. If the second sample does not exceed the UCLs, a third sample is taken within 48 hours. If neither the second or third sample results exceeded the UCLs, the first sample is considered in error.

If the second or third sample verifies an exceedance, the well in question is placed on excursion status. Upon verification of the excursion, the USNRC Project Manager and the WDEQ-LQD is notified by telephone or email within 24 hours and notified in writing within thirty (30) days. A written report describing the excursion event, corrective actions, and corrective action results will be submitted to the NRC within 60 days of the excursion confirmation.

If an excursion is verified, the following methods of corrective action will be instituted (not necessarily in the order given) dependent upon the circumstances:

- A preliminary investigation will be completed to determine the probable cause.

- Production and/or injection rates in the vicinity of the monitor well will be adjusted as necessary to increase the net bleed, thus forming a hydraulic gradient toward the production zone.

- Individual wells will be pumped to enhance recovery of mining solutions.

- Injection into the well field area adjacent to the monitor well may be suspended. Recovery operations continue, increasing the overall bleed rate and the recovery of wellfield solutions.

In addition to the above corrective actions, sampling frequency of the monitor well on excursion status will be increased to once every seven days.

If an excursion is not controlled within 30 days following confirmation of the excursion, the WDEQ requires that a sample must be collected from each of the affected monitoring wells and analyzed for the following parameters: ammonia; antimony; arsenic; barium; beryllium; bicarbonate; boron, cadmium, calcium, carbonate; chloride; chromium;

conductivity; copper; fluoride; gross alpha; gross beta; iron; lead; magnesium; manganese; mercury; molybdenum; nitrate + nitrite; pH; potassium; selenium; sodium; sulfate; radium-226 and 228; thallium; TDS; uranium; vanadium; and zinc.

If the concentration of the UCL parameters detected in the monitor well(s) does not begin to decline within 60 days after the excursion is verified, injection into the production zone adjacent to the excursion will be suspended to further increase the net water withdrawals. Injection will be suspended until a declining trend in the concentration of the UCL parameters is established. Additional measures will be implemented if a declining trend does not occur in a reasonable time period. After a significant declining trend is established, normal operations will be resumed with the injection and/or production rates regulated such that net withdrawals from the area will continue. The declining trend will be maintained until the concentrations of excursion parameters in the monitor well(s) have returned to concentrations less than respective UCLs.

If an excursion is controlled, but the fluid which moved out of the production zone during the excursion has not been recovered within 60 days following confirmation of the excursion, the operator will submit to the WDEQ-LQD and the NRC within 90 days following confirmation of the excursion a plan and compliance schedule meeting the requirements of LQD Rules and Regulations, Chapter 13, Section 13(b).

•A monthly report on the status of an excursion shall be submitted to the LQD administrator beginning the first month the excursion is confirmed and continuing until the excursion is over. The monthly report shall contain the requirements described in LQD Rules and Regulations, Chapter 12, Section 12(e). An excursion will be considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion, or if only one excursion indicator exceeds its respective UCL by less than 20%.

5.7.8.3 Surface Water Monitoring

Pre-operational surface water quality monitoring was performed as discussed in Sections 2.7 and 2.9. The proposed license area does not contain perennial streams and all surface water features are ephemeral and only contain natural runoff during heavy rainfall and snowmelt events. Current coal-bed methane operations contribute a small amount of surface discharge, which maintains some ponding at select locations across the site for portions of the year. Upstream and downstream samples from all pre-operational surface water locations will be obtained quarterly when water is present. Surface water samples are collected using methods similar to groundwater. Samples are collected in the appropriate container(s) and field measurements for pH and conductivity are performed and documented using the techniques described in groundwater sampling methods. The sample bottle must be rinsed with the sample water. The bottle is then filled with the mouth of the sample bottle pointed down stream to prevent collecting debris. If samples involve analysis that requires filtration, collect water in a clean bucket for transfer to the filter apparatus. Treatment of sample containers, preservation techniques, holding times, and shipping techniques are identical to those used for groundwater samples previously described.

Surface water samples will be analyzed for Pb-210; Ra-226; Th-230; Unat; and Po-210. Surface water monitoring results will be submitted in the semi-annual environmental and effluent reports submitted to NRC.

5.7.9 QUALITY ASSURANCE PROGRAM

A quality assurance program will be implemented at the Moore Ranch Uranium Project for all relevant operational monitoring and analytical procedures. The objective of the program will be to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program will provide assurance to the regulatory agencies and the public that the monitoring results are valid. The Uranium One Quality Assurance Plan for Wyoming ISR Operations is provided in Addendum 5-A.

The QA program will address the following:

- Formal delineation of organizational structure and management responsibilities. Responsibility for both review/approval of written procedures and monitoring data/reports will be provided.

- Minimum qualifications and training programs for individuals performing radiological monitoring and those individuals associated with the QA program.

- Written procedures for QA activities. These procedures will include activities involving sample analysis, calibration of instrumentation, calculation techniques, data evaluation, and data reporting.

- Quality control (QC) in the laboratory. Procedures will cover statistical data evaluation, instrument calibration, duplicate sample programs and spike sample programs. Outside laboratory QA/QC programs are included.

- Provisions for periodic management audits to verify that the QA program is effectively implemented, to verify compliance with applicable rules, regulations and license requirements, and to protect employees by maintaining effluent releases and exposures ALARA.

QA procedures will include:

1. Environmental monitoring procedures.
2. Testing procedures.
3. Exposure procedures.
4. Equipment operation and maintenance procedures.
5. Employee health and safety procedures.
6. Incident response procedures.

5.8 REFERENCES

[1] USNRC Regulatory Guide 8.31, *Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Recovery Facilities Will Be As Low As Reasonably Achievable* (Revision 1, May 2002).

[2] USNRC Regulatory Guide 8.29, *Instructions Concerning Risks From Occupational Radiation Exposure* (Revision 1, February 1996).

[3] USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure* (Revision 3, June 1999).

[4] USNRC Regulatory Guide 3.56, *General Guidance For Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills* (May 1986).

[5] USNRC Regulatory Guide 8.30, *Health Physics Surveys in Uranium Recovery Facilities* (Revision 1, May 2002).

[6] USNRC Regulatory Guide 8.34, *Monitoring Criteria and Methods To Calculate Occupational Radiation Doses* (July 1992).

[7] USNRC Regulatory Guide 8.25, *Air Sampling in the Workplace* (Revision 1, June 1992).

[8] USNRC Regulatory Guide 8.15, *Acceptable Programs For Respiratory Protection* (Revision 1, October 1999).

[9] USNRC Regulatory Guide 8.7, *Instructions For Recording and Reporting Occupational Radiation Exposure Data* (Revision 1, June 1992).

[10] USNRC Regulatory Guide 8.36, *Radiation Exposure to the Embryo/Fetus* (July 1992).

[11] USNRC Regulatory Guide 8.22, *Bioassay at Uranium Mills* (Revision 1, August 1988).

[12] USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills* (Revision 1, April 1980).

ADDENDUM 5-A

WYOMING ISR OPERATIONS QUALITY ASSURANCE PLAN

Wyoming In Situ Recovery Projects Quality Assurance Plan

Prepared by
Uranium One Americas
Casper, Wyoming

Policy and Signature Page

Uranium One Americas is committed to establishing, maintaining, and implementing an effective Quality Assurance program that achieves quality in all activities through planning, performing, assessing, and continually improving the process.

The achievement of quality is an interdisciplinary function led by management and is the responsibility of all personnel. Work is accomplished through the resources of people, equipment, and procedures. Managers are responsible for ensuring that people have the information, resources, and support necessary to complete the work in a safe, efficient, and quality manner. All work performed by Uranium One Americas at Wyoming In Situ Recovery (ISR) sites must comply with the requirements of this Quality Assurance Project Plan.

Prepared By: ______________________ Date: ______________

Approved By: ______________________ Date: ______________

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1 INTRODUCTION

This Quality Assurance Plan is applicable to the environmental monitoring program implemented by Uranium One Americas at Wyoming ISR sites. The plan provides the quality requirements for field collection of samples and the subsequent analysis of those samples at a laboratory.

2 QUALITY PLAN REVIEW, REVISION AND DISTRIBUTION

This Quality Assurance Plan will be reviewed by affected project managers in accordance with the company policy for controlled documents. Revisions will be made at the direction of the Manager of Environmental and Regulatory Affairs, Wyoming to reflect changes in work scope, organizational interfaces or new regulatory requirements. This plan will be reviewed annually to ensure the content is valid and applicable to monitoring activities. Revisions to this plan will require approvals at the same level as the original document. At a minimum, copies of this QA Plan shall be available to all affected employees and support organizations.

3 REGULATORY REQUIREMENTS

This Quality Assurance Plan is designed to incorporate quality assurance/quality control requirements and guidance the following regulatory references:

– USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills*, Revision 1, April 1980.

– USNRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Steams and the Environment*, Revision 1, February 1979.

4 ORGANIZATION

Administration of the environmental monitoring programs in Wyoming is assigned to the Manager of Environmental and Regulatory Affairs, Wyoming. The Manager may delegate the day-to-day implementation of the environmental monitoring program to other EMC employees or to outside contractors, but he may not delegate the ultimate responsibility. Such assignment shall be in writing.

Key positions within the Uranium One Americas management system include:

Senior Vice President, ISR Operations – The Senior Vice President, ISR Operations has responsibility for overall management of Wyoming operations for Uranium One Americas. The Senior Vice President, ISR Operations reports to the Executive Vice President, Uranium One Americas.

Director of Environmental and Regulatory Affairs - The Director of Environmental and Regulatory Affairs has responsibility for preparation and oversight of environmental monitoring programs for Uranium One Americas. The Director of Environmental and Regulatory Affairs reports to the Executive Vice President, Uranium One Americas.

Manager of Environmental and Regulatory Affairs, Wyoming – The Manager of Environmental and Regulatory Affairs, Wyoming has responsibility for the overall management of the environmental monitoring programs for Uranium One Americas. The Manager of Environmental and Regulatory Affairs, Wyoming reports to the Senior Vice President, ISR Operations.

Senior Environmental Specialist – The Senior Environmental Specialist has responsibility for the day-to-day supervision of the environmental monitoring programs for Uranium One Americas. The Senior Environmental Specialist reports to the Manager of Environmental and Regulatory Affairs, Wyoming.

Radiation Safety Officer – The Radiation Safety Officer has responsibility for the overall management of the radiation safety program for Uranium One Americas including implementation of QA Program requirements related to radiation safety programs. The Radiation Safety Officer reports to the Manager of Environmental and Regulatory Affairs, Wyoming.

5 QUALITY OBJECTIVES

Environmental data for the Wyoming ISR sites, derived through long-term monitoring and data interpretation, will be of sufficient quantitative and qualitative value to determine whether performance criteria are being met. The type and quality of data provided to the appropriate regulatory agencies will be used to document the performance of the uranium recovery operation and later attainment of reclamation and restoration goals.

Monitoring strategy for sampling and analytical QA objectives for data include:

– Data will be of sufficient quality to withstand scientific and legal scrutiny.
– Data will be acquired in accordance with procedures appropriate for their intended use.
– Data will be of known accuracy and precision.

– Data will be complete, representative, and comparable.

5.1 Field Quality Objectives

The field and analytical methods chosen for use in completing the work are industry standards and are consistent with accepted standards for conducting environmental investigations.

5.2 Laboratory Quality Objectives

The quality of data generated by the analytical laboratory is dependent on method precision, accuracy, and sensitivity and the basic nature of the analysis and type of equipment used to perform an analysis. Precision is a measure of the reproducibility of an analytical measurement, and accuracy is the difference between a measured value and a true or known value. These considerations are dependent upon the sample matrix and performance criteria, and method sensitivity may not be achieved in all sample matrices.

5.2.1 Precision

Precision is the agreement between a set of replicate measurements without assumption about or knowledge of the true value. Precision is assessed on the basis of repetitive measurements. Replicate field measurements of ground water are not needed because they are sequentially recorded during well purging. Evaluations will be performed to judge the precision of both field and laboratory measurement processes.

Duplicate sample analyses are used to monitor the overall precision that can be expected for a particular environmental medium within an analytical sample batch. Requirements for the collection frequency of QA samples will be specified in the site-specific environmental planning document sample events.

In the laboratory, precision is a measure of reproducibility and may be determined by repeated analysis of laboratory control samples (LCSs) or reference standards or by duplicate analysis. The laboratory will demonstrate precision through analysis of replicate standards and performance samples prior to analysis of investigative samples as required by the particular analytical method.

5.2.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. The analytical laboratory will analyze reference materials to verify that the analytical results are not biased. Calibration and operational checks of field instruments will verify that no bias is present in field measurements.

5.2.3 Accuracy

Accuracy is the nearness of a measurement or the mean of a set of measurements, to the true value and is usually expressed as the difference between the two values or the difference as a percentage of true value.

It is not possible to directly assess accuracy of field measurements and water levels because true values for these measurements are not known. To ensure accuracy of the field data, instruments and equipment used in surveying, sampling, or obtaining the measurements will be maintained and calibrated. Accuracy of surface water and ground water field measurements is addressed indirectly through instrument checks and calibrations, which will be documented in field logbooks or on field data sheets, as appropriate.

Accuracy will be assessed for analytical data by examining the results obtained from laboratory Quality Control (QC) samples. The primary means of determining the accuracy of an analytical method is to compare the results of repeated measurements of laboratory control samples and reference material with published known values. The secondary method of accessing accuracy is to analyze matrix spike samples. Accuracy requirements of routine analytical services are specified in the analytical methods. Accuracy for each analysis will be stated as a percent recovery in laboratory analytical reports.

5.2.4 Representativeness

Representativeness is generally ensured through the use of standard sampling protocols. Representativeness will be accomplished:

- Through extensive sampling that includes implementation of field QA/QC procedures.
- By careful and informed selection of sampling sites, sampling depths, and analytical parameters
- Through the proper collection and handling of samples to avoid interferences and to minimize constituent loss
- By monitoring field activities to ensure procedure compliance and adherence to sampling protocols
- By meeting sample care and custody requirements

5.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability is ensured by employing approved sampling plans, standardized field procedures, and experienced personnel using properly maintained and calibrated instruments. In the laboratory, sample handling and preparation procedures, analytical procedures, holding times, and QA protocols will be adhered to. All data in a particular data set will be obtained by the same methods and will use consistent units for reportable data. Prescribed QC procedures will be used to provide results of known quality. Data will be grouped and evaluated according to similar sampling methods, sampling media, and laboratory analytical methods.

5.2.6 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the analyte of interest. An evaluation of sensitivity is included in the analytical methods that are used to analyze samples.

6 PERSONNEL AND TRAINING

6.1 Personnel Requirements

6.1.1 Training

Personnel will be qualified to perform their assigned job through meeting basic job description requirements, education standards, experience, and ongoing performance reviews. Training will be provided when needed to maintain proficiency; to adapt to new technologies, equipment, or instruments; and to perform new assigned responsibilities.

The Senior Environmental Specialist is responsible for determining site-required training and communicating the requirements to appropriate managers. Managers are responsible for determining training needs of their staff. Personnel assigned to environmental monitoring activities are responsible for ensuring that their required training are documented and are maintained in a current status for their assignments. At a minimum, individual training requirements will be reviewed annually and updated as needed.

The Senior Environmental Specialist is responsible for ensuring that personnel assigned to environmental monitoring tasks are sufficiently familiar with the implementing documents (e.g., plans, procedures, and drawings) and the requirements established for environmental monitoring, sample collection, analysis, documenting and reporting activities, and demonstrating proficiency.

The Senior Environmental Specialist will ensure that personnel assigned to field sampling activities can demonstrate proficiency when performing the work or that they are properly supervised by a person who is proficient.

6.1.2 Certifications

QA staff that performs independent assessments of environmental monitoring activities or management systems will be qualified as lead assessors.

Laboratories used for analysis of samples collected for characterization, compliance, or other purposes will be required to pass an audit or be certified by the National Environmental Laboratory Accreditation Conference (NELAC).

7 DATA GENERATION AND ACQUISITION

This section addresses aspects of the measurement system design and implementation to ensure that appropriate methods for sampling, analysis, data handling, and QC are employed and will be thoroughly documented.

7.1 Sampling Process Design

The data obtained through monitoring site conditions will be of sufficient quantity and quality to achieve environmental monitoring objectives.

Monitoring procedures for the Wyoming ISR sites have been established. These monitoring programs are designed to ensure that monitoring data would satisfy applicable regulations and would ensure that there were no unacceptable risks to human health or the environment. The site-specific environmental monitoring plan defines the sample locations and sampling frequency and determines the types of analyses that will be conducted on the samples collected from these locations. The plans are reviewed every 5 years, and changes to sampling strategies may be proposed on the basis of analytical results, site conditions, or regulatory requirements.

7.2 Sampling Methods

Field measurements and sample collection will follow procedures attached to nationally recognized consensus standards such as EPA methods, American Society for Testing and Materials standards, or instrument manufacturer recommended procedures. Deviation from approved procedures requires approval by the Senior Environmental Specialist before the start of work.

7.2.1 Sample Collection Procedures

Sampling procedures used at Wyoming ISR sites will be managed as controlled documents and will be amended according to the requirements of this plan.

Procedures must be followed for documenting field activities and delivering the samples to the laboratory. Procedures will identify the methods employed to obtain representative field measurements and samples of specified media. The procedures will identify the equipment, instruments, and sampling tools that are needed and, where appropriate, performance criteria (e.g., special handling, operational checks, field calibrations) to ensure the quality of the field data.

The Senior Environmental Specialist is responsible for ensuring that inspections, operations and maintenance activities, field measurements, and specified samples are properly documented, occur at the prescribed frequency and locations, and are obtained in compliance with procedures and requirements specified in the project documents. Daily QC checks and data reviews will ensure that requirements have been met. If field conditions prevent inspections, required field measurements, and/or specified sample collection, the conditions will be fully documented in the field book as a field variance.

7.2.2 Field Measurements and Sampling Methods

Field measurements and sampling schedules are summarized in the environmental monitoring procedures. The data obtained through these activities will be used to monitor compliance with performance requirements. Field procedures used in well inspections, field measurements, sample collection methods, field data, equipment and supplies applicable to the field activities, sample preservation requirements, and QC sample requirements are described in the environmental monitoring procedures.

7.3 Preparation and Decontamination Requirements for Sampling Equipment

7.3.1 Requirements for Sample Containers, Preservation, and Holding Times

Nondedicated equipment used in obtaining samples will be visually inspected and cleaned before use at each sample location. Measures will be taken (e.g., storage in trays, plastic bags, or boxes) to protect clean or decontaminated equipment while it is not being used. Sample containers will be inspected for integrity and cleanliness before being used. Suspect containers will be discarded in a manner that will preclude their inadvertent use, or they will be tagged and segregated for return to the supplier.

7.3.2 Container Requirements

Sample containers will be new or pre-cleaned. Containers will be of an adequate size to contain the required sample volume and of an approved material (e.g., amber/clear glass or HDPE) that does not promote sample degradation. As appropriate, supplier provided certificates of cleanliness will be retained with the project documentation.

Water samples collected for analysis will be filled to near 90 percent of capacity to allow for expansion.

7.3.3 Preservation and Holding Times

Efforts to preserve the integrity of the samples through prescribed chemical additives and/or temperature-controlled storage will be maintained as appropriate from the time the containers are received, throughout the sample collection and shipping process, and will continue until all analyses are performed. Procedures that will be employed to collect and preserve the integrity of the samples are described in the procedures. Holding times begin at the time the sample is collected, not when the sample is received by the laboratory.

7.3.4 Decontamination Procedures and Materials

Where practical, dedicated pumps will be installed in monitor wells and disposable materials will be used to minimize the decontamination requirements. The final rinse following equipment decontamination will be collected as an equipment blank QC sample.

7.4 Sample Handling and Custody Requirements

Sample handling, custody, and shipping procedures are addressed in the environmental monitoring procedures. A minimum number of individuals should be involved in sample collection and handling to ensure integrity of the sample and compliance with custody procedures. To maintain evidence of authenticity, the samples collected must be properly identified and easily discernable from like samples. To maintain the integrity of the sample, proper preservation, storage, and shipping methods will be used.

Unused sampling equipment, sample containers, and coolers that have been shipped or transported to a sampling location will be kept in a clean, temperature-controlled, and secure location to minimize damage, tampering, degradation, and possible cross-contamination.

7.4.1 Identification, Handling, Packaging, and Storage

7.4.1.1 Sample Identification

Environmental samples and associated QC samples will be assigned a unique identification number. In addition to the unique number, QC samples will be assigned a fictitious location identifier that is consistent with the sample location identification scheme.

Samples will be identified by a label or tag attached to the sample container that specifies, as appropriate, the project, sample location, unique identification number, preservatives added, date and time collected, and the sampler's name. Sample labels, tags, and/or container markings should be completed with indelible (waterproof) ink. Clear tape may be placed over each sample label for added protection, if needed.

7.4.1.2 Sample Handling and Storage

During field collection, sample containers may be stored in boxes, trays, or coolers, as dictated by protection and preservation needs. Samples that require refrigeration will be stored in coolers with sufficient ice to maintain the required temperature controls during field collection, packaging, and shipping. Samples that are not transported to the laboratory the day of collection must be stored in containers that will prevent damage or degradation of the sample. In addition, samples must be stored in locked containers or buildings when they are out of the direct control of the responsible custodian. Samples stored overnight or at locations where access is not solely controlled by the custodian will have custody seals placed on the outside of the container (cooler or box) as a measure of security.

7.4.1.3 Sample Custody

To ensure the integrity of the sample, the field custodian is responsible for the care, packaging, and custody of the samples until they are transferred to the laboratory.

Chain of Custody forms will be used to list all samples and transfers of sample possession to provide documentation that the samples were in constant custody between collection and analysis. The filled-in Chain of Sample Custody form, a copy of which is retained by the originator, will accompany samples that are sent or transported to the analytical laboratory.

7.4.1.4 Sample Packaging and Shipping

All samples will be handled, packaged, and transported or shipped in accordance with applicable U.S. Department of Transportation requirements. Sample storage containers (e.g., boxes or coolers) and sample containers will be securely packaged to protect the contents from damage, spilling, leaking, or breaking. Void space in shipping containers should be filled with an inert material or additional ice, if appropriate, to further protect and secure the contents.

Custody seals are not required for containers or samples that are transported directly to the analytical laboratory for analysis or interim storage. Custody seals are required for shipping containers (e.g., coolers or boxes) that are sent by common carrier. Clear tape should be placed over the seals as protection against tearing during shipment.

Mailed sample packages will be registered with return receipt requested. If packages are sent by common carrier, receipts are retained as part of the chain of custody documentation. Other commercial carrier documents shall be maintained with the chain of custody records.

7.4.2 Laboratory Requirements

7.4.2.1 Laboratory Sample Receipt

The subcontract analytical laboratory personnel are responsible for the care and custody of samples from the time they are received until the time the sample is analyzed and archive portions are discarded. On arrival at the laboratory, laboratory personnel must examine the container and document the receiving condition, including the integrity of custody seals, when applicable. When opening the shipping container, laboratory personnel will examine the contents and record the condition of the individual sample containers (e.g., bottles broken or leaking), the temperature (when applicable), method of shipment, carrier name(s), and other information relevant to sample receipt and log-in. Laboratory personnel verify that the information on the sample containers matches the information on the Chain of Sample Custody form.

7.4.2.2 Discrepancies Identified During Sample Receipt

If discrepancies are identified during the sample receiving process, laboratory personnel will attempt to resolve the problem by checking all available information (e.g., other markings on sample containers and type of sample), recording appropriate notes on the Chain of Sample Custody form, and contacting the Senior Environmental Specialist to resolve any questions.

If the laboratory judges the sample integrity to be questionable (e.g., samples arrive damaged or leaking, or the temperature range is exceeded), the Senior Environmental Specialist will be contacted and will bring in appropriate technical staff to make a decision regarding rejecting or flagging the data and/or re-sampling the location. Damaged samples will be rescheduled for collection and analysis, if necessary.

Discrepancies noted during sample receiving at a subcontracted laboratory or testing facility will be resolved in accordance with the procurement documents. In general, the Senior Environmental Specialist will be contacted to facilitate resolution of a problem.

7.4.2.3 Sample Disposition

When sample analyses and necessary QA/QC checks have been completed in the laboratory, the residual sample material and wastes generated as a result of the analytical process will be treated, shipped, and disposed of in accordance with all applicable federal, state, and local transportation and waste management requirements. When samples are stored, they will be protected to prevent damage or degradation. At a minimum, samples shall not be removed from the laboratory sooner than 60 days after the delivery of laboratory data reports.

7.4.3 Analytical Methods

Laboratories involved in the analysis of samples will have a written QA/QC program that provides rules and guidelines to ensure reliability and validity of the work conducted at the laboratory.

The analytical procedures to be used by subcontracted laboratory services will be specified in the procurement documents. These procedures typically consist of EPA methods. The use of these methods will ensure that required method detection limits and project reporting limits are achieved for each of the requested analytes.

Required analytical methods will be documented in appropriate site-specific documents.

7.4.3.1 Subcontracted Laboratory Requirements

The subcontracted laboratory will have a documented QA program in place, the implementation of which may be independently verified through proposal reviews, prior history, and/or pre-award survey. As appropriate, subcontracted laboratories will use EPA or EPA-approved methods or other methods specified and approved within the provisions of the procurement documents. Subcontracted laboratories are required to pass an audit or be certified by NELAC. Internal method requirements for analysis of spikes, duplicates, or replicates will be followed and may be used as performance indicators for these services.

Data turnaround times, sample disposition, and other requirements of the analytical laboratory are identified in procurement documents. The laboratory must obtain authorization from the Senior Environmental Specialist for changes to the procurement documents.

Work submitted to the laboratory may not be subcontracted by the laboratory without the prior consent of Uranium One Americas.

7.4.4 Quality Assurance/Quality Control

7.4.4.1 Field QA/QC

A variety of instruments, equipment, sampling tools, and supplies will be used to collect samples and to monitor site conditions. Proper inspection, calibration, maintenance, and use of the instruments and equipment are required to ensure field data quality. In addition, field QA will be implemented through the use of approved procedures, proper cleaning and decontamination, protective storage of equipment and supplies, and timely data reviews during field activities. The QC objective of these data collection activities is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of the data.

QC samples will consist of field duplicates, equipment rinsate blanks, and trip blanks, as appropriate, for the matrix and analytes involved. An additional volume of ground water for selected analyses will be collected for matrix spike/matrix spike duplicate (MS/MSD) use, as requested by the laboratory. Field QC samples will be used to quantitatively and qualitatively evaluate the analytical performance of the laboratory and to assess external and internal effects on the accuracy and comparability of the reported results. Field QC samples will be uniquely identified.

Where applicable, field measurement data will be compared to previous measurements obtained at the same location. Large variations (greater than 30 percent) in field measurement data at a location will be examined to evaluate whether general trends are developing. Variations in data that cannot be explained will be assigned a lower level of confidence through assignment of qualifiers or will be flagged for additional sampling or evaluation.

7.4.4.2 Laboratory QA/QC

Laboratory QC checks are internal system checks and control samples introduced by the laboratory into the sample analysis stream. These checks are used to validate data and calculate the accuracy and precision of the data. The objectives of the laboratory QA/QC program should be to:

- Ensure that procedures and any revisions are documented
- Ensure that analytical procedures are conducted according to sound scientific principals and have been validated
- Monitor the performance of the laboratory by a systematic inspection program and provide for corrective measures, as necessary.
- Collaborate with other laboratories in establishing quality levels, as appropriate
- Ensure that data are properly recorded and archived

Internal QA procedures for analytical services will be implemented by the laboratory in accordance with the laboratory's standard operating procedures. Data sheets, which also report the blank and spiked sample checks that have been performed, will be provided and will indicate when a QC check was performed. Analytical data that do not meet acceptance criteria will be qualified and flagged in accordance with standard operating procedures.

Laboratory quality control procedures are defined within the particular analytical method or are defined in procurement documents.

7.4.5 Instrument/Equipment Testing, Inspection, Calibration, and Maintenance

A variety of equipment, instruments, and sampling tools will be used to collect data and samples for the Wyoming ISR sites. Proper maintenance, calibration, and use of equipment and instruments are imperative to ensure the quality of all the data that are collected.

Field and laboratory equipment, instruments, tools, gauges, and other items used in performing work tasks that require preventive maintenance will be serviced in accordance with manufacturers' recommendations and instructions. When applicable, technical procedures will identify the manufacturers' instructions and recommended frequency for servicing the equipment. Preventive maintenance for calibrated measuring and test equipment will be performed either by field or laboratory personnel who are knowledgeable of the equipment, or by manufacturer's authorized service center as part of routine calibration tasks. Records of equipment calibration, repair, or replacement of controlled instruments will be filed and maintained in accordance with the applicable records management requirements.

Instruments that are not calibrated to the manufacturers' specifications will display a warning tag to alert the sampler and analyst that the instrument has only limited calibration.

7.4.5.1 Field Equipment and Instruments

Field equipment, instruments, and associated supplies used to obtain field measurements and collect samples are specified in sampling procedures.

Field personnel will conduct visual inspections and operational checks of field equipment and instruments before they are shipped or carried to the field and before using the equipment or instruments in field data collection activities. Whenever any equipment, instrument, or tool is found to be defective or fails to meet project requirements, it will not be used, and as appropriate, it will be tagged defective and segregated to prevent inadvertent use. Backup equipment, instruments, and tools should be available on site or within 1-day shipment to avoid delays in the field schedule.

The Senior Environmental Specialist is responsible for the overall maintenance, operation, calibration, and repairs made to field equipment, instruments, and tools. He is also responsible for ensuring that the field book has adequate documentation that describes any maintenance, repairs, and calibrations performed in the field.

Equipment and instruments used to obtain data will be maintained and calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturers' specifications. Calibration of equipment and instruments will be performed at approved intervals, as specified by the manufacturer, or more frequently as conditions dictate. Calibration standards used as reference standards will be traceable to the National Institute of Standards and Technology or other recognized standards when available. Instruments found to be out of tolerance will be tagged defective and segregated to prevent inadvertent use.

In some instances, calibration periods will be based on usage rather than periodic calibration. Equipment will be calibrated or checked as a part of its operational use.

Records of field calibration will be documented on forms provided for technical procedures or recorded in the field logbook. Calibration checks will be performed in accordance with procedures.

Procedures recommended by the manufacturer will be used for equipment preventive maintenance. Backup equipment, supplies, and critical spare parts (e.g., tape, bottles, filters, pH paper, tubing, probes, electrodes, and batteries) will be kept on site to minimize downtime. The Senior Environmental Specialist is responsible for ensuring that routine maintenance is performed and that tools and spare parts used to conduct routine maintenance are available.

7.4.5.2 Laboratory Equipment and Instruments

As part of the QA/QC program for the analytical laboratory, routine preventive maintenance is conducted to minimize the occurrence of instrument failure and other system malfunctions. The laboratory will maintain a schedule for servicing critical items and will perform routine maintenance, scheduled maintenance and repair, or coordinate with a vendor to arrange for maintenance and repair service, as required. All laboratory instruments will be maintained in accordance with the manufacturers' specifications and the requirements of the specific method employed. Equipment will be tested during routine calibration, and deficiencies will be corrected as specified in procedures.

The concentration of standards and frequency of initial and continuing calibration of analytical instruments will be as specified in the laboratory procedures. Calibration data will be provided with the analytical data package. Calibration records pertaining to subcontracted laboratory services will be filed and maintained by the laboratory in accordance with internal procedures.

7.4.6 Instrument/Equipment Calibration and Frequency

Calibration of analytical laboratory equipment will be based on approved written procedures. The concentration of standards and frequency of initial and continuing calibration of analytical instruments will be as specified in the laboratory SOPs. The analytical laboratory will maintain calibration records. Calibration data will be provided with the analytical data package, as specified in the procurement documents.

7.4.7 Inspection/Acceptance of Supplies and Consumables

7.4.7.1 Sample Containers

Sample containers for water, soil, sediment, and other media will be provided by the subcontracted laboratory and will be new or pre-cleaned. As appropriate, supplier-provided certificates of cleanliness will be retained with field documentation.

Containers will be visually inspected for integrity and cleanliness before being used. Suspect containers will not be used and will be discarded in a controlled manner to prevent inadvertent future use. If sufficient quantities of containers are suspect, the laboratory will immediately be notified of the condition and requested to provide a sufficient quantity of replacement containers. Suspect containers will be collected, segregated, and tagged for return to the analytical laboratory. The Senior Environmental Specialist will describe the situation in the field book as a field variance.

7.4.7.2 Supplies and Consumables

The Senior Environmental Specialist is responsible for ensuring that supplies, materials, and consumable items used during field activities are properly inspected for integrity, cleanliness, and compliance with specified tolerances and that they are appropriate to the activity. Items with a specified shelf life or expiration date will be labeled. Expired materials will not be used and will be properly disposed of or returned to the laboratory for disposal, as appropriate. Supplies, materials, and equipment will be inventoried at the conclusion of the sampling event in preparation for the next scheduled event.

7.4.8 Data Acquisition Requirements through Non-Direct Measurements

Data acquired through non-direct measurements may include data from historical databases, literature references, background information from historical facility files, climatic data, and regional geology or hydrology descriptions. Generally, these data are ancillary to the project.

Data from historical databases or historical facility files should be evaluated within the context in which they are presented and a determination made as to how accurate the data of interest may be. The exact nature of the evaluation likely will have to be made on a case-by-case basis. Information obtained from literature references should be from peer-reviewed journals or books whenever possible. Information such as climatic data and regional geology or hydrology descriptions should be obtained from documents produced by state or federal agencies whenever possible.

7.4.9 Data Management

Project data are generated mainly from routine sampling of monitor wells, routine operations system sampling, and occasional soil sampling events. The Senior

Environmental Specialist is responsible for managing project data in compliance with Uranium One Americas requirements.

Field data books are assembled for most sampling events. These books contain information such as sample location identification (ID), date, QA sample ID, well purge method, sampling method, and field measurements. These are completed at the time of sample collection.

Data from samples submitted to an analytical laboratory are received as both hard copy and as electronic data. The hard copy analytical reports are archived in the project records along with the original field data forms and other relevant hard copy forms or documents containing project data. The hard copy forms are categorized in the project records according to the project filing procedures. Electronic data are also archived in the project records according to the project filing procedures.

7.5 Data Validation and Usability

Technical data, including field data and results of laboratory analyses, will be routinely verified and validated to ensure that the data are of sufficient quality and quantity to meet the project's intended data needs. Results of data validation efforts will be documented and summarized in the site-specific validation reports. The Senior Environmental Specialist is responsible for initiating the review, verification, validation, and screening associated with field and/or laboratory data.

7.5.1 Field Measurement Data

The objective of field data verification is to ensure that data are collected in a consistent manner and in accordance with procedures and schedules established in the Wyoming ISR environmental planning documents. Field data validation procedures include a review of raw data and supporting documentation generated from field investigations. The data are reviewed for completeness, transcription errors, compliance with procedures, and accuracy of calculations.

The person doing the validation (in consultation with the Senior Environmental Specialist, if required) may correct problems that are found or noted in field documentation. Corrections to data forms will be made by lining through the incorrect entry, correcting the information, then initialing and dating the corrected information. The person validating the document, with the consent of the Senior Environmental Specialist, may also determine that incorrect data should not be entered into a database or that the data should have an additional qualifier.

7.5.2 Laboratory Data

The laboratory performing the analyses will document the analytical data in accordance with standard procedures inherent in the analytical methods and as approved by the Senior Environmental Specialist, if required.

Once the data package is received from the analytical laboratory, laboratory records and data package requirements will be checked to assess the completeness of the data package, and the data will be validated by personnel qualified and experienced in laboratory data validation.

The QC data provided by the laboratory (method blanks, matrix spikes, etc.) will be evaluated to see if they are within the acceptance range. If they are not, the data set affected by the QC samples will be evaluated to determine if corrective action is necessary.

7.5.2.1 Quality Control Samples

QC samples consisting of trip blanks, equipment rinsate blanks, field duplicate samples (replicated or co-located samples), laboratory spikes, laboratory blanks, laboratory duplicates, and laboratory control samples (including thermoluminescent dosimeters) are evaluated in the data validation process.

7.5.3 Qualification of Data and Corrective Actions

Qualification criteria are defined in the Uranium One Americas procedures. In addition to the process of qualifying the data, other corrective actions may be used. These may include reanalysis of the data by the laboratory or re-sampling of the affected locations. Other corrective actions to prevent contamination of future samples may also be proposed.

7.5.4 Determination of Anomalous Data

The final aspect of data validation involves the screening of both field and laboratory analytical data for potentially anomalous data points.

7.5.4.1 Data Screening

The initial step in determining potentially anomalous data points consists of screening all data from a sampling event for values that fall outside a designated historical data range. The historical data range used for comparison will be from previous sampling events.

7.5.4.2 Technical Review

The next step involves a review of the screened data by a qualified individual experienced in data review. Each data point will be evaluated to determine if the data point is acceptable or if follow-up action is required. This evaluation will consider factors such as number of historical data points, analyte concentration, magnitude of the deviation from the historical data range, number of historical non-detects, variability of the historical data, location of the sample point relative to other potential interfering activities, and correlation with other analytes.

7.5.4.3 Follow-up Actions

Follow-up actions can include one or more of the following:

- Requesting a laboratory check of calculations and dilutions
- Sample reanalysis
- Re-sampling
- Comparison to results from the next sampling event
- Data qualification

Based on the results of the follow-up action, the Senior Environmental Specialist will make a final determination of validity of the data point. The data point will be considered acceptable or it will be qualified, and a record of the action will be made. A summary of any anomalous data will be included in the site-specific data validation report.

7.5.4.4 Data Qualification

After the Senior Environmental Specialist has determined that a data point is anomalous, the data point will be qualified with an "R" flag (unusable) in the database. Qualification of data will be noted with a brief justification for the qualification.

7.6 Documentation and Records

The requirements for documentation and records management apply to the preparation, review, approval, issue, use, and revision of documents or forms that prescribe processes, specify requirements, or establish design. Records must be specified, prepared, reviewed, approved, and maintained as directed by Uranium One Americas policy.

Field and laboratory data will be sufficiently documented to provide a scientifically defensible record of the activities and analyses performed. Records of field variance reports, internal reviews, field and laboratory records of tests and analyses, field logs, Chain of Custody forms, and project reports will be used in interpreting and assessing the usability of the data. Standardized forms and computer files, codes, programs, and printouts will be designed to eliminate errors made during data entry and reduction. Calculation steps are described in the technical and analytical procedures and software lists. Routine data-transfer and data-entry verification checks are performed.

Laboratories must demonstrate continued proficiency through participation in performance evaluation programs required by the USNRC and WDEQ.

7.6.1 Records Management Plan

A site-specific records management plan shall be prepared to identify the records to be generated, file locations, and retention schedule for the Wyoming ISR site. The records management plan establishes the requirements for preparing, preserving, and storing records. Project personnel will work with the Senior Environmental Specialist, or his designee, to ensure that environmental monitoring records are correctly identified and maintained in accordance with the plan. Modifications to the plan shall be submitted to the Senior Environmental Specialist and are subject to his review and approval.

7.6.2 Document Control and Changes

Uranium One Americas policy and procedures will be followed to ensure that the preparation, issuance, and revisions to project documents and forms will be controlled so that current and correct information is available at the work location. These project documents (e.g., plans, procedures, drawings, and forms) and subsequent revisions will be reviewed for adequacy and approved before being issued for use. Written records and photo documentation will be handled in a manner that ensures association to the activity, the samples, and their locations. The Senior Environmental Specialist can authorize minor changes to project documents without requiring a formal review process.

At a minimum, personnel responsible for environmental monitoring activities at the Wyoming ISR site will have access to the applicable documents and will be knowledgeable of the contents before the associated work assignment.

Nonroutine sampling and field investigations will be documented in the file. The Senior Environmental Specialist will be briefed on and will approve all nonroutine field investigations before the work begins.

7.6.3 Corrections to Documents

When practical, correction of errors should be made by the individual who made the entry. The method used to make a correction is to draw a line through the error, enter the correct information, then initial and date the entry. The erroneous material must not be obscured.

When a document requires replacement due to illegibility or inaccuracies, the document will be voided, and a replacement document will be prepared. A notation will be made on the voided document that a replacement document was completed. The voided document will be retained with the field documentation.

7.6.4 Project Documents

Project documents are written materials that provide a background or history of the work, establish the basis for the work, give guidance to the work, and provide a summary of the work. They may be documents such as technical reports, technical and administrative plans, inspection or test documents, and design or as-built drawings. Documents prepared for the Wyoming ISR site that establishes instructions or procedures will be developed in accordance with the applicable requirements. Documents that are subject to revision will be managed and issued as controlled documents. These include, but are not limited to, the following documents:

- Quality Assurance Plans and Procedures
- Site-Specific Environmental Monitoring and Sampling Plans

7.6.5 Procedure Requirements

Uranium One Americas personnel will comply with the requirements of all approved written procedures or other instructions. Any deviation from approved field procedures must be authorized by the Senior Environmental Specialist. Field changes to project plans or deviation from procedures will be documented in the field book as a field variance and communicated to the Senior Environmental Specialist as soon as possible.

The Senior Environmental Specialist will be notified of any changes to subcontract laboratory procedures. He will be informed of and review changes to laboratory procedures. Impacts will be identified to the Senior Environmental Specialist. As appropriate, procedure changes that affect laboratory data will be identified and documented during the data review, verification, and validation activities. As appropriate, the Senior Environmental Specialist will inform Uranium One Americas management of technical or other substantive changes to laboratory procedures that may affect reporting limits or analytical sensitivity.

7.6.6 Field Documentation

Field documentation requirements are specified in the sampling procedures. All entries in field documents will be made with indelible (waterproof) ink and will be legible, reproducible, accurate, complete, and traceable to the sample measurements and/or site location. These documents will be retained as project records. Field documents are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the field sampling activities. Field logbooks and forms (e.g., sample collection data sheets, field measurement data forms, Chain of Custody forms, and shipping forms) will be stored in a manner that protects them from loss or damage.

The Senior Environmental Specialist will adequately document and identify field measurements and each sample collected. Field records will be completed at the time the observation or measurement is made and when the sample is collected. Project documents and written procedures will be available at the work site. The Senior Environmental Specialist will ensure that specified requirements are followed so that an accurate record of sample collection and transfer activities is maintained.

As appropriate, sample disposition will be specified to the subcontract laboratory in the appropriate procurement documents.

7.6.6.1 Field Books and Forms

Any person conducting field sampling will maintain a field book to provide a daily record of field activities associated with monitoring and sampling events and to document relevant operations and measurements. If initials are used in place of signatures, a signature/initials log will be maintained to identify personnel who are authorized to record, review, and authenticate field data.

Field books for project activities will be prepared, managed, and maintained in accordance with project records requirements. Project field books will be prepared and issued by the Senior Environmental Specialist. Field book information may include documentation associated with routine or ad hoc field measurements and sampling, chain of custody, soil boring and well installation, sampling equipment, calibration records and standards, and general field notes, including repairs made to equipment and instruments.

7.6.6.2 Field Variance and Nonconformance Documentation

Changes from specified field protocols established in planning documents or standard operating procedures must be authorized by the Senior Environmental Specialist and fully documented by the person doing the sampling. Field variances will be reported in a timely manner to evaluate the impact the variance has on the data or system operations. Field variance reporting applies to deviations from (1) prescribed field sampling and measurement requirements; (2) specified shipping, handling, or storage requirements; and (3) decontamination procedures.

A variance must be documented whenever an activity is performed or sample is obtained where:

- The activity performed or sample collection technique does not fall within the methods or protocols specified.
- The monitoring or measurement instrument that was used was out of calibration or had failed an operational check.
- Insufficient documentation results in the inability to trace the activity, measurement, or sample to the prescribed or selected location
- There is a loss of or damage to records that cannot be duplicated.

The variance should be fully described, and corrective action, if applicable, should be taken immediately. Comments describing the variance will be used during data evaluation to assess the use of associated results and validity of the data. Field variances should be noted in the field data sheet, on a general log sheet, or in the activity logbook. As appropriate, field variances will be summarized in the report at the conclusion of the activity.

7.6.6.3 Chain of Sample Custody

The custody of individual samples will be documented by recording each sample's identification, number of containers, and matrix on a standardized Chain of Custody form. This form will be used to list all transfers of sample possession.

7.6.7 Laboratory Documentation

The format and content of laboratory reports depend on contract requirements, regulatory reporting formats, and whether explanatory text is required. At a minimum, the laboratory data report will include the following items:

- Analytical method used

- Date and time of analysis
- The Chain of Custody form
- Sample receiving documentation
- QC data results and report
- Sample data results by analysis, including method detection limits, reporting limits, and dilution factors
- Summary of results (e.g., case narrative)
- Certification by the laboratory that the analytical data meet applicable data quality requirements

Analytical data that do not meet specified criteria will be qualified and flagged to allow data evaluation before use. Any nonconformances or difficulties encountered during analyses will be documented with each data package.

7.6.8 Reports Received from Subcontractors

7.6.8.1 Laboratory or Other Data Reports

Reporting requirements and formats will be defined in procurement documents issued for subcontracted services. The Senior Environmental Specialist will be consulted regarding difficulties or nonconformance associated with subcontracted analytical services and will resolve disputes that could affect data quality.

7.6.8.2 Plans and Technical Reports

The criteria for technical reports received from subcontracted services may include a deliverable schedule for draft and final documents, required reviews, format, software type and version requirements, and contents of the document, including any supporting documents, data, and references.

7.7 Quality Improvement, Assessment, and Oversight

All personnel must continually seek to improve the quality of their work. This section addresses the activities for assessing the effectiveness of the implementation of the project and associated QA/QC requirements.

7.7.1 Quality Improvement

Management encourages innovation and continuous improvement in the work environment by fostering a "no fault" attitude to encourage the identification of problems and to create an atmosphere of openness to suggestions for improvement. All personnel are encouraged to identify and suggest improvements.

Personnel have the freedom and authority to stop work until effective corrective action has been taken. Work that is performed by subcontractors will be subject to oversight. The work may be suspended immediately for imminent threats to health, safety, environmental release, or significant adverse quality issues. Re-start of such work stoppages will be at the direction of the Senior Vice President, ISR Operations.

7.7.2 Assessment and Response Actions

Assessments of project activities will be planned and scheduled with the appropriate levels of management. The Director of Environmental and Regulatory Affairs is responsible for scheduling and administering the internal assessment plan. When the assessment is conducted, results will be evaluated to measure the effectiveness of the implemented quality system. Assessment activities may include management assessments and independent assessments.

Assessment activities will be documented. Reports resulting from management assessments will be issued to the responsible manager and distributed internally to project management. Assessment activities involving subcontracted services will be coordinated with the appropriate levels of project management and will be documented.

The Senior Environmental Specialist will promptly define corrective actions and correct deficiencies identified through assessments. Corrective actions will be independently verified by staff not organizationally reporting to the Senior Environmental Specialist. Verification will be documented and retained in the assessment file.

7.7.2.1 Management Assessments

Included in the management assessments are human resource issues, operations issues, resource allocation, financial performance, financial controls, and quality control. The Senior Vice President, ISR Operations is responsible for ensuring that project staff supports these activities as delegated, that they observe firsthand the work in progress, communicate with those performing the work, identify potential or current problems, and identify good practices.

The Senior Vice President, ISR Operations shall determine the scope, schedule, and responsibilities for site-specific management assessment. All levels of management are responsible for responding to assessment findings and completing agreed-upon corrective actions.

7.7.2.2 Independent Assessments

Independent assessments (e.g., audits and surveillances) will be planned, performed, and documented in accordance with written instructions, procedures, or checklists.

Personnel who lead independent assessments (audits or surveillances) must be qualified, have reporting independence, and have access to the areas of inquiry. The Senior Vice President, ISR Operations or designee will track, report on the status, and verify closure of independent assessments and external assessment findings.

The Senior Vice President, ISR Operations is responsible for responding to assessment findings and ensuring that agreed-upon corrective actions are completed in a timely manner.

7.7.3 Reviews

Reviews are an integral component to the success of project activities. Reviews are conducted during planning and throughout the project to ensure that project objectives will be met. Reviews conducted at the project level may consist of:

- Management reviews—to ensure the adequacy of planning and availability of resources
- Administrative and technical reviews—typically include reviews of project documents to ensure that project objectives are clearly described and sufficiently planned, scheduled, and managed in accordance with project management strategies.
- Procurement Reviews—typically Uranium One Americas policies and procedures that apply to purchasing goods and services. Subcontracted analytical laboratories are required to have a documented QA program. Laboratory capability may be evaluated through review of the QA program description or through pre-award survey or vendor audit activities. The results of the survey are documented and provided to the laboratory.
- Readiness Reviews—Readiness reviews are routinely conducted to ensure that appropriate planning has taken place to allow the work to proceed safely and effectively and to ensure that as many contingencies and prerequisites as possible have been reviewed and addressed for the work. The Senior Vice President, ISR Operations is responsible for determining the level of rigor and formality of project readiness reviews based on complexity, frequency, and risk of work. Readiness reviews are routinely planned and conducted before the start of major project activities, before the start of new or infrequent tasks, and prior to scheduled sampling events.
- Independent Peer Reviews—May be conducted to solicit input for the planned technical approach and data quality objectives of the project or task.

- Data Review—to ensure that the data collected and used for each activity of the project are of sufficient quality. The Senior Environmental Specialist will conduct data reviews as a quality measure to ensure the adequacy and completeness of field activities. In addition, data review, verification, and validation will be conducted after a sampling event. Analytical data will be reviewed and summarized in the laboratory report. The results will include an explanation of any laboratory problems and their possible effects on data quality.

7.7.4 Reports to Management

Management assessments, internal assessments, and external appraisal report findings are documented. The QA organization maintains the schedule and file for these reports that are typically issued to the responsible manager.

Quality improvement actions (e.g., planning, lessons learned, nonconformance reporting, tracking and follow-up, and reviews) will be documented and reported to management.

6 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

The objective of groundwater restoration, surface reclamation, and facility decommissioning is to return the affected environment (groundwater and land surface) to conditions such that they are suitable for uses for which they were suitable prior to mining. The methods to achieve this objective for both the affected groundwater and the land surface are described in the following sections.

6.1 PLANS AND SCHEDULES FOR GROUNDWATER QUALITY RESTORATION

6.1.1 Groundwater Restoration Criteria

The purpose of groundwater restoration is to protect groundwater adjacent to the mining zone. Approval of an aquifer exemption by the WDEQ and the EPA is required before mining operations can begin. The aquifer exemption removes the mining zone from protection under the Safe Drinking Water Act (SDWA). Approval is based on existing water quality, the ability to commercially produce minerals, and the lack of use as an underground source of drinking water (USDW). Groundwater restoration prevents any mobilized constituents from affecting aquifers adjacent to the ore zone.

The goal of the groundwater restoration efforts will be to return the groundwater quality of the production zone, on a wellfield average, to the standard of pre-mining class of use or better using Best Practicable Technology (BPT) as defined in §35-11-103(f)(i) of the Wyoming Environmental Quality Act, 2006. The pre-mining class of use will be determined by the baseline water quality sampling program which is performed for each wellfield, as compared to the use categories defined by the WDEQ, Water Quality Division (WQD). Baseline, as defined for this project, shall be the mean of the pre-mining baseline data after outlier removals. Restoration shall be demonstrated in accordance with Chapter 11, Section 5(a)(ii) of the WDEQ, Land Quality Division Rules and Regulations.

The evaluation of restoration of the groundwater within the production zone shall be based on the average baseline quality over the production zone. Baseline water quality will be collected for each wellfield from the wells completed in the planned production zone (i.e., MP-Wells). The evaluation of restoration will be conducted on a parameter by parameter basis. Restoration Target Values (RTVs) are established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-mining values. Table 6.1-1 entitled Baseline Water Quality Parameters lists the parameters included in the RTVs.

Baseline values will not be changed unless the operational monitoring program indicates that baseline water quality has changed significantly due to accelerated movement of groundwater, and that such change justifies redetermination of baseline water quality. Such a change would require resampling of monitor wells and review and approval by the WDEQ.

Table 6.1-1 Baseline Water Quality Parameters

Parameter (units)
Dissolved Aluminum (mg/l)
Ammonia Nitrogen as N (mg/l)
Dissolved Arsenic (mg/l)
Dissolved Barium (mg/l)
Boron (mg/l)
Dissolved Cadmium (mg/l)
Dissolved Chloride (mg/l)
Dissolved Chromium (mg/l)
Dissolved Copper (mg/l)
Fluoride (mg/l)
Gross Alpha (pCi/l)
Gross Beta (pCi/l)
Total and Dissolved Iron (mg/l)
Dissolved Mercury (mg/l)
Dissolved Magnesium (mg/l)
Total Manganese (mg/l)
Dissolved Molybdenum (mg/l)
Dissolved Nickel (mg/l)
Nitrate + Nitrite as N (mg/l)
Dissolved Lead (mg/l)
Radium-226 (pCi/L)

Table 6.1-1 Baseline Water Quality Parameters

Parameter (units)
Radium-228 (pCi/L)
Dissolved Selenium (mg/l)
Dissolved Sodium (mg/l)
Sulfate (mg/l)
Uranium (mg/l)
Vanadium (mg/l)
Dissolved Zinc (mg/l)
Dissolved Calcium (mg/l)
Bicarbonate (mg/l)
Carbonate (mg/l)
Dissolved Potassium (mg/l)
Total Dissolved Solids (TDS) @ 180°F (mg/l)

Source: WDEQ LQD Guideline 8, Hydrology, March 2005

6.1.2 Estimate of Post-Mining Groundwater Quality

EMC has estimated the post-mining water quality based on the experience of COGEMA Mining, Inc. in Production Units 1 through 9 at the Irigaray ISR project located in the Powder River Basin near the proposed Moore Ranch Uranium Project[1]. The Irigaray data was selected because of the proximity and similar geologic conditions to Moore Ranch. Cogema employed ammonium bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine production units located in a 30 acre site.

The water quality of the Irigaray ore zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Table 6.1-2. The chemical alteration of the ore zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations.

Table 6.1-2 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Aluminum (mg/l)	<0.05 – 4.25	<1.037
Ammonia Nitrogen as N (mg/l)*	<0.05 – 1.88	23
Dissolved Arsenic (mg/l)	<0.001 – 0.105	<0.601
Dissolved Barium (mg/l)	<0.01 – 0.12	<1.067
Boron (mg/l)	<0.01 – 0.225	<0.442
Dissolved Cadmium (mg/l)	<0.002 – 0.013	<0.979
Dissolved Chloride (mg/l)*	5.3 – 15.1	277
Dissolved Chromium (mg/l)	<0.002 – 0.063	<1.018
Dissolved Copper (mg/l)	<0.002 – 0.04	<0.828
Fluoride (mg/l)	0.11 – 0.66	<1
Total and Dissolved Iron (mg/l)	0.02 – 11.8	<1.098
Dissolved Mercury (mg/l)	<0.0002 - <0.001	<0.971
Dissolved Magnesium (mg/l)	0.02 – 9.0	45.7
Total Manganese (mg/l)	<0.005 – 0.190	1.249
Dissolved Molybdenum (mg/l)	<0.02 - <0.1	<1.067
Dissolved Nickel (mg/l)	<0.01 - <0.2	<1.018
Nitrate + Nitrite as N (mg/l)	<0.2 – 1.0	<3
Dissolved Lead (mg/l)	<0.002 - <0.050	<1.018
Radium-226 (pCi/L)	0 – 247.7	200.5
Dissolved Selenium (mg/l)	<0.001 – 0.416	0.247
Dissolved Sodium (mg/l)	95 - 280	827
Sulfate (mg/l)	136 - 824	639
Uranium (mg/l)	<0.0003 – 18.8	7.411
Vanadium (mg/l)	<0.05 – 0.55	<1.067
Dissolved Zinc (mg/l)	<0.01 – 0.200	<0.065
Dissolved Calcium (mg/l)*	1.6 – 33.5	199.2
Bicarbonate (mg/l)*	5 - 144	1343
Carbonate (mg/l)	0 - 96	<2

Table 6.1-2 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Potassium (mg/l)	0.4 – 17.5	9
Total Dissolved Solids (TDS) @ 180°F (mg/l)	308 - 1054	2451

* Parameters with RTV other than baseline

EMC expects similar baseline and post-mining water quality at the Moore Ranch site. The success of groundwater restoration at the Irigaray site is discussed in Section 6.1.5.

6.1.3 Groundwater Restoration Method

The commercial groundwater restoration program consists of two stages, the restoration stage and the stability monitoring stage. The restoration stage typically consists of three phases:

1) Groundwater transfer;
2) Groundwater sweep;
3) Groundwater treatment.

These phases are designed to optimize restoration equipment used in treating groundwater and to minimize the volume of groundwater consumed during the restoration stage. EMC will monitor the quality of groundwater in selected wells as needed during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary. Online production wells used in restoration will be sampled for uranium concentration and for conductivity to determine restoration progress on a pattern-by-pattern basis.

The sequence of the activities will be determined by EMC based on operating experience and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by EMC.

A reductant may be added at any time during the restoration stage to lower the oxidation potential of the mining zone. Either a sulfide or sulfite compound may be added to the injection stream in concentrations sufficient to establish reducing conditions within the mining zone. EMC may also employ bioremediation as a reduction process.

Reductants are beneficial because several of the metals, which are solubilized during the leaching process, are known to form stable insoluble compounds, primarily as sulfides.

Dissolved metal compounds that are precipitated under reducing conditions include those of arsenic, molybdenum, selenium, uranium and vanadium.

6.1.3.1 Groundwater Transfer

During the groundwater transfer phase, water may be transferred between a wellfield commencing restoration and a wellfield commencing mining operations. Also, a groundwater transfer may occur within the same wellfield, if one area is in a more advanced state of restoration than another.

Baseline quality water from the wellfield commencing mining will be pumped and injected into the wellfield in restoration. The higher TDS water from the wellfield in restoration will be recovered and injected into the wellfield commencing mining. The direct transfer of water will act to lower the TDS in the wellfield being restored by displacing affected groundwater with baseline quality water.

The goal of the groundwater transfer phase is to blend the water in the two wellfields until they become similar in conductivity. The water recovered from the restoration wellfield may be passed through ion exchange (IX) columns and/or filtered during this phase if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens.

For the groundwater transfer between wellfields to occur, a newly constructed wellfield must be ready to commence mining. Therefore this phase may be initiated at any time during the restoration process. If a wellfield is not available to accept transferred water, groundwater sweep or some other activity will be utilized as the first phase of restoration.

The advantage of using the groundwater transfer technique is that it reduces the amount of water that must ultimately be sent to the waste water disposal system during restoration activities.

6.1.3.2 Groundwater Sweep

Groundwater sweep may be used as a stand-alone process where groundwater is pumped from the wellfield without injection causing an influx of baseline quality water from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The plume of affected water near the perimeter of the wellfield is also drawn inside the boundaries of the wellfield. Groundwater sweep may also be used in conjunction with the groundwater treatment phase of restoration. The water produced during groundwater sweep is disposed of in an approved manner.

The rate of groundwater sweep will be dependent upon the capacity of the waste water disposal system and the ability of the wellfield to sustain the rate of withdrawal.

6.1.3.3 Groundwater Treatment

Either following or in conjunction with the groundwater sweep phase water will be pumped from the mining zone to treatment equipment at the surface. Ion exchange (IX), reverse osmosis (RO) or Electro Dialysis Reversal (EDR) treatment equipment will be utilized during this phase of restoration.

Groundwater recovered from the restoration wellfield will be passed through an IX system prior to RO/EDR treatment, as part of the waste disposal system or it will be re-injected into the wellfield. The IX columns exchange the majority of the contained soluble uranium for chloride or sulfate. Additionally, prior to or following IX treatment, the groundwater may be passed through a de-carbonation unit to remove residual carbon dioxide that remains in the groundwater after mining.

At any time during the process, a reductant (either biological or chemical), which will be used to create reducing conditions in the mining zone, may be metered into the restoration wellfield injection stream. The concentration of reductant injected into the formation is determined by how the mining zone groundwater reacts with the reductant. The goal of reductant addition is to decrease the concentrations of redox sensitive elements.

All or some portion of the restoration recovery water can be sent to the RO unit. The use of an RO unit 1) reduces the total dissolved solids in the affected groundwater, 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits, 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal, and 4) enhances the exchange of ions from the formation due to the large difference in ion concentration. The RO passes a high percentage of the water through the membranes, leaving 60 to 90 percent of the dissolved salts in the brine water or concentrate. The clean water, called permeate, will be re-injected or stored for use in the mining process. The permeate may also be de-carbonated prior to re-injection into the wellfield. The brine water that is rejected contains the majority of dissolved salts in the affected groundwater and is sent for disposal in the waste system. Make-up water, which may come from water produced from a wellfield that is in a more advanced state of restoration, water being exchanged with a new mining unit, water being pumped from a different aquifer, the purge of an operating wellfield or a combination of these sources, may be added prior to the RO or wellfield injection stream to control the amount of "bleed" in the restoration area.

The reductant (either biological or chemical) added to the injection stream during this stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding the reductant, the Eh of the aquifer is lowered thereby decreasing the solubility of these elements. Regardless of the reductant used, a comprehensive safety plan regarding reductant use will be implemented.

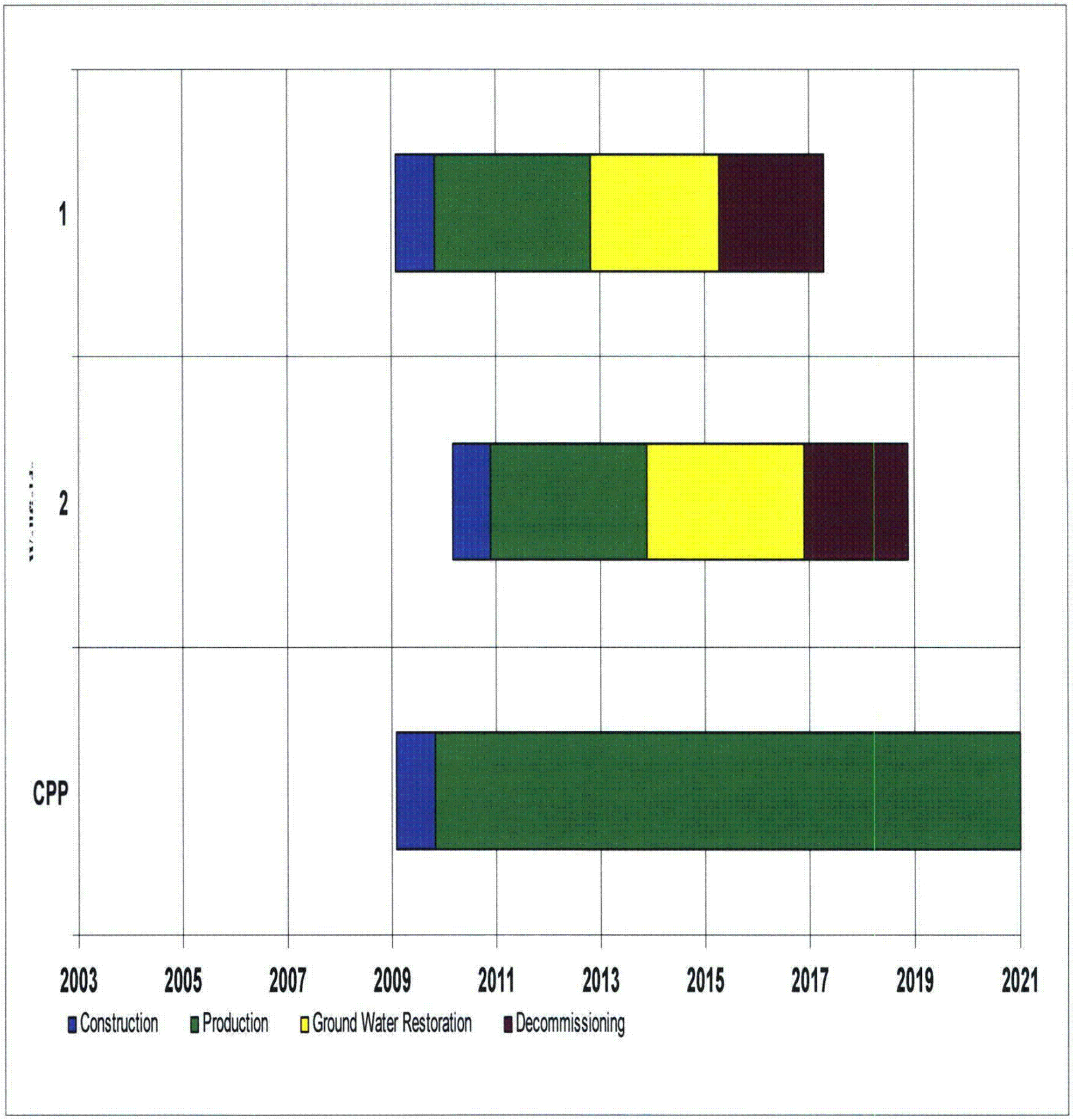
If necessary, sodium hydroxide may be used during the groundwater treatment phase to return the groundwater to baseline pH levels. This will assist in immobilizing certain parameters such as trace metals.

The number of pore volumes treated and re-injected during the groundwater treatment phase will depend on the efficiency of the RO in removing Total Dissolved Solids (TDS) and the success of the reductant in lowering the uranium and trace element concentrations. Estimates of the number of pore volumes required for each restoration phase are discussed in Section 6.6.

6.1.4 Restoration Schedule

The proposed Moore Ranch mine schedule is shown in Figure 6.1-1 showing the estimated schedule for restoration. The restoration schedule is preliminary based on EMC's current knowledge of the area and are based the completion of mining activities for the three wellfields. As the Moore Ranch Project is developed, the restoration schedule will be defined further.

Figure 6.1-1 Proposed Moore Ranch Operations and Restoration Schedule



6.1.5 Effectiveness of Groundwater Restoration Techniques

The groundwater restoration methods described in this application have been successfully applied at other uranium ISR facilities in the Powder River Basin as well as in Nebraska and Texas. A number of uranium ISR mines in Wyoming, Nebraska, and Texas have successfully restored groundwater and obtained regulatory approval of restoration using these techniques. The following two ISR facilities are located in the Powder River Basin near the proposed Moore Ranch Project.

- Smith Ranch/Highland Uranium Project

Groundwater restoration activities at the Smith Ranch-Highland Uranium Project currently operated by Power Resources, Inc. (PRI) have been approved by the NRC and the WDEQ for the R&D operations and for the A-Wellfield during commercial operations. In 1987, the NRC confirmed successful restoration of the Q-sand project. Although one well exhibited uranium and nitrate levels above the target restoration values, the wellfield averages on a whole were below the targets.

In 2004, the NRC concurred with the WDEQ's determination that the A-wellfield at Highland had been restored in accordance with the applicable regulatory requirements[2]. Not all of the parameters were returned to baseline conditions, but the groundwater quality was consistent with the pre-mining class of use.

- Irigaray/Christensen Ranch Uranium Project

Groundwater restoration activities at the Irigaray/Christensen Ranch Uranium Project operated by Cogema Mining, Inc. have been approved by the NRC and the WDEQ for Wellfields 1 through 9 following commercial operations and groundwater restoration. Post-mining water quality in the nine production units was described in Section 6.1.2. The WDEQ determined that twenty-seven of twenty-nine constituents were restored below the restoration target values. Only bicarbonate and manganese did not meet the baseline range. WDEQ determined that these two constituents met the criteria of pre-mining class of use. Based on this, the WDEQ determined that the groundwater, as a whole, had been returned to its pre-mining class of use and that the post restoration groundwater conditions did not significantly differ from the background water quality.

In 2006, the NRC concurred with the WDEQ's determination that wellfields 1 through 9 at Irigaray had been restored in accordance with the applicable regulatory requirements[3]. NRC determined that Cogema used best practicable technology and agreed that the WDEQ class-of-use standards were met.

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6.1.6 Environmental Effects of Groundwater Restoration

Based on the effectiveness of groundwater restoration at other ISR mines in the Powder River Basin, EMC expects that the proposed groundwater restoration techniques will successfully return the mining zone at Moore Ranch to the restoration target values. As discussed in Section 6.1.1, the purpose of restoring the groundwater to these restoration target values is to protect adjacent groundwater that is outside the production zone. If a constituent cannot technically or economically be restored to its restoration target value within the exploited production zone, WDEQ and NRC will require that EMC demonstrate that leaving the constituent at a higher concentration will not be a threat to public health and safety or the environment or produce an unacceptable impact to the use of adjacent groundwater resources. EMC believes that the application of proven best practicable technology for groundwater restoration and the regulatory requirements that are in place at the State and federal level will ensure that there is no adverse impact on the water quality of groundwater outside the production zone.

The proposed restoration methods consume groundwater. Groundwater recovered during groundwater sweep is generally directly disposed in the waste water system. Approximately 20 to 25 percent of the groundwater treatment flow through the RO system is disposed as RO brine. This consumption of groundwater is an unavoidable consequence of groundwater treatment. Impacts and water usage during operations and restoration are discussed in more detail in Section 7.2.5.1.

6.1.7 Groundwater Restoration Monitoring

6.1.7.1 Monitoring During Active Restoration

During restoration, lixiviant injection is discontinued and the quality of the groundwater is constantly being improved, thereby greatly diminishing the possibility and relative impact of an excursion. Therefore, the monitor ring wells (M-Wells), overlying aquifer wells (MO or MS-Wells), and underlying aquifer wells (MU or MD-Wells) are sampled once every 60 days and analyzed for the excursion parameters, chloride, total alkalinity and conductivity. Water levels are also obtained at these wells prior to sampling.

In the event that unforeseen conditions (such as snowstorms, flooding, equipment malfunction) occur, the WDEQ will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event.

The mining zone will monitored on a frequent basis adequate enough to determine success of restoration, optimize efficiency of restoration techniques, and determine any

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areas of the wellfield that need additional attention. Samples will be monitored for all of the parameters shown in Table 6.1-1 at the start of restoration and all or selected parameters through restoration as needed.

6.1.7.2 Restoration Stability Monitoring

A minimum six month groundwater stability monitoring period will be implemented to show that the restoration goal has been adequately maintained. The following restoration stability monitoring program will be performed during the stability period:

- The monitor ring wells will be sampled once every two months and analyzed for the UCL parameters, chloride, total alkalinity (or bicarbonate) and conductivity; and

- At the beginning, middle and end of the stability period, the MP-Wells will be sampled and analyzed for the parameters in Table 6.1-1.

In the event that unforeseen conditions (such as snowstorms, flooding, equipment malfunction) occur, the WDEQ will be contacted if any of the M-Wells or MP-Wells cannot be monitored within 65 days of the last sampling event.

The six month stability monitoring period is specified in WDEQ-LQD Guideline 4. The criteria to establish restoration stability will be based on wellfield averages for water quality. A determination of aquifer stablility should be made upon the "trends" in the data; i.e., a stable aquifer should not exhibit rapid upward or downward trends or be oscillating back and forth over a wide range of values. The data is evaluated against baseline quality and variability to determine if the restoration goal is met and if the water is restored at a minimum to within the class of use.

6.1.8 Well Plugging and Abandonment

Wellfield plugging and surface reclamation will be initiated once the regulatory agencies concur that the groundwater has been adequately restored and that groundwater quality is stable. All production, injection and monitor wells and drillholes will be abandoned in accordance with WS-35-11-404 and Chapter VIII, Section 8 of the WDEQ-LQD Rules and Regulations to prevent adverse impacts to groundwater quality or quantity.

Wells will be plugged and abandoned in accordance with the following program.

- When practicable, all pumps and tubing will be removed from the well.
- All wells will be plugged from total depth to within 23 feet of the collar with a nonorganic well abandonment plugging fluid of neat cement or bentonite based grout mixed in the recommended proportion of 20 lbs per barrel of water, to yield an abandonment fluid with a 10 minute gel strength of at least 20 lbs/100 sq ft and a filtrate volume not to exceed 13.5 cc.
- The casing is cut off at least three feet below the ground surface. Abandonment fluid is topped off to the top of the cut-off casing. A steel plate is placed atop the sealing mixture showing the permit number, well identification, and date of plugging.
- A cement plug is placed at the top of the casing (if cement is not within three feet of the surface), and the area is backfilled, smoothed, and leveled to blend with the natural terrain.

As an alternative method of well plugging, a dual plug procedure may be used where a cement plug will be set using slurry of a weight of no less than 12 lbs/gallon into the bottom of the well. The plug will extend from the bottom of the well upwards across the first overlying aquitard. The remaining portion of the well will be plugged using a bentonite/water slurry with a mud weight of no less than 9.5 lbs/gallon. A 10-foot cement top plug will be set to seal the well at the surface.

6.1.9 Restoration Wastewater Disposal

EMC plans to install deep disposal wells (EPA UIC Class I non-hazardous wells) at the Moore Ranch Uranium Project as the primary liquid waste disposal method. EMC believes that permanent deep disposal is preferable to evaporation in evaporation ponds. Disposal in a Class I well permanently isolates the waste water from the public and the environment. Alternatives assessed by EMC for waste water disposal are discussed in Section 8.

Based on the expected post mining concentrations of groundwater quality constituents discussed in Section 6.1.2 and the proposed groundwater restoration techniques discussed in Section 6.1.3, EMC projects that the restoration injection stream will exhibit the range of characteristics shown in Table 6.1-3.

Table 6.1-3 Projected Moore Ranch Restoration Injection Stream Water Quality

Parameter	Units	Min	Max
Calcium	mg/l	350	700
Magnesium	mg/l	50	150
Sodium	mg/l	400	950
Potassium	mg/l	40	90
Carbonate	mg/l	0	0.3
Bicarbonate	mg/l	200	1250
Sulfate	mg/l	900	2500
Chloride	mg/l	300	1000
Nitrate	mg/l	0.01	0.5
Fluoride	mg/l	0.01	2
Silica	mg/l	10	65
Total Dissolved Solids	mg/l	1000	6500
Conductivity	µmho/cm	1000	5500
Alkalinity	mg/l	165	1025
pH	Std. Units	6	12
Arsenic	mg/l	0.01	1
Cadmium	mg/l	0.0001	0.001
Iron	mg/l	0.5	15
Lead	mg/l	0.01	0.04
Manganese	mg/l	0.01	1.5
Mercury	mg/l	0.0001	0.001
Molybdenum	mg/l	0.1	1.5
Selenium	mg/l	0.01	0.5
Uranium	mg/l	0.05	15
Ammonia	mg/l	0.1	0.5
Radium-226	pCi/l	500	5000

All compatible liquid wastes generated during groundwater restoration at Moore Ranch will be disposed in the planned deep wells. An application is under preparation for submittal to the WDEQ for a Class I UIC Permit for the Moore Ranch Uranium Project.

6.2 PLANS AND SCHEDULES FOR RECLAIMING DISTURBED LANDS

6.2.1 Introduction

All lands disturbed by the mining 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 6.1.8.

- Determination of appropriate cleanup criteria for structures (Section 6.3) and soils (Section 6.4).

- 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 6.3.

- 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.

6.2.2 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.

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.

6.2.3 Topsoil Handling and Replacement

In accordance with WDEQ-LQD requirements, topsoil is salvaged from building sites, permanent storage areas, main access roads, graveled wellfield access roads and chemical storage sites. Conventional rubber-tired, scraper-type earth moving equipment is typically used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations is determined by wellfield pattern emplacement and designated wellfield access roads within the wellfields, which will be determined during final wellfield construction activities.

As described in Section 2.6, topsoil thickness varies within the permit area from non-existent to several feet in depth. However, typical topsoil stripping depths are expected to range from 3 to 6 inches.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles will be generally located on the leeward side of hills to minimize wind erosion. Stockpiles will not be located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles will be seeded as soon as possible after construction with the permanent seed mix. In accordance with WDEQ-LQD requirements, all topsoil stockpiles will be identified with a highly visible sign with the designation "Topsoil."

During mud pit excavation associated with well construction, exploration drilling and delineation drilling activities, topsoil is separated from subsoil with a backhoe. When use of the mud pit is complete, all subsoil is replaced and topsoil is applied. Mud pits only remain open a short time, usually less than 30 days. Similarly, during pipeline construction, topsoil is stored separate from subsoil and is replaced on top of the subsoil after the pipeline ditch is backfilled.

6.2.4 Final Contouring

Recontouring of land where surface disturbance has taken place will restore it to a surface configuration that will blend in with the natural terrain and will be consistent with the post mining land use. Since no major changes in the topography will result from the proposed mining operation, a final contour map is not required. As a result, the pre-operations contour shown on Figure 2.1-2 will generally show post-mining contour.

6.2.5 Revegetation Practices

Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. During mining operations the topsoil stockpiles, and as much as practical of the disturbed wellfield areas will be seeded to establish a vegetative cover to minimize wind and water erosion. After topsoiling prior to final reclamation, an area will normally be seeded with a nurse crop to establish a standing vegetative cover along with the permanent seed mix. A long term temporary seed mix may be used in the wellfields and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long term seed mix typically consists of one or more of the native wheat grasses (i.e. Western Wheatgrass, Thickspike Wheatgrass).

Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent mix typically contains native wheat grasses, fescues, and clovers. Typical seeding rates will be 12-14 lbs of pure live seed per acre.

The success of permanent revegetation in meeting land use and reclamation success standards will be assessed prior to application for bond release by utilizing the "Extended Reference Area" method as detailed in WDEQ-LQD Guideline No. 2 - Vegetation (March 1986). This method compares, on a statistical basis, the reclaimed area with adjacent undisturbed areas of the same vegetation type.

The Extended Reference Areas will be located adjacent to the reclaimed area being assessed for bond release and will be sized such that it is at least half as large as the area being assessed. In no case will the Extended Reference Area be less than 25 acres in size.

The WDEQ-LQD will be consulted prior to selection of Extended Reference Areas to ensure agreement that the undisturbed areas chosen adequately represent the reclaimed areas being assessed. The success of permanent revegetation and final bond release will be assessed by the WDEQ-LQD.

6.3 PROCEDURES FOR REMOVING AND DISPOSING OF STRUCTURES AND EQUIPMENT

6.3.1 Preliminary Radiological Surveys and Contamination Control

Prior to process plant decommissioning, a preliminary radiological survey will be conducted to characterize the levels of contamination on structures and equipment and to identify any potential hazards. The survey will support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. In general, the contamination control program used during mining operations (as discussed in Section 5.7) will be appropriate for use during decommissioning of structures.

Based on the results of the preliminary radiological surveys, gross decontamination techniques will be employed to remove loose contamination before decommissioning activities proceed. This gross decontamination will generally consist of washing all accessible surfaces with high-pressure water. In areas where contamination is not readily removed by high-pressure water, a decontamination solution (e.g., dilute acid) may be used.

6.3.2 Removal of Process Buildings and Equipment

The majority of the process equipment in the process building will be reusable, as well as the building itself. Alternatives for the disposition of the building and equipment are discussed in this section.

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., will be inventoried, listed and designated for one of the following removal alternatives:

- Removal to a new location for future use;
- Removal to another licensed facility for either use or permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other unrestricted use by others.

EMC believes that process buildings will be decontaminated, dismantled and released for use at another location. If decontamination efforts are unsuccessful, the material will be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a solid waste disposal site or to a NRC-licensed disposal facility if contaminated.

All waste that could pose a threat to human health and the environment will disposed of offsite,EMC. This will effectively control, minimize, or eliminate post-closure escape of nonradiological hazardous constituents, leachate, contaminated rainwater or waste composition products to the ground or surface waters, or to the atmosphere.

6.3.2.1 Building Materials, Equipment and Piping to be Released for Unrestricted Use

Salvageable building materials, equipment, pipe and other materials to be released for unrestricted use will be surveyed for alpha contamination in accordance with NRC guidance. Release limits for alpha radiation are as follows:

- Removable alpha contamination of 1,000 dpm/100cm^2
- Average total alpha contamination of 5,000 dpm/100 cm^2 over an area no greater than one square meter
- Maximum total alpha contamination of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2.

Decontamination of surfaces will be guided by the ALARA principle to reduce surface contamination to levels as far below the limits as practical. Particular attention will be given to equipment and structures in which radiological materials could accumulate in inaccessible locations including piping, traps, junctions, and access points. Contamination of these materials will be determined by surveys at accessible locations. Items that cannot be adequately characterized or that are too large to be scanned will be considered contaminated in excess of the limits and will be disposed at a properly licensed facility.

Non-salvageable contaminated equipment, materials, and dismantled structural sections will be sent to an NRC-licensed facility for disposal. In most cases, the byproduct material will be shipped as Low Specific Activity (LSA-I) material, UN2912, pursuant to 49 CFR 173.427.

6.3.2.2 Preparation for Disposal at a Licensed Facility

If facilities or equipment are to be moved to a facility licensed for disposal of 11e.(2) byproduct material, the following procedures may be used.

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce interior contamination as necessary for safe handling.
- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be contaminated the equipment will be washed down and decontaminated to permit safe handling.
- The equipment will be disassembled only to the degree necessary for transportation. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the plant building.
- Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in lined roll off containers or covered dump trucks or drummed in barrels for delivery to the receiving facility.
- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.

6.3.3 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed at a disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. EMC is investigating alternatives for disposal at existing sites licensed to receive 11e.(2) byproduct material including Pathfinder Mines, Kennecott Uranium Company, and Denison Mines. An agreement for disposal of 11e.(2) byproduct material will be in place before construction of the Moore Ranch project commences. A current disposal agreement will be maintained at a minimum of one licensed disposal facility throughout licensed operations.

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation (DOT) Hazardous Materials Regulations (49 CFR Part 173) and the NRC transportation regulations (10 CFR 71).

6.4 METHODOLOGIES FOR CONDUCTING POST-RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS

6.4.1 Cleanup Criteria

Surface soils will be cleaned up in accordance with the requirements of 10 CFR Part 40, Appendix A, including a consideration of ALARA goals and the chemical toxicity of uranium. The proposed limits and ALARA goals for cleanup of soils are summarized in Table 6.4-2.

On April 12, 1999, the NRC issued a Final Rule (64 FR 17506) that requires the use of the existing soil radium standard to derive a dose criterion for the cleanup of byproduct material. The amendment to Criterion 6(6) of 10 CFR Part 40, Appendix A was effective on June 11, 1999. This "benchmark approach" requires that NRC licensees model the site-specific dose from the existing radium standard and then use that dose to determine the allowable quantity of other radionuclides that would result in a similar dose to the average member of the critical group. These determinations must then be submitted to NRC with the site reclamation plan or included in license applications. This section documents the modeling and assumptions made by EMC to derive a standard for natural uranium in soil for the proposed Moore Ranch Project.

Concurrent with publication of the Final Rule, NRC published draft guidance (64 FR 17690) for performing the benchmark dose modeling required to implement the final rule. Final guidance was published as Appendix E to NUREG-1569[4]. This guidance discusses acceptable models and input parameters. This guidance, guidance from the RESRAD Users Manual[5], the Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil[6] and site-specific parameters were used in the modeling as discussed in the following sections.

6.4.1.1 Determination of Radium Benchmark Dose

RESRAD Version 6.3 computer code was used to model the Moore Ranch site and calculate the annual dose from the current radium cleanup standard.

The following supporting documentation for determination of the radium benchmark dose is attached in Appendix C:

- The RESRAD Data Input Basis (Appendix C-1) provides a summary of the modeling performed with RESRAD and the values that were used for the input parameters. A sensitivity analysis was performed for parameters which are important to the major component dose pathways and for which no site specific data was available.

- Selected graphs produced with RESRAD that present the results of the sensitivity analysis performed on the input parameters are attached (Appendix C-2).
- A full printout of the final RESRAD modeling results for the resident farmer scenario with the chosen input values is attached (Appendix C-3 and Appendix C-4.). The printout provides the modeled maximum annual dose for calculated times for the 1,000- year time span and provides a breakdown of the fraction of dose due to each pathway.
- Graphs produced by RESRAD in Appendix C-5 provide the modeling results for the maximum dose during the 1,000 year time span for both radium-226 and natural uranium. A series of graphs depicts the summed dose for all pathways and the component pathways that contribute to the total dose.

The maximum dose from Ra-226 contaminated soil at the 5 pCi/g above background cleanup standard, as determined by RESRAD, for the residential farmer scenario at Moore Ranch was 39.5 mrem/yr. This dose was based upon the 5 pCi/g surface (0 to 6-inch) Ra-226 standard and was noted at time, t = 0 years. The two major dose pathways were external exposure and plant ingestion (water independent). For these two pathways, a sensitivity analysis was performed for important parameters for which no site specific information was available. The 39.5 mrem/yr dose from radium is the level at which the natural uranium radiological end point soil standard will be based as described in Section 6.4.1.2.

6.4.1.2 Determination of Natural Uranium Soil Standard

RESRAD was used to determine the concentration of natural uranium in soil distinguishable from background that would result in a maximum dose of 39.5 mrem/yr. The method involved modeling the dose from a set concentration of natural uranium in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable natural uranium concentration in soil.

For ease of calculations, a preset concentration of 100 pCi/g natural uranium was used for modeling the dose. The fractions used were 48.9 percent (or pCi/g) U-234, 48.9 percent (or pCi/g) U-238 and 2.2 percent (or pCi/g) U-235. The distribution coefficients that were selected for each radionuclide were RESRAD default values. A sensitivity analysis was performed using a range of distribution coefficients to evaluate potential effects of not using site specific data. All other input parameters were the same as those used in the Ra-226 benchmark modeling. The RESRAD output showing the input parameters is provided in Appendix C-3.

Using a natural uranium concentration in soil of 100 pCi/g, RESRAD determined a maximum dose of 7.5 mrem/yr. at time, t = 0 years. The printout of the RESRAD data summary is provided in Appendix C-4.

To determine the uranium soil standard, the following formula was used:

$$\text{Uranium Limit} = \left(\frac{\text{100 pCi/g natural uranium}}{\text{7.5 mrem/yr. natural uranium dose}}\right) \text{x 39.5 mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = \text{526 pCi/g natural uranium}$$

The natural uranium limit is applied to soil cleanup with the Ra-226 limit using the unity rule. To determine whether an area exceeds the cleanup standards, the standards are applied according to the following formula:

$$\left(\frac{\text{Soil Uranium Concentration}}{\text{Soil Uranium Limit}}\right) + \left(\frac{\text{Soil Radium Concentration}}{\text{Soil Radium Limit}}\right) < 1$$

This approach will be used to determine the radiological impact on the environment at Moore Ranch from releases of source and byproduct materials.

6.4.1.3 Uranium Chemical Toxicity Assessment

The chemical toxicity effects from uranium exposure are evaluated by assuming the same exposure scenario as that used for the radiation dose assessment. In the Benchmark Dose assessment for the resident farmer scenario, it was assumed that the diet consisted of 25 percent of the meat, fruits, and vegetables grown at the site. No intake of contaminated food through the aquatic or milk pathways was considered probable. Also, the model showed that the contamination would not affect the groundwater quality. Therefore, the same model will be used in assessing the chemical toxicity. The intake from eating meat was shown to be negligible compared to the plant pathway and therefore is not shown here. This is confirmed by the results of the RESRAD calculations shown in Appendix C-4.

The method and parameters for estimating the human intake of uranium from ingestion are taken from NUREG/CR-5512 Vol. 1[7]. The uptake of uranium in food is a product of the uranium concentration in soil and the soil-to-plant conversion factor. The annual intake in humans is then calculated by multiplying the annual consumption by the uranium concentration in the food. Since the soil-plant conversion factor is based on a dry weight, the annual consumption must be adjusted to a dry-weight basis by multiplying by the dry-weight to wet-weight ratio. Parameters for these calculations are given in Section 6.5.9 of the NUREG/CR-5512. Table 6.4-1 provides the parameters used in these calculation and results for leafy vegetables, other vegetables, and fruit. Annual intakes of 14 kg/year and 97 kg/year were assumed for leafy vegetables and other vegetables and fruit, respectively. Consistent with Appendix C-3 dose calculations, it was assumed that 25 percent of the food was grown on the site. It was also assumed that the uranium concentration in the garden or orchard was 526 pCi/g. This corresponds to the uranium Benchmark Concentration for surface soils. Using a conversion factor for natural uranium of 1 mg = 677 pCi, then 526 pCi/g is equivalent to 777 mg/kg. The human intake shown in the first column of Table 6.4-1 is equal to the product of the parameters given in the subsequent columns. Table 6.4-1 shows that the total annual uranium intake from all food sources from the site is 51 mg/yr.

The two-compartment model of uranium toxicity in the kidney from oral ingestion was used to predict the burden of uranium in the kidney following chronic uranium ingestion[8]. This model allows for the distribution of the two forms of uranium in the blood, and consists of a kidney with two compartments, as well as several other compartments for uranium distribution, storage and elimination including the skeleton, liver, red blood cells (macrophages) and other soft tissues.

Table 6.4-1: Annual Intake of Uranium from Ingestion

Human Intake (mg/yr)	*Soil Concentration (mg/kg)*	*Soil to Plant Ratio (mg/kg plant to mg/kg soil)*	*Annual Consumption (kg)*	*Dry Weight Wet Weight Ratio*	*Food Source*
9.2	777	1.7E-2	3.5	0.2	Leafy Vegetables
35	777	1.4E-2	13	0.25	Other Vegetables
6.7	777	4.0E-3	12	0.18	Fruit
51					Total

The total burden to the kidney is the sum of the two compartments. The mathematical representation for the kidney burden of uranium at steady state can be derived as follows:

$$Q_P = \frac{IR \times f_1}{\lambda_P \left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pk} - f_{pk1}\right)}$$

Where:

Q_P	=	uranium burden in the plasma, μg
IR	=	dietary consumption rate, mg U/d
f_1	=	fractional transfer of uranium from GI tract to blood, unit less
f_{ps}	=	fractional transfer of uranium from plasma to skeleton, unit less
f_{pr}	=	fractional transfer of uranium from plasma to red blood cells, unit less
f_{pl}	=	fractional transfer of uranium from plasma to liver, unit less
f_{pt}	=	fractional transfer of uranium from plasma to soft tissue, unit less
f_{pk1}	=	fractional transfer of uranium from plasma to kidney, compartment 1, unit less;
λ_p	=	biological retention constant in the plasma, d-1.

The burden in kidney compartment 1 is:

$$Q_{k1} = \lambda_P \times Q_P \times \frac{f_{pk1}}{\lambda_{k1}}$$

Where:

Q_{k1}	=	uranium burden in kidney compartment 1, mg;
λ_{k1}	=	biological retention constant of uranium in kidney compartment 1, d-1.

Similarly, for compartment 2 in the kidney, the burden is:

$$Q_{k2} = \lambda_P \times Q_P \times \frac{f_{pk2}}{\lambda_{k2}}$$

Where:

Q_{k2}	=	uranium burden in kidney compartment 2, µg;
λ_{k2}	=	biological retention constant of uranium in kidney compartment 2, d-1;
f_{pk2}	=	fractional transfer of uranium from plasma to kidney compartment 2, unit less.

The total burden to the kidney is then the sum of the two compartments is:

$$Q_{k1} + Q_{k2} = \frac{IR \times f_1}{\left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pt} - f_{pk1}\right)} \times \left(\frac{f_{pk1}}{\lambda_{k1}} + \frac{f_{pk2}}{\lambda_{k2}}\right)$$

The parameter input values for the two-compartment kidney model include the daily intake of uranium estimated for residents at this site, and the ICRP 69 values recommended by the ICRP as listed below. The daily uranium intake rate was estimated to be 0.14 mg/day (51 mg/year) from ingestion while residing at this site.

IR	=	0.14 mg/day
f_1	=	0.02
f_{ps}	=	0.105
f_{pr}	=	0.007
f_{pl}	=	0.0105
f_{pt}	=	0.347
f_{pk1}	=	0.00035
f_{pk2}	=	0.084
λ_{k1}	=	ln(2)/5 yrs
λ_{k2}	=	ln(2)/7 days

where ln(2) = 0.693…

Given a daily uranium intake of 0.14 mg/day at this site and the above equation, the calculated uranium in the kidneys is 0.0093 mg U, or a concentration of 0.03 µg U/g kidney. This is three percent of the 1.0 µg U/g value that has generally been understood to protect the kidney from the toxic effects of uranium. Some researchers have suggested that mild effects may be observable at levels as low as 0.1 µg U/g of kidney tissue. Using 0.1 µg U/g as a criterion, then the intake is thirty percent of the level where mild effects may be observable.

The EPA evaluated the chemical toxicity data and found that mild proteinuria has been observed at drinking water levels between 20 and 100 µg/liter. Assuming water intake of 2 liters/day, this corresponds to an intake of 0.04 to 0.2 mg/day. Using animal data and a conservative factor of 100, the EPA arrived at a 30 µg/liter limit for use as a National Primary Drinking Water Standard (Federal Register/Vol.65, No.236/ December 7, 2000). This is equivalent to an intake of 0.06 mg/day for the average individual. Naturally, since large diverse populations are potentially exposed to drinking water sources regulated using these standards, the EPA is very conservative in developing limits.

This analysis indicates that a soil limit of 526 pCi/g of natural uranium would result in an intake of approximately 0.14 mg/day. Using the most conservative daily limit corresponding to the National Primary Drinking Water standard, a soil limit of 225 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day. Therefore exposure to soils containing 225 pCi/g of natural uranium should not result in chemical toxicity effects. Since the roots of a fruit tree would penetrate to a considerable depth, limiting subsurface uranium concentrations to 225 pCi/g will be considered appropriate as well.

ALARA considerations require that an effort be made to reduce contaminants to as low as reasonably achievable levels. The ALARA goals are normally based on a cost-benefit analysis. For the cleanup of gamma-emitting radionuclides, the cost of cleanup becomes excessively high as soil concentrations and/or gamma emission rates become indistinguishable from background.

Cleanup of uranium mill sites has demonstrated that conservatively derived gamma action levels along with appropriate field survey and sampling procedures result in near background radium-226 concentrations for the site. In addition, the presence of a mixture of radium-226 and uranium will tend to drive the cleanup to even lower radium-226 concentrations. It is therefore believed that no specific ALARA goal is required for surface radium-226.

EMC proposes an ALARA goal of limiting the natural uranium concentration in the top 15 cm soil layer to 150 pCi/g, averaged over 100 m^2. The uranium concentration should be limited to 225 pCi/g for all soil depths because of chemical toxicity concerns (Table 2.4-2).

Table 6.4-2
Soil Cleanup Criteria and Goals

	Radium-226 (pCi/gm)		**Natural Uranium (pCi/gm)**	
Layer Depth	*Limit*	*Goal*	*Limit*	*Goal*
Surface (0-15 cm)	5	5	225	150
Subsurface (15 cm layers)	15	15	225	225

6.4.2 Excavation Control Monitoring

EMC will use hand-held and GPS-based gamma surveys to guide soil remediation efforts. Field personnel will monitor excavations with hand-held detection systems to guide the removal of contaminated material to the point where there is high probability that an area meets the cleanup criteria. Support will be provided by GPS-based gamma surveys periodically to more accurately assess the progress of excavation.

6.4.3 Surface Soil Cleanup Verification and Sampling Plan

Cleanup of surface soils will be restricted to a few areas where there are known spills and, potentially, small spills near wellheads. Final GPS-based gamma surveys will be conducted in potentially contaminated areas. Areas will be divided into 100 m^2 grid blocks. Soil samples will be obtained from grid blocks with gamma count rates exceeding the gamma action level. The samples will be five-point composites and will be analyzed at an offsite laboratory for radium-226 and natural uranium.

Pre-reclamation surveys will also be conducted as described in Section 6.2.1 in areas where known contamination has occurred or the potential for unknown soil contamination exists.

6.4.4 Quality Assurance

Verification soil samples will be sent to a commercial laboratory for analysis of radium-226 and natural uranium. The commercial laboratory will be required to have a well-defined quality assurance program that addresses the laboratory's organization and management, personal qualifications, physical facilities, equipment and instrumentation, reference materials, measurement traceability and calibration, analytical method validation, standard operating procedures (SOPs), sample receipt, handing, storage, records, and appropriate licenses. EMC will maintain a laboratory QA file that will include, at a minimum, the laboratory's Quality Assurance Manual (QAM) and audit reports.

6.5 DECOMMISSIONING HEALTH PHYSICS AND RADIATION SAFETY

The health physics and radiation safety program for decommissioning will ensure that occupational radiation exposure levels will be kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee will be on site during any decommissioning activities where a potential radiation exposure hazard exists. In general, the radiation safety program discussed in Section 5 will be used as the basis for development of the decommissioning health physics program. Health physics surveys conducted during decommissioning will be guided by applicable sections of Regulatory Guide 8.30[9] or other applicable standards at the time.

6.5.1 Records and Reporting Procedures

At the conclusion of site decommissioning and surface reclamation, a report containing all applicable documentation will be submitted to the NRC. Records of all contaminated materials transported to a licensed disposal site will be maintained for a period of five years or as otherwise required by applicable regulations at the time of decommissioning.

6.6 FINANCIAL ASSURANCE

EMC will maintain surety instruments in the form of an Irrevocable Letter of Credit to cover the costs of reclamation including the costs of groundwater restoration, the decommissioning, dismantling and disposal of all buildings and other facilities, and the reclamation and revegetation of affected areas. Additionally, in accordance with NRC and WDEQ requirements, an updated Annual Surety Estimate Revision will be submitted to the NRC and WDEQ each year to adjust the surety instrument amount to reflect existing operations and those planned for construction or operation in the following year. After review and approval of the Annual Surety Estimate Revision by the NRC and WDEQ, EMC will revise the surety instrument to reflect the revised amount. EMC will 1) automatically extend the existing surety amount if the NRC has not approved the extension at least 30 days prior to the expiration date; 2) revise the surety arrangement within 3 months of NRC approval of a revised closure (decommissioning) plan, if estimated costs exceed the amount of the existing financial surety; 3) update the surety to

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cover any planned expansion or operational change not included in the annual surety update at least 90 days prior to beginning associated construction; and 4) provide NRC a copy of the State's surety review and the final surety arrangement.

Groundwater restoration costs are based on treatment of 1 pore volume for groundwater sweep and 65 pore volumes for reverse osmosis and reductant/bioremediation. Wellfield pore volumes are determined using the following equation:

Wellfield Pore Volume = (Affected Ore Zone Area) x (Average Completed Thickness) x (Flare Factor) x (Porosity)

Flare factor has been determined for PRI's Smith Ranch wellfields to be approximately 1.5 to 1.7. This flare factor was estimated using a three dimensional groundwater flow model (MODFLOW) in conjunction with an advective particle tracking technique (MODPATH). Horizontal and vertical flare factors of 1.5 and 1.3, respectively, have been approved by the US Nuclear Regulatory Commission for the Hydro Resources, Inc. Churchrock licensing action in New Mexico. COGEMA Mining, Inc., at the Irigaray/Christensen Ranch sites, uses an overall flare factor of 1.44. Accordingly, EMC is using a flare factor of 1.5 for the surety estimate attached in Appendix D.

6.7 REFERENCES

[1] COGEMA Mining, Inc., *Wellfield Restoration Report, Irigaray Mine*, June 2004.

[2] U.S. Nuclear Regulatory Commission, *Review of Power Resources, Inc.'s A-Wellfield Ground Water Restoration Report for the Smith Ranch-Highland Uranium Project*, June 29, 2004.

[3] U.S. Nuclear Regulatory Commission, *Technical Evaluation Report, Review of Cogema Mining, Inc.'s Irigaray Mine Restoration Report, Production Units 1 through 9, Source Materials License SUA-1341*, September 2006.

[4] U.S. Nuclear Regulatory Commission, NUREG-1569, *Standard Review Plan for In situ Leach Uranium Extraction License Applications."* 2003.

[5] Argonne National Laboratory, C. Yu, A. J. Zielen, J.-J. Cheng, D. J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W. A. Williams, and H. Peterson. *User's Manual for RESRAD Version 6.* 2001.

[6] Argonne National Laboratory, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil*, 1993.

[7] U.S. Nuclear Regulatory Commission, NUREG/CRR-5512 (PNL-7994) Vol. 1, *Residual Radioactive Contamination from Decommissioning,* 1992.

[8] International Commission on Radiation Protection (ICRP), ICRP Publication 69. *Age-dependent Doses to Members of the Public from Intake of Radionuclides: Part 3 Ingestion Dose Coefficients*. 1995.

[9] U.S. Nuclear Regulatory Commission, Regulatory Guide No. 8.30, *Health Physics Surveys in Uranium Recovery Facilities*, May 2002.

APPENDIX D

Reclamation Cost Estimates

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Closure Cost Estimate
Moore Ranch In-Situ Recovery Project
Uranium One, Americas

Total Restoration and Reclamation Cost Estimates

No.	Cost Item	Cost
1	GROUNDWATER RESTORATION COST*	$9,142,061
2a1	PLANT EQUIPMENT REMOVAL AND DISPOSAL COST	$400,368
2b1	BUILDING DEMOLITION AND DISPOSAL COST	$1,587,065
3	SOIL REMOVAL & DISPOSAL COST	$393,025
4	TOTAL WELL ABANDONMENT COST	$445,834
5	WELLFIELD EQUIPMENT REMOVAL & DISPOSAL COST	$1,312,451
6	TOPSOIL REPLACEMENT & REVEGETATION COST	$740,294
7	MISCELLANEOUS RECLAMATION COST	$122,007
	Subtotal Restoration and Reclamation Cost Estimate	$14,143,104
	Administration,Overhead and Contingency (25%) - CPP	$3,535,776
	Total - CPP	$17,678,880

Worksheet 1, No. I --
GROUNDWATER RESTORATION

Cost Item	Mining Unit Wellfield 1	Wellfield 2	Sub Total	Notes
Technical Assumptions				
Wellfield Area (Ft^2)	1,611,720	2,247,696		
Wellfield Area (Acres)	37.00	51.60		
Affected Ore Zone Area (Ft^2)	1,611,720	2,247,696		
Avg Completed Thickness (Ft)	20	20		
Factor for Flare	1.5	1.5		
Affected Volume:	48,351,600	67,430,880		
Porosity	0.25	0.25		
Gallons per Cubic Foot	7.48	7.48		
Gallon per Pore Volume	90,417,492	126,095,746		
Number of Wells in Unit(s)				
Recovery Wells	160	195		
Injection Wells	245	227		
Monitor Wells	63	81		
Average Well Spacing (Ft)	112	112		
Average Well Depth (Ft)	265	245		
I Groundwater Sweep				
A. Plant & Office				
Operating Assumptions:				
Flowrate (gpm)	500	500		
PV's Required	1.00	1.00		
Total Gallons for Treatment	90,417,492	126,095,746		
Total Kgals for Treatment	90,417	126,096		
Cost Assumptions:				
Power				
Avg Connected Hp	100	100		
Kwh's/Hp	0.75	0.75		
$/Kwh	0.05	0.05		$.02 plus demand charges per quote
Gallons per Minute	500	500		
Gallons per Hour	30000	30000		
Cost per Hour	$3.75	$3.75		
Cost per Kgal ($)	$0.125	$0.125		
Chemicals				
Barium Chloride ($/Kgals)	$0.041	$0.041		Costs from operating ISR facility experience (Cogema)
Antiscalent ($/Kgals)	$0.000	$0.000		Costs from operating ISR facility experience (Cogema)
Elution ($/Kgals)	$0.099	$0.099		Costs from operating ISR facility experience (Cogema)
Repair & Maintenance ($/Kgals)	$0.061	$0.061		Costs from operating ISR facility experience (Cogema)
Analysis ($/Kgals)	$0.164	$0.164		Costs from operating ISR facility experience (Cogema)
Total Cost per Kgal	$0.49	$0.49		
Total Treatment Cost	$44,305	$61,787		
Utilities				
Power ($/Month)	1,800	1200		
Propane ($/Month)	800	400		
Time for Treatment				
Minutes for Treatment	180,835	252,191		
Hours for Treatment	3,014	4,203		
Days for Treatment	126	175		
Average Days per Month	30	30		
Months for Treatment	4.2	5.8		
Years for Treatment	0.35	0.49		
Utilities Cost ($)	$10,884	$9,340		
TOTAL PLANT & OFFICE COST	**$55,188**	**$71,127**	**$126,315**	
B. WELLFIELD				
Cost Assumptions:				
Power				
Avg Flow/Pump (gpm)	5	5		
Avg Hp/Pump	5	5		
Avg # of Pumps Required	100	100		
Avg Connected Hp	500	500		
Kwh's/Hp	0.75	0.75		
$/Kwh	0.05	0.05		
Gallons per Minute	500	500		
Gallons per Hour	30000	30000		
Costs per Hour ($)	$18.75	$18.75		
Costs per Gallon ($)	$0.0006	$0.0006		
Costs per Kgal ($)	$0.63	$0.63		
Repair & Maintenance ($/Kgals)	$0.016	$0.016		
Total Cost per Kgal	$0.641	$0.641		
TOTAL WELLFIELD COST	$57,958	$80,827		
TOTAL GROUNDWATER SWEEP COST	**$113,146**	**$151,955**	**$265,100**	

Worksheet 1, No. II
GROUNDWATER RESTORATION

Cost Item	Mining Unit Wellfield 1	Mining Unit Wellfield 2	Sub Total	Notes
II GW Treatment - RO				
A. PLANT				
Operating Assumptions:				
Flowrate (gpm)	500	500		
PV's Required	7.00	7.00		
Total Gallons for Treatment	632,922,444	882,670,219		
Total Kgals for Treatment	632,922	882,670		
Feed to RO (gpm)	500	500		
Permeate Flow (gpm)	375	375		
Brine Flow (gpm)	125	125		
Average RO Recovery	75%	75%		
Cost Assumptions:				
Power				
Avg Connected Hp	20	20		
kWh/Hp	0.75	0.75		
$/Kwh	0.05	0.05		$.02 plus demand charges per quote
Gallons per Minute	500	500		
Gallons per Hour	30000	30000		
Cost per Hour ($)	$0.75	$0.75		
Cost per Gallon ($)	$0.0000	$0.0000		
Cost per Kgal ($)	$0.03	$0.03		
Chemicals				
Sulfuric Acid ($/Kgals)	$0.076	$0.076		Costs from operating ISR facility experience (Cogema)
Caustic Soda ($/Kgals)	$0.111	$0.111		Costs from operating ISR facility experience (Cogema)
Hydrochloric Acid ($Kgals)	$0.009	$0.009		Costs from operating ISR facility experience (Cogema)
Hydrochloric Sulfide ($Kgals)	$0.304	$0.304		Costs from operating ISR facility experience (Cogema)
Repair & Maintenance ($Kgals)	$0.279	$0.279		Costs from operating ISR facility experience (Cogema)
Sampling & Analysis ($/Kgals)	$0.164	$0.164		Costs from operating ISR facility experience (Cogema)
Total Cost per Kgal ($)	$0.97	$0.97		
Total Pumping Cost ($)	$612,669	$854,425		
Utilities				
Power ($/Month)	1,800	1,200		
Propane ($/Month)	800	400		
Time for Treatment	0	0		
Minutes for Treatment	1,265,845	1,765,340		
Hours for Treatment	21,097	29,422		
Days for Treatment	879	1,226		
Average Days per Month	30	30		
Months for Treatment	29	40		
Utilities Cost ($)	$75,183	$64,523		
TOTAL PLANT COST	**$687,852**	**$918,947**	**$1,606,799**	
B. WELLFIELD				
Cost Assumptions:				
Power				
Avg Flow/Pump (gpm)	3.13	2.56		
Avg Hp/Pump	5	5		
Avg # of Pumps Required	160	195		Using Recovery Pumps
Avg Connected Hp	800	975		
Kwh's/Hp	0.75	0.75		
$/Kwh	0.05	0.05		
Gallons per Minute	500	500		
Gallons per Hour	30000	30000		
Costs per Hour ($)	$30.00	$36.56		
Costs per Gallon ($)	$0.0010	$0.0012		
Costs per Kgal ($)	$1.00	$1.22		
Repair & Maintenance ($/Kgals)	$0.016	$0.016		
Total Cost per Kgal	$1.016	$1.235		
MIT cost ($150/well)	$36,750.000	$34,050.000		
TOTAL WELLFIELD COST	**$643,049**	**$1,089,877**	**$1,732,926**	
TOTAL GW TREATMENT RO COST	**$1,367,651**	**$2,042,875**	**$3,410,525**	

Worksheet 1, No III --
GROUNDWATER RESTORATION

Cost Item	Mining Unit Wellfield 1	Wellfield 2	Sub Total	Notes
III Deep Disposal Well				
Operating Assumptions:				
Total Disposal Requirement				
RO Brine Total Gallons	158,230,611	220,667,555		
RO Brine Total Kgallons	158,231	220,668		
Brine Concentration Factor	1	1		
Total Concentrated Brine (Gals)	158,230,611	220,667,555		
Months of RO Operation	28.9	40.3		
Average Monthly Reqm't (Gallons)	5,472,000	5,472,000		
Average Brine Flow (gpm)	125.0	125.0		
Total DDW Disposal (Gallons)	158,230,611	220,667,555		
Total DDW Disposal (Kgallons)	158,231	220,668		
Cost Assumptions:				
Avg Connected Hp	150	150		
Kwh's/Hp	0.75	0.75		
$/Kwh	0.05	0.05		$.02 plus demand charges per quote
Gallons per Minute	125.0	125.0		
Gallons per Hour	7500	7500		
Cost per Hour ($)	$5.63	$5.63		
Cost per Gallon ($)	$0.0008	$0.0008		
Cost per Kgal ($)	$0.75	$0.75		
Chemicals				
RO Antiscalent ($/Kgals)	$0.192	$0.192		Costs from operating ISR facility experience (Cogema)
WDW Antiscalent ($/Kgals)	$0.226	$0.226		Costs from operating ISR facility experience (Cogema)
Sulfuric Acid ($/Kgals)	$0.280	$0.280		Costs from operating ISR facility experience (Cogema)
Corrosion Inhibitor	$0.217	$0.217		Costs from operating ISR facility experience (Cogema)
Algacide	$0.080	$0.080		Costs from operating ISR facility experience (Cogema)
Other	$0.000	$0.000		Costs from operating ISR facility experience (Cogema)
Repair & Maint. ($/Kgals)	$0.230	$0.230		Costs from operating ISR facility experience (Cogema)
Total Cost per Kgal	$1.975	$1.975		
TOTAL DEEP DISPOSAL WELL COST	**$312,505**	**$435,818**	**$748,324**	

Worksheet 1, Nos. IV & V –
GROUNDWATER RESTORATION

Cost Item	Mining Unit Wellfield 1	Labor Cost Factors			Wellfield 2	Notes
IV STABILIZATION MONITORING						
Operating Assumptions:						
Time of Stabilization (mos)	28.9				40.3	
Frequency of Analysis (mos)	3				3	
Total Sets of Analysis	10				14	
Cost Assumptions:						
Power ($/Month)	$1,600				$1,600	
Total Power Cost	$46,266				$64,523	
Sampling & Analysis (each set)	$20,790				$26,730	63, 81 Monitoring Wells @ $330 per event
Total Sampling & Analysis Cost ($)	$207,900				$374,220	
Utilities ($/Month)	$400				$400	
Total Utilities Cost ($)	$11,567				$16,131	
TOTAL STABILIZATION COST	$265,733				$454,873	
V LABOR						
Cost Assumptions:	No.	Cost/Hour	Hours/Year	Cost		
Crew:						
1. Supervisor	1	29	2080	$60,320		
2. Operators	4	22	2080	$183,040		
3. Maintenance	4	20	2080	$166,400		
4. Vehicles	5	20.21	1000	$101,050		WDEQ Guideline No.12, Table D-1
Cost per Year				$510,810		
Time Required - Years	2.41				3.36	
TOTAL RESTORATION LABOR COST	**$1,230,899**				**$1,716,605.65**	

Worksheet 1, Nos. VI, VII & Summary --
GROUNDWATER RESTORATION

Cost Item	Mining Unit Wellfield 1	Wellfield 2	Sub Total	Notes
VI RESTORATION CAPITAL REQUIREMENTS				
I Deep Disposal Well(s)	1	0		
II Plug and Abandon DDW	$250,000	0		
III Reverse Osmosis Unit	$0	0		Already in Processing Plant
TOTAL RESTORATION CAPITAL REQUIREMENTS	**$250,000**	*$0*		
VII RESTORATION OF EXCURSION WELLS				
I Overlying Sand Well(s)				
Total Wells in Excursion	1	1		Assume no excursions during Year 1
Cost of Clean-Up	$100,000	$100,000		
Total Overlying Sand Cleanup	$100,000	$100,000		
II Ore Zone (70 sand) Wells				
Total Wells in Excursion	1	1		
Cost of Clean-Up	$100,000	$100,000		
Total Ore Zone (70 Sand) Cleanup	$100,000	$100,000		
III Underlying Sand Wells				
Total Wells in Excursion	1	3		
Cost of Clean-Up	$100,000	$100,000		
Total Underlying Sand Well Cleanup	$100,000	$300,000		
TOTAL WELLFIELD COST				
TOTAL EXCURSION CLEANUP COST	**$300,000**	**$500,000**	**$800,000**	
SUMMARY:				
I GROUNDWATER SWEEP	$113,146	$151,955		
II REVERSE OSMOSIS	$1,367,651	$2,042,875		
III WASTE DISPOSAL WELL	$312,505	$435,818		
IV STABILIZATION	$265,733	$454,873		
SUB TOTAL	$2,059,035	$3,085,521		
V LABOR	$1,230,899	$1,716,606		Included in OPEX costs
VI CAPITAL	$250,000	$0		
VII EXCURSION CLEANUP	$300,000	$500,000		
TOTAL GROUNDWATER RESTORATION COST	**$3,839,934**	**$5,302,127**	**$9,142,061**	

Worksheet 2 a 1
CENTRAL PROCESSING PLANT EQUIPMENT REMOVAL AND DISPOSAL

	Moore Ranch CCP								
Cost Item	Office & Laboratory	Main Process Building	Maintenance Building	Resin + Sand Filter Media	External Tanks	Header Houses		Sub Total	**Notes**
Volume (Yds^3)	0	200	40	110	20	169			
Quantity per Truck Load (Yds^3)	20	20	20	20	20	20			
Number of Truck Loads	0	10	2	5.5	1	8			
I Decontamination Cost									
Decontamination Cost ($/Load)	900	900	900	900	900	900			
Percent Requiring Decontamination	20%	100%	20%	0%	50%	100%			
Total Cost	$0	$9,000	$360	$0	$450	$7,600			
II Dismantle and Loading Cost									
Cost per Truck Load ($)	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000			
Total Cost	$0	$100,000	$20,000	$55,000	$10,000	$84,444			
III Oversize Charges									
Percent Requiring Permits	40%	40%	40%	0%	50%	40%			
Cost per Truck Load ($)	$500	$500	$500	$500	$500	$500			
Total Cost	$0	$2,000	$400	$0	$250	$1,689			
IV Transportation & Disposal									
A. Landfill									
Percent to be Shipped	100%	80%	100%	0%	100%	80%			
Distance (Miles)	50	50	50	50	50	50			
Transport Cost ($/Ton-Mile)	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22			
Transportation Cost	$0	$1,901	$475	$0	$238	$1,605			
Disposal Fee per Cubic Yard	$58	$58	$58	$58	$58	$58			
Disposal Cost ($)	$0	$9,280	$2,320	$0	$1,160	$7,836			
Total Cost	$0	$11,181	$2,795	$0	$1,398	$9,442			
B. Licensed Site									
Percent to be Shipped	0%	20%	0%	100%	0%	20%			
Distance (Miles)	160	160	160	160	160	160			
Transport Cost ($/Ton-Mile)	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22			
Transport Cost	$0	$6,912	$0	$19,008	$0	$5,837			
Disposal Cost ($/Ton)	$300	$300	$300	$300	$300	$300			
Quantity per Truck Load (Yds^3)	20	20	20	20	20	20			
Quantity per Truck Load (Tons)	21.6	21.6	21.6	21.6	21.6	21.6			Based on avg 80lbs per cf
Disposal Cost	$0	$12,960	$0	$35,640	$0	$10,944			
Total Cost	$0	$24,141	$2,795	$35,640	$1,398	$20,386			
Total Cost	$0	$35,322	$5,590	$35,640	$2,795	$29,827			
TOTAL COST	**$0**	**$146,322**	**$26,350**	**$90,640**	**$13,495**	**$123,560**		**$400,368**	

Worksheet 2 a 2
SATELLITE PLANT EQUIPMENT REMOVAL AND DISPOSAL

Cost Item	Moore Ranch Satellite Plant: Satellite Process Building	Maintenance Building	Resin + Sand Filter Media	External Tanks	Header Houses		Sub Total	Notes
Volume (Yds³)	100	40	110	20	169			
Quantity per Truck Load (Yds³)	20	20	20	20	20			
Number of Truck Loads	5.0	2.0	5.5	1	8.4			
I Decontamination Cost								
Decontamination Cost ($/Load)	900	900	900	900	900			
Percent Requiring Decontamination	100%	20%	0%	50%	100%			
Total Cost	$4,500	$360	$0	$450	$7,600			
II Dismantle and Loading Cost								
Cost per Truck Load ($)	$10,000	$10,000	$10,000	$10,000	$10,000			
Total Cost	$50,000	$20,000	$55,000	$10,000	$84,444			
III Oversize Charges								
Percent Requiring Permits	40%	40%	0%	50%	40%			
Cost per Truck Load ($)	$500	$500	$500	$500	$500			
Total Cost	$1,000	$400	$0	$250	$1,689			
IV Transportation & Disposal								
A. Landfill								
Percent to be Shipped	80%	100%	0%	100%	80%			
Distance (Miles)	50	50	50	50	50			
Transport Cost ($/Ton-Mile)	$0.22	$0.22	$0.22	$0.22	$0.22			
Transportation Cost	$950	$475	$0	$238	$1,605			
Disposal Fee per Cubic Yard	$58	$58	$58	$58	$58			
Disposal Cost ($)	$4,640	$2,320	$0	$1,160	$7,836			
Total Cost	$5,590	$2,795	$0	$1,398	$9,442			
B. Licensed Site								
Percent to be Shipped	20%	0%	100%	0%	20%			
Distance (Miles)	160	160	160	160	160			
Transport Cost ($/Ton-Mile)	$0.22	$0.22	$0.22	$0.22	$0.22			
Transport Cost	$3,456	$0	$19,008	$0	$5,837			
Disposal Cost ($/Ton)	$300	$300	$300	$300	$300			
Quantity per Truck Load (Yds³)	20	20	20	20	20			
Quantity per Truck Load (Tons)	21.6	21.6	21.6	21.6	21.6			Based on avg 80lbs per cf
Disposal Cost	$6,480	$0	$35,640	$0	$10,944			
Total Cost	$12,070	$2,795	$35,640	$1,398	$20,386			
Total Cost	$17,661	$5,590	$35,640	$2,795	$29,827			
TOTAL COST	**$73,161**	**$26,350**	**$90,640**	**$13,495**	**$123,560**		**$327,207**	

Worksheet 2 b 1--
CENTRAL PROCESSING PLANT BUILDING DEMOLITION AND DISPOSAL

	Moore Ranch CCP					
Cost Item	Office & Laboratory	Main Process Building	Maintenance Building	Header Houses	Sub Total	**Notes**
STRUCTURE DEMOLITION & DISPOSAL						
Structural Character						
Demolition Volume (Ft^3)	90,000	1,700,000	144,000	2,400		
Unit Cost of Demolition ($/ Ft^3)	$0.300	$0.300	$0.300	$0.300		
Total Demolition Cost	$27,000	$510,000	$43,200	$720		
Weight of Disposal Material in Tons	41	765	65	1		
Factor for Gutting	0.5	1	0.8	1		
Cost for Gutting ($)	$13,500	$510,000	$34,560	$720		
Quantity per Truck Load (Ton)	21.6	21.6	21.6	21.6		
Number of Truckloads	1.9	35.4	3.0	0.1		
Distance to Landfill	60	60	60	60		
Unit Cost (Ton-Mile)	$0.22	$0.22	$0.22	$0.22		
Transportation Cost	$534.60	$10,098.00	$855.36	$14.26		
Disposal Cost ($/ton)	$58.00	$58.00	$58.00	$58.00		
Disposal Cost ($)	$2,349.00	$44,370.00	$3,758.40	$62.64		
TOTAL STRUCTURE DEMO & DISPOSAL	**$43,384**	**$1,074,468**	**$82,374**	**$1,517**	**$1,201,742**	
CONCRETE DECONTAMINATION, DEMO & DISPOSAL						
Area	9000	29700	8000	3000		
Average Thickness (Ft)	0.75	0.75	0.75	0.75		
Volume (Ft^3)	6750	22275	6000	11880		
Weight of Disposal Concrete Assuming 145lbs/cubic foot	978,750	3,229,875	870,000	1,722,600		
Weight of Disposal in Tons	489	1615	435	861		
Percent Requiring Decontamination	0%	100%	0%	10%		
Volume Decontaminated (Ft^2)	0	22,275	0	1,188		
Decontamination ($/$Ft^2$)	$0.4500	$0.4500	$0.4500	$0.4500		
Decontamination Cost	$0	$10,024	$0	$535		
Demolition ($/$Ft^2$)	$5.10	$5.10	$5.10	$5.10		
Demolition Cost	$45,900	$151,470	$40,800	$15,300		
Transportation & Disposal						
A. Onsite Disposal						
Percent to be Disposed Onsite	100%	80%	100%	100%		
Transportation Cost	$0	$0	$0	$0		
Disposal Cost per Cubic Yard ($)	$7.50	$7.50	$7.50	$7.50		On-site disposal
Disposal Cost ($)	$1,875	$6,188	$1,667	$3,300		
B. Licensed Site						
Percent to be Shipped	0%	20%	0%	0%		
Distance (Miles)	160	160	160	160		
Unit Cost (Ton-Mile)	$0.22	$0.22	$0.22	$0.22		
Transportation Cost ($)	$0	$11,369	$0	$0		
Disposal Cost ($/Ton)	$300	$300	$300	$300		
Disposal Cost ($)	$0	$96,896	$0	$0		
TOTAL TRANSPORT & DISPOSAL COST	**$47,775**	**$275,947**	**$42,467**	**$19,135**	**$385,323**	
TOTAL BUILDING DEMO & DISPOSAL COST	**$91,159**	**$1,350,415**	**$124,840**	**$20,651**	**$1,587,065**	

Worksheet 2 b 2 --
SATELLITE PLANT BUILDING DEMOLITION AND DISPOSAL

Cost Item	Moore Ranch Satellite Plant: Satellite Process Building	Maintenance Building	Header Houses	Sub Total	Notes
STRUCTURE DEMOLITION & DISPOSAL					
Structural Character					
Demolition Volume (Ft^3)	192000	180000	2400		
Unit Cost of Demolition ($/ Ft^3)	$0.300	$0.300	$0.300		
Total Demolition Cost	$57,600	$54,000	$720		
Weight of Disposal Material in Tons	86	81	1		
Factor for Gutting	1	0.8	1		
Cost for Gutting ($)	$57,600	$43,200	$720		
Quantity per Truck Load (Ton)	21.6	21.6	21.6		
Number of Truckloads	4.0	3.8	0.1		
Distance to Landfill	60	60	60		
Unit Cost (Ton-Mile)	$0.22	$0.22	$0.22		
Transportation Cost	$1,140.48	$1,069.20	$14.26		
Disposal Cost ($/ton)	$58.00	$58.00	$58.00		
Disposal Cost ($)	$5,011.20	$4,698.00	$62.64		
TOTAL STRUCTURE DEMO & DISPOSAL	**$121,352**	**$102,967**	**$1,517**	**$225,836**	
CONCRETE DECONTAMINATION, DEMO & DISPOSAL					
Area	29700	8000	3000		
Average Thickness (Ft)	0.75	0.75	0.75		
Volume (Ft^3)	22275	6000	11880		
Weight of Disposal Concrete Assuming 145lbs/cubic foot	3,229,875	870,000	1,722,600		
Weight of Disposal in Tons	1615	435	861		
Percent Requiring Decontamination	100%	0%	10%		
Volume Decontaminated (Ft^2)	22,275	0	1,188		
Decontamination ($/$Ft^2$)	$0.4500	$0.4500	$0.4500		
Decontamination Cost	$10,024	$0	$535		
Demolition ($/$Ft^2$)	$5.10	$5.10	$5.10		
Demolition Cost	$151,470	$40,800	$15,300		
Transportation & Disposal					
A. Onsite Disposal					
Percent to be Disposed Onsite	85%	100%	100%		
Transportation Cost	$0	$0	$0		
Disposal Cost per Cubic Yard ($)	$7.50	$7.50	$7.50		On-site disposal
Disposal Cost ($)	$6,188	$1,667	$3,300		
B. Licensed Site					
Percent to be Shipped	15%	0%	0%		
Distance (Miles)	160	160	160		
Unit Cost (Ton-Mile)	$0.22	$0.22	$0.22		
Transportation Cost ($)	$8,527	$0	$0		
Disposal Cost ($/Ton)	$300	$300	$300		
Disposal Cost ($)	$72,672	$0	$0		
TOTAL TRANSPORT & DISPOSAL COST	**$248,880**	**$42,467**	**$19,135**	**$310,482**	
TOTAL BUILDING DEMO & DISPOSAL COST	**$370,232**	**$145,434**	**$20,651**	**$536,317**	

Worksheet 3 b --
SOIL REMOVAL & DISPOSAL

	Moore Ranch					
Cost Item	Office & Laboratory	Main Process Building	Maintenance Building	Header Houses	Sub Total	**Notes**
SOIL EXCAVATION, TRANSPORT & DISPOSAL						
Removal Under Building Footprints						
Excavation, Front End Loader	$38	$126	$34	$13		$81.81/hr per WDEQ Guideline12 and 150 cy/hr
Quantity to be Shipped (Ft^3)	563	1,856	500	188		Assume removal of 3" of Contaminated Soil under Primary Areas over 25% of building area, Disposal at a Licensed facility (ft3)
Weight in Tons	28.125	92.8125	25	9.375		
Distance (Miles)	160	160	160	160		
Transportation Unit Cost (Ton/Mile)	$0.220	$0.220	$0.220	$0.220		
Transportation Cost	$990	$3,267	$880	$330		
Disposal Fee ($/Ton)	$2,500	$2,500	$2,500	$2,500		
Disposal Cost ($)	$70,313	$232,031	$62,500	$23,438	$388,281	
Removal NPDES Pts.						
Quantity to be Shipped (Ft^3)	0	0	0	0		Zero discharge facility
Weight in Tons	0	0	0	0		
Distance (Miles)	160	160	160	160		
Transportation Cost Ton/Mile ($)	$0.220	$0.220	$0.220	$0.220		
Transportation Cost	$0	$0	$0	$0		
Disposal Fee ($/Ton)	$300	$300	$300	$300		
Disposal Cost ($)	$0	$0	$0	$0		
Total NPDES Removal Cost	$0	$0	$0	$0	$0	
TOTAL SOILS EXC., TRANSPORT & DISPOSAL	**$70,313**	**$232,031**	**$62,500**	**$23,438**	**$388,281**	
RADIATION SURVEY						
Area Required (Acres)	0.21	0.68	0.18	0.07		
Survey Cost ($/Acre)	$1,200	$1,200	$1,200	$1,200		
Number of Structures	1	1	1	12		
Cost per Structure ($)	$225	$225	$225	$225		
TOTAL RAD SURVEY COST	**$473**	**$1,043**	**$445**	**$2,783**	**$4,744**	
TOTAL SOIL REMOVAL & DISPOSAL COST	**$70,785**	**$233,074**	**$62,945**	**$26,220**	**$393,025**	

Worksheet 4 --
Well Abandonment

Cost Item	Mining Unit			Notes
	Wellfield 1	Wellfield 2	Sub Total	
Number of Wells	468	503		Includes injection, recovery and monitor wells.
Average Depth (ft)	265	215		
Average Diameter (inch)	5	5		
Area of Annulus (ft^2)	0.1364	0.1364		
Materials				
Bentonite Chips Required (Ft^3/Well)	20.5	20.5		150 feet of clay above water
Bags of Chips Required/Well	27	27		
Cost per Bag ($)	$6.45	$6.45		
Cost/Well Bentonite Chips ($)	$174	$174		
Gravel Fill Required (Ft^3/Well)	15.7	8.9		Avg depth less 300 feet filled w/ gravel
Cost of Gravel/Yd^3 ($)	$20	$20		
Cost/Well Gravel Fill ($)	$12	$7		
Cement Cone/Markers Req'd/Well	1	1		
Cost of Cement Cones Markers ($)	$6	$6		
Total Materials Cost per Well	$192	$187		
Labor				
Hours Required per Well	3	3		
Labor Cost per Hour	$70	$70		
Total Labor Cost per Well ($)	210	210		
Equipment Rental				
Hours Required per Well	1	1		
Backhoe w/Operator Cost/Hr ($)	$60	$60		
Total Equipment Cost per Well ($)	$60	$60		
Total Cost per Well ($)	$462	$457		
TOTAL WELL ABANDONMENT COST ($)	**$216,106**	**$229,728**	**$445,834**	

Worksheet 5, No. I --
WELLFIELD EQUIPMENT REMOVAL & DISPOSAL

	Mining Unit			
Cost Item	Wellfield 1	Wellfield 2	Sub Total	**Notes**
I Wellfield Piping				
A. Removal				
Total Number of Wells	468	422		Includes total injection and recovery wells
Feeder lines from HH to Injection wells 1" HDPE (Ft)	111,334	153,084		From Preliminary Design- MR Wellfield 1 & Wellfield 2 takeoffs
Pregnant solution feeder lines from production wells to HH 1" HDPE (Ft)	51,396	49,818		From Preliminary Design- MR Wellfield 1 & Wellfield 2 takeoffs
Total Quantity of 1" HDPE Piping (Ft)	162,730	202,902		
Plastic Volume (Ft^3)	533.67	665.41		ISCO specs.for 1" HDPE DR 11
Chipped Volume Assuming 30% Void Space (Ft^3)	693.77	865.03		
Disposal Weight (tons)	27.75	34.60		Year 1 buildout only to include Wellfield 1
Quantity per Truck Load (Tons)	21.6	21.6		Based on 20 cy per truckload and 80lbs per cf
Total Number of Truck Loads	2	2		
Total Length of Feeder line Trench (ft)	41,580	47,340		Includes Shared Trenches
Pipeline Removal Unit Cost ($/ft of trench)	$2.25	$2.25		Quote - Jordan Construction
Total Cost for Trunkline Removal ($)	$93,556	$106,516		
Total Cost - Removal	$93,556	$106,516	$200,072	
B. Survey & Decontamination				
Percent Requiring Decontamination	0	0		No survey or decon needed. Total volume to low level disposal
Loads for Decontamination	0	0		
Cost for Decontamination ($/Load)	$600	$600		
Cost for Decontamination ($)	$0	$0	$0	
C. Transport & Disposal				
1.) Landfill				
a. Transportation				
Percent to be Shipped	0%	0%		
Loads to be Shipped	0	0		
Distance (Miles)	50	50		
Transportation Cost (Ton/Mile) ($)	$0.22	$0.15		
Transportation Cost ($)	$0	$0	$0	
b. Disposal				
Disposal Fee per Yd^3	$58	$58		
Yds^3 per Load	20	20		
Disposal Cost ($)	$0	$0		
Total Cost - Landfill	$0	$0	$0	
2.) Licensed Site				
a. Transportation				
Percent to be Shipped	100%	100%		
Loads to be Shipped	2	2		
Tons to be Shipped	27.75	34.60		
Distance (Miles)	160	160		
Transportation Ton/Mile ($)	$0.220	$0.220		
Transportation Cost ($)	$977	$1,218		
b. Disposal				
Disposal Fee per ton	$300	$300		
Disposal Cost ($)	8,325	10,380		
Total Cost - Licensed Site	9,302	11,598		
Total Cost - Transport & Disposal	9,302	11,598		
Total Cost - WF Piping Removal & Disposal	**102,858**	118,114	$220,972	

Closure Cost Estimate
Moore Ranch ISR Project
Uranium One, Americas

Worksheet 5, No. II
WELLFIELD EQUIPMENT REMOVAL & DISPOSAL

Cost Item	Mining Unit Wellfield 1	Wellfield 2	Sub Total	Notes
II Production Well Pumps				
A. Pump and Tubing Removal				
Number of Production Wells	160	195		
Cost of Removal ($/well)	$200	$201		
Cost of Removal ($)	$32,000	$39,195		
Number of Pumps per Truck Load	180	180		
Number of Truck Loads (Pumps)	0.89	1.08		
Weight of Pumps	20.89	21.08		Assume 20 T per truck
B. Survey & Decontamination (Pumps)				
Percent Requiring Decontamination	50%	50%		
Loads for Decontamination	0.44	0.54		
Cost for Decontamination ($/Load)	$600	$600		
Cost for Decontamination ($)	$267	$325		
C. Tubing Volume Reduction & Loading				
Length per Well (Ft)	265	245		
Total Quantity (Ft^3)	139.0	156.7		Thickness Based on ISCO DR 11 1" HDPE PSI 160 (R1=.05479', R2=.04425')
Chipped Volume Assuming 30% Void Space (Ft^3)	180.8	203.7		
Cost of Removal ($/Ft)	$0.03	$0.03		
Cost of Removal ($)	$7.95	$7.35		
Quantity per Truck Load (Ft^3)	540	540		
Number of Truck Loads	1	1		
D. Transport & Disposal				
1.) Landfill				
a. Transportation				
Percent to be Shipped (Pumps)	50%	50%		
Loads to be Shipped	0.4	0.5		
Distance (Miles)	50	50		
Transportation Ton/Mile ($)	$0.22	$0.22		
Transportation Cost ($)	$106	$129		
b. Disposal				
Disposal Fee per Yd^3	$58	$58		
Yds^3 per Load	20	20		
Disposal Cost ($)	$516	$628		
Total Cost - Landfill	$621	$757		
2.) Licensed Site				
a. Transportation				
Percent to be Shipped (Pumps)	50%	50%		
Percent to be Shipped (Tubing)	100%	100%		
Loads to be Shipped	2.00	2.00		
Distance (Miles)	50	50		
Transportation Ton/Mile ($)	$0.22	$0.22		
Transportation Cost ($)	$475	$475		
b. Disposal				
Disposal Cost per Ft^3	$300	$300		
Disposal Fee per Yd^3	20	20		
Quantity Per Truck Load (Yds^3)	$12,000	$12,000		
Disposal Cost ($)	$12,475	$12,475		
Total Cost - Licensed Site	$12,950	$12,950		
Total Cost - Transport & Disposal	$13,572	$13,707		
Total Cost - Pump Removal & Disposal	**$45,846**	**$53,235**	**$99,081**	

Closure Cost Estimate
Moore Ranch ISR Project
Uranium One, Americas

Worksheet 5, No. III
WELLFIELD EQUIPMENT REMOVAL & DISPOSAL

Cost Item	Mining Unit Wellfield 1	Wellfield 2	Sub Total	Notes
III Buried Trunkline				
A. Removal				
Trunk lines from Resin Plant to HH HDPE Pipe (Ft)	73,954	139,270		
Pregnant solution trunk lines form HH to Resin Plant 8" HDPE Pipe (Ft)	73,954	139,270		
Total Quantity of HDPE Piping (Ft)	147,907	278,541		assume avg 8-in dia.
Plastic Volume (Ft^3)	99,775	187,897		Thickness Based on ISCO DR 11 8" PSI 160 (R1=.7188', R2=.5494')
Chipped Volume Assuming 30% Void Space (Ft^3)	129,707	244,266		
Disposal Tons	968	1,823		13.089lb/ft per ISCO
Quantity per Truck Load (Tons)	21.6	21.6		
Total Number of Truck Loads	45	85		
Total Length of Trunkline Trench (ft)	4,352	9,871		
Pipeline Removal Unit Cost ($/ft of trench)	$4.00	$4.00		
Total Cost for Trunkline Removal ($)	$17,407	$39,486	$56,892	
B. Survey & Decontamination				
Percent Requiring Decontamination	0	0		No survey or decon needed. Total volume to low level disposal
Loads for Decontamination	0	0		
Cost for Decontamination ($/Load)	$600	$600		
Cost for Survey & Decontamination ($)	$0	$0	$0	
C. Transportation & Disposal				
1.) Landfill				
a. Transportation				
Percent to be Shipped	0%	0%		
Loads to be Shipped	0	0		
Distance (Miles)	50	50		
Transportation Cost (Ton/Mile) ($)	$0.22	$0.22		
Transportation Cost ($)	$0	$0		
b. Disposal				
Disposal Fee per Yd^3	$58	$58		
Yds^3 per Load	20	20		
Disposal Cost ($)	$0	$0		
Total Cost - Landfill	$0	$0		
2.) Licensed Site				
a. Transportation				
Percent to be Shipped	100%	100%		
Loads to be Shipped	45	85		
Tons to be Shipped	967.98	1,822.91		
Distance (Miles)	160	160		
Transportation Ton/Mile ($)	$0.220	$0.220		
Transportation Cost ($)	$34,073	$64,166		
b. Disposal				
Disposal Fee per ton	$300	$300		
Disposal Cost ($)	$290,394	$546,873		
Total Cost - Licensed Site	$324,467	$611,039	$935,506	
Total Cost Transportation & Disposal	**$324,467**	**$611,039**	**$935,506**	
Total Cost - Buried Trunkline Removal & Disposal	**$341,873**	**$650,525**	$992,398	
TOTAL WELLFIELD EQUIPMENT REMOVAL & DISPOSAL COST	**$490,577**	**$821,874**	**$1,312,451**	

Worksheet 6, No. I
TOPSOIL REPLACEMENT & REVEGETATION

	Mining Unit			
Cost Item	Wellfield 1	Wellfield 2	Sub Total	**Notes**
I Process Plant and Office Building				
A. Topsoil Handling & Grading				
Affected Area (Acres)	11.0	0		
Average Affected Thickness (Ins)	12	13		
Topsoil Volume (Yds^3)	17,779	0		
Unit Cost	$5	$6		Price from Dragstrip Soil Cover Project MT
Sub Total - Topsoil	$88,895	$0		
B. Radiation Survey & Soil Analysis				
Unit Cost ($/Ac)	$800	$801		
Sub Total - Survey & Analysis	$8,816	$0		
C. Revegation				
Fertilizer ($/Ac)	$232.00	$232.00		Price from Dragstrip Soil Cover Project MT
Seeding Prep & Seeding ($/Ac)	$227.00	$227.00		Price from Dragstrip Soil Cover Project MT
Mulching & Crimping ($/Ac)	$100.00	$100.00		Price from Dragstrip Soil Cover Project MT
Sub Total Cost/Acre	$559.00	$559.00		
Sub Total Revegation	$6,160	$0		
TOTAL PLANT AND OFFICE BUILDING TOPSOIL REPLACEMENT & REVEG COST	**$103,871**	**$0**	**$103,871**	

Worksheet 6, Nos. II & III
TOPSOIL REPLACEMENT & REVEGETATION

Cost Item	Mining Unit Wellfield 1	Wellfield 2	Sub Total	Notes
II Wellfields				
A. Topsoil Handling & Grading				
Affected Area (Acres)	16	20		Equals trench length times 15 feet wide
Average Affected Thickness (Inch)	12	12		
Topsoil Volume (Yds^3)	25,518	31,784		
Unit Cost - Haul/Place/Grading ($/cy)	$5.00	$5.00		Price from Dragstrip Soil Cover Project MT
Sub Total - Topsoil	$127,589	$158,922		
B. Radiation Survey & Soil Analysis				
Unit Cost ($/Ac)	$800	$800		
Sub Total - Survey & Analysis	$12,653	$15,761		
C. Spill Cleanup				
Affected Area (Acres)	0	0		
Affected Area (Ft^2)	0	0		
Affected Area Thickness (Ft)	0.5	0.5		
Affected Volume (Ft^3)	0	0		
Quantity per Truckload (Ft^3)	540	540		
Quantity to be Shipped (Loads)	0	0		
Distance (Miles)	160	160		
Transportation Cost (Ton/Mile) ($)	$0.22	$0.22		
Transportation Cost ($)	$0	$0		
Handling Cost ($/Load)	$400	$400		
Handling Cost ($)	$0	$0		
Disposal Fee ($/Ton)	$300	$300		
Disposal Cost ($)	$0	$0		
Sub Total - Spill Cleanup	$0	$0		
D. Revegation				
Fertilizer ($/Ac)	$232.00	$232.00		Price from Dragstrip Soil Cover Project MT
Seeding Prep & Seeding ($/Ac)	$227.00	$227.00		Price from Dragstrip Soil Cover Project MT
Mulching & Crimping ($/Ac)	$100.00	$100.00		Price from Dragstrip Soil Cover Project MT
Sub Total Cost/Acre	$559.00	$559.00		
Sub Total Revegation	$8,842	$11,013		
Sub Total - Wellfields	$149,084	$185,696		
TOTAL WELLFIELDS COST	**$149,084**	**$185,696**		
III Roads				
A. Topsoil Handling & Grading				
Affected Area (Acres)	0.91	1.52		3305 feet by 12 feet wide- 2 track access
Average Affected Thickness (Ins)	12	12		
Topsoil Volume (Yds^3)	1,469	2,444		
Unit Cost - Haul/Place/Grading ($/cy)	$5.00	$5.00		Price from Dragstrip Soil Cover Project MT
Sub Total - Topsoil	$7,344	$12,222		
B. Radiation Survey & Soil Analysis				
Unit Cost ($/Ac)	$800	$800		
Sub Total - Survey & Analysis	$728	$1,212		
C. Revegation				
Fertilizer ($/Ac)	$232	$232		Price from Dragstrip Soil Cover Project MT
Seeding Prep & Seeding ($/Ac)	$227	$227		Price from Dragstrip Soil Cover Project MT
Mulching & Crimping ($/Ac)	$100	$100		Price from Dragstrip Soil Cover Project MT
Sub Total Cost/Acre	$559	$559		
Sub Total Revegation	$509	$847		
Sub Total - Roads	$8,582	$14,281		
TOTAL ROADS COST	**$8,581.77**	**$14,281.31**		

Worksheet 6, Nos IV & V
TOPSOIL REPLACEMENT & REVEGETATION

Cost Item	Mining Unit Wellfield 1	Mining Unit Wellfield 2	Sub Total	Notes
IV Other				
A. Topsoil Handling & Grading				
Affected Area (Acres)	4	4		
Average Affected Thickness (Ins)	6	6		
Topsoil Volume (Yds^3)	3,227	3,227		
Unit Cost - Haul/Place/Grading ($/Ac)	$5.00	$5.00		Price from Dragstrip Soil Cover Project MT
Sub Total - Topsoil	$16,133	$16,133		
B. Radiation Survey & Soil Analysis				
Unit Cost ($/Ac)	$800	$800		
Sub Total - Survey & Analysis	$3,200	$3,200		
C. Revegation				
Fertilizer ($/Ac)	$232.00	$232.00		Price from Dragstrip Soil Cover Project MT
Seeding Prep & Seeding ($/Ac)	$227.00	$227.00		Price from Dragstrip Soil Cover Project MT
Mulching & Crimping ($/Ac)	$100.00	$100.00		Price from Dragstrip Soil Cover Project MT
Sub Total Cost/Acre	$559.00	$559.00		
Sub Total Revegation	$2,236	$2,236		
Sub Total - Other	$21,569	$21,569		
TOTAL OTHER COST	**$21,569**	**$21,569**		
V Remedial Action				
A. Topsoil Handling & Grading				
Affected Area (Acres)	15	10		
Average Affected Thickness (Ins)	12	12		
Topsoil Volume (Yds^3)	24,200	16,133		
Unit Cost - Haul/Place/Grading ($/cy)	$5.00	$5.00		Price from Dragstrip Soil Cover Project MT
Sub Total - Topsoil	$121,000	$80,667		
B. Radiation Survey & Soil Analysis				
Unit Cost ($/Ac)	$800	$800		
Sub Total - Survey & Analysis	$12,000	$8,000		
C. Revegation				
Fertilizer ($/Ac)	$232.00	$232.00		Price from Dragstrip Soil Cover Project MT
Seeding Prep & Seeding ($/Ac)	$227.00	$227.00		Price from Dragstrip Soil Cover Project MT
Mulching & Crimping ($/Ac)	$100.00	$100.00		Price from Dragstrip Soil Cover Project MT
Sub Total Cost/Acre	$559.00	$559.00		
Sub Total Revegation	$8,385	$5,590		
TOTAL REMEDIAL ACTION	**$141,385**	**$94,257**	**$235,642**	
TOTAL TOPSOIL REPLACEMENT & REVEGETATION COST (Total of 7I through 7V)	**$424,491**	**$315,803**	**$740,294**	

Worksheet 7, Nos I - VII
MISCELLANEOUS RECLAMATION

	Cost Item	Mining Unit			Notes
		Wellfield 1	Wellfield 2	Sub Total	
I	**Fence Removal & Disposal**				
	Quantity (Ft)	11,637	10,086		Based on Perimeter Monitoring Wells
	Cost of Removal/Disposal ($/Ft)	$1.50	$1.50		
	Cost of Removal/Disposal ($)	$17,456	$15,129	$32,585	
II	**Powerline Removal & Disposal**				
	Quantity (Ft)	44,584	53,261		Power to Wells, header houses. Other power already in place by CBM companies
	Cost of Removal/Disposal ($/Ft)	$0.50	$0.50		
	Cost of Removal/Disposal ($)	$22,292	$26,630	48922.11	
III	**Powerpole Removal & Disposal**				
	Quantity	0	0		Overhead powerpoles and lines will remain in place for future gas production
	Cost of Removal/Disposal ($/Each)	0	0		
	Cost of Removal/Disposal ($)	$0.00	$0.00	$0.00	
IV	**Transformer Removal & Disposal**				
	Quantity	4	5		
	Cost of Removal/Disposal ($/Each)	4500	4500		Tri-County Electric will remove at no cost, WDEQ Guideline No.12, App. H
	Cost of Removal/Disposal ($)	18000	22500	40500	
V	**Culvert Removal & Disposal**				
	Quantity (Ft)	0	0		None
	Cost of Removal/Disposal ($/Ft)	$4.56	$4.56		($91.24/20') WDEQ Guideline No.12, App. J
	Cost of Removal/Disposal ($)	$0.00	$0.00	0	
VI	**Guardrail Removal**				
	Quantity (Ft)	0	0		None
	Cost of Removal/Disposal ($/Ft)	$6.50	$6.50		
	Cost of Removal/Disposal ($)	$0	0	0	
VII	**Low Water Stream Crossing**				
	Quantity	0	0		None
	Cost of Removal/Disposal ($/Each)	$8,000	$8,000		
	Cost of Removal/Disposal ($)	$0	$0	0	
	TOTAL MISCELLANEOUS COST	**$57,747**	**$64,259**	**$122,007**	