2.9.4.3 Conclusions

Baseline sediment radionuclide data from the 2007 survey were collected and analyzed according to Regulatory Guide 4.14 protocols. The corresponding historical survey data generally corroborate 2007 survey results. With respect to stream sediments, the 2007 and historical data sets, while technically incomplete individually, combined may be considered sufficient by the NRC and WDEQ/LQD in terms of adequately characterizing potential seasonal variations in overall radionuclide concentrations. The scheduled second sampling of stream sediments during the fall of 2007 was carried out as planned and results are provided in Addendum 2.9-A. With respect to pond sediment data, the historical data simply augment the 2007 survey data resulting in a more robust respective characterization. This information should be sufficient to meet the completeness requirements for site characterization of sediment radionuclide concentrations for administrative review as indicated by the USNRC and the WDEQ/LQD.

2.9.4.4 References

Conoco, Inc. 1980. *Environmental Report for the Sand Rock Mill Project, Campbell County, Wyoming.* Docket No. 40-8743. July, 1980.

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. *Radiological Effluent and Environmental Monitoring at Uranium Mills.* Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

Quarter 1 and 2 results are higher on average than Rn-222 concentrations reported in the historical baseline survey (Figures 2.9-27 and 2.9-28), particularly during quarter 1. Considering spatial, temporal, sampling, and analytical variability in radon measurements, however, the range of values for both data sets is not considered inconsistent with the national average ambient outdoor background level of about 0.4 pCi/L (Foster, 1993). No information in the Conoco report is provided with respect to how the historical Rn-222 data were collected or analyzed.

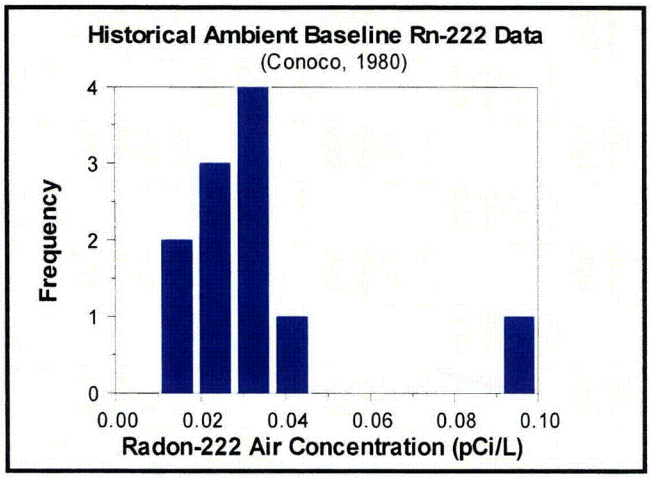

Figure 2.9-27: Frequency histogram of average monthly concentrations across all sampling locations for the historical data.

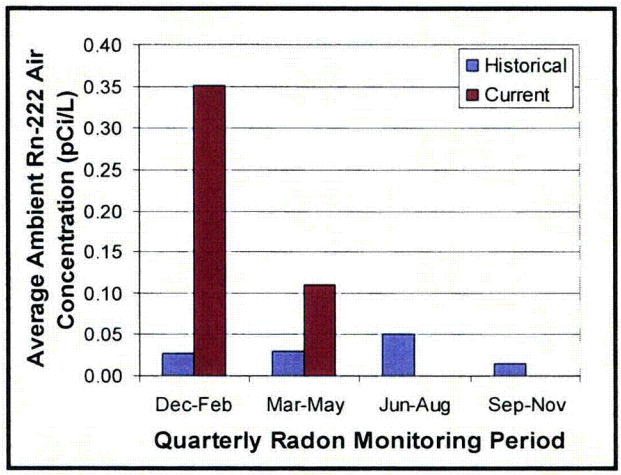

Figure 2.9-28: Current average quarterly results to date for all locations and corresponding average quarterly values across the site based on the historical data.

The historical data were collected on a monthly basis from May 1979 through March 1980. Thus, only the month of April is not represented in that data set. Combined, the historical and current data sets to date provide a reasonable idea of the magnitude of ambient Rn-222 air concentrations that can be expected to result in the remaining quarters of the current radon monitoring program. Based on all currently available data, the remaining quarters are unlikely to produce results in excess of the national average (0.4 pCi/L).

2.9.5.3 Conclusions

Baseline ambient gamma dose rate and radon-222 air concentration data for the 2007 radiological survey of the Moore Ranch Uranium Project area are being collected and analyzed according to Regulatory Guide 4.14 protocols. To date, two quarters of data are available and those results are presented in this section. The remaining two quarters of data is contained in Addendum 2.9-A. The historical ambient gamma and radon data from the 1980 Conoco study were evaluated and compared to the current data to allow consideration to determine the completeness of licensing/permitting applications for administrative review prior to completion of the recommended full year of monitoring for these radiological parameters. The data and

comparisons presented provide a reasonable indication of the results expected in the remaining quarters of the current year-long baseline monitoring program.

2.9.5.4 References

Conoco, Inc. 1980. *Environmental Report for the Sand Rock Mill Project, Campbell County, Wyoming*. Docket No. 40-8743. July, 1980.

Foster, B. 1993. *Radon: An Invisible Threat*. National Conference of State Legislatures. Energy, Science and Natural Resources Program. State Legislative Report, Vol. 18, No. 8, July 1, 1993

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. *Radiological Effluent and Environmental Monitoring at Uranium Mills*. Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

monitoring period are not likely to differ significantly from results to date, or with data from most nearby uranium recovery sites.

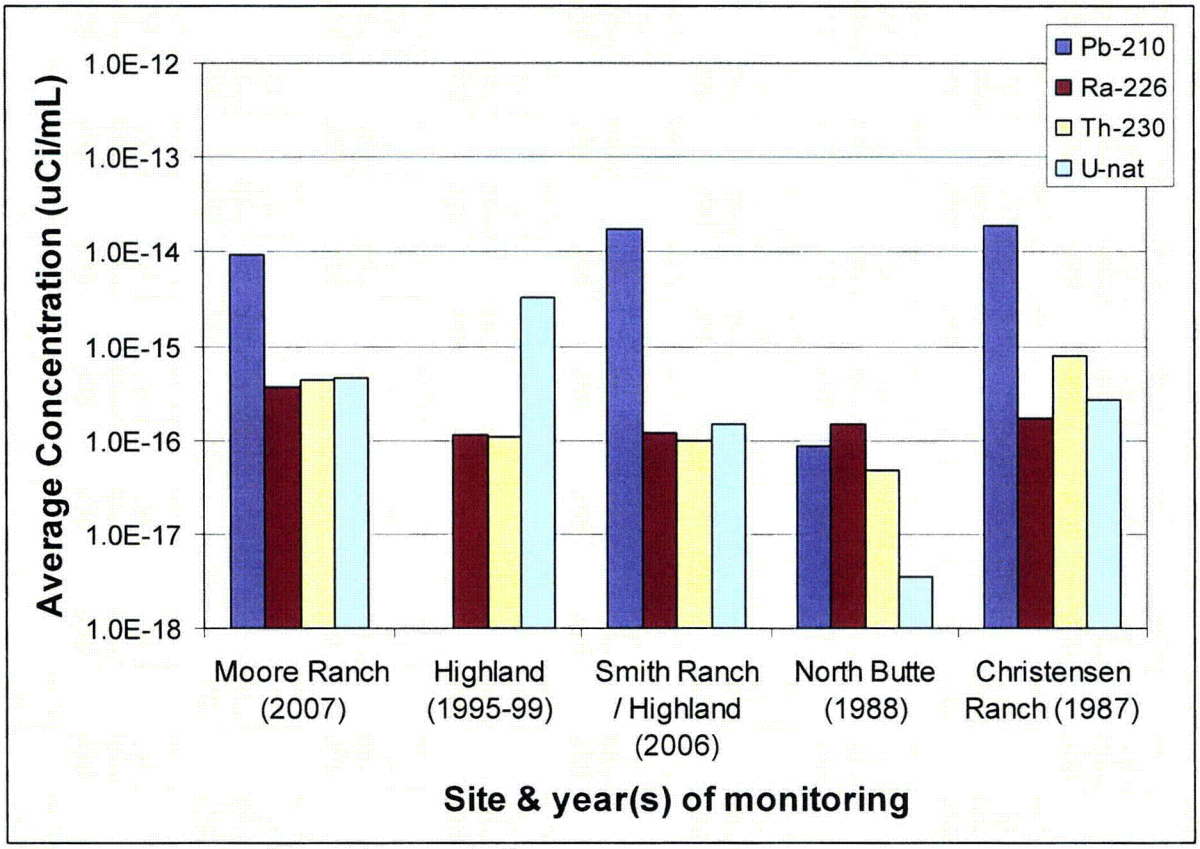

Figure 2.9-32: Average air particulate results to date for Moore Ranch compared to nearby uranium recovery sites in the region including Highland (NRC, 2004), Smith Ranch/Highland (NRC, 2004), North Butte (NRC, 2006) and Christensen Ranch (Cogema Mining, Inc 1996)

2.9.6.3 Conclusions

Baseline air particulate concentration data for the 2007 radiological survey of the Moore Ranch Uranium Project area are being collected and analyzed according to Regulatory Guide 4.14 protocols. To date, one quarter and one additional month of data are available and those results are presented in this section and the remaining data for the 2007 monitoring program is contained in Addendum 2.9-A. The historical air particulate data as reported in the 1980 Conoco study are thought to be incorrect and thus were not used to augment this portion of radiological characterizations. Alternate comparisons with air particulate data from nearby uranium recovery sites in the region generally support a conclusion that remaining data for the 2007 monitoring

program are likely to be similar to those collected to date and that the air particulate characterization of the Moore Ranch site should be deemed complete for purposes of administrative review of the application.

2.9.6.4 References

Cogema Mining, Inc, 1996. *Permit to Mine No. 478, A-2 Update and U.S. NRC License Renewal Application: Source Material License SUA-1341*, Irigary and Christensen Ranch Projects, January 1996.

Conoco, Inc. 1980. *Environmental Report for the Sand Rock Mill Project, Campbell County, Wyoming.* Docket No. 40-8743. July, 1980.

U.S. Nuclear Regulatory Commission (NRC). 2004. *Reynolds Ranch Amendment Permit to Mine No. 1548 – Smith Ranch – Highland Uranium Project.* Volume I, Chapters 1-10. ADAMS Accession No. ML050390095

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. *Radiological Effluent and Environmental Monitoring at Uranium Mills.* Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 2006. *North Butte ISL Satellite Project, Campbell County, Wyoming*, Power Resources, Inc., Volume I,, ADAMS Accession No. ML061740064

mineralized zones at the site (see Figure 2.9-35). Thorium-230 comparisons, not shown, were in good agreement as all results were near ELI's reporting limit of 0.2 pCi/g.

2.9.8.3 Conclusions

Radiological groundwater data for the Moore Ranch Uranium Project is being collected and analyzed according to Regulatory Guide 4.14 protocols. Results to date, along with historical groundwater data and summary comparisons of analytical results between the two data sets, are presented in this section. Current and historical data have reasonable agreement for most parameters. Uranium results deviate significantly in a few cases, two of which appear related to transcription errors in the historical report. Respective results for historic wells 8-3 and 1808 should not be considered. The remaining 2 quarters of data for the current groundwater monitoring program is contained in Addendum 2.9-A. The combined data sets provide a reasonable characterization of radionuclide concentrations in groundwater and these parameters are unlikely to change significantly through the remainder of the baseline monitoring program. Based on this conclusion, the data should be considered complete for purposes of administrative review of the license and permit applications.

2.9.8.4 References

Conoco, Inc. 1980. *Environmental Report for the Sand Rock Mill Project, Campbell County, Wyoming*. Docket No. 40-8743. July, 1980.

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. *Radiological Effluent and Environmental Monitoring at Uranium Mills*. Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

Historical results consistently suggest higher radionuclide contents in vegetation at the site compared to the current data (Figure 2.9-41). As with other current/historical survey comparisons described in this report, uncertainty due to random analytical variability, or systematic uncertainty due to differences in analytical methods, are both possible contributors to such differences. Again, there was no information presented in the Conoco report of analytical methods used. For Ra-226 and uranium, there is reasonable agreement between the two data sets. Based on the historical data, there is no indication of significant differences in radionuclide concentrations by vegetation type (Figure 2.9-42). Thus, compositing of all vegetation types encountered at a given sampling location is likely to be generally representative of any given species.

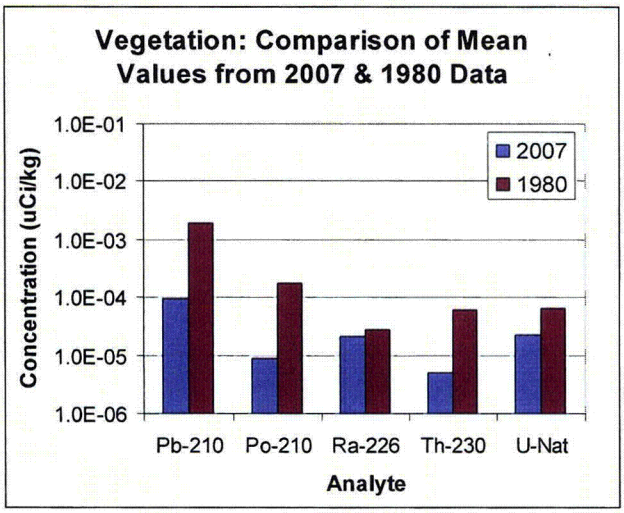

Figure 2.9-41: Mean results for vegetation samples from the 2007 survey compared to historical results (Conoco, 1980).

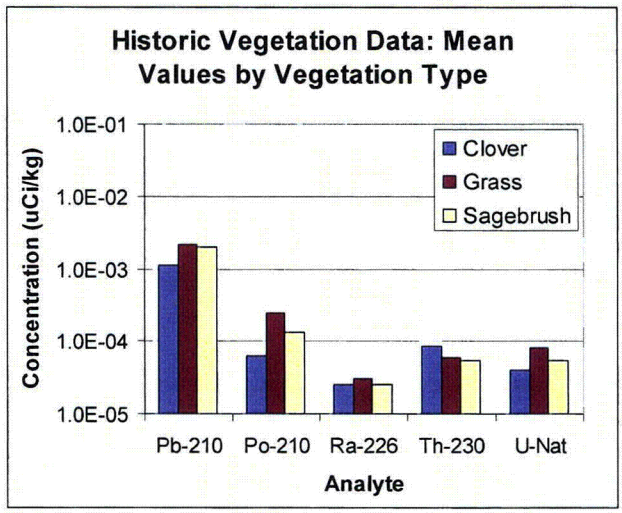

Figure 2.9-42: Mean historical results by vegetation type.

2.9.10.3 Conclusions

Baseline vegetation sampling data for the 2007 radiological survey of the Moore Ranch Uranium Project area are being collected and analyzed according to Regulatory Guide 4.14 protocols. To date, data from two of three scheduled sampling events are available and those results are presented in this section. The historical vegetation data as reported in the 1980 Conoco study are higher on average for each radionuclide analyzed, but data uncertainty due to differing analytical methods may be responsible for much of the difference. Remaining data for the final 2007 sampling are contained in Addendum 2.9-A.

ADDENDUM 2.9-A

Supplemental Analytical Monitoring Data

SUPPLEMENTAL ANALYTICAL MONITORING DATA:

ADDITIONAL BASELINE RADIOLOGICAL SURVEY RESULTS FOR THE MOORE RANCH URANIUM PROJECT SITE

Prepared for:

Energy Metals Corp.
Dba Uranium One Americas

February 15, 2008

Prepared by:

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TABLE OF CONTENTS

2.9.1(s) Introduction.....1

2.9.4(s) Sediment Sampling.....2

2.9.5(s) Ambient Gamma and Radon Monitoring.....4

2.9.6(s) Air Particulate Monitoring.....9

2.9.8(s) Groundwater Monitoring.....13

2.9.9(s) Surface Water Monitoring.....17

2.9.10(s) Vegetation Sampling.....18

2.9.1(s) Introduction

This document contains additional baseline radiological monitoring results to supplement data presented in Section 2.9 of the radioactive source materials license application submitted by Energy Metals Corporation (Energy Metals Corporation US, 2007) to the U.S. Nuclear Regulatory Commission (NRC), as well as a permit application submitted to the Wyoming Department of Environmental Quality / Land Quality Division (WDEQ/LQD). These regulatory agencies are currently reviewing licensing/permitting applications with respect to proposed in-situ recovery (ISR) operations at the Moore Ranch Uranium Project site in Campbell County, WY.

The additional data presented in this supplemental report pertain to baseline radiological parameters as indicated in NRC Regulatory Guide 4.14 to be collected at specified intervals over time and analyzed as part of pre-operational site monitoring (NRC, 1980). Certain respective data in the license/permit applications were in progress at the time of submission (as of October 3, 2007), and were supplemented with historical data to allow administrative review to proceed. This report was prepared in accordance with the intent stated in the licensing/permitting applications to provide all additional baseline monitoring data to the NRC and WDEQ/LQD once available.

This supplemental report, in conjunction with the applicable (corresponding) sections of the original licensing/permitting applications, completes baseline radiological measurements and monitoring data for the Moore Ranch Uranium Project site as recommended in Regulatory Guide 4.14. Subsequent section headings and numberings in this supplemental report correspond to those used in the original NRC license application (Energy Metals Corporation US, 2007), but with an added "(s)" notation to indicate supplemental material.

2.9.1.1(s) References

Energy Metals Corporation US. 2007. License Application, Technical Report. Moore Ranch Uranium Project. Volume II, Section 2.9 through 10-3. NRC website, ADAMS accession number ML072851268 (URL: http://www.nrc.gov/reading-rm/adams.html)

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. Radiological Effluent and Environmental Monitoring at Uranium Mills. Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

2.9.4(s) Sediment Sampling

In accordance with Regulatory Guide 4.14 protocols, baseline stream sediment sampling at the Moore Ranch Uranium Project site was conducted in spring (April 27-28, 2007) and fall (August 30, 2007). Stream sediment sampling locations were identical for both sampling events. This section supplements corresponding sections of the original NRC license application (Energy Metals Corporation US, 2007) and completes a final baseline characterization of radiological parameters in stream sediments at the site.

2.9.4.1(s) Methods

2.9.4.1.1(s) Stream Sediment Sampling

Stream sediment sampling methods for the fall 2007 sampling event were identical to those described for the spring 2007 sampling event in the original NRC license application (Energy Metals Corporation US, 2007).

2.9.4.2(s) Sediment Sampling Results

2.9.4.2.1(s) Stream Sediment Sample Results

Final descriptive summary statistics of stream sediment data for each indicated Regulatory Guide 4.14 analyte are provided in Tables 2.9-7(s/a) and 2.9-7(s/b). In general, stream sediment baseline results are similar to those found for both surface and subsurface soils at the site. Although sediment data for the fall 2007 sampling event are slightly higher on average than the spring 2007 sampling event, the differences appear to be within a range consistent with normal measurement variability. This is also true in comparison with the historical survey data [Table 2.9-8(s)].

Table 2.9-7(s/a): Summary statistics for radionuclide concentrations in stream sediment samples from the Moore Ranch Uranium Project Area (collected spring, 2007).

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.2	0.30	1.3	1.6	0.7	7
Pb-210	1.7	0.80	1.5	3.2	1.0	7
Th-230	0.5	0.10	0.5	0.7	0.4	7
U-nat	0.8	0.18	0.8	1.0	0.5	7

Table 2.9-7(s/b): Summary statistics for radionuclide concentrations in stream sediment samples from the Moore Ranch Uranium Project Area (collected fall, 2007).

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.6	0.69	1.3	3.1	1.1	7
Pb-210	4.9	3.00	4.1	11.0	2.3	7
Th-230	1.6	1.04	0.9	3.2	0.8	7
U-nat	3.1	3.04	1.7	9.6	1.1	7

Table 2.9-8(s): Summary statistics for radionuclide concentrations in stream sediment samples from the historical 1980 survey.

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.3	0.46	1.2	1.8	0.8	4
Pb-210*	-	-	-	-	-	-
Th-230	1.4	0.40	1.4	2.0	0.9	5
U-nat	1.9	1.06	2.1	3.3	0.6	5

* Analysis results not completed at time of 1980 Conoco report

2.9.4.3(s) Conclusions

Baseline sediment radionuclide data from the 2007 survey were collected and analyzed according to Regulatory Guide 4.14 protocols. The historical survey data for the site (Conoco, 1980) generally corroborate 2007 survey results. With respect to stream sediments, the 2007 baseline data set is now complete per the regulatory guidance recommended by the NRC and WDEQ/LQD. With respect to pond sediment data, these data are also complete as presented in the original NRC license application (Energy Metals Corporation US, 2007).

2.9.4.4(s) References

Conoco, Inc. 1980. Environmental Report for the Sand Rock Mill Project, Campbell County, Wyoming. Docket No. 40-8743. July, 1980.

Energy Metals Corporation US. 2007. License Application, Technical Report. Moore Ranch Uranium Project. Volume II, Section 2.9 through 10-3. NRC website, ADAMS accession number ML072851268 (URL: http://www.nrc.gov/reading-rm/adams.html)

2.9.5(s) Ambient Gamma and Radon Monitoring

Consistent with Regulatory Guide 4.14 protocols, ambient gamma and radon monitoring at the Moore Ranch Uranium Project site was conducted continuously between December 4, 2007 and January 3, 2008. This section supplements corresponding sections of the original NRC license application (Energy Metals Corporation US, 2007) and completes a final baseline characterization of ambient gamma doses and radon concentrations at the site.

2.9.5.1(s) Methods

2.9.5.1.1(s) Ambient Gamma Dose Rate Monitoring

Gamma monitoring methods for collecting, analyzing and reporting respective baseline data are described in the original NRC license application (Energy Metals Corporation US, 2007). As indicated in the application, the third quarterly TLD change out was delayed one month to synchronize the TLD monitoring schedule with Landauer's normal quarterly schedule to help simplify data management, calculations and records keeping.

2.9.5.1.2(s) Ambient Radon-222 Monitoring

Ambient radon monitoring methods for collecting, analyzing and reporting respective baseline data are described in the original NRC license application (Energy Metals Corporation US, 2007).

2.9.5.2(s) Ambient Gamma and Radon Results

2.9.5.2.1(s) Ambient Gamma Dose Rate Monitoring

Final passive gamma dose monitoring results are presented in Table 2.9-11(s). Assuming conventional radiation weighting and quality dose factors for photons, the estimated gamma dose rates (mrem/hr) shown in Table 2.9-11(s) agree reasonably well with the gamma exposure rate scan data found in Section 2.9.2 of the baseline report as presented in the original NRC application. Similarly, these gamma dose rate values agree reasonably well with the historical gamma exposure rate data (μR/hr) provided for M and T grids in Figure 2.10-7 in the Conoco report, which were measured by a pressurized ionization chamber (Conoco, 1980).

Table 2.9-11(s): Final quarterly environmental gamma dose rate monitoring data for Moore Ranch.

Passive Monitoring Station ID	TLD Issue Date	Field Installation Date	Monitoring End Date	Landauer GROSS Result (mrems)	Estimated Quarterly Field Dose (mrem)	Estimated Daily Field Dose (mrem)	Estimated Field Dose Rate (mrem/hr)
QUARTER 1							
MR-1	10/1/2006	12/4/2006	3/5/2007	47.1	29.3	0.322	0.013
MR-2	10/1/2006	12/4/2006	3/5/2007	50.3	32.5	0.357	0.015
MR-3	10/1/2006	12/4/2006	3/5/2007	47.1	29.3	0.322	0.013
MR-4	10/1/2006	12/4/2006	3/5/2007	47.8	30.0	0.330	0.014
MR-5	10/1/2006	12/4/2006	3/5/2007	42.1	24.3	0.267	0.011
MR-6	10/1/2006	12/4/2006	3/5/2007	54.6	36.8	0.404	0.017
MR-7	10/1/2006	12/4/2006	3/5/2007	51.1	33.3	0.366	0.015
MR-8	10/1/2006	12/4/2006	3/5/2007	52.1	34.3	0.377	0.016
MR-9	10/1/2006	12/4/2006	3/5/2007	44.8	27.0	0.297	0.012
MR-10	10/1/2006	12/4/2006	3/5/2007	41.0	23.2	0.255	0.011
Transit control	10/1/2006	-	3/5/2007	39.2	-	-	-
Deploy control	10/1/2006	-	3/5/2007	39.8	-	-	-
QUARTER 2							
MR-1	1/1/2007	3/5/2007	6/9/2007	58.4	34.1	0.355	0.015
MR-2	1/1/2007	3/5/2007	6/9/2007	56.5	32.2	0.335	0.014
MR-3	1/1/2007	3/5/2007	6/9/2007	55.9	31.6	0.329	0.014
MR-4	1/1/2007	3/5/2007	6/9/2007	56.3	32.0	0.333	0.014
MR-5	1/1/2007	3/5/2007	6/9/2007	47.0	22.7	0.236	0.010
MR-6	1/1/2007	3/5/2007	6/9/2007	68.8	44.5	0.464	0.019
MR-7	1/1/2007	3/5/2007	6/9/2007	69.9	45.6	0.475	0.020
MR-8	1/1/2007	3/5/2007	6/9/2007	78.5	54.2	0.565	0.024
MR-9	1/1/2007	3/5/2007	6/9/2007	73.1	48.8	0.508	0.021
MR-10	1/1/2007	3/5/2007	6/9/2007	71.8	47.5	0.495	0.021
Transit control	1/1/2007	-	6/9/2007	74.4	-	-	-
Deploy control	1/1/2007	-	6/9/2007	58.7	-	-	-
QUARTER 3							
MR-1	4/1/2007	6/9/2007	10/4/2007	53.9	26.9	0.230	0.010
MR-2	4/1/2007	6/9/2007	10/4/2007	57.6	30.6	0.262	0.011
MR-3	4/1/2007	6/9/2007	10/4/2007	43.4	16.4	0.140	0.006
MR-4	4/1/2007	6/9/2007	10/4/2007	43.7	16.7	0.143	0.006
MR-5	4/1/2007	6/9/2007	10/4/2007	55.9	28.9	0.247	0.010
MR-6	4/1/2007	6/9/2007	10/4/2007	57.9	30.9	0.264	0.011
MR-7	4/1/2007	6/9/2007	10/4/2007	54.4	27.4	0.234	0.010
MR-8	4/1/2007	6/9/2007	10/4/2007	48.4	21.4	0.183	0.008
MR-9	4/1/2007	6/9/2007	10/4/2007	52.8	25.8	0.221	0.009
MR-10	4/1/2007	6/9/2007	10/4/2007	48.3	21.3	0.182	0.008
Transit control	4/1/2007	-	10/4/2007	51.9	-	-	-
Deploy control	4/1/2007	-	10/4/2007	58.8	-	-	-
QUARTER 4							
MR-1	10/1/2007	10/4/2007	1/3/2008	47.9	39.7	0.436	0.018
MR-2	10/1/2007	10/4/2007	1/3/2008	45.3	37.1	0.408	0.017
MR-3	10/1/2007	10/4/2007	1/3/2008	48.4	40.2	0.442	0.018
MR-4	10/1/2007	10/4/2007	1/3/2008	49.4	41.2	0.453	0.019
MR-5	10/1/2007	10/4/2007	1/3/2008	-	-	-	-
MR-6	10/1/2007	10/4/2007	1/3/2008	53.1	44.9	0.493	0.021
MR-7	10/1/2007	10/4/2007	1/3/2008	49.6	41.4	0.455	0.019
MR-8	10/1/2007	10/4/2007	1/3/2008	52.7	44.5	0.489	0.020
MR-9	10/1/2007	10/4/2007	1/3/2008	50.5	42.3	0.465	0.019
MR-10	10/1/2007	10/4/2007	1/3/2008	50.0	41.8	0.459	0.019
Transit control	10/1/2007	-	1/3/2008	37.6	-	-	-
Deploy control	10/1/2007	-	1/3/2008	42.8	-	-	-

1 - Results listed in blue calculated using deploy control dose only due to suspect transit control result

As expected from initial data reported in the original license application, seasonal fluctuations in ambient field gamma dose rates at a given location seldom varied by more than 0.01 mrem/hr (never by more than 0.02 mrem/hr). Spatial and temporal variability in background sources of gamma radiation combined with measurement uncertainty are likely responsible for a higher degree of variation observed in some cases.

2.9.5.2.2(s) Ambient Rn-222 Monitoring

Final baseline Rn-222 monitoring results are presented in Table 2.9-12(s).

Table 2.9-12(s): Final quarterly ambient radon-222 baseline monitoring data for Moore Ranch.

Passive Monitoring Station ID	Radon Detector ID	Package Open Date	Field Installation Date	Quarter End (seal) Date	Quarterly Result (pCi-days/L)[1]	Quarterly Result (pCi/L)[1]
QUARTER 1						
MR-1	4639785	12/2/2006	12/4/2006	3/5/2007	9.4	0.1
MR-2	4639861	12/2/2006*	12/4/2006	3/5/2007	34.4	0.4
MR-3	4639862	12/2/2006*	12/4/2006	3/5/2007	42.3	0.5
MR-4	4639864	12/2/2006*	12/4/2006	3/5/2007	43.5	0.5
MR-5	4639874	12/2/2006	12/4/2006	3/5/2007	34.4	0.4
MR-6	4639875	12/2/2006	12/4/2006	3/5/2007	36.8	0.4
MR-7	4639876	12/2/2006	12/4/2006	3/5/2007	37.4	0.4
MR-8	4639884	12/2/2006*	12/4/2006	3/5/2007	31.3	0.3
MR-9	4639885	12/2/2006*	12/4/2006	3/5/2007	38.6	0.4
MR-10	4639886	12/2/2006*	Not installed**	12/2/2006	35.6	3.6
MR-10	4619417 (replacement)	1/9/2007	1/9/2007	3/5/2007	6.0	0.11
QUARTER 2						
MR-1	4680455	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-2	4680456	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-3	4680459	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-4	4680434	3/5/2007	3/5/2007	6/9/2007	11.5	0.1
MR-5	4680435	3/5/2007	3/5/2007	6/9/2007	12.0	0.1
MR-6	4680436	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-7	4680449	3/5/2007	3/5/2007	6/9/2007	17.9	0.2
MR-8	4680450	3/5/2007	3/5/2007	6/9/2007	18.6	0.2
MR-9	4680451	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-10	4680533	3/5/2007	3/5/2007	6/9/2007	12.0	0.1
QUARTER 3						
MR-1	4680404	6/5/2007[1]	6/9/2007	10/4/2007	82.4	0.9
MR-2	4680405	6/5/2007[1]	6/9/2007	10/4/2007	52.5	0.4
MR-3	4680349	6/9/2007	6/9/2007	10/4/2007	14.8	0.1
MR-4	4680350	6/9/2007	6/9/2007	10/4/2007	22.7	0.2
MR-5	4680351	6/9/2007	6/9/2007	10/4/2007	51.9	0.4
MR-6	4680352	6/9/2007	6/9/2007	10/4/2007	38.6	0.3
MR-7	4680379	6/9/2007	6/9/2007	10/4/2007	197.7	1.7
MR-8	4680378	6/9/2007	6/9/2007	10/4/2007	163.3	1.4
MR-9	4680377	6/9/2007	6/9/2007	10/4/2007	177.6	1.5
MR-10	4680375	6/9/2007	6/9/2007	10/4/2007	154.9	1.3
QUARTER 4						
MR-1	4680424	10/4/2007	10/4/2007	1/3/2008	6.0	0.1
MR-2	4680423	10/4/2007	10/4/2007	1/3/2008	6.0	0.1
MR-3	4680426	10/4/2007	10/4/2007	1/3/2008	6.0	0.1
MR-4	4680432	10/4/2007	10/4/2007	1/3/2008	6.0	0.1
MR-5	4680431	10/4/2007	10/4/2007	1/3/2008	-	-
MR-6	4680430	10/4/2007	10/4/2007	1/3/2008	6.0	0.1
MR-7	4680429	10/4/2007	10/4/2007	1/3/2008	6.0	0.1
MR-8	4680428	10/4/2007	10/4/2007	1/3/2008	6.0	0.1
MR-9	4680427	10/4/2007	10/4/2007	1/3/2008	6.0	0.1
MR-10	4680425	10/4/2007	10/4/2007	1/3/2008	6.0	0.1

[1]Results listed in blue were below analytical reporting limits
*Comprimised packaging seal from Landauer
**Sealed immediately and submitted for analysis - intended as a control detector for units with compromised packaging

Although final baseline results are higher on average than Rn-222 concentrations reported in the historical baseline survey [Figure 2.9-28(s)], the range of values for both data sets is not inconsistent with the national average ambient outdoor background level of about 0.4 pCi/L (Foster, 1993). This is particularly true considering the potential for spatial, temporal, sampling, and analytical variability in radon measurements.

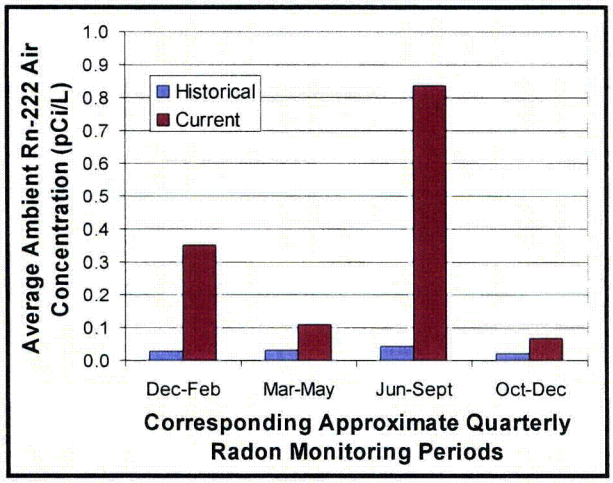


Figure 2.9-28(s): Current average quarterly results to date for all locations and corresponding average quarterly values across the site based on the historical data.

2.9.5.3(s) Conclusions

Baseline ambient gamma dose rate and radon-222 air concentration data for the 2007 radiological survey of the Moore Ranch ISR uranium project area were collected and analyzed according to Regulatory Guide 4.14 protocols. The updated data presented in this supplementary report, combined with initial data submitted with the original NRC application, complete a year-long baseline monitoring program and should fulfill respective requirements for licensing/permitting applications with the NRC and WDEQ/LQD.

2.9.5.4(s) References:

Conoco, Inc. 1980. Environmental Report for the Sand Rock Mill Project, Campbell County, Wyoming. Docket No. 40-8743. July, 1980.

Energy Metals Corporation US. 2007. License Application, Technical Report. Moore Ranch Uranium Project. Volume II, Section 2.9 through 10-3. NRC website, ADAMS accession number ML072851268 (URL: http://www.nrc.gov/reading-rm/adams.html)

Foster, B. 1993. Radon: An Invisible Threat. National Conference of State Legislatures. Energy, Science and Natural Resources Program. State Legislative Report, Vol. 18, No. 8, July 1, 1993

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. Radiological Effluent and Environmental Monitoring at Uranium Mills. Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

2.9.6(s) Air Particulate Monitoring

Consistent with Regulatory Guide 4.14 protocols, air particulate monitoring at the Moore Ranch Uranium Project site was conducted between February 2007 and January 2008. This section supplements corresponding sections of the original NRC license application (Energy Metals Corporation US, 2007) and completes a final baseline characterization of air particulate concentrations at the site.

2.9.6.1(s) Methods

Air particulate monitoring methods for collecting, analyzing and reporting respective baseline data are described in the original NRC license application (Energy Metals Corporation US, 2007).

2.9.6.2(s) Air Particulate Sampling Results

Final air particulate monitoring results are presented in Table 2.9-13(s) and graphically illustrated in Figure 2.9-31(s). Where values were reported as below the reporting limit, the reporting limit was assigned for the graphical comparisons shown in Figure 2.9-31(s).

Table 2.9-13(s): Final baseline air particulate monitoring data for Moore Ranch.

Air Station ID	Monitoring Period	Air Volume Sampled (mL)	Radionuclide	Concentration (uCi/mL)	Error Estimate (uCi/mL)	LLD (uCi/mL)	Effluent Conc.* (uCi/mL)	% Effluent Concentration
MRA-1	2/6/07 - 5/9/07	2.83E+09	U-nat	4.24E-16	N/A	1.00E-16	9.00E-14	0.47
			Ra-226	3.18E-16	2.83E-16	1.00E-16	9.00E-13	0.04
			Pb-210	1.02E-14	2.19E-15	2.00E-15	6.00E-13	1.70
			Th-230	< 1.00E-16	0.00E+00	1.00E-16	2.00E-14	< 0.5
	5/21/07 - 6/28/07	3.08E+09	U-nat	1.62E-16	N/A	1.00E-16	9.00E-14	0.18
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	5.84E-15	1.92E-15	2.00E-15	6.00E-13	0.97
			Th-230	< 1.00E-16	0.00E+00	1.00E-16	2.00E-14	< 0.50
	6/28/07 - 10/1/07	3.36E+09	U-nat	6.55E-16	N/A	1.00E-16	9.00E-14	0.73
			Ra-226	1.79E-16	1.79E-16	1.00E-16	9.00E-13	0.02
			Pb-210	1.84E-14	1.73E-15	2.00E-15	6.00E-13	3.07
			Th-230	8.33E-16	3.87E-16	1.00E-16	2.00E-14	4.17
	10/1/07 - 11/28/07	1.78E+09	U-nat	5.00E-15	N/A	1.00E-16	9.00E-14	5.56
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	5.11E-15	1.40E-15	2.00E-15	6.00E-13	0.85
			Th-230	< 1.00E-16	N/A	1.00E-16	2.00E-14	< 0.50
MRA-2	2/6/07 - 5/9/07	2.32E+09	U-nat	5.60E-16	N/A	1.00E-16	9.00E-14	0.62
			Ra-226	4.74E-16	3.45E-16	1.00E-16	9.00E-13	0.05
			Pb-210	1.19E-14	2.63E-15	2.00E-15	6.00E-13	1.98
			Th-230	4.31E-16	3.02E-16	1.00E-16	2.00E-14	2.16
	5/21/07 - 6/28/07	1.71E+09	U-nat	3.51E-16	N/A	1.00E-16	9.00E-14	0.39
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	< 2.00E-15	N/A	2.00E-15	6.00E-13	< 0.33
			Th-230	< 1.00E-16	0.00E+00	1.00E-16	2.00E-14	< 0.50
	6/28/07 - 10/1/07	2.85E+09	U-nat	1.23E-15	N/A	1.00E-16	9.00E-14	1.36
			Ra-226	8.42E-16	3.86E-16	1.00E-16	9.00E-13	0.09
			Pb-210	2.13E-14	2.00E-15	2.00E-15	6.00E-13	3.54
			Th-230	2.14E-15	6.32E-16	1.00E-16	2.00E-14	0.11
	10/1/07 - 1/9/08	2.84E+09	U-nat	< 1.00E-16	N/A	1.00E-16	9.00E-14	< 0.1
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	1.79E-14	1.90E-15	2.00E-15	6.00E-13	2.98
			Th-230	< 1.00E-16	N/A	1.00E-16	2.00E-14	< 0.50
MRA-3	2/6/07 - 5/10/07	1.76E+09	U-nat	3.98E-16	N/A	1.00E-16	9.00E-14	0.44
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	9.32E-15	3.13E-15	2.00E-15	6.00E-13	1.55
			Th-230	1.93E-15	6.25E-16	1.00E-16	2.00E-14	9.66
	5/21/07 - 6/28/07	6.99E+08	U-nat	7.15E-16	N/A	1.00E-16	9.00E-14	0.795
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	2.02E-14	8.15E-15	2.00E-15	6.00E-13	3.36
			Th-230	< 1.00E-16	0.00E+00	1.00E-16	2.00E-14	< 0.50
	6/28/07 - 10/1/07	1.78E+09	U-nat	1.69E-16	N/A	1.00E-16	9.00E-14	0.19
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	3.59E-14	3.26E-15	2.00E-15	6.00E-13	5.98
			Th-230	< 1.00E-16	N/A	1.00E-16	2.00E-14	< 0.50
	10/1/07 - 1/9/08	3.18E+09	U-nat	4.08E-16	N/A	1.00E-16	9.00E-14	0.45
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	1.16E-14	1.48E-15	2.00E-15	6.00E-13	1.94
			Th-230	< 1.00E-16	N/A	1.00E-16	2.00E-14	< 0.50
MRA-4	2/6/07 - 5/10/07	1.80E+09	U-nat	7.22E-16	N/A	1.00E-16	9.00E-14	0.80
			Ra-226	8.33E-16	4.44E-16	1.00E-16	9.00E-13	0.09
			Pb-210	1.22E-14	3.22E-15	2.00E-15	6.00E-13	2.03
			Th-230	5.56E-16	3.89E-16	1.00E-16	2.00E-14	2.78
	5/21/07 - 6/28/07	1.62E+09	U-nat	2.47E-16	N/A	1.00E-16	9.00E-14	0.27
			Ra-226	8.64E-16	6.79E-16	1.00E-16	9.00E-13	0.10
			Pb-210	< 2.00E-15	N/A	2.00E-15	6.00E-13	< 0.33
			Th-230	< 1.00E-16	0.00E+00	1.00E-16	2.00E-14	< 0.50
	6/28/07 - 10/1/07	3.94E+09	U-nat	2.79E-16	N/A	1.00E-16	9.00E-14	0.31
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	1.65E-14	1.50E-15	2.00E-15	6.00E-13	2.76
			Th-230	< 1.00E-16	N/A	1.00E-16	2.00E-14	< 0.50
	10/1/07 - 1/9/08	3.53E+10	U-nat	1.14E-16	N/A	1.00E-16	9.00E-14	0.13
			Ra-226	< 1.00E-16	N/A	1.00E-16	9.00E-13	< 0.01
			Pb-210	1.22E-14	1.42E-15	2.00E-15	6.00E-13	2.04
			Th-230	< 1.00E-16	N/A	1.00E-16	2.00E-14	< 0.50

Final prep volume is 0.95 liter
LLD's are from Reg. Guide 4.14
*Effluent concentration limit from 10 CFR Part 20 - Appendix B - Table 2
Solubility Class:
- Year for Natural Uranium
- Week for Radium-226
- Day for lead-210

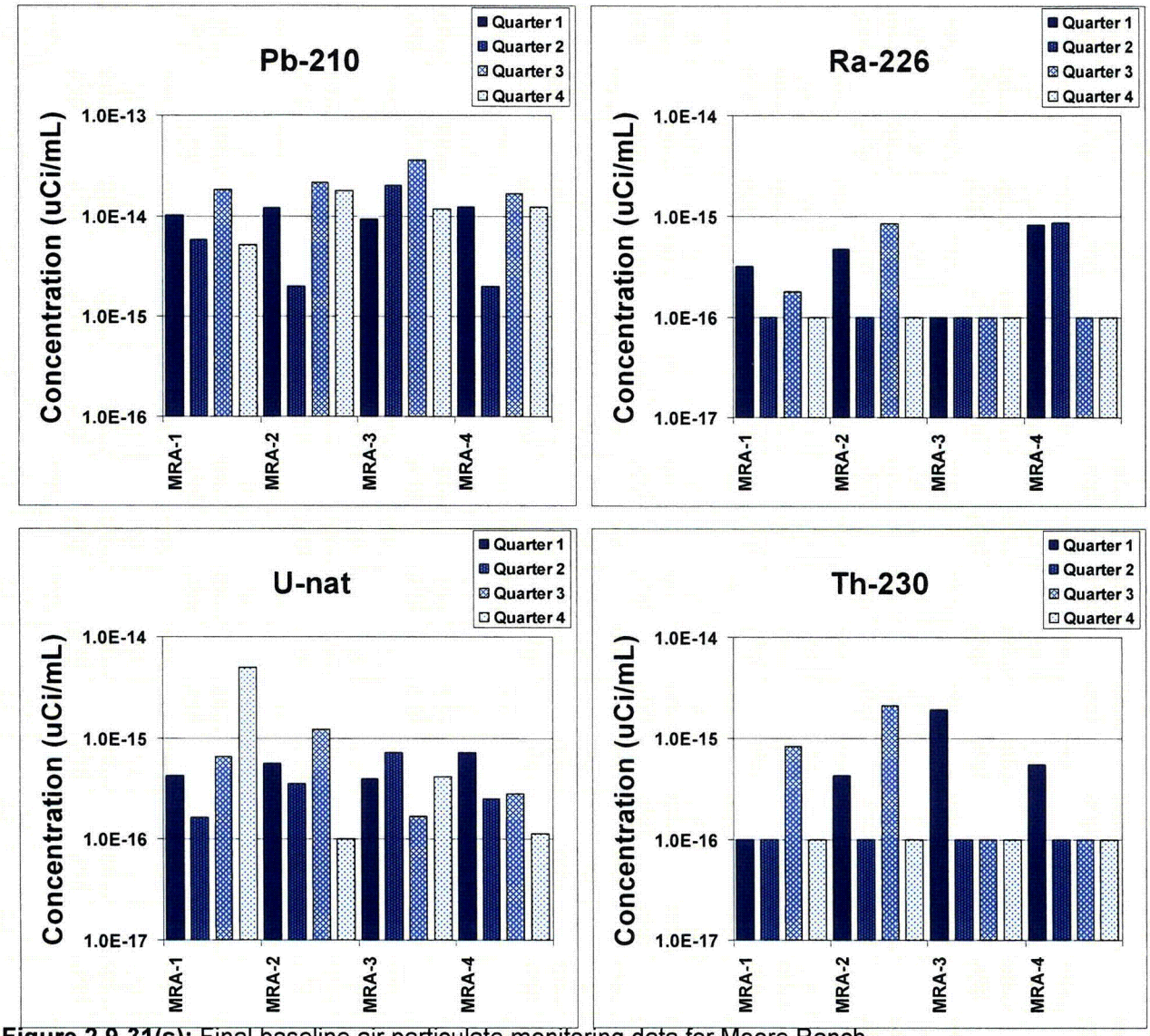


Figure 2.9-31(s): Final baseline air particulate monitoring data for Moore Ranch.

2.9.6.4(s) Conclusions

Baseline air particulate concentration data for the 2007 radiological survey of the Moore Ranch ISR uranium project area were collected and analyzed according to Regulatory Guide 4.14 protocols. The updated data presented in this supplementary report, combined with initial data submitted with the original NRC application, complete a year-long baseline monitoring program and should fulfill respective requirements for licensing/permitting applications with the NRC and WDEQ/LQD.

2.9.6.4(s) References:

Energy Metals Corporation US. 2007. License Application, Technical Report. Moore Ranch Uranium Project. Volume II, Section 2.9 through 10-3. NRC website, ADAMS accession number ML072851268 (URL: http://www.nrc.gov/reading-rm/adams.html)

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. Radiological Effluent and Environmental Monitoring at Uranium Mills. Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

2.9.8(s) Groundwater Monitoring

Consistent with Regulatory Guide 4.14 protocols, periodic baseline sampling of groundwater wells at the Moore Ranch Uranium Project site was conducted in 2007. This section supplements corresponding sections of the original NRC license application (Energy Metals Corporation US, 2007) and completes an overall baseline characterization of radiological groundwater conditions at the site.

2.9.8.1(s) Methods

Groundwater monitoring methods for collecting, analyzing and reporting respective baseline data are described in the original NRC license application (Energy Metals Corporation US, 2007).

2.9.8.2(s) Groundwater Sampling Results

Final results for dissolved radiological groundwater parameters are shown in Table 2.9-15(s). Parameters in suspended form were also evaluated, but results are not presented here (those data, reporting limits, and other details can be found in supplementary data updates also being submitted to the NRC and WDEQ/LQD with respect to Section 2.7 of the original application that pertains specifically to groundwater).

Table 2.9-15(s): Analytical results for radiological parameters in groundwater samples collected as part of 2007 baseline surveys. Values with less-than qualifiers were all below analytical reporting limits.

Well No.	Sampling Date	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	2/16/2007	10	<1.0	82.6	2.1	<0.2	126
	10/2/2007	1.8	<1.0	88	<1.0	<0.2	109
	11/15/2007	4.7	<1.0	55.8	<1.0	<0.2	80
MR-OMW-1	4/27/2007	<1.0	<1.0	0.8	2.8	<0.2	6.7
	9/26/2007	<1.0	<1.0	0.8	<1.0	<0.2	0.6
	11/15/2007	3.8	1.8	1.1	<1.0	<0.2	0.6
MR-MW-1	9/26/2007	<1.0	<1.0	21.4	2	<0.2	161
MR-UMW-1	5/11/2007	<1.0	<1.0	0.8	<1.0	<0.2	6.4
	10/3/2007	<1.0	<1.0	0.7	<1.0	<0.2	4.7
MR-OMW-2	5/10/2007	<1.0	<1.0	1.1	2.5	1	1.8
	9/27/2007	<1.0	<1.0	0.6	<1.0	<0.2	1.1
	11/13/2007	<1.0	2.6	3	<1.0	<0.2	1.2
MR-MW-2	3/21/2007	31	51	138	<1.0	<0.2	495
	9/26/2007	<1.0	<1.0	206	2.9	0.6	576
	11/13/2007	13	3.9	302	3.4	<0.2	567
MR-UMW-2	5/11/2007	<1.0	1.8	1	<1.0	<0.2	75
	9/26/2007	<1.0	<1.0	<0.2	<1.0	<0.2	30
	11/13/2007	2.4	2.3	1	<1.0	<0.2	55
MR-OMW-3	9/25/2007	<1.0	<1.0	0.6	<1.0	0.7	1.1
	11/1/2007	6.2	1.9	0.7	<1.0	<0.2	0.7
MR-MW-3	3/22/2007	69	34	280	<1.0	<0.2	56
	10/3/2007	<1.0	<1.0	1.4	<1.0	<0.2	<0.2
	11/1/2007	25	9.9	335	<1.0	<0.2	63
MR-UMW-3	4/26/2007	<1.0	<1.0	1.1	9.5	<0.2	0.9
	10/3/2007	<1.0	<1.0	1.4	<1.0	<0.2	<0.2
MR-OMW-4	4/30/2007	<1.0	<1.0	1.8	2	<0.2	0.5
	9/27/2007	<1.0	<1.0	1.1	1.6	0.5	0.7
	11/20/2007	8.2	<1.0	1.5	2.2	<0.2	0.7
MR-MW-4	4/30/2007	<1.0	<1.0	45.7	1.7	<0.2	87
	9/27/2007	<1.0	<1.0	31.9	1.7	<0.2	41
	11/20/2007	7.2	<1.0	26.1	<1.0	<0.2	31
MR-UMW-4	5/9/2007	<1.0	<1.0	1	3.3	<0.2	46
	9/27/2007	<1.0	<1.0	0.8	<1.0	<0.2	44
	11/20/2007	13	1.6	1.4	<1.0	<0.2	41
MR-MW-6	4/26/2007	<1.0	<1.0	1.3	<1.0	<0.2	6.7
	9/25/2007	<1.0	<1.0	1.9	2.4	<0.2	12.0
	11/12/2007	2.8	<1.0	1	<1.0	<0.2	10.9
MR-MW-7	4/26/2007	<1.0	1.6	1.1	<1.0	<0.2	6.7
	9/25/2007	<1.0	<1.0	1.4	<1.0	<0.2	36.3
	11/12/2007	11	2.5	2	<1.0	<0.2	31.0
MR-MW-9	5/1/2007	<1.0	2	2.5	<1.0	<0.2	39
	9/25/2007	<1.0	<1.0	6.7	<1.0	<0.2	39
	11/15/2007	3.9	<1.0	5.3	<1.0	<0.2	36
MR-MW-11	5/4/2007	<1.0	<1.0	26	3.5	0.9	69
	10/1/2007	2.2	<1.0	22	-	0.4	60
	11/1/2007	3.8	4.2	26	<1.0	<0.2	60
MR-885	5/2/2007	41	31	309	1.8	<0.2	51
	10/2/2007	12	3.5	272	<1.0	<0.2	51
	11/15/2007	20	9.9	263	<1.0	0.4	48
MR-1808	5/3/2007	<1.0	<1.0	9.1	<1.0	0.4	0.8
	10/1/2007	<1.0	5.3	1.1	<1.0	<0.2	<0.2
	11/12/2007	4.9	1.6	1.5	4.3	<0.2	<0.2
MR-8-3	5/2/2007	<1.0	<1.0	0.8	3	<0.2	1.3
	9/27/2007	<1.0	<1.0	0.7	<1.0	<0.2	1.1
	11/15/2007	8.6	2.3	1.4	4.6	<0.2	1.1
Stockwell #1	4/27/2007	<1.0	<1.0	0.8	1.6	<0.2	6.7
	10/1/2007	<1.0	<1.0	0.7	<1.0	<0.2	0.7
	11/20/2007	12	<1.0	1	1.8	<0.2	0.9
Stockwell #2	4/27/2007	<1.0	<1.0	0.9	3.9	<0.2	6.7
	10/1/2007	<1.0	<1.0	0.5	<1.0	<0.2	32.8
	11/20/2007	10	<1.0	3.6	<1.0	<0.2	30.2
Stockwell #3	4/27/2007	<1.0	<1.0	3.3	3.5	<0.2	6.7
	10/1/2007	<1.0	<1.0	3.2	<1.0	<0.2	21.2
	11/20/2007	14	1.9	2.7	2.4	<0.2	11.7
Stockwell #4	5/9/2007	<1.0	<1.0	<0.2	<1.0	0.9	4.8
	10/1/2007	1.5	<1.0	<0.2	<1.0	<0.2	4.6
	11/20/2007	4	2.4	<0.2	<1.0	<0.2	5.0

Graphical representations of average values for select Regulatory Guide 4.14 radionuclides by monitoring well from the results provided in Table 2.9-15(s) are shown in Figure 2.9-36(s). Sample results below analytical reporting limits were assigned the reporting limit value to calculate the mean. A number of reported results for the sample collected on 10/3/2007 at well MR-MW-3 are clearly inconsistent with corresponding results from other sampling dates and thus were not used in calculating the mean for that well.

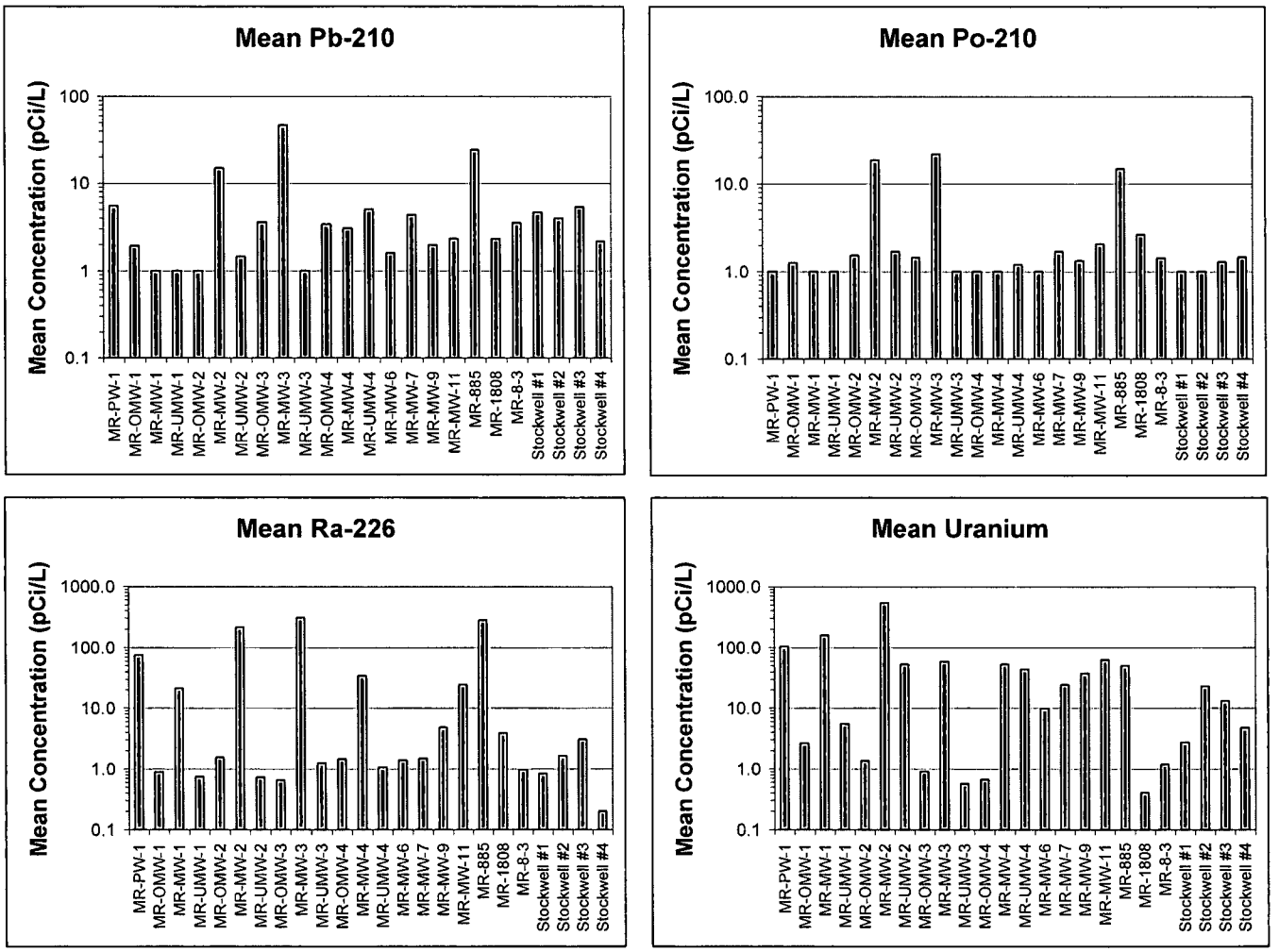


Figure 2.9-36(s): Average concentrations of select Regulatory Guide 4.14 radionuclides from 2007 baseline groundwater monitoring samples.

2.9.8.3(s) Conclusions

The updated radiological baseline data groundwater presented in this supplementary report, combined with initial data submitted with the original NRC application, should fulfill baseline groundwater monitoring program requirements for licensing/permitting applications with the NRC and WDEQ/LQD.

2.9.8.3(s) References:

Energy Metals Corporation US. 2007. License Application, Technical Report. Moore Ranch Uranium Project. Volume II, Section 2.9 through 10-3. NRC website, ADAMS accession number ML072851268 (URL: http://www.nrc.gov/reading-rm/adams.html)

U.S. Nuclear Regulatory Commission (NRC). 1980. Regulatory Guide 4.14. Radiological Effluent and Environmental Monitoring at Uranium Mills. Revision 1. Nuclear Regulatory Commission Office of Standards Development. Washington, D.C.

2.9.9(s) Surface Water Monitoring

In the fourth quarter of 2007, most surface water impoundments were either dry or there were issues with accessing the middle of the ponds. As a result, no additional baseline data for Regulatory Guide 4.14 radionuclides in surface water is available. The data provided in the original application represent fall 2006 and spring 2007 samplings of surface waters at the site and those data should provide adequate characterization of respective baseline conditions.

2.9.10(s) Vegetation Sampling

In accordance with Regulatory Guide 4.14 protocols, baseline vegetation sampling at the Moore Ranch Uranium Project site was conducted as three separate sampling events during the growing season (April 30, June 9, and August 30, 2007). Vegetation sampling locations were identical for each sampling event as shown in Figure 2.9-38 of the original NRC license application (Energy Metals Corporation US, 2007). This section supplements corresponding sections of the original NRC license application and completes a final baseline characterization of radiological parameters for vegetation at the site.

2.9.10.1(s) Methods

Vegetation sampling methods for the August 2007 sampling event were identical to those described for the first two 2007 events in the original NRC license application (Energy Metals Corporation US, 2007).

2.9.10.2(s) Vegetation Sampling Results

Final (updated) summary statistics for 2007 baseline vegetation sampling results are shown in Table 2.9-18(s).

Table 2.9-18(s): Summary statistics for all vegetation samples collected in 2007 at the Moore Ranch Uranium Project site.

Analyte	Mean (uCi/kg)	Std. Dev. (uCi/kg)	Median (uCi/kg)	Max (uCi/kg)	Min (uCi/kg)	n
Pb-210	1.6E-04	1.1E-04	1.3E-04	3.2E-04	4.6E-05	9
Po-210	1.9E-05	1.8E-05	1.0E-05	4.8E-05	9.2E-07	9
Ra-226	2.4E-05	1.4E-05	2.0E-05	5.1E-05	6.1E-06	9
Th-230	6.3E-06	8.0E-06	4.9E-06	2.6E-05	0.0E+00	9
U-nat	2.7E-05	2.5E-05	2.0E-05	6.0E-05	0.0E+00	9

For each Regulatory Guide 4.14 radionuclide, the second sampling had lower values than the other two samplings (Figure 2.9-39). With the addition of the third and final round of vegetation data, the location to the northeast of processing facilities (V-1) area had the highest mean radionuclide levels of the three sampling locations (Figure 2.9-40). Lead-210 had the greatest activity levels of the five radionuclides analyzed, which is likely due to a higher relative abundance of Pb-210 in air particulates from radon decay products. This latter observation is supported by the air particulate data presented in Section 2.9.6(s) [note in Figure 2.9-31(s) that Pb-210 air particulate concentrations are generally 1-2 orders of magnitude higher than other radionuclides evaluated].

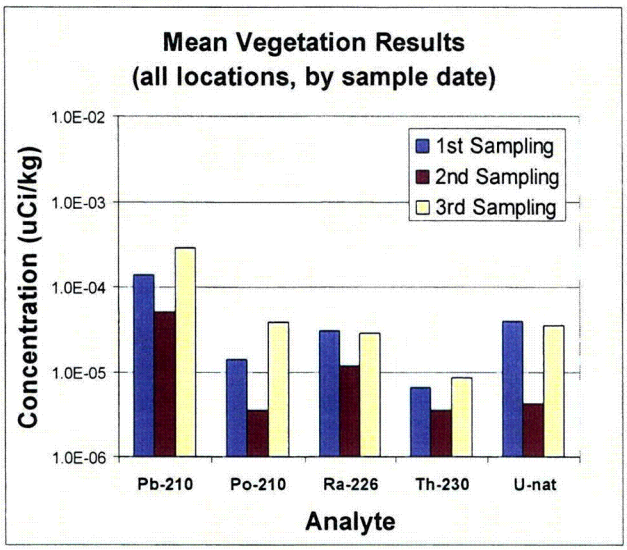


Figure 2.9-39: Analytical results for vegetation samples by sampling date for all locations.

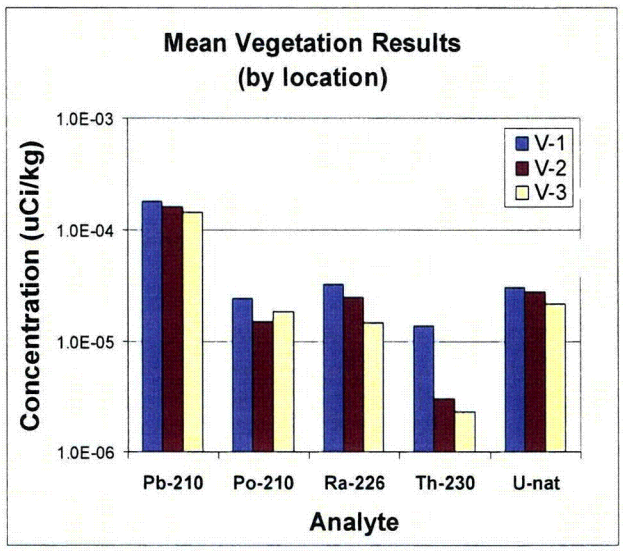


Figure 2.9-40: Analytical results for vegetation samples by sampling location.

2.9.10.3(s) Conclusions

Baseline vegetation sampling data for the 2007 radiological survey of the Moore Ranch Uranium Project area were collected and analyzed according to Regulatory Guide 4.14 protocols. Updated results presented in this supplemental section supersede corresponding results presented in the original NRC license application and should complete respective baseline characterization requirements for licensing/permitting evaluations.

2.9.10.4(s) References

Energy Metals Corporation US. 2007. License Application, Technical Report. Moore Ranch Uranium Project. Volume II, Section 2.9 through 10-3. NRC website, ADAMS accession number ML072851268 (URL: http://www.nrc.gov/reading-rm/adams.html)

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.

A numerical groundwater flow model has been developed based on site-derived information (top and bottom elevations of the hydrostratigraphic units, water level elevations, and aquifer properties) that replicates the unconfined conditions observed at the site. The numerical model was used to simulate aquifer response across the Permit Area during typical and proposed production and restoration phases of all wellfields. The results of those simulations are provided in Appendix B4. Results of the model simulations indicated several feet of drawdown will occur across each wellfield during production at a one percent bleed. Particle tracking clearly shows an inward gradient toward the wellfield during wellfield production. Full description of the model development and model simulations is provided in the Appendix B4 report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008b).

More detailed modeling will be performed at the wellfield scale to ensure that pumping rates at individual well patterns will maintain an overall inward gradient at all times during production of the wellfield.

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.

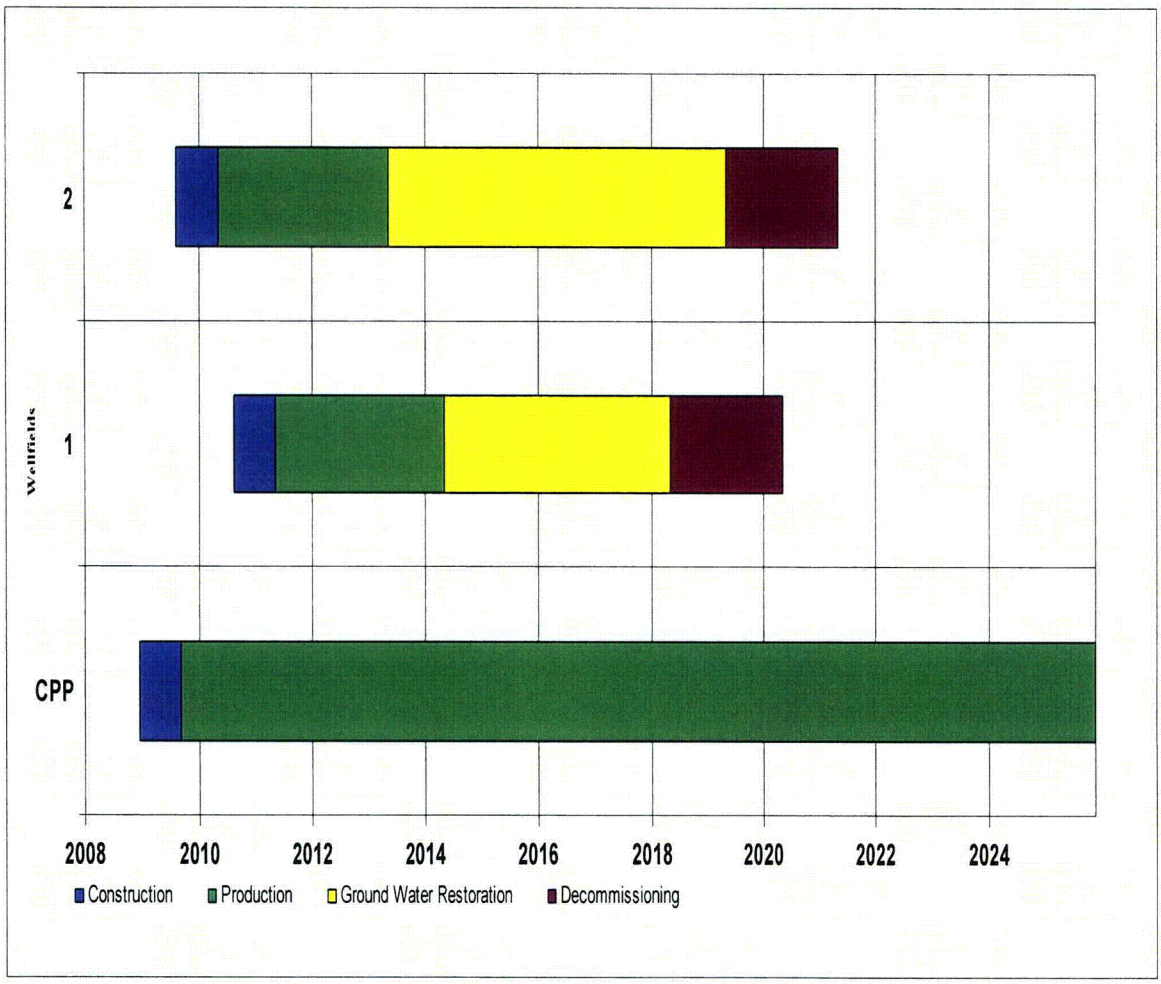
3.1.3.1 Wellfield Operational Monitoring

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.

Figure 3.1-6: Proposed Moore Ranch Operations Schedule



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.

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 Facility Areas Where Fumes or Gases May Be Generated

A description of the areas in the proposed plant facility where radiological gases or air particulate could be generated is contained in Section 5.7 and are shown in Figure 5.7-1 as monitoring locations.

Other potential sources of non-radiological fumes or gases can result from use of process related chemicals. The potential sources of non-radiological fumes or gases are minimal in the ion exchange process area since the mining solutions contained in the process equipment are maintained under a positive pressure. The area within the plant facility with the greatest potential to generate non-radiological fumes or gases is the precipitation area. As described in Sections 3.1.4.4, 3.2.1.3, and 3.2.3.1, the primary chemicals used in the precipitation area are sulfuric or hydrochloric acid, hydrogen peroxide, and anhydrous

ammonia. A description of the preventive/mitigative controls and monitoring for each of these potential chemical fumes is provided in the following list:

- Sulfuric or Hydrochloric Acid Fumes

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

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

- Hydrogen Peroxide Fumes

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

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

- Anhydrous Ammonia Fumes

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

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

If any of the potential fumes described above are detected, then building ventilation in the process equipment area will be accomplished by the use of an exhaust system that draws in fresh air and sweeps the plant air out to the atmosphere as described in Section 4.

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

3.2.3.3 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

3.3.1 Wellfield Operations/Ion Exchange Circuit

The wellfield and ion exchange circuits operate at a steady state, and deviations from the normal operating flow rates and pressure profiles (±10 percent or greater) are indicative of operating upsets. An automatic emergency shut down system consisting of pressure and flow rate switches will be provided for these circuits when normal operating parameters are exceeded. Instrumentation and control related to these circuits to accommodate emergency shutdown systems and alarms are listed below:

- Instrumentation will be provided to measure total production and injection flow and pressure on the main trunk lines at the Central Plant. Flows and pressures will be monitored continuously and will be displayed locally on the metering instrumentation and displayed at the facility control room. Automatic shutdown and alarms will be provided for deviations outside of established operating parameters.

- The individual well flows and pressures are adjusted and controlled within the headerhouses. Instrumentation will be provided to measure total production and injection flow and pressures into and out of the individual headerhouses. Flows and pressures will be monitored continuously and will be displayed locally on the metering instrumentation or headerhouse main display, and displayed at the facility control room. In addition, instrumentation will be provided to indicate the pressure and flow of the individual injection and production wells to record an alarm in the event of a change in flow that might indicate a leak or rupture in the system. Wellfield headerhouses will also be equipped with water sensors and alarms to detect the presence of liquids in the basement of wellfield headerhouses. Automatic shutoff valves and alarms will be provided for deviations outside of established operating parameters for the systems controlled within the headerhouse.

In the event of an automatic shutdown, an alarm notifies the operator of the situation. Once the upset (broken piping, leaking vessels, etc.) is identified and corrective action taken, only then can the circuit be manually restarted. This type of control system provides the best protection against fluid spills to the environment by limiting the amount of fluid released and providing immediate notification to facility operators, enhancing response to any upset conditions. Back-up for the automatic emergency shutdown systems are provided by local displays and controls for the metering instrumentation or headerhouse displays if systems controls or displays in the Central Plant should become temporarily unavailable.

3.3.2 Process Areas

In the process areas, tank levels are measured in chemical storage tanks as well as process tanks. Instrumentation will be installed to provide continuous monitoring of chemical and process tank levels. Other instrumentation may also be provided in process areas to provide continuous monitoring for rates and pressures of process fluids and chemicals and other in-line instrumentation used for process measurements. Readout from process area instrumentation will be displayed on the facility control room monitors and will be displayed locally on the metering instrumentation providing backup monitoring.

Alarms and automatic shutdown of systems (where needed) will be provided for deviations outside of established operating parameters. The alarms and automatic shutdown systems will provide the best protection against upset conditions of process fluids or chemicals by limiting the amount of fluids or chemicals released and immediate notification to facility operators, enhancing response to any upset conditions. The continuous monitoring will also be used operate the plant process at maximum efficiency.

3.3.3 Yellowcake Drying Systems

Instrumentation and controls for the yellowcake drying system are described in detail in Section 4.1.2. 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 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.

Readout from the yellowcake drying instrumentation will be displayed on the facility control room monitors providing continuous monitoring and will be displayed locally on the metering instrumentation providing backup monitoring for shift checks by the dryer operator. Checks must be made and logged at least hourly during drying operations and records will be retained for three years. The instrumentation and controls described above are adequate to determine if conditions are within the prescribed ranges to ensure that equipment is operating consistently near peak efficiency and provides immediate notification if conditions are not within the prescribed operating ranges, as required in 10 CFR 40, Appendix A, Criterion 8.

In accordance with 10 CFR 40, Appendix A, Criterion 8, effluent control devices will be operative at all times during drying and packaging operations. Drying and packaging operations will shutdown if effluent controls become inoperative. If instrumentation shows that equipment is not operating within the prescribed ranges, then corrective actions must be taken to restore proper operating conditions. If this cannot be done without shutdown and repairs, then drying operations must cease as soon as practicable. Operations will not be restarted after cessation due to abnormal performance until all needed corrective actions have been completed. Any cessation, corrective actions, and restarts of dryer operations will be reported to the NRC in writing within 10 days of the subsequent restart as required by 10 CFR 40, Appendix A, Criterion 8A. This reporting requirement does not apply to routine maintenance of dryer system components.

3.3.4 Process Waste Water Disposal

Process waste water will be disposed of through deep disposal wells as described earlier in this Section 3 and Section 4. 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 type of instrumentation and control system provides the best protection against process waste water spills to the environment by limiting the amount of fluid released and providing immediate notification to facility operators enhancing response to any upset conditions. Pressure monitoring in the tubing/casing annulus also provides immediate indicators of potential well integrity issues. Back-up for the automatic emergency shutdown systems are provided by local displays and controls for the metering instrumentation in the central plant and at the wellhead if systems controls or displays in

the central plant control room should become temporarily unavailable. In addition, inspections of the disposal wells will be conducted once per shift.

3.3.5 Radiological Monitoring Instrumentation

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)

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 cfm each. 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

5 OPERATIONS

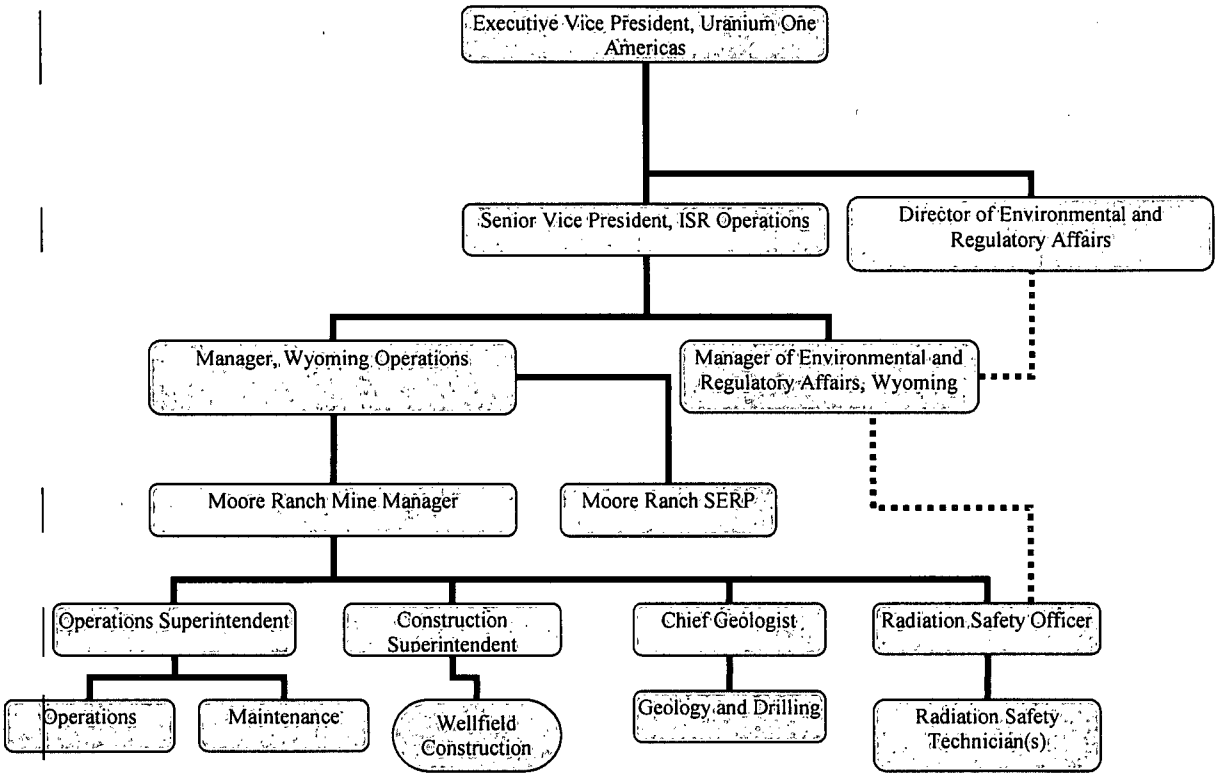
Energy Metals Corporation, US (EMC) is committed to conducting all operations in conformance with applicable laws, regulations and requirements of the various regulatory agencies. The responsibilities described below have been designed to ensure compliance and further implement EMC's policy for providing 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 Executive Vice President through the Chief Operating Officer.

5.1.2 Executive Vice President

The Executive Vice President (EVP) is responsible for interpreting and acting upon the Board of Director's policy and procedural decisions. The EVP has the responsibility and authority for the radiation safety and environmental compliance programs at all Uranium One Americas facilities. The 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 EVP is also responsible for company compliance with all regulatory license conditions/stipulations, regulations and reporting requirements. The EVP 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.

5.1.5 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 reports directly to the Senior Vice President.

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 Senior Vice President and 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 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.

5.1.8 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.

5.1.9 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.

5.1.11 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.

5.1.12 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.

5.1.12.1 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.

5.1.12.2 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.

5.1.12.3 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

Instructions 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;
- 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).

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. 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.

The MILDOS model inputs will be used to estimate the radon gas released to the environment, which will be reported in the Semiannual Radiological Effluent and Environmental Monitoring Reports required under 10 CFR Part 40.65. Section 7.3.1.1 discusses the factors and equations used to estimate source term contributions to the total radon effluent releases from Moore Ranch. These individual source terms include radon released due to production releases during operations, restoration releases, new wellfield

releases, and releases due to resin transfer. On a semiannual basis, the actual operational history of the Moore Ranch facility will be used to estimate the actual radon gas releases due to operations for the period. The following specific data for each reporting period will be applied to the source term estimate methodology to determine radon gas releases:

Production Releases: Actual average production flow rate and operating factor for the period.

Restoration Releases: Actual average restoration flow rate and operating factor for the period.

New Wellfield Releases: Total number of new wellfields started up during the period.

Resin Transfer Releases: Total number of resin transfers from satellite facilities during the period.

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.

- Surface Releases

  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].

5.7.2.2 Beta Surveys

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 contamination surveys will be performed using a Ludlum Model 2224 portable scaler/ratemeter with a Ludlum 43-1-1 alpha/beta scintillator probe or equivalent. Beta dose rate surveys will be performed with a Ludlum Model 44-6 sidewall G-M detector 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).

5.7.2.3 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 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 5.7.4.

Figure 5.7-1

Proposed Moore Ranch Central Plant Survey and Sampling Locations

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 RECORDS

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 5.7.2.3. 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.

Following is a discussion of the exposure determination methods and documentation of results.

5.7.4.1 Natural Uranium Internal Exposure

Exposure calculations for airborne natural uranium will be performed 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:

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 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:

$$I_r = \frac{1}{170} \sum_{i=1}^{n} \frac{Wi \times t_i}{PF}$$

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 5.7.2.3. 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.

5.7.4.4 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.

3. Special urine samples may be obtained based on circumstances as determined by the RSO. These circumstances may include known or suspected ingestion, failure of engineering controls, or damage or failure of respiratory protection equipment.

4. 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.

4. 5. Action levels for urinalysis will be established based upon Table 1 in USNRC Regulatory Guide 8.22. Routine determination of internal exposure will be performed using the results of air monitoring to estimate uranium intake as discussed in Section 5.7.4.1. In the event that positive bioassay results confirm an intake, the RSO will conduct an investigation into the circumstances and make a determination whether internal exposure for an individual should be determined based on bioassay results. Internal exposure determinations based on bioassay results will be performed based on the guidance in USNRC Regulatory Guide 8.9.

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

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.

Uncontaminated materials, equipment, instruments, and other materials will be surveyed for alpha contamination before removal from the restricted and controlled areas. 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. The 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.

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.

5. 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.

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

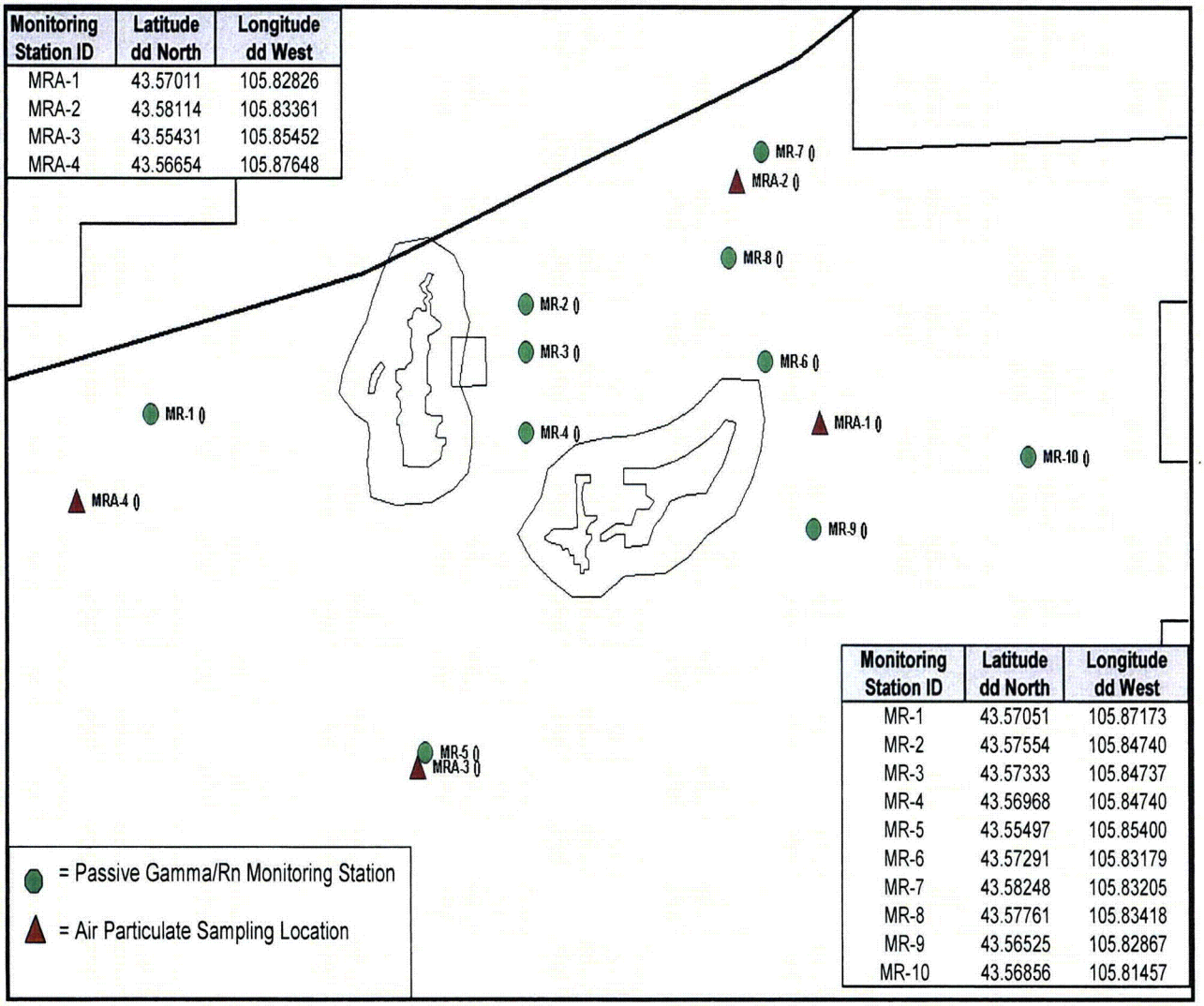
Operational soil sampling will be conducted on an annual basis. Locations will include each of the four air particulate sampling locations located within the site boundaries. Samples will be collected as discrete grab samples of surface soils as indicated in Table 2 of Regulatory Guide 4.14, and will 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. .

Subsurface Soil

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

Figure 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 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-4). Gamma radiation will be monitored through the use of environmental dosimeters obtained from a NVLAP certified vendor. The environmental dosimeter used for direct radiation measurements will be the InLight dosimeter from Landauer. 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 V 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 Appendix B4, 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 aquifers (68-sand and 60-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.

The area of Wellfield 2 where the 68 and 70 sand coalesce is considered one aquifer and the underlying aquifer in this area will be the 60 sand. Additional monitor wells may be placed in the 68 sand 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 wellfield 2 area 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. A numerical groundwater flow model has been developed, calibrated and validated to site conditions that replicate the unconfined conditions present across portions of the Permit Area. The model was used to design pumping tests that would adequately stress the 70 Sand such that hydraulic communication can be demonstrated between monitor wells and the production zone. A simulation of such a pump test was conducted. The simulation demonstrates that multiple pumping tests will be required to establish hydraulic communication between the production area and the monitor well ring. Simulations and full description of the model development and model simulations is provided in the Appendix B4 report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008b).

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

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[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).

[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).

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 primary goal of the groundwater restoration efforts will be to return the groundwater quality of the production zone, on a wellfield average, to the preoperational (baseline) water quality conditions using Best Practicable Technology. Recognizing that restoration activities are not likely to return groundwater to the exact water quality that existed prior to in situ operations (as discussed in Section 6.5.1), a secondary restoration standard of class of use will be applied. The secondary standard of class of use will be applied only after restoration using BPT no longer shows significant improvement in groundwater quality and continuing restoration activities would not provide a significant benefit. The pre-mining baseline water quality and 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 and NUREG-1569 Section 6.

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)

Table 6.1-1 Baseline Water Quality Parameters

Parameter (units)
Dissolved Molybdenum (mg/l)
Dissolved Nickel (mg/l)
Nitrate + Nitrite as N (mg/l)
Dissolved Lead (mg/l)
Radium-226 (pCi/L)
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

Table 6.1-2 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
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
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 unconfined conditions present in the 70 Sand result in development of relatively steep drawdown cones during pumping that are of limited areal extent. Therefore the area of "dewatering" tends to be localized around the production well. Data collected during the 5-Spot Pump Test indicates that aquifer recovery occurs rapidly once an extraction well is shut in. Efficient groundwater sweep for both production and restoration can be

accomplished by "pulsing" of extraction wells by cycling them on and off. The pulsing can be achieved by either switching groups of extraction wells on and off or by alternating between injection and extraction cycles within individual well patterns. Pulsing of wells will effectively resaturate portions of the aquifer that may have been temporarily dewatered by any individual extraction well. A model simulation illustrating this technique and a description of the model development is provided in Appendix B2 (technical memorandum "5 Spot Pump Test, Results, Analysis and Modeling, Moore Ranch Uranium Project," Petrotek 2008a).

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 chemical reductant, 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 chemical reductant 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.

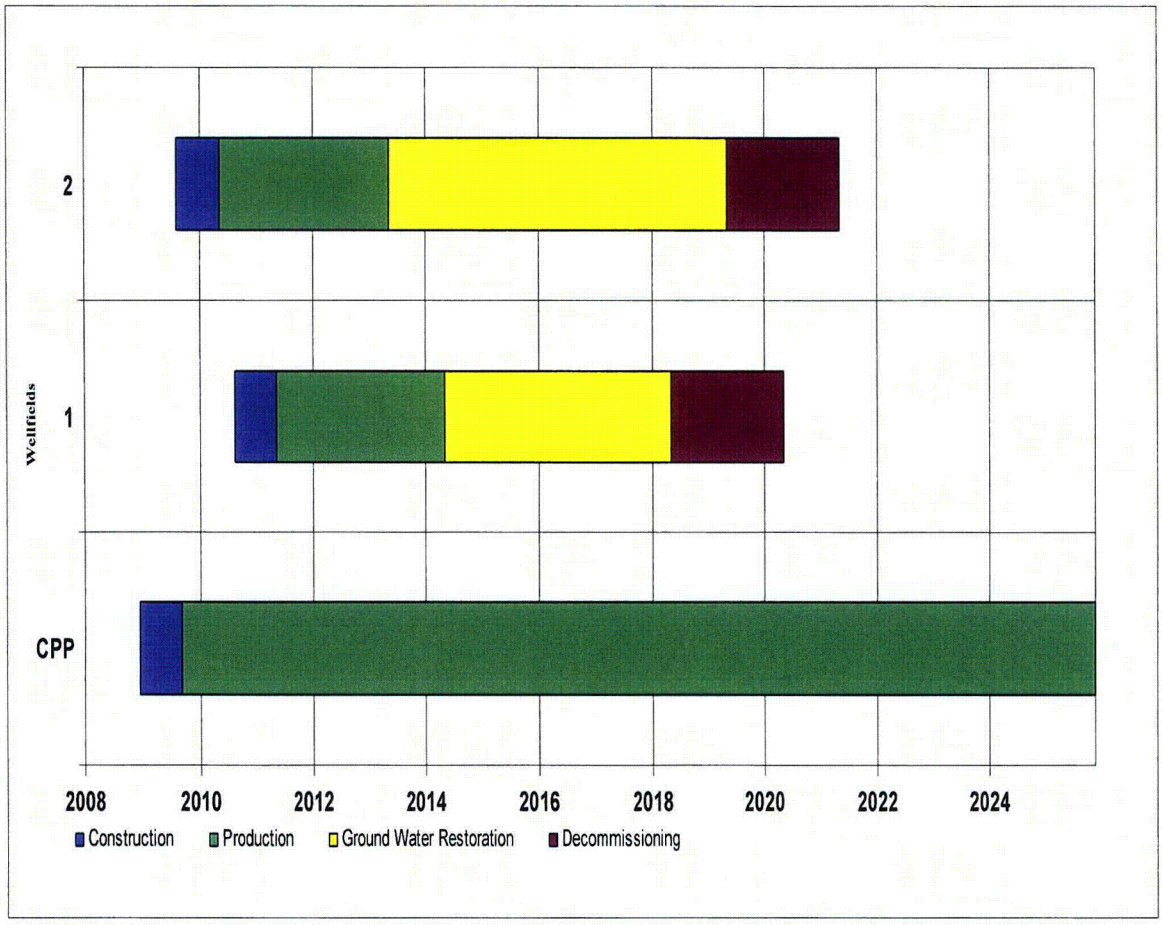
If necessary, sodium hydroxide may be used during the groundwater treatment phase to return the groundwater to baseline pH levels. This will assist in immobilizing certain parameters such as trace metals.

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. Numerical modeling results indicate that it will take longer than 2.5 years to complete restoration, because of the limited saturated thickness of the aquifer and the need to balance drawdown between the two wellfields during concurrent production and restoration phases. Assuming 6 pore volumes of groundwater is required to reach restoration goals, modeling estimates indicate it will take approximately 4 years to restore Wellfield 1 and 6 years to restore Wellfield 2 included limited Groundwater sweep. Note that Wellfield 2 now includes what was previously Wellfields 2 and 3 in the Permit Application. This results in a larger pore volume calculation than would be the case if the wellfields were considered separately. Results of the simulation and full description of the model development and model simulations is provided in the Appendix B4 report "Numerical Modeling of Groundwater Conditions Related to Insitu Recovery at the Moore Ranch Uranium Project, Wyoming" (Petrotek 2008b).

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.

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

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. If increasing trends are confirmed during the stability period for all or part of a wellfield, then an evaluation of the potential cause of the increasing trends will be conducted and corrective actions will be taken, including continued restoration using Best Practical Technology if needed.

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.

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.

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- 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.

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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:

$$\text{Uranium Limit} = \left(\frac{100\ \text{pCi/g natural uranium}}{7.5\ \text{mrem/yr. natural uranium dose}}\right) \text{x } 39.5\ \text{mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = 526\ \text{pCi/g natural uranium}$$

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

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 6 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. The numerical modeling results contained in Appendix B4 indicate a horizontal flare factor of approximately 1.2 and it is assumed that the vertical flare will be similar resulting in a total wellfield flare factor of 1.4 to 1.5. Accordingly, EMC is using a flare factor of 1.5 for the surety estimate attached in Appendix D. Using the equation provided above with a porosity of 0.2, the wellfield pore volume for Wellfields 1 and 2 would be approximately 65,511,727 gallons and 94,151,490 gallons respectively.

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.

7.5.1 Chemical Risk

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

7.5.1.1 Sulfuric Acid

Sulfuric acid is used to split the uranyl carbonate complex from rich eluate into carbon dioxide gas and uranyl ions in preparation for precipitation using hydrogen peroxide. The sulfuric acid will be stored in a tank located outdoors and piped to the central plant for use in the precipitation circuit. The concentration of sulfuric acid fumes that are immediately dangerous to life and health (IDLH) is 15 mg/m^3. In the risk analysis from NUREG/CR-6733, a spill of 93 percent sulfuric acid was not deemed a significant inhalation hazard to workers as long as normal air dilution is available from the facility ventilation system. NUREG/CR-6733 also noted that sulfuric acid reacts vigorously with ammonia, sodium carbonate, and water, all of which will be present at Moore Ranch.

The use of sulfuric acid is subject to Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 1,000 pounds. As discussed in Section 3, the Moore Ranch design includes a sulfuric acid tank with a capacity of 6,000 gallons. Based on the design capacity, EMC will be subject to the Emergency Response Plan requirements.

<u>Accident Prevention</u>

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

- To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, the sulfuric acid storage tank will be located separately from other process tanks.
- Construction of all storage tanks, piping, and associated appurtenences will be in accordance with current industry standards.
- All tanks are enclosed limiting the amount of vapors that can escape to the atmosphere.

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

- Containment will be provided for 110% of the total storage capacity constructed of chemically compatible materials.

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

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

Mitigation/Accident Response

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

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

7.5.1.2 Anhydrous Ammonia

Anhydrous ammonia is used for pH adjustment during the precipitation process. The ammonia will be stored in a tank located outdoors and piped to the Central Plant for use in the precipitation circuit. Ammonia in the liquid form is not the primary hazard. The liquid will evaporate to a gaseous state. The IDLH concentration of ammonia is 300 parts per million (ppm). NUREG/CR-6733 identified an ammonia leak as a significant risk factor within a plant structure because ventilation rates adequate to dilute ammonia fumes in a localized area to maintain concentrations below the IDLH in the event of a leak would not be feasible. An additional hazard associated with ammonia is that it reacts vigorously with sulfuric acid, which will also be present in the precipitation circuit.

The use of anhydrous ammonia is subject to various regulatory programs including the following:

- Risk Management Planning (RMP) required in 40 CFR Part 68 for threshold quantities (TQs) in excess of 10,000 pounds;
- Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 500 pounds; and
- Reportable Quantities (RQs) for spills from the Comprehensive Environmental, Response, Compensation and Liability Act (CERCLA) in 40 CFR § 302.4 for spills in excess of 100 pounds.

As discussed in Section 3, the Moore Ranch design includes an anhydrous ammonia tank with a capacity of 90,000 pounds with the potential for expansion to correspond to expansion of the central plant. Based on this design capacity, EMC will be subject to all of the aforementioned regulatory programs.

In addition to the listed regulatory programs, the Process Safety Management (PSM) of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119 applies to anhydrous ammonia for TQs in excess of 10,000 pounds. In the State of Wyoming, industrial safety at ISR mines is regulated by OSHA. PSM standard does not apply. Therefore, EMC will apply OSHA's PSM standard during the development of the ammonia system design and operating procedures.

Accident Prevention

Prevention methods utilized to minimize potential impacts to human health and the environment from a release of anhydrous ammonia include the following:

- To minimize the probability and consequence of an ammonia accident, the EMC system design and operating procedures will be consistent with American National Standards Institute (ANSI) recommendations[11]. These recommendations include 1) providing an excess flow valve located as close to the storage tank as possible that automatically closes if the flow rate exceeds a specific value; 2) the use of appropriate ANSI and American Society of Material Evaluation (ASME) standard codes for norrefrigerated pressure piping; and 3) provision of positive pressure, self-contained, full face respirators in the immediate vicinity of the ammonia piping and process operations. The ammonia piping will be placed so as to minimize the potential for impact from vehicles or other objects that might cause ruptures.

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

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

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

- Containment will be provided for 110% of the total storage capacity constructed of chemically compatible materials.

- Monitors and alarms will be placed in areas of the central plant facility where potential fumes could be generated for early detection of a potential accidental release.

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

Mitigation/Accident Response

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

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

7.5.1.3 Hydrogen Peroxide

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

As noted in NUREG/CR-6733, a hydrogen peroxide piping system leak in a process building has the potential to result in localized vapor concentrations in excess of the IDLH value of 75 ppm within several minutes. A leak in a confined space has the potential to generate lethal concentrations of vapor at an even faster rate. EMC will incorporate recommendations concerning materials of construction for tanks and piping systems and the use of local ventilation with explosion-proof fans to control vapors in the event of a leak of hydrogen peroxide.

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

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

As discussed in Section 3, the Moore Ranch design includes the use of hydrogen peroxide at a concentration of 50 percent contained in a hydrogen peroxide tank with a capacity of 6,000 gallons. With the design hydrogen peroxide concentration and capacity, EMC will not be subject to the aforementioned regulatory programs.

Accident Prevention

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

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

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

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

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

- Containment will be provided for 110% of the total storage capacity constructed of chemically compatible materials.

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

Mitigation/Accident Response

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

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

7.5.1.4 Oxygen

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

Accident Prevention

The design and installation of underground and above-ground gaseous oxygen piping at Moore Ranch including material specifications, velocity restrictions, location and

specifications for valves, and design specifications for metering stations and filters will be in accordance with industry standards contained in CGA G-4.4[12]. Headerhouses will be equipped with an exhaust ventilation system. Oxygen monitoring will be conducted prior to entry into confined spaces where oxygen buildup could occur.

Combustibles such as oil and grease will burn in oxygen if ignited. EMC will ensure that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1[13].

Mitigation/Accident Response

EMC will develop procedures that implement emergency response instructions for a spill or fire involving oxygen systems. Emergency response procedures will include instructions in the following:

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

7.5.1.5 Carbon Dioxide

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

7.5.1.6 Sodium Carbonate and Sodium Chloride

Sodium carbonate and sodium chloride are primarily inhalation hazards. Soda ash and carbon dioxide will be used to prepare sodium carbonate for injection in the wellfield. Sodium carbonate and sodium chloride are also used for regeneration of ion exchange resin.

Accident Prevention

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

- To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, the hydrogen peroxide storage tanks will be located separately from other process tanks with incompatible chemicals.
- Dry storage and handling systems will be designed to industry standards to control the discharge of dry material.
- All tanks are enclosed limiting the amount of dust that can escape to the atmosphere.
- Daily shift inspections of plant and chemical storage facilities are conducted for early detection of potential deficiencies.
- Bulk storage facilities will be located inside of the central plant providing full containment of released materials.
- Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.

Mitigation/Accident Response

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

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

7.5.1.7 Sodium Sulfide

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

Accident Prevention

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

- Sodium sulfide can be flammable and contact with heat, flame, or other sources of ignition will be avoided.
- Sodium sulfide will be stored separately from incompatible chemicals such as hydrogen peroxide and sulfuric acid.
- Construction of all storage tanks, piping, and associated appurtenences will be in accordance with current industry standards.
- All tanks are enclosed limiting the amount of vapors that can escape to the atmosphere.
- Daily shift inspections of plant and chemical storage facilities are conducted for early detection of potential deficiencies.
- Containment will be provided for 110% of the total storage capacity constructed of chemically compatible materials.
- Offloading procedures will be developed and implemented to ensure proper steps and precautions are followed during offloading into bulk storage areas.

Mitigation/Accident Response

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

- Immediate notifications
- Evacuation procedures

- Perimeter establishment
- Personal Protective Equipment requirements
- Site mitigation, neutralization, and cleanup
- Reporting

7.5.2 Radiological Risk

7.5.2.1 Tank Failure

A spill of the materials contained in the process tanks at the Moore Ranch Project will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the central plant. The tanks at Moore Ranch will contain injection and production solutions, ion exchange resin, pregnant eluant, yellowcake, and liquid waste.

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

NUREG/CR-6733 also assessed the potential dose from a catastrophic spill from an ion exchange column resulting in the release of the entire contents of the vessel and the resultant release of radon gas. Based on a number of assumptions, the predicted dose was 1.3 rem in a 30-minute period to a worker in the area. Any change to the Rn-222 concentration or exposure time has a linear affect on dose. For example, if the room size is doubled or the exposure time is halved, then the dose will be halved. NUREG/CR-6733 recommended that the use of ventilation or atmosphere-supplying respirators designed to protect against gases would be sufficient to mitigate doses, that unprotected personnel should evacuate spill areas near ion-exchange columns, and that ISR facilities maintain

proper equipment, training, and procedures to respond to large lixiviant spills or ion-exchange column failure.

Accident Prevention

The plant will be designed to control and confine liquid spills from tanks should they occur. The central plant building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, and/or double-walled tanks will perform a similar function for any process chemical vessels located outside the central plant building.

All tanks will be constructed of fiberglass or steel with the exception of the hydrogen peroxide storage tank, which will typically be constructed of aluminum. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary. Other prevention methods include shift inspections of plant areas including tanks.

Mitigation/Accident Response

The Moore Ranch Central Plant will be designed in accordance with standard industry building codes and will incorporate containment adequate to contain the contents of the largest tank in the facility at a minimum. As discussed in Section 4.1, area ventilation will be provided to control concentrations of airborne radioactive material in the central plant. Finally, EMC will prepare spill response procedures, provide spill response equipment and materials, require the use of protective equipment, and will train employees in proper spill response methods. Emergency response procedures will include instructions in the following:

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

7.5.2.2 Plant Pipe Failure

The rupture of a pipe within the central plant will be easily detected by operating staff and can be quickly controlled. Spilled solution will be contained and managed in the same fashion as for a tank failure.

7.5.3 Groundwater Contamination Risk

7.5.3.1 Lixiviant Excursion

Excursions of lixiviant at ISR facilities have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized by the mining process. These excursions are typically classified as horizontal or vertical. A horizontal excursion is a lateral movement of mining solutions outside the mining zone of the ore-body aquifer. A vertical excursion is a movement of solutions into overlying or underlying aquifers.

The historical experience at other ISR uranium operations indicates that the selected indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer boundary is significantly degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Accident Prevention

EMC will control the lateral movement of lixiviant by maintaining well field production flow at a rate slightly greater than the injection flow. This difference between production and injection flow is referred to as process bleed. The bleed solution will either be recycled in the plant or sent to the liquid waste disposal system. When process bleed is properly distributed among the many mining patterns within the wellfield, mining solutions are contained within the monitor well ring.

EMC will monitor for lateral movement of lixiviant using a horizontal excursion monitoring system. This system consists of a ring of monitor wells completed in the same aquifer and zone as the injection and production wells. Monitor wells will be installed as discussed in Section 5.7.8. Monitor wells will be sampled biweekly for approved excursion indicators. Corrective actions will be taken if early signs of lixiviant migration are detected prior to reaching excursion status.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers. EMC will prevent vertical excursions through aquifer testing programs and

rigorous well construction, abandonment, and testing requirements. Aquifer testing is conducted before mining wells are installed to detect any leaks in the confining layers. Aquifer test reports are submitted to the WDEQ for review and approval before well construction activities may proceed. Well construction and integrity testing will be conducted in accordance with WDEQ regulations and methods approved by NRC and WDEQ. Construction and integrity testing methods were discussed in detail in Section 3.1. Well abandonment is conducted in accordance with methods approved and monitored by the WDEQ and discussed in detail in Section 6.2.

EMC will monitor for vertical excursions in the overlying aquifer using shallow monitor wells. These wells will be located within the wellfield boundary at a density of one well per four acres. Shallow monitor wells will be sampled biweekly for approved excursion indicators. Corrective actions will be taken if early signs of lixiviant migration are detected prior to reaching excursion status.

Mitigation\Accident Response

Corrective actions and excursion response will be conducted as described in Section 5.7.8.

7.5.4 Wellfield Spill Risk

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the central plant, would result in a release of injection or production solution which would contaminate the ground in the area of the break. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination.

Spill Prevention

All piping from the 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 headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each headerhouse 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, small leaks at pipe joints and fittings in the headerhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. EMC will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service.

Mitigation/Spill Response

Following repair of a leak, EMC will require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

EMC will develop a response plan for wellfield spills that will include:

- Notification procedures
- Spill containment and recovery procedures
- Post spill sampling and cleanup procedures
- Reporting procedures

7.5.5 Transportation Accident Risk

Transportation of hazardous materials to and from the Moore Ranch Project can be classified as follows:

- Shipments of uranium-laden resin from the Moore Ranch Central Plant to a licensed facility for toll "milling" and return shipments of barren, eluted resin. Resin will be transported in tank trucks to a nearby licensed facility for elution, precipitation, and drying.

- Shipments of dried yellowcake. Yellowcake will be transported in 208-L (55-gal.) drums to a distant conversion facility for refining and conversion. Conversion facilities are currently located in Metropolis, Illinois and Port Hope, Ontario, Canada.

- Shipments of process chemicals or fuel from suppliers to the site.

- Shipment of radioactive waste from the site to a licensed disposal facility.

Accident risks involving potential transportation occurrences and mitigating measures are discussed in the following sections.

7.5.5.1 Accidents Involving Ion Exchange Resin Shipments

A potential transportation risk associated with operation of the Moore Ranch Project as a uranium extraction plant using toll "milling" at another licensed processing facility is the transfer of the ion exchange resin to and from the plant. Loaded ion exchange resin would be transported from the Moore Ranch Project in a 4,000 gallon capacity tanker trailer. It is currently anticipated that up to four loads of uranium-laden resin may be transported for elution and up to four loads of barren eluted resin may be returned on a daily basis. The transfer of resin will occur on a combination of private, county and State roads. For shipments of ion exchange resin to a central processing facility, NRC determined that the probability of an accident involving such a truck was 0.009 in any year[14].

Resin or eluate shipments will be treated similarly to yellowcake shipments in regards to Department of Transportation (DOT) and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material for both uranium-laden and barren resin. General shipping procedures are outlined as follows:

- The resin, either loaded or eluted, will be shipped as "Exclusive Use Only". This will require the outside of each container or tank to be marked "Radioactive LSA" and placarded on four sides of the transport vehicle with "Radioactive" diamond signs.

- A bill of lading will be included for each shipment (including eluted resin). The bill of lading will indicate that a hazardous cargo is present. Other items identified shall be the shipping name, ID number of the shipped material, quantity of material, the estimated activity of the cargo, the transport index and the package identification number.

- Before each shipment of loaded or barren eluted resin, the exterior surfaces of the tanker will be surveyed for alpha contamination. In addition, gamma exposure rates will be obtained from the surface of the tanker and inside the cab of the tractor. All of the survey results will appear on the bill of lading.

- Properly licensed and trained drivers will transport the resin between the Moore Ranch Project and the toll "milling" facility.

Accident Prevention

Actions taken to prevent accidents involving shipments of ion exchange resins include the following:

- Properly licensed and trained drivers will transport the resin between the Moore Ranch Project and the toll "milling" facility.
- Trucks and tanker trailers used to transport ion exchange resins will be maintained in good operating condition.
- Inspections will be conducted of the Truck and tanker trailer prior to shipment of ion exchange resins. Transportation equipment will be taken out of service if any significant deficiencies are identified that could affect safe operation and transport and will not be place back into service until the deficiencies are corrected.
- Transport of ion exchange resin will only occur on maintained gravel or paved roads and will not occur during extreme or unsafe weather conditions.

Mitigation/Accident Response

EMC will develop an emergency response plan for yellowcake and other transportation accidents to or from the Moore Ranch Project. EMC personnel will receive training for responding to a transportation accident. The emergency response plan will include descriptions of the following provisions:

- DOT Regulations
- Carrier Emergency Response Procedures
- Spill Kits
- Immediate Response and notification
- Accident Scene Response
- Spill cleanup
- Concluding Activities
- Review of Accident Documentation
- Review of Monitoring and Sampling Data
- Site Abandonment
- Reporting

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium-laden resin where all of the tanker contents were spilled. Because the uranium is ionically-bonded to the resin and the resin is in a wet condition during shipment, the radiological

and environmental impacts of such a spill are minimal. The radiological and environmental impact of a similar accident with barren, eluted resin would be less significant. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

In the event of a transportation accident involving the resin transfer operation, EMC will institute its emergency response plan for transportation accidents. To minimize the impacts from such an accident, the following procedures will be followed:

- Each truck will be equipped with a communication device that will allow the driver to communicate with either the shipper or receiver. In the event of an accident and spill, the driver will be able to communicate with either site to obtain help.

- A check-in and check-out procedure will be instituted where the driver will notify the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, an emergency response team will respond and search for the vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.

- Each resin transport vehicle will be equipped with an emergency spill kit which the driver can use to begin containment of any spilled material. The kit will include plastic sheeting to cover spilled material until cleanup operations can begin.

- Both the shipping and receiving facilities will be equipped with emergency response kits to quickly respond to a transportation accident.

- Personnel and truck drivers will have specialized training to handle an emergency response to a transportation accident.

7.5.5.2 Accidents Involving Yellowcake Shipments

NUREG-0706 concluded that the probability of a truck accident involving shipments of yellowcake in any year is 11 percent for each uranium extraction facility. This calculation used average accident probabilities (4.0×10^{-7}/km for rural interstate, 1.4×10^{-6}/km for rural two-lane road, and 1.4×10^{-6}/km for urban interstate) that NUREG/CR-6733 determined were conservative.

As with resin shipments, yellowcake shipments will be made in accordance with DOT and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA)

material and will follow the same general shipping procedures as outlined for ion exchange resin shipments in Section 7.5.5.1.

Accident Prevention

Actions taken to prevent accidents involving shipments of yellowcake include the following:

- Properly licensed and trained drivers will transport the yellowcake between the Moore Ranch Project and the toll "conversion" facility.
- Trucks and trailers used to transport ion exchange resins will be maintained in good operating condition.
- Inspections will be conducted of the Truck and trailer prior to shipment of yellowcake. Transportation equipment will be taken out of service if any significant deficiencies are identified that could affect safe operation and transport and will not be place back into service until the deficiencies are corrected.
- Transport of yellowcake will only occur on maintained gravel or paved roads and will not occur during extreme or unsafe weather conditions.

Mitigation/Accident Response

EMC will develop an emergency response plan for yellowcake and other transportation accidents to or from the Moore Ranch Project. EMC personnel will receive training for responding to a transportation accident. The emergency response plan will include descriptions of the following provisions:

- DOT Regulations
- Carrier Emergency Response Procedures
- Spill Kits
- Immediate Response and notification
- Accident Scene Response
- Spill cleanup
- Concluding Activities
- Review of Accident Documentation
- Review of Monitoring and Sampling Data
- Site Abandonment
- Reporting

The worst case accident scenario involving yellowcake transportation would be an accident involving the transport truck where the integrity of one or more drums containing yellowcake was breached, resulting in a release to the environment. Unlike ion exchange resin shipments, ISR operators do not typically transport their own yellowcake to conversion facilities but rather contract with transport companies that specialize in shipments of yellowcake. These companies have extensive emergency response programs including spill response equipment on board, drivers trained in radiological emergency response, constant monitoring of truck location and operating parameters, and standing contracts with environmental emergency response contractors for cleanup of spills. As with ion exchange resin, the primary environmental impact associated with an accident involving the spill of yellowcake would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. To minimize the impacts from such an accident, the following procedures will be followed:

- Each truck will be equipped with a communication device that will allow the driver to communicate with either the shipper or receiver. In the event of an accident and spill, the driver will be able to communicate with either site to obtain help.

- A check-in and check-out procedure will be instituted where the driver will notify the receiving facility prior to departure from his location. If the resin shipment fails to appear within a set time, an emergency response team will respond and search for the vehicle. This system will assure reasonably quick response time in the case that the driver is incapacitated in the accident.

- Each yellowcake transport vehicle will be equipped with an emergency spill kit which the driver can use to begin containment of any spilled material. The kit will include plastic sheeting to cover spilled material until cleanup operations can begin.

- Both the shipping and receiving facilities will be equipped with emergency response kits to quickly respond to a transportation accident.

Personnel and truck drivers will have specialized training to handle an emergency response to a transportation accident.

7.5.5.3 Accidents Involving Shipments of Process Chemicals

It is estimated that approximately 4 bulk chemical, fuel, and supply deliveries will be made per working day throughout the operational life of the project. Types of deliveries will include carbon dioxide, oxygen, salt, soda ash, hydrogen peroxide, ammonia, sulfuric acid, and fuel. All shipments will be made in accordance with the applicable DOT hazardous materials shipping provisions.

7.5.5.4 Accidents Involving Radioactive Wastes

Low level radioactive 11(e).2 by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential environmental impact in the event of an accident. Shipments are generally made bulk in sealed roll off containers in accordance with the applicable DOT hazardous materials shipping provisions and will follow the same general shipping procedures, accident prevention, mitigation, and accident response outlined for ion exchange resin and yellowcake shipments.

7.5.6 Fires and Explosions

The fire and explosion hazard of the CPP will be minimal as the plant does not use flammable liquids in the recovery process and building and equipment materials are largely made up of non-flammable materials such as steel or concrete.. Natural gas used for building heat would be the primary source for a potential fire or explosion. In the CPP the uranium will be in solution, adsorbed on ion exchange resin, wet yellowcake slurry, or as a dried yellowcake powder contained in a sealed drum or the vacuum dryer. An explosion, therefore, would not appreciably disperse the uranium to the environment.

In the wellfields, injection and recovery well piping systems are manifolded for ease of operational control. Piping manifolds, submersible pump motor starters/controllers, and gaseous oxygen delivery systems are situated within electrically heated, all weather buildings. These are commonly referred to as "Headerhouses". An accumulation of gaseous oxygen would be the primary source for a potential fire or explosion. Such an event could result in the rupture of a leaching solution pipeline within the building and a spill of leaching solution.

Fire Prevention

Prevention methods utilized to minimize potential impacts to human health and the environment from fire or explosion scenarios discussed above include the following:

- Spilled liquids or slurries would be confined to the building sump or to the runoff control system.
- The sealed drums and Vacuum Dryer at Smith Ranch would contain the dried yellowcake powder, and any potential releases would be contained within the Dryer Building.
- Both the gaseous oxygen and primary leaching solution lines entering each headerhouse are equipped with automatic low pressure shut off valves to minimize the delivery of oxygen to a fire or of liquids to a spill.
- Additionally, each Headerhouse is equipped with a continuously operating exhaust fan that would assist in preventing the build-up of oxygen in the building.
- Procedures will be in place for confined space work or hot work for monitoring of oxygen build-up prior to start of work.

Mitigation/Emergency Response

Automatic detection and alarm systems along with sprinkler systems will be installed in the central plant and other facilities at the Moore Ranch Project. Fire extinguishers will be placed at accessible locations in all buildings and vehicles for quick response and training will be provided for appropriate personnel in use of fire extinguishers. EMC personnel will receive training for responding to a fire or explosion. The emergency response plan will include descriptions of the following provisions:

- Notification and evacuation procedures
- Personal protective equipment
- General fire fighting safety rules
- Reporting procedures
- Electrical and gas emergencies

7.5.7 Accident Risk Associated with Coal Bed Methane Development

The presence of CBM development on the Moore Ranch Project site presents accident risks that are not commonly associated with ISR mining. These additional accident risks, the control methods that the CBM operators currently have in place, additional control measures proposed by EMC, and the potential effect of accidents on the health and safety of EMC employees and the public and the security of licensed material are discussed in the following sections. The potential accident scenarios that could impact EMC operations are based on those analyzed by the BLM in the 2003 FEIS for the Powder River Basin.

7.5.7.1 Methane Migration and Seepage

CBM development includes potentially increased risks of methane seepage, fires, or explosions. Methane is not biologically toxic, but high concentrations in confined spaces can displace oxygen and present a danger of fire or explosion.

Methane gas can reach the surface by naturally occurring seepage along fault lines, fractures, or sandstone layers in areas where coal beds are shallow. Gas migration could also be enhanced during CBM development in areas along a coal outcrop, which are not present on the Moore Ranch site. Non-CBM wells that penetrate the coal seam may provide pathways for migration of methane if the casings or plugs are inadequate or faulty or lack isolation through the coal horizons.

BLM reported in the 2003 FEIS that experience in the Powder River Basin has shown that few cases of methane seeps that involve potentially explosive concentrations of gas have occurred.

Accident Prevention

The potential for migration of methane in CBM wells is minimized or prevented by the use of the current CBM industry standards for cementing and casing wells that isolate or protect all zones from gas or fluid migration. Well construction methods for CBM wells were discussed in detail in Section 7.2.9.1.

Mitigation

Risks from methane associated with oil and gas wells, including CBM wells, are controlled through the BLM-mandated conditions of approval for the Application for Permit to Drill (APD) that address well conditions, casing, ventilation, and plugging procedures appropriate to site-specific CBM development plans. In addition, CBM operators must have emergency plans and employee training programs that address fire prevention and control measures.

7.5.7.2 Pipeline Ruptures

CBM development involves the potential for leaks or ruptures of gas flowlines or pipelines. Most ruptures occur when heavy equipment accidentally strikes the pipeline while operating in close proximity. These ruptures may result in a fire or explosion if a spark or open flame ignites the escaping gas.

The projected development area of the Moore Ranch Project includes approximately 2,100 feet of gas pipeline. Based on a statistical average of one significant safety incident per year per 4,154 miles of total pipeline[15], 0.0001 additional pipeline safety incidents (including ruptures) may occur within the license area per year over the life of the project.

Based on the low incident rate, location of pipelines, and the preventative measures planned for the Moore Ranch Project, there is an insignificant increase in risks to human health and safety and control of licensed material associated with potential pipeline ruptures from CBM-related facilities.

Accident Prevention

Materials used in the pipelines are designed and selected in accordance with applicable standards to minimize the potential for a leak or rupture. Pipeline markers are posted at frequent intervals along the pipelines to warn excavators and to reduce the risk of accidental rupture from excavating equipment. EMC will work with CBM operators located on the proposed license area to ensure that all gas collection and transmission lines within proposed development areas are adequately marked to prevent accidental rupture by EMC activities.

Mitigation

The CBM operators monitor the pipeline flows by either remote sensors or daily inspections of the flow meters. Routine monitoring reduces the probability of effects to health and safety from ruptures by facilitating the prompt detection of leaks. If pressure losses are detected, the wells are shut in until the problem is isolated and addressed. Accident response will be similar to what is described above in Section 7.5.6 (Fire and Explosions).

7.5.8 Natural Disaster Risk

NUREG/CR-6733 considered the potential risks to an ISR facility from natural disasters. Specifically, the risk from an earthquake and a tornado strike were analyzed. NRC determined that the primary hazard from these natural events was from dispersal of yellowcake from a tornado strike and failure of chemical storage facilities, resulting in the possible reaction of process chemicals. NUREG/CR-6733 recommended that

licensees follow industry best practices during design and construction of chemical facilities. EMC is committed to following these standards.

The Moore Ranch Project is located in Campbell County Wyoming, in which 69 tornadoes touch downs were recorded in a period from 1950 through 2003[17]. Of those, 65 tornadoes were classified as F0 (with wind speeds of 40-72 miles per hour and described as a gale tornado) or F1 tornadoes (described as moderate with wind speeds of 73-112 miles per hour). Four of the 69 tornadoes were classified as F2 with wind speeds of 113-157 miles per hour and described as significant tornadoes. Based on the Fujita Scale, the type of damage that can be expected from an F2 tornado is roof damage, unsecured mobile homes pushed off foundations, and light structures severely damaged or destroyed. Based on maximum wind speed probability, the eastern third of the state can expect a tornado between 10,000 and 100,000 years,

NUREG-0706 estimated the probability of occurrence of a tornado in the area in which the project is located is about 3×10^{-4} per year. The area was categorized as Region 3 in relative tornado intensity. For this category, the wind speed of the design tornado was 240 mph (F4 tornado), of which 190 mph is rotational and 50 mph is translational. The Moore Ranch structures are not designed to withstand a tornado of this intensity.

The nature of the operation is such that little more could be done to secure the facility with advance warning than without it. NUREG-0706 postulated a "no warning" tornado. It was conservatively assumed that a maximum inventory of 50 short tons of yellowcake was onsite when the tornado strikes, and that 15% of the contained material was released. In this analysis, NRC assumed that the tornado lifts about 25,100 lb of yellowcake (equivalent to the contents of twenty-six 55-gallon drums). The conservative model assumed that all of the yellowcake was in a respirable form, was entrained as the vortex passed over the site and upon reaching the site boundary, was dispersed by the trailing winds. The model predicted a maximum exposure at a distance of approximately 2.5 miles from the mill, where the 50-year dose commitment to the lungs of an individual was estimated to be 8.3×10^{-7} rem (0.8 mrem). NUREG/CR-6733 reviewed this model scenario and found it to be valid for ISR operations.

Mitigation and Emergency Response

NUREG/CR-6733 concluded that tornado risk is very low at uranium ISR facilities and that no design or operational changes were required to mitigate the risk. One recommendation was that chemical storage tanks be located sufficiently far apart that leaks caused by tornado damage would not result in chemical reactions. EMC will institute procedures and provide instructions to operating personnel for response and mitigation of natural disasters and any associated spills of radioactive materials. Emergency response procedures will include:

- Notification to personnel of potential severe weather
- Evacuation procedures
- Damage inspection and reporting
- Cleanup and mitigation of spills of radioactive materials or chemicals

7.6 ECONOMIC AND SOCIAL EFFECTS OF CONSTRUCTION AND OPERATION

7.6.1 Construction

The construction phase would cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities. Impacts to community services in rural Campbell County or the nearby towns of Midwest and Edgerton in Natrona County, and Wright in Campbell County, such as roads, housing, schools, and energy costs would be minor or non-existent and temporary.

An estimated 50 percent (25 workers) of the construction work force would be based in Campbell County, which contains the Project site. The workforce hired outside of the County would likely be based in Casper, located in the neighboring Natrona County, as Casper is a regional economic hub that provides a variety of construction services and labor for projects located throughout Wyoming.

Most construction work available to the local construction labor pool consists of temporary contract work that varies in duration, depending on the scope of each construction project. Further, the number of unemployed construction workers does not represent the number of workers that would be available to the proposed project from the local construction labor pool. The number is an annual average that does not take into account monthly variations in the available construction labor pool from construction start-ups and completions. Contractors for projects located throughout northeastern Wyoming typically hire from the local construction labor pool. The actual number of construction workers available for the proposed project would potentially draw from the entire construction labor pool of 6,268 (2005 estimate; the construction labor pool as of 2007 is likely to be larger), as construction activities from some active projects would conclude so that workers would be available for future projects.

7.6.2 Operations Workforce

An estimated 40 to 60 people would be required for the operation of the proposed Moore Ranch Project. It is not known how many of the required operations workforce would be

hired from outside of Campbell and Natrona Counties. In the event that the entire operations workforce and their families relocated to the counties, the population increase would be a maximum of 150, based on the 2005 average household size of 2.52 in Wyoming. This increase would account for 0.1 percent of the population of Campbell and Natrona Counties, and is smaller than the projected annual growth rate. Therefore, there would be little to no effect to the vacancy rates of any type of housing in Gillette area or Campbell County.

7.6.3 Effects to Housing

The Moore Ranch License Area lies within commuting distance of Gillette and Wright, in Campbell County; and Casper in Natrona County, so that workers from these counties would likely commute from their homes. There would be no impact to temporary housing located within commuting distance (an estimated 1 to 2 hours) of the License Area.

In the event that workers from outside the local area are hired for construction, temporary housing such as motel/hotel rooms and RV sites located within commuting distance would be required, as no on-site housing (man camp) would be available. The available stock of motel/hotel rooms would accommodate relocating workers.

It is recognized, however, that the coal bed methane gas and mineral industries are presently a dominating factor for temporary housing availability in the area, and the workforce employed in these industries occupy much of the temporary housing that becomes available.

It is anticipated that few of the construction work force during any phase of the proposed Project would purchase or rent housing of any type. Therefore, there would be no effects on the costs of any type of housing in the counties. Because rental housing usually require a long-term lease (generally a minimum of 6 months), only operations employees would likely enter into this type of lease agreement. Under a hiring scenario that assumes all of the proposed operations workforce would need to relocate to the area, 40 to 60 housing units would be required over the life of the project. In 2006, there were a total of 60 vacant housing units in Campbell and Natrona Counties, which would not meet the future demand for housing in the counties from anticipated population growth. Therefore, there would be little to no effect to the rental rates of any type of housing in Gillette or Campbell County.

Household projections estimate an increase in households from 2000 to 2030 as 140 percent in Campbell County and 73 percent in Natrona County. The existing housing stock would not accommodate the projected households. Local communities in general are aware of the pressing need for the new residential development.

7.6.4 Effects to Services

It is likely that both the construction and operating work force would be from the Campbell and Natrona Counties, or other nearby counties in northeast Wyoming, and would not require permanent or temporary housing. In the event that up to 50 percent of the construction and operating workforce are non-local workers, it is anticipated that there would be a less than one percent increase in the population of Campbell and Natrona Counties from the permanent relocation of the workers and their families. Most non-local workers would utilize temporary housing. Because existing mobile home and RV parks will be used for a majority of the temporary housing, the Project will not require new water, sewer, electrical lines, or other infrastructure. There will be no additional demands of increases in service levels for local infrastructure, such as police, fire, water, or utilities. In addition, there would be little measurable increase in non-basic employment, as these jobs are generated from ongoing employment of the existing base of construction workers, and would be maintained through the continued employment of local construction workers. Therefore, construction and operation of the Project would not significantly affect the various public and non-public facilities and services described above from the in-migration of workers for non-basic employment opportunities.

7.6.5 Effects to Traffic

The most heavily used public road segment would be State Highway 387 between I-25 to the west and State Highway 59 to the east. Access to Moore Ranch from Gillette would be from State Highway 59, and from Casper would be from I-25. Construction traffic, the construction workforce, and the operations workforce would converge on Moore Ranch on State Highway 387 from the east and the west. The existing traffic levels on the highway are low. The highest levels of project-related traffic would be from the operations workforce, and assuming there would be an average of one employee per vehicle, per one-way vehicle trip, there could be an increase of 5.4 percent in daily traffic along the highway. This 5.4 percent (10.8 percent for two trips per day) increase is well below the 25 percent threshold generally used for predicting significant effects to a transportation system.

Equipment needed for construction and installation of the proposed facility would include heavy equipment (cranes, bulldozers, graders, track hoes, trenchers, and front-end loaders), and heavy- and light-duty trucks. It is anticipated that heavy equipment will be transported primarily to the site during off-peak traffic hours.

7.6.6 Economic Impact Summary

Economic impacts are summarized in the benefit-cost analysis in Section 9.

7.7 ENVIRONMENTAL JUSTICE

The U.S Census 2000 Decennial Population program provides race and poverty characteristics for Census Tracts and Block Groups, which are subdivisions of Census Tracts. The Moore Ranch License Area and the surrounding 2-mile buffer are contained within five Census Tracts and one additional Block Group that encompass portions of Campbell, Converse, Johnson, and Natrona Counties.

As summarized in Table 7.7-1, the combined population of the surrounding Census Tracts was 4,799. Minority populations accounted for a small percentage of the total population, with percentages of minorities generally similar to or smaller than those of the state as a whole.

The State of Wyoming was selected to be the geographic area to compare the demographic data for the population in the affected Census Tracts. This determination was based on the need for a larger geographic area encompassing affected area Census Tracts in which equivalent quantitative resource information is provided. The population characteristics of the affected Census Tracts are compared with Wyoming population characteristics to determine whether there are concentrations of minority or low-income populations in the Census Tracts relative to the state.

The data in Table 7.7-1 show that minority populations in the affected Tracts account for an overall smaller proportion of the population than the proportion of minority populations at the state level. No concentrations of minority populations were identified as residing near the proposed Project facilities, as residents nearest to the Moore Ranch Area are rural populations, while most of the minority population lives in Gillette and communities along the I-25 corridor to the south. There would be no disproportionate impact to minority population from the construction and implementation of the Moore Ranch Project.

With the exception of Census Tracts 9551 in Johnson County and 14.01 in Natrona County, the populations within the Tracts exhibit lower rates of people living below the poverty level than the state. Census Tracts 9551 and 14.01 contain rural populations; therefore, there is no concentration of people living below the poverty level in these Tracts. No disproportionate adverse environmental impacts would occur in populations living below the poverty level within the Census Tracts from proposed Project activities.

Table 7.7-1 Race and Poverty Level Characteristics of the Population in the Moore Ranch Permit Area Census Tracts

	State of Wyoming	Percent of Total State Population	Census Tract 1, Campbell County	Percent of Census Tract 1	Census Tract 9566, Converse County	Percent of Census Tract 9566	Block Group 1, Census Tract 9566, Converse County	Percent of Block Group 1, Census Tract 9566	Census Tract 9551, Johnson County	Percent of Census Tract 9551	Census Tract 14.01, Natrona County	Percent of Census Tract 14.01	Census Tract 18, Natrona County	Percent of Census Tract 18	Total
Total	493,782	100.0	4,779	100.0	2,944	100.0	1,412	100.0	1,918	100.0	3,478	100.0	3,285	100.0	**17,816**
Urban:	322,073	65.2	418	8.7	0	0.0	0	0.0	0	0.0	0	0.0	9	0.3	**427**
Inside urbanized areas	125,706	25.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9	0.3	**9**
Inside urban clusters	196,367	39.8	418	8.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	**418**
Rural	171,709	34.8	5,615	117.5	2,944	100.0	1,412	100.0	1,918	100.0	3,478	100.0	3,276	99.7	**18,643**
White alone	454,095	92.0	4,671	97.7	2,805	95.3	1,331	94.3	1,877	97.9	3,284	94.4	3,150	95.9	**17,118**
Black or African American alone	3,126	0.6	1	0.0	6	0.2	3	0.2	1	0.1	11	0.3	8	0.2	**30**
American Indian and Alaska Native alone	11,363	2.3	22	0.5	18	0.6	13	0.9	8	0.4	41	1.2	45	1.4	**147**
Asian alone	2,972	0.6	4	0.1	12	0.4	5	0.4	3	0.2	8	0.2	6	0.2	**38**
Native Hawaiian and Other Pacific Islander alone	232	0.0	2	0.0	1	0.0	1	0.1	0	0.0	8	0.2	2	0.1	**14**
Some other race alone	12,595	2.6	24	0.5	60	2.0	46	3.3	11	0.6	47	1.4	28	0.9	**216**
Two or more races	9,399	1.9	55	1.2	42	1.4	13	0.9	18	0.9	79	2.3	46	1.4	**253**
People who are Hispanic or Latino	31,384	6.4	88	1.8	113	3.8	73	5.2	52	2.7	106	3.0	78	2.4	**510**
Median household income in 1999	37,892	-	55,233	-	47,250	-	44,821	-	40,053	-	38,629	-	45,481	-	na
Per capita income in 1999	19,134	-	21,886	-	22,673	-	19,598	-	20,595	-	15,601	-	21,084	-	na
Population with income in 1999 below poverty level:	54,777	-	398	-	157	-	85	-	241	-	571	-	191	-	**1,643**
Percent below poverty level	11.1%	-	8.3%	-	5.3%	-	6.0%	-	12.6%	-	16.4%	-	5.8%	-	**9.2%**

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