6.1.3 SOIL SAMPLING

In addition to the estimates of surface soil Ra-226 concentrations presented in Section 6.1.2 of this report (based on gamma survey results), comprehensive baseline soil sampling and analyses were conducted in accordance with Regulatory Guide 4.14 protocols. Data from these sampling efforts represent discrete, systematic locations involving 5-cm sampling depths for surface soils and incremental profile sampling to a depth of 1 meter for subsurface soils (NRC, 1980). With gamma/Ra-226 correlation grid and subsurface soil samplings, 15-cm surface soil depths are also represented in the survey data set. Surface soil radionuclide concentration data from both 5-cm and 15-cm soil depths are presented in this section in accordance with NUREG-1569 application review recommendations (NRC, 2003). In addition, summary descriptive statistics for historical survey data from the site (Conoco, 1980) are presented for comparison purposes and to further augment the overall characterization of soil radionuclide concentrations across the site.

6.1.3.1 Methods

6.1.3.1.1 Surface Soil Sampling

Soil sampling for the current survey was conducted in April of 2007. The surface soil sampling design involved a radial grid pattern with the proposed Moore Ranch Central Plant at the center of the grid. Discrete soil samples were collected along transects radiating in 8 compass directions from the plant at 300 meter intervals. Each transect was about 1,500 meters long, resulting in the collection of 5 samples per transect for a total of 41 "grid samples" that were subsequently analyzed by Energy Laboratories, Inc. (ELI) in Casper, WY. All samples were analyzed for Ra-226, along with other select analytes that are automatically included with ELI's high-purity germanium (HPGe) gamma spectroscopy analysis package for analysis of naturally occurring radionuclides. In addition, 10 percent of these samples were further analyzed for natural uranium (U-nat), Th-230, and Pb-210. An additional 4 surface soil samples were collected at the air particulate monitoring stations per Regulatory Guide 4.14 specifications.

All grid and air station surface soil samples were collected with a hand trowel to a depth of 5 cm, double bagged, and labeled. Location ID numbers, date, and GPS coordinates for each sampling location were recorded in the field log book. Samples were hand-delivered to ELI in Casper, WY along with chain of custody / analysis request forms. Samples were dried, crushed, ground, and thoroughly homogenized prior to analysis. For samples analyzed by HPGe gamma spectroscopy, aliquots were weighed and placed into counting tins, then sealed for about 21 days prior to counting to allow ingrowth of short-lived Ra-226 progeny and approximate equilibrium conditions to become established. Separate aliquots were used for analyses requiring wet radiochemical methods.

6.1.3.1.2 Depth Profile Soil Sampling

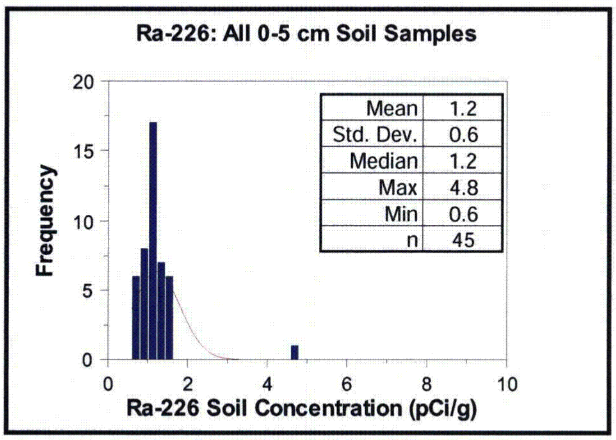
Five depth profile sampling locations were selected also based on Regulatory Guide 4.14 recommendations. One location was in the approximate center of planned Moore Ranch Central Plant facilities, with the other four locations located along radial transects used for surface soil sampling, at 750 meters from the plant in four compass directions.

Samples were collected with a hand-coring soil sample collector in 15-cm increments to a depth of 105 cm or until rocks prevented further coring device penetration. Sample collection, lab delivery, chain of custody, sample preparation, and analysis protocols were the same as those described above in Section 6.1.3.1.1 for surface soil samples. All soil depth profile samples were analyzed by HPGe gamma spectroscopy for Ra-226 and ELI's suite of naturally occurring radionuclides. The top-most and bottom-most layers of each depth sampling location were further analyzed for natural U, Th-230, and Pb-210 by wet radiochemical methods.

6.1.3.2 Soil Sampling Results

6.1.3.2.1 Surface Soil Sample Results

Frequency histograms of Ra-226 concentrations for all 0-5 and 0-15 depth samples are provided in Figure 6.1-17, with tabulations of respective summary statistics. The 0-15 cm result statistics include a mix of discrete, depth profile sample locations and composited correlation grid sampling locations. In both categories, results exceeding 2 pCi/g are from samples selectively collected in small, localized areas of higher gamma exposure rate readings. Excluding these few higher results, surface soil Ra-226 concentrations across the site averaged about 1.1 pCi/g.



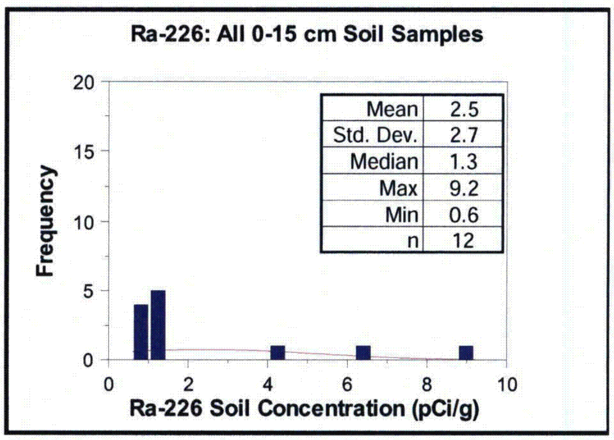


Figure 6.1-17: Frequency histograms and tabular summary statistics for soil Ra-226 concentrations among 0-5 cm and 0-15 cm samples. The 0-15 cm samples included composited correlation grid samples and discrete, depth profile sampling locations.

All 2007 surface soil sampling locations are shown in Figure 6.1-18, with color-coded Ra-226 ranges and annotations to show individual results. Given that low-end measurements averaged about 1.1 pCi/g, and respective analytical uncertainty was on the order of ± 0.2 – 0.5 pCi/g, it is reasonable to conclude that aside from relatively small, localized areas where consistently higher gamma readings exist at the site, baseline soil Ra-226 concentrations are unlikely to exceed 2 pCi/g. This conclusion is supported by comparison of measured soil sampling results with the continuous, kriged map of estimated soil Ra-226 concentrations based on gamma scan data (Figure 6.1-19).

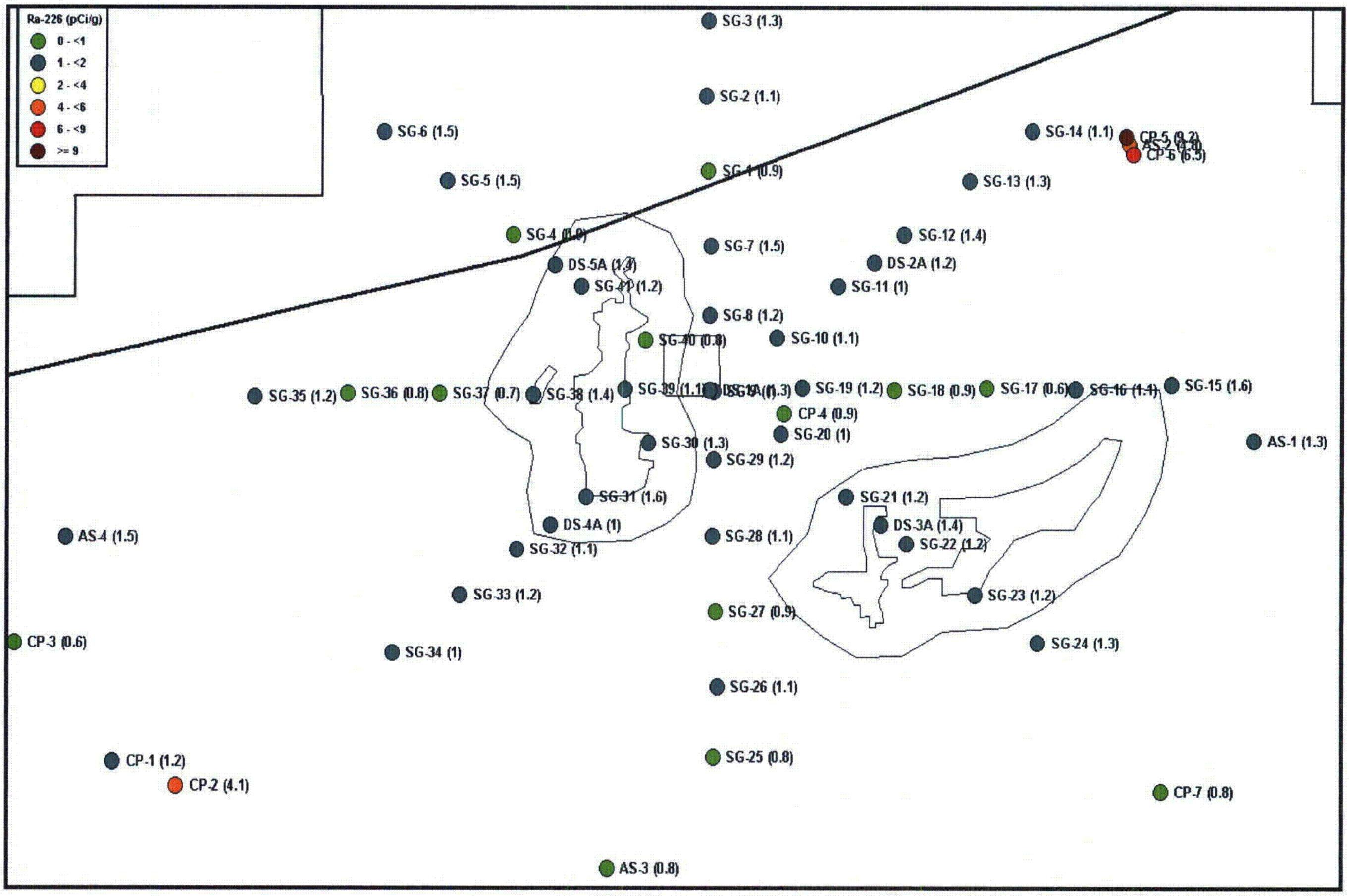


Figure 6.1-18: Surface soil sampling locations with color-coded Ra-226 ranges and individually annotated ID numbers and results.

In general, Figure 6.1-19 shows good agreement between measured and estimated Ra-226 concentrations in surface soils. Although there are apparent differences in some cases, mapping increment breakpoints are somewhat arbitrary for illustrative purposes, and the width of mapping increments is relatively narrow in relation to analytical uncertainties. Furthermore, mapped soil sample results primarily represent discrete samples and small-scale spatial variability (e.g. within a few meters) can be equally significant. In other words, small numerical differences between measured and estimated values (e.g. 0.1 – 0.5 pCi/g) can suggest disagreement on the map in Figure 6.1-19, even though respective results are unlikely to be significantly different in a statistical or truly quantitative sense. Overall, soil sampling results support the validity of continuous kriged estimates of Ra-226 concentrations based on gamma scan data (Figures 6.1-14 and 6.1-19).

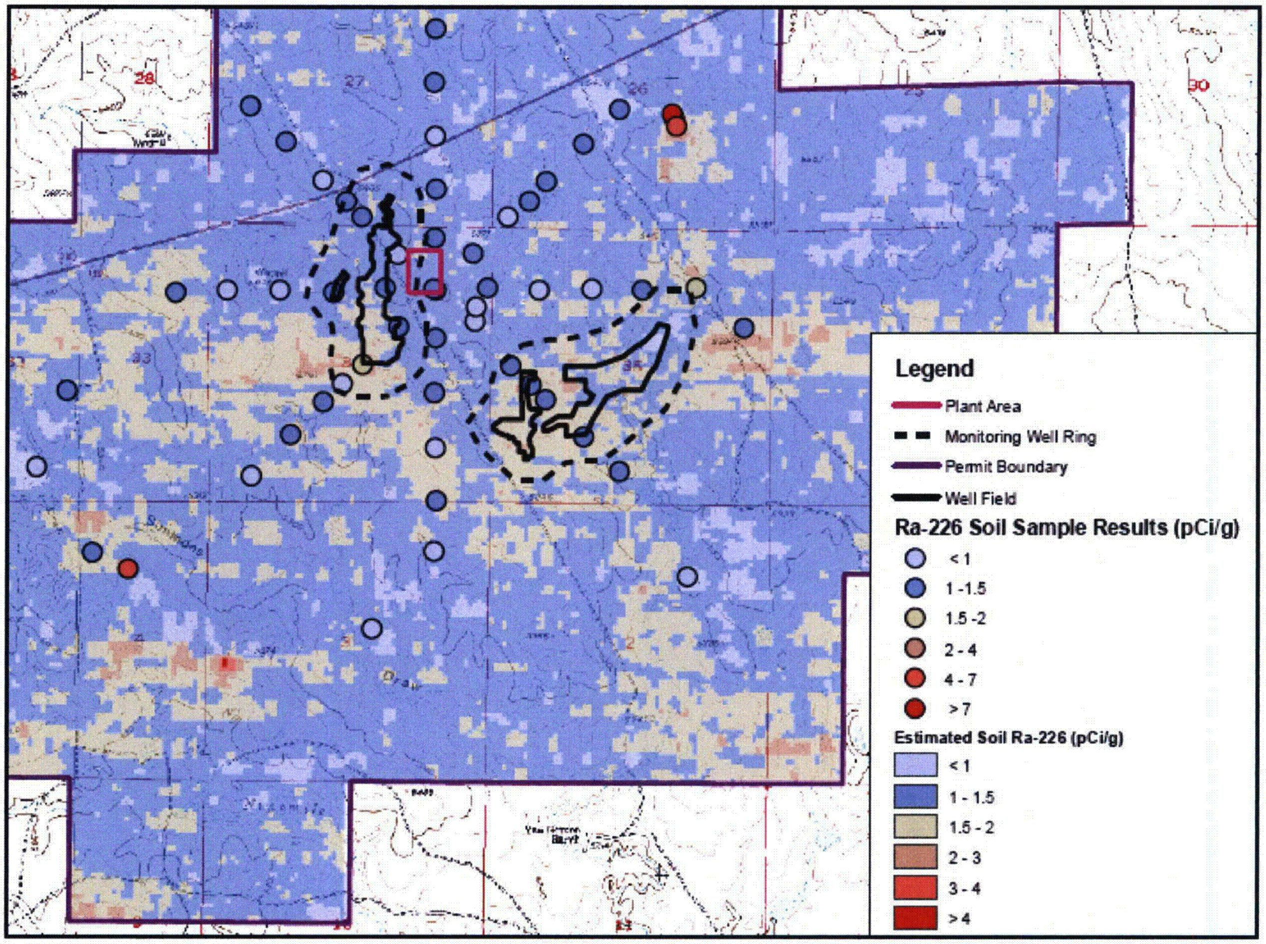


Figure 6.1-19: Gamma survey-based estimates of soil Ra-226 concentrations across the Moore Ranch License Area, with an overlay of actual surface soil sample results. Note that mapping increments in the upper half of the scale for soil sample results are widened to better illustrate measured Ra-226 results exceeding 4 pCi/g.

The historical Conoco survey data for surface soil Ra-226 concentrations (Figure 6.1-20) also agree reasonably well with the above results. A t-test comparison of 0-5 cm depth soil sampling results from the current and historical surveys did not reveal a significant difference between data sets at the 95% confidence level ($p = 0.08$), but a non-parametric Wilcoxon Rank Sum did ($p = 0.009$). There is no documented information on what analytical methods were used in the Conoco study. Despite some apparent distributional differences, mean and median values were nearly identical. Qualitatively, both data sets support the earlier conclusion that outside of the few relatively small areas of the site with elevated gamma readings, Ra-226 concentrations in surface soils are unlikely exceed 2 pCi/g. It does not appear that any areas with significantly elevated gamma readings were sampled in the historical survey.

Summary statistics for analytes other than Ra-226 in surface soil samples are given in Table 6.1-3. These statistics are given by sample series as denoted by their respective sample ID prefixes [AS = air station; SG = soil grid; DS (A) = depth sample (surface layer)], as well as for the historical survey data. Cases of higher mean and maximum values in the AS series are attributable to a sample collected in a location where high Ra-226 and gamma readings were also found (see sample locations AS-2, CP-5 and CP-6 in Figure 6.1-18). In general, historical survey data results for these analytes compare reasonably well with current survey data. This is particularly true when looking at median values, which helps reduce the influence of at least one notable exception - the comparatively high maximum Pb-210 value of 60 pCi/g found in one historical sample.

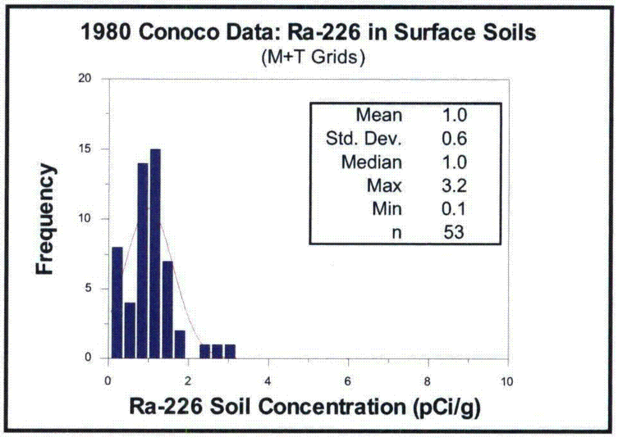


Figure 6.1-20: Frequency histogram and tabular summary statistics for 0-5 cm soil Ra-226 concentrations from the historical Conoco baseline survey.

Table 6.1-3: Summary statistics for Pb-210, Th-230, and U-nat in surface soil samples.

Sample Series	Sample Depth (cm)	Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
AS	0-5	Pb-210	2.3	1.0	2.3	3.5	1.1	4
		Th-230	1.4	1.9	0.5	4.3	0.3	4
		U-nat	1.2	1.1	0.8	2.8	0.6	4
SG	0-5	Pb-210	3.2	1.3	3.2	4.6	2.0	4
		Th-230	0.4	0.1	0.4	0.5	0.3	4
		U-nat	0.8	0.1	0.8	0.9	0.7	4
DS (A)	0-15	Pb-210	0.5	0.4	0.5	1.2	0.1	5
		Th-230	0.4	0.1	0.4	0.5	0.3	5
		U-nat	0.9	0.1	0.9	1.0	0.7	5
Historical Data	0-5	Pb-210	8.4	18.2	2.7	60	1.4	10
		Th-230	1.4	0.6	1.3	2.7	0.8	10
		U-nat	1.6	1.6	0.9	5.1	0.0	10

6.1.3.2.2 Subsurface Soil Sample Results

Subsurface sampling locations and respective surface layer Ra-226 results are shown in Figure 6.1-18, with "DS" sample ID prefixes (labeling for sample location DS-1 is obscured in the figure, but is located in the very center of the radial grid pattern where processing plant facilities will be located). Summary statistics for each depth sample increment and each indicated Regulatory Guide 4.14 analyte are provided in Table 6.1-4. There are no readily apparent trends between analyte and depth, suggesting that vertical distribution of these radionuclides is fairly consistent to a depth of 1 meter. None of the localized areas at the site with consistently higher gamma readings were sampled for subsurface soil profiles as the applicable Regulatory Guide 4.14 grid pattern for this investigation was followed.

Table 6.1-4: Summary statistics for Ra-226, Pb-210, Th-230, and U-nat in depth profile soil samples.

Sample Series	Sample Depth (cm)	Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
DS (A)	0-15	Ra-226	1.3	0.2	1.3	1.4	1.0	5
		Pb-210	0.5	0.4	0.5	1.2	0.1	5
		Th-230	0.4	0.1	0.4	0.5	0.3	5
		U-nat	0.9	0.1	0.9	1.0	0.7	5
DS (B)	15-30	Ra-226	1.4	0.2	1.3	1.6	1.2	5
DS (C)	30-45	Ra-226	1.4	0.3	1.3	1.8	1.1	5
DS (D)	45-60	Ra-226	1.3	0.2	1.2	1.6	1.1	5
DS (E)	60-75	Ra-226	1.1	0.3	1.3	1.4	0.8	5
DS (F)	75-90*	Ra-226	1.1	0.3	1.3	1.4	0.8	5
DS (G)	90-105*	Ra-226	1.1	0.3	1.1	1.4	0.9	4
		Pb-210	0.3	0.1	0.3	0.4	0.1	5
		Th-230	0.5	0.1	0.5	0.7	0.3	5
		U-nat	1.5	1.2	0.8	3.2	0.6	5
DS (A-G)	All depths	Ra-226	1.2	0.2	1.3	1.8	0.8	34
		Pb-210	0.4	0.31	0.4	1.2	0.1	10
		Th-230	0.5	0.13	0.5	0.7	0.3	10
		U-nat	1.2	0.87	0.9	3.2	0.6	10

*One sample was truncated at 85 cm due to rock

Despite differences in depth sampling increments, the historical survey data for Ra-226 in subsurface samples (Table 6.1-5) agree well with the summary statistics provided above in Table 6.1-4. General similarities can also be seen for Pb-210, Th-230, and U-nat in most cases (Table 6.1-6). As with 2007 survey data, there do not appear to be any significant differences or trends with depth for the historical radionuclide data.

Table 6.1-5: Summary statistics of historical baseline survey data (Conoco, 1980) for Ra-226 in subsurface depth profile soil samples.

Sample Series	Sample Depth (ft)	Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
M+T Grids	0-1	Ra-226	1.3	0.4	1.3	2.1	0.7	10
M+T Grids	1-2	Ra-226	1.3	0.5	1.3	2.4	0.8	10
M+T Grids	2-3	Ra-226	1.1	0.4	1.2	1.9	0.6	10

Table 6.1-6: Individual sample results for Pb-210, Th-230, and U-nat in subsurface soil samples from the historical baseline survey.

Sample Series	Sample Depth (ft)	Analyte	Result (pCi/g)
M Grid (center)	0-1	Pb-210 Th-230 U-nat	0.8 1.0 1.6
M Grid (center)	1-2	Pb-210 Th-230 U-nat	1.6 1.4 2.5
M Grid (center)	2-3	Pb-210 Th-230 U-nat	0.6 1.0 1.7
T Grid (center)	0-1	Pb-210 Th-230 U-nat	0.6 1.4 2.4
T Grid (center)	1-2	Pb-210 Th-230 U-nat	1.1 2.1 2.3
T Grid (center)	2-3	Pb-210 Th-230 U-nat	3.1 3.3 3.6

6.1.3.3 Conclusions

Baseline soil 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. These data sets, combined with the continuous kriged estimates of Ra-226 concentrations across the site based on the extensive gamma survey data presented in Section 6.1.2, provide a thoroughly detailed and comprehensive characterization of existing soil radionuclide concentrations across the site. This information should meet respective baseline characterization requirements as indicated by the USNRC and the WDEQ/LQD for ISR licensing/permitting applications.

Note: Radionuclides listed in Tables 6.1-4 through 6.1-6 are believed to be in approximate secular equilibrium. Apparent discrepancies may be due to differences in analytical techniques (gamma spectroscopy versus dissolution/wet radiochemistry).

6.1.4 Sediment Sampling

In April of 2007, baseline sediment sampling was conducted at the Moore Ranch Project area in accordance with Regulatory Guide 4.14 protocols (NRC, 1980). Both ephemeral stream drainage channels and surface water impoundments were sampled. In all, 7 samples were collected from three primary stream drainage channels found at the site, at license area boundaries both upstream and downstream of the planned plant location. Stream drainage channel sediment sampling in April was the first of two planned sampling events, the other scheduled to occur in late summer or fall of 2007. These two sampling events are intended to characterize radionuclide content in stream sediments during seasonal runoff and low-flow conditions (NRC, 1980). Although drainage channel sampling locations generally had moist sediments during the spring sampling, none of locations sampled had flowing or standing water present and most were grassy in nature (Figure 6.1-21).

Figure 6.1-21: Sediment sampling: typical ephemeral stream drainage channel at the Moore Ranch site.

Sediment samples were collected from 13 surface water impoundments representing the majority of impoundments found at the site (primarily stockponds). These locations all had surface water present at the time of sampling (Figure 6.1-22). For surface water impoundment sediments, a one-time sampling event is indicated by Regulatory Guide 4.14 as sufficient to document respective radiological conditions.

Figure 6.1-22: Sediment sampling: typical surface water impoundment at the Moore Ranch site.

This section presents results of 2007 sediment sampling at the Moore Ranch Uranium Project area. Summary statistics of sediment sampling data from the historical survey of the site (Conoco, 1980) are presented for comparison purposes and to further augment the overall characterization of radionuclide concentrations in sediments across the site.

6.1.4.1 Methods

6.1.4.1.1 Stream Sediment Sampling

Stream sediment sampling locations were determined from topographical maps to represent the primary drainages found at the site. At each location, four sediment sub-samples were collected with a hand trowel to a depth of 5 cm each, along a transect spanning the width of the lowest portion of the ephemeral stream channel. The four sub-samples were composited to represent the average radionuclide concentration across the drainage channel. Composite sediment samples were subsequently double bagged, and labeled. Location ID numbers, date, and GPS coordinates for each sampling location were recorded in the field log book.

Samples were hand-delivered to ELI in Casper, WY along with chain of custody / analysis request forms. Samples were dried, crushed, ground, and thoroughly homogenized prior to analysis. All samples were analyzed for Ra-226, along with other select analytes that are automatically included with ELI's gamma spectroscopy analysis package for analysis of naturally occurring radionuclides. In addition, all stream sediment samples were further analyzed for U-nat, Th-230, and Pb-210. For samples analyzed by HPGe gamma spectroscopy, aliquots were weighed and placed into counting tins, then sealed for about 21 days prior to counting to allow ingrowth of short-lived Ra-226 progeny and approximate equilibrium conditions to become established. Separate aliquots were used for analyses requiring wet radiochemical methods.

6.1.4.1.2 Surface Water Impoundment Sediment Sampling

Sediment sampling locations for surface water impoundments (hereafter referred to as "ponds") were determined from a combination of topographical maps and consultation with a staff member from EMC familiar with actual pond locations (most ponds were not shown on available maps). At each pond, a single grab sample of sediment was collected with a hand trowel to a depth of 5 cm, in a location near the waters edge that was both convenient for sampling and that appeared relatively undisturbed (Figure 6.1-23). Pond sediment samples were double bagged and labeled. Location ID numbers, date, and GPS coordinates for each sampling location were recorded in the field log book.

Figure 6.1-23: Pond sediment sampling at the Moore Ranch Uranium Project site.

Lab delivery, chain of custody, sample preparation, and analysis protocols for pond sediment samples were the same as those described in above in Section 6.1.4.1.1 for stream sediment samples. All samples were analyzed by gamma spectroscopy for Ra-226 and ELI's suite of naturally occurring radionuclides, as well as for U-nat, Th-230, and Pb-210 by wet radiochemical methods.

6.1.4.2 Sediment Sampling Results

6.1.4.2.1 Stream Sediment Sample Results

Descriptive summary statistics of the stream sediment data for each indicated Regulatory Guide 4.14 analyte are provided in Table 6.1-7. Individual stream drainage channel sampling locations and respective Ra-226 results are shown in Figure 6.1-24, with "SS" sample ID prefixes. In general, stream sediment baseline results are similar to those found for both surface and subsurface soils at the site.

Table 6.1-7: Summary statistics for radionuclide concentrations in stream sediment samples from the Moore Ranch Uranium Project area.

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

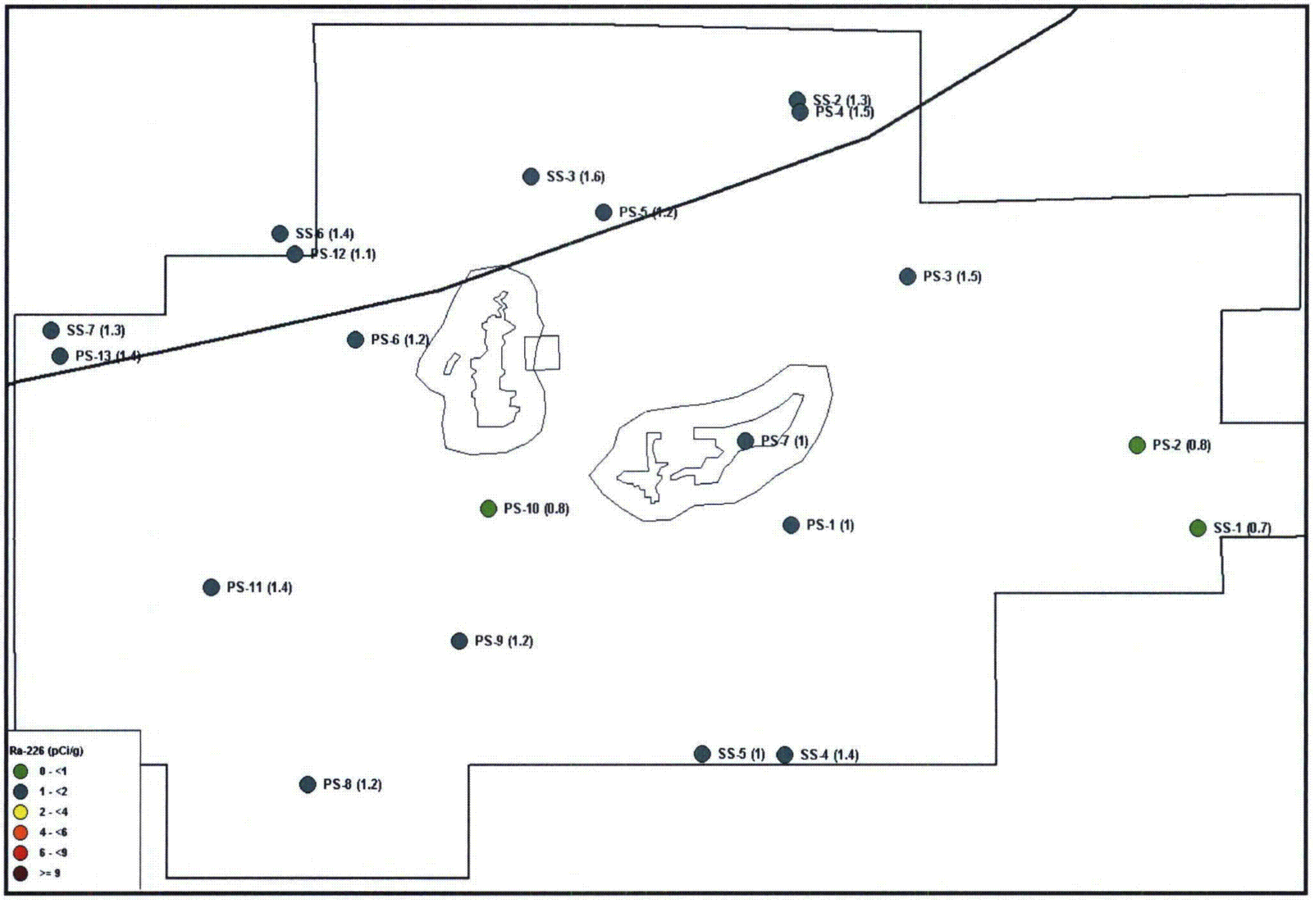


Figure 6.1-24: Sediment sampling locations and respective Ra-226 concentration results for both ephemeral stream drainage channels and surface water impoundments (ponds).

Stream sediment sample results from the historical survey (Conoco, 1980) are summarized in Table 6.1-8. Results for Pb-210 were not completed at the time of the Conoco report, but the other results are very similar to results from the 2007 survey. Because the historical samples were collected in the fall of 1980, they represent "low-flow" conditions and suggest that seasonal variations in stream sediment radionuclide concentrations are not likely to be significant. Furthermore, historical "low-flow" data combined with "high-flow" data collected in the spring of 2007 might be considered by NRC and WDEQ as sufficient overall documentation of stream sediment conditions with respect to license applications.

Table 6.1-8: 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

6.1.4.2.2 Pond Sediment Sample Results

Descriptive summary statistics of these data for each indicated Regulatory Guide 4.14 analyte are provided in Table 6.1-9. Individual pond sediment sampling locations and respective Ra-226 results are shown in Figure 6.1-10, with "PS" sample ID prefixes. In general, pond sediment results are similar to those of stream sediments as well as surface/subsurface soils at the site.

Table 6.1-9: Summary statistics for radionuclide concentrations in 2007 pond sediment samples from the Moore Ranch Project area.

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.2	0.24	1.2	1.5	0.8	13
Pb-210	1.1	0.57	1.1	2.2	-0.1	13
Th-230	0.5	0.20	0.4	1.0	0.3	13
U-nat	1.1	0.78	1.0	2.7	0.1	13

Pond sediment sample results from the historical survey (Conoco, 1980) are summarized in Table 6.1-10. Results for Pb-210 were not completed at the time of the Conoco report, but the other results agree reasonably well with pond sediment results from the 2007 survey.

Table 6.1-10: Summary statistics for radionuclide concentrations in pond 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	0.93	0.9	3.5	0.4	12
Pb-210*	-	-	-	-	-	-
Th-230	1.3	0.28	1.3	1.6	0.8	12
U-nat	2.1	1.20	1.7	4.5	0.5	13

* Analysis results not completed at time of 1980 Conoco report

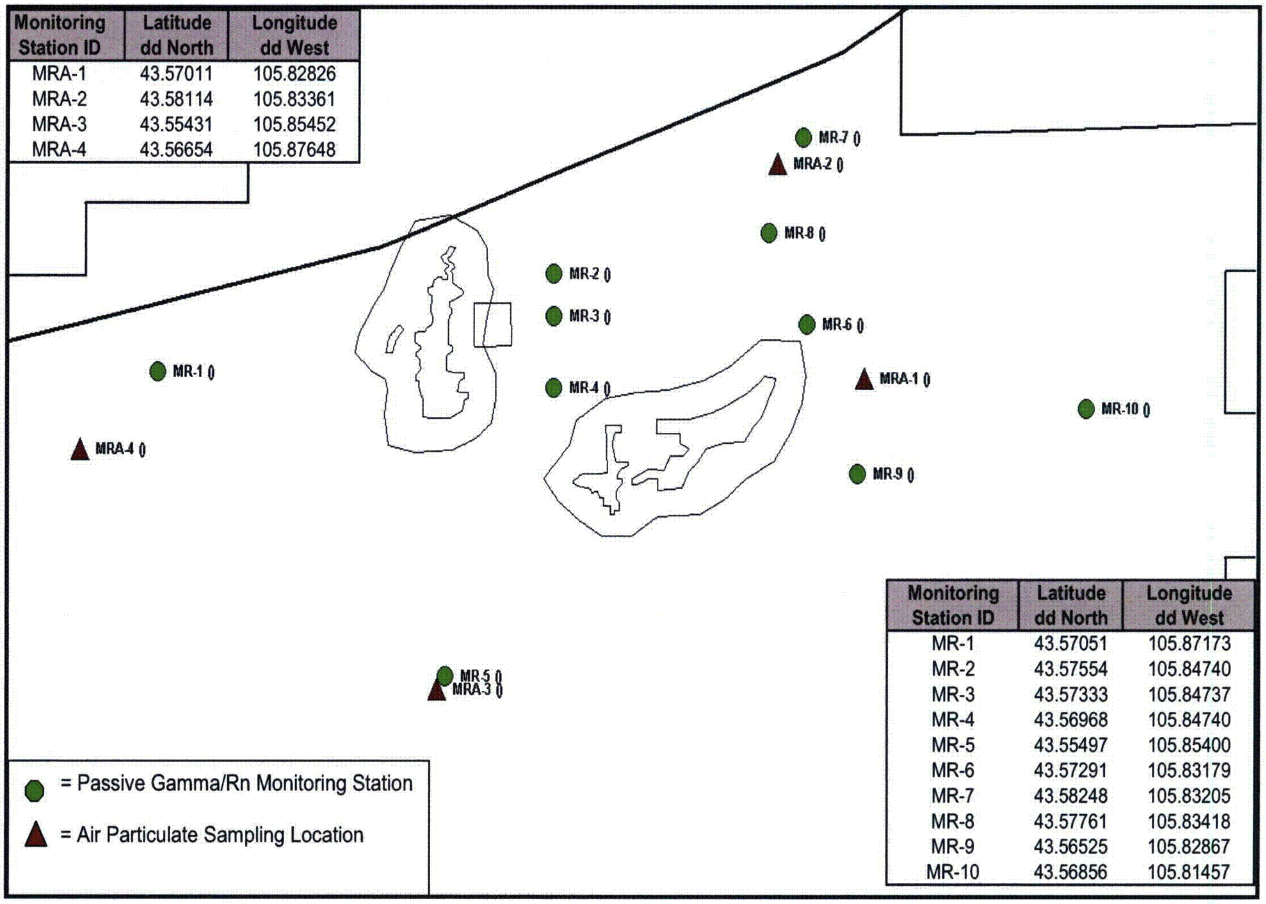
6.1.4.3 Conclusions

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. The scheduled second sampling of stream sediments during the fall of 2007 was carried out as planned and results are provided in Addendum 6.1-A. With respect to pond sediment data, the historical data simply augment the 2007 survey data resulting in a more robust respective characterization.

6.1.5 Ambient Gamma and Radon Monitoring

Continuous passive monitoring of ambient gamma dose rates and radon concentrations was initiated in December 2006. Regulatory Guide 4.14 calls for 12 consecutive months of respective monitoring data as part of the overall radiological characterization of the site (NRC, 1980). These data are being collected and reported on a quarterly basis. Two quarters of 2006-2007 monitoring data (hereafter termed "2007 data") are available and presented in this section. The remaining two quarters of data is contained in Addendum 6.1-A.

Corresponding historical data (Conoco, 1980) are also summarized and compared to the two quarters of 2007 monitoring data.



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

Figure 6.1-25: Passive gamma/radon and air particulate monitoring station locations at the Moore Ranch Project area.

Passive devices for monitoring ambient gamma dose rates and radon levels are each housed at the same station. Station locations were selected based on Regulatory Guide 4.14 guidance, including consideration for the locations of plant facilities, prevailing wind directions, air monitoring stations, and practical access. In all, 10 of these passive stations were installed, including one or more stations located near each air particulate monitoring station. Locations of passive monitoring stations, as well as air particulate sampling stations, are shown in Figure 6.1-25.

6.1.5.1 Methods

6.1.5.1.1 Ambient Gamma Dose Rate Monitoring

Passive monitoring of gamma dose rates at the site is being conducted with thermo-luminescent dosimeters (TLDs) supplied by Landauer, Incorporated. The TLDs are housed in insulated plastic spigot covers, attached to fence posts (Figure 6.1-26). Radon monitoring devices are also housed in these spigot covers.

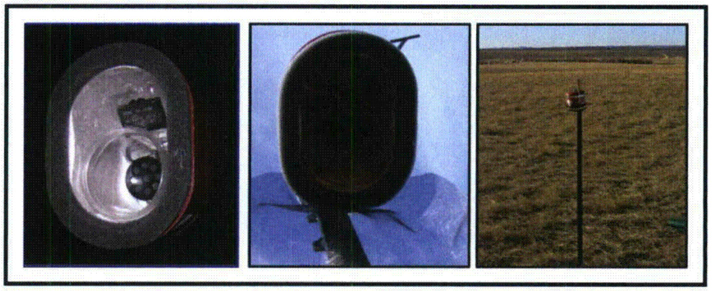


Figure 6.1-26: Photos of passive gamma/radon monitoring station equipment.

Each batch of TLDs contains a "transit" and "deploy" control TLD badge to account for background doses received by field badges when not actually deployed at the site. The transit control is stored at the Tetra Tech office in Fort Collins, Colorado (away from any radioactive sources) at all times except while in transit to and from Landauer. The deploy control badge accompanies the transit control badge at all times except for the short period of time it must travel to or from the site along with field badges during their respective deployment or removal from the site.

Landauer reports a "net" dose result, calculated by subtracting the gross deploy control badge result from each field badge result. This gives the net above background dose, which is useful for occupational dose assessments relative to regulatory dose limits, but is not applicable for environmental monitoring where the total dose received at the site during the monitoring period is of interest. For this, a different calculation is required, one that subtracts only the fraction of control badge dose that corresponds with the amount of time the field badges are not actually deployed at the site. For Moore Ranch, the calculations used to obtain this gamma dose value are outlined as follows:

1. Determine the average daily dose rate for the transit control badge:
    - Assuming the control badge receives background doses at a relatively constant rate, this is calculated as the gross reported dose (mrem), divided by the total number of days from TLD issuance to TLD analysis by the dosimetry vendor.
2. Determine the total dose to the field dosimeter whenever accompanied by the transit control badge:

- Assume the field badge receives the same average daily dose rate as the transit control badge for all periods while stored or transported together with the transit control badge.
- Calculate the total dose to the field dosimeter whenever accompanied by the transit control badge as: (Result from step 1 above) × (number of days from TLD issuance to TLD analysis, minus the number of days the field badge was actually deployed at the site)

3. Determine any additional background dose received by the field badge during deployment to and from the site:
   - Calculate the difference between the deploy control badge and the transit control badge, assuming this value represents the additional total dose received by the field badge during transport to and from the site.
4. Calculate total dose received by the field TLD while not deployed at the site:
   - Add the total doses calculated in steps 2 and 3 above.
5. Calculate the total dose received by the field TLD while deployed at the site:
   - Subtract the result in step 4 above from the gross result for the field TLD as reported by the vendor.

Due to scheduling issues involving initial TLD issuance from Landauer versus initial deployment of badges to the site to begin the gamma monitoring program, begin/end dates for the first two quarters of TLD data for Moore Ranch were out of sync with Landauer's normal quarterly schedule. The third quarterly change out will be delayed one month to synchronize the TLD monitoring schedule with Landauer's normal quarterly schedule. This will not affect the results, but should simplify calculations and records keeping.

6.1.5.1.2 Ambient Radon-222 Monitoring

Passive monitoring of Rn-222 air concentrations at the site is being conducted with Radtrak® alpha-track radon gas detectors supplied by Landauer. These radon detectors are housed along with the environmental TLDs as shown in Figure 6.1-26. The radon detectors are supplied by the vendor in special sealed packages designed to prevent the detectors from radon exposure prior to the beginning of the monitoring period. Upon completion of the site monitoring period, special sealing stickers supplied by the vendor are applied to detector openings to prevent further radon exposure until the device is analyzed by the vendor for average Rn-222 concentration (in pCi/L).

Prior to initial deployment of radon detectors to Moore Ranch, it was necessary to open the first quarter's batch of detectors prior to traveling to the site in order construct the housing assemblies. This operation was performed as quickly as possible to minimize any potential radon exposures not due to site conditions. Within a few hours, housing assemblies were completed and this first batch of radon detectors was double-sealed in plastic bags and placed inside the company truck (parked outside in Fort Collins, Colorado) until deployment to the site two days later.

Another issue arose with the first batch of radon detectors while constructing the housing assemblies. Two of the sealed bags (containing 3 radon detectors each) were discovered to be compromised. As a result, one of these detectors was designated for use as a "control" detector and immediately sealed with the sealing sticker. This detector was sent back to Landauer for processing, and a replacement detector was ordered for subsequent deployment to the site. Landauer was notified of the faulty packaging, and no other cases of compromised packaging seals have been discovered.

6.1.5.2 Ambient Gamma and Radon Results

6.1.5.2.1 Ambient Gamma Dose Rate Monitoring

Passive gamma dose monitoring results to date are presented in Table 6.1-11. Assuming conventional radiation weighting and quality dose factors for photons, the estimated gamma dose rates (mrem/hr) shown in Table 6.1-11 agree reasonably well with the gamma exposure rate scan data presented in Section 6.1.2 of this report. Similarly, these gamma dose rate values agree closely with the historical gamma exposure rate data (μR/hr) provided for M and T grids in the Conoco report, which were measured by a pressurized ionization chamber (Conoco, 1980).

Table 6.1-11: Environmental gamma dose rate monitoring data for quarters 1 and 2 at Moore Ranch.

Passive Monitoring Station ID	TLD Issue Date	Field Installation Date	Monitoring End Date*	Landauer GROSS Result (mrems)	Landauer NET Result (mrems)	Estimated Quarterly Field Dose (mrem)[1]	Estimated Daily Field Dose (mrem)[1]	Estimated Field Dose Rate (mrem/hr)[1]
QUARTER 1								
MR-1	10/1/2006	12/4/2006	3/5/2007	47.1	7.3	29.6	0.325	0.014
MR-2	10/1/2006	12/4/2006	3/5/2007	50.3	10.5	32.8	0.360	0.015
MR-3	10/1/2006	12/4/2006	3/5/2007	47.1	7.3	29.6	0.325	0.014
MR-4	10/1/2006	12/4/2006	3/5/2007	47.8	8.0	30.3	0.333	0.014
MR-5	10/1/2006	12/4/2006	3/5/2007	42.1	2.3	24.6	0.270	0.011
MR-6	10/1/2006	12/4/2006	3/5/2007	54.6	14.8	37.1	0.408	0.017
MR-7	10/1/2006	12/4/2006	3/5/2007	51.1	11.3	33.6	0.369	0.015
MR-8	10/1/2006	12/4/2006	3/5/2007	52.1	12.3	34.6	0.380	0.016
MR-9	10/1/2006	12/4/2006	3/5/2007	44.8	5.0	27.3	0.300	0.013
MR-10	10/1/2006	12/4/2006	3/5/2007	41.0	1.2	23.5	0.258	0.011
Transit control	10/1/2006	-	3/5/2007	39.2	-0.6	-	-	-
Deploy control	10/1/2006	-	3/5/2007	39.8	0.0	-	-	-
QUARTER 2								
MR-1	1/1/2007	3/5/2007	6/9/2007	58.4	7.3	34.1	0.355	0.015
MR-2	1/1/2007	3/5/2007	6/9/2007	56.5	10.5	32.2	0.335	0.014
MR-3	1/1/2007	3/5/2007	6/9/2007	55.9	7.3	31.6	0.329	0.014
MR-4	1/1/2007	3/5/2007	6/9/2007	56.3	8.0	32.0	0.333	0.014
MR-5	1/1/2007	3/5/2007	6/9/2007	47.0	2.3	22.7	0.236	0.010
MR-6	1/1/2007	3/5/2007	6/9/2007	68.8	14.8	44.5	0.464	0.019
MR-7	1/1/2007	3/5/2007	6/9/2007	69.9	11.3	45.6	0.475	0.020
MR-8	1/1/2007	3/5/2007	6/9/2007	78.5	12.3	54.2	0.565	0.024
MR-9	1/1/2007	3/5/2007	6/9/2007	73.1	5.0	48.8	0.508	0.021
MR-10	1/1/2007	3/5/2007	6/9/2007	71.8	1.2	47.5	0.495	0.021
Transit control	1/1/2007	-	6/9/2007	74.4	-0.6	-	-	-
Deploy control	1/1/2007	-	6/9/2007	58.7	0.0	-	-	-

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

It appears that continuous monitoring of ambient field gamma dose rates at the site with TLDs or other dosimeters was not conducted during the historical Conoco study (no gamma dose rate information was provided in that report). However, given that the field dose rates (mrem/hr) for quarters 1 and 2 in Table 6.1-11 are fairly similar to each other in most cases, and both agree reasonably well with gamma exposure rate data collected in the fall of 2007 (see Section 6.1.2.2.4, Figure 6.1-13), suggests that temporal fluctuations in ambient field gamma dose rates at a given location are unlikely to vary by more than 0.01 mrem/hr. Spatial and temporal variability in background sources of gamma radiation, combined with measurement uncertainty, are likely responsible for the higher degree of variation observed in some cases through two quarters.

6.1.5.2.2 Ambient Rn-222 Monitoring

Passive Rn-22 monitoring results to date are presented in Table 6.1-12. Note that the "control" radon detector for quarter 1 registered a significantly higher value relative to all other detectors. Landauer's review of the records for this detector revealed no analysis or reporting errors. Other than for the early return shipping trip to Landauer, this detector was subject to the exact same conditions as all other detectors in the same batch, suggesting that this detector was somehow exposed to elevated alpha radiation during return shipping. It is thus reasonable to exclude this result from consideration as a control detector as intended. Because all other quarter 1 detectors had readings similar to one another (whether respective packaging was compromised or not), it is also reasonable to assume that the compromised packaging for some detectors did not significantly affect the results of the detectors involved. Therefore, all data for detectors actually deployed in the field in quarter 1 are assumed to be valid as reported.

Table 6.1-12: Ambient radon-222 monitoring data for quarters 1 and 2 at 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	4639785	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-2	4639861	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-3	4639862	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-4	4639864	3/5/2007	3/5/2007	6/9/2007	11.5	0.1
MR-5	4639874	3/5/2007	3/5/2007	6/9/2007	12.0	0.1
MR-6	4639875	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-7	4639876	3/5/2007	3/5/2007	6/9/2007	17.9	0.2
MR-8	4639884	3/5/2007	3/5/2007	6/9/2007	18.6	0.2
MR-9	4639885	3/5/2007	3/5/2007	6/9/2007	6.0	0.06
MR-10	4639886	3/5/2007	3/5/2007	6/9/2007	12.0	0.1

[1]Results shown in blue are 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

Quarter 1 and 2 results are higher on average than Rn-222 concentrations reported in the historical baseline survey (Figures 6.1-27 and 6.1-28), 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.

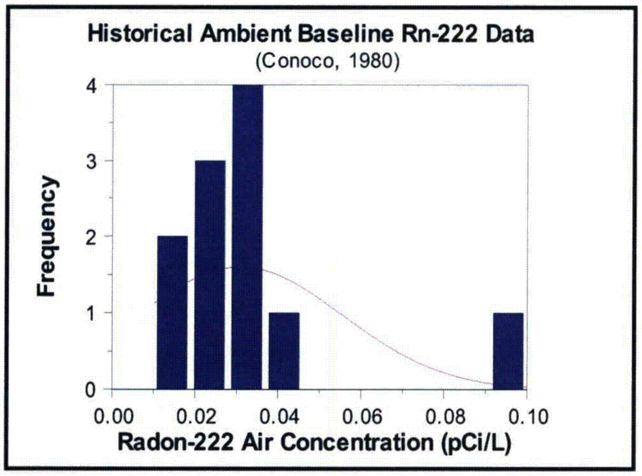


Figure 6.1-27: Frequency histogram of average monthly concentrations across all sampling locations for the historical data.

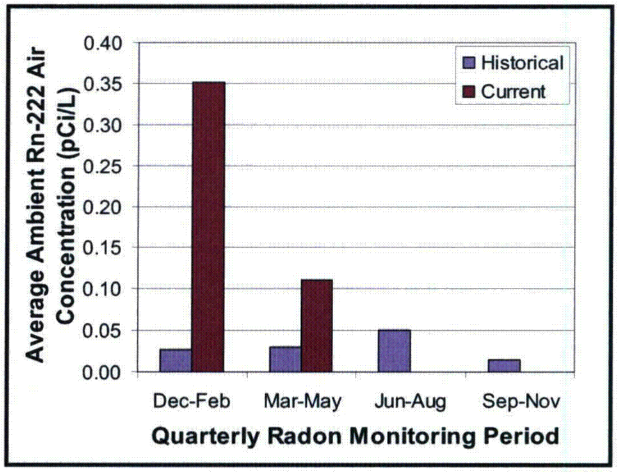


Figure 6.1-28: Current average quarterly results to date for all locations and corresponding average quarterly values across the site based on the historical data.

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).

6.1.5.3 Conclusions

Baseline ambient gamma dose rate and radon-222 air concentration data for the 2007 radiological survey of the Moore Ranch Uranium Project area were collected and analyzed according to Regulatory Guide 4.14 protocols. Two quarters of data are presented in this section. The remaining two quarters of data is contained in Addendum 6.1-A.

6.1.6 Air Particulate Monitoring

Continuous monitoring of baseline air particulate radionuclide concentrations was initiated in early February 2007 at four on-site locations. Regulatory Guide 4.14 calls for 12 consecutive months of respective monitoring data as part of the overall radiological characterization of the site (NRC, 1980). These data are being collected and reported on a quarterly basis. One quarter and one additional month of 2007-2008 monitoring data (hereafter termed "2007 data") are presented in this section. The remaining air particulate monitoring data is contained in Addendum 6.1-A. No off-site locations were planned for the air monitoring program as no known residences are currently located within 10 kilometers of the site as described in Regulatory Guide 4.14 (NRC, 1980).

Recent air monitoring data from other nearby ISR sites in this region of Wyoming have also been compiled and compared to current results to date for Moore Ranch.

Low-volume air particulate sampling station locations were selected based on the historical air sampling locations and Regulatory Guide 4.14 guidance, including consideration for the locations of plant facilities, prevailing wind directions, available electrical power, and practical access. Initially, only two of the four air sampling stations had available hard-line electrical power. The other two stations were set up using solar/wind generation equipment to supply electrical power to the air samplers. Locations of the air particulate monitoring stations are shown in Figure 6.1-25 of the previous section of this report.

6.1.6.1 Methods

The air particulate monitoring program is being conducted with Model DF-40L-8 electric powered air samplers from F&J Specialty Products, Inc. (Figure 6.1-29). These samplers are calibrated by the manufacturer and programmed to draw about 30 liters of air intake per minute through a 47 mm glass fiber air sampling filter. The air samplers are housed in protective coolers mounted on elevated steel platforms such that the intake and sample filter holder assembly is positioned at about 5 feet above the ground surface (Figure 6.1-30). This is intended to approximate an average breathing zone height.

Figure 6.1-29: F&J air particulate sampler.

Figure 6.1-30: Air sampling station equipment and systems setup including hard-line and solar/wind powered units at Moore Ranch.

Filters are collected weekly to help prevent dust loading and are 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 is submitted to ELI in Casper, WY for analysis of Ra-226, U-nat, Th-230, and Pb-210.

6.1.6.2 Air Particulate Sampling Results

Baseline air particulate sampling results to date are presented in Table 6.1-13 and are also graphically illustrated in Figure 6.1-31. In most cases, analytical results are above the lower limits of detection (LLD). The LLD values listed are those specified in Regulatory Guide 4.14. The effluent concentration values are provided by ELI as a relevant part of reporting for these data because they represent regulatory limits for each listed radionuclide in terms of doses to the public. This gives an indication of baseline conditions in this context and will help with evaluations of above background internal dose assessments via inhalation and ingestion pathways for data collected during ISR recovery operations.

Table 6.1-13: Air particulate monitoring data for quarter 1 (Feb 6 – May 9) and a subsequent 1-month period of monitoring (May 21 – June 28) at 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
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
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
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

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

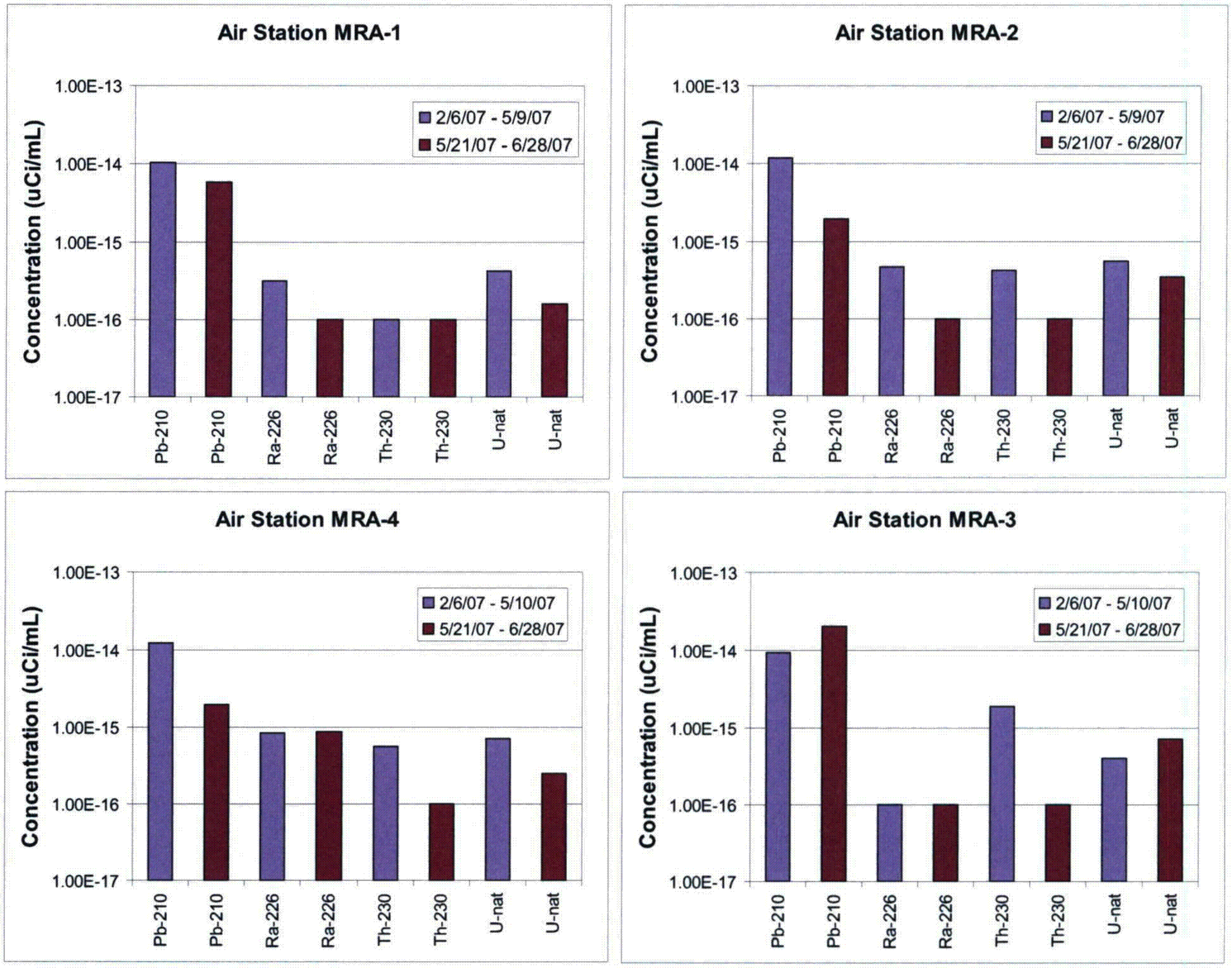


Figure 6.1-31: Air particulate results for quarter 1 and the subsequent month of sampling.

A comparison of average air particulate radionuclide concentrations to date at Moore Ranch with average corresponding concentrations at other nearby uranium recovery sites in this region of Wyoming (see Figure 2.2-2) is shown in Figure 6.1-32. In general, results are reasonably comparable for most radionuclides evaluated. In particular, data for Smith Ranch (about 37 miles SSW of the Moore Ranch site) and Christensen Ranch (about 19 miles NNW of the Moore Ranch site) are very similar to results to date for Moore Ranch. Lead-210 and U-nat results for the North Butte site (about 16 miles NNW of the site) are significantly lower than data from the other sites shown in Figure 6.1-32, but Ra-226 and Th-230 data are very similar across all of these sites. Real differences in background site characteristics could be responsible for lower Pb-210 and U-nat values at the North Butte site compared to other sites in the region, but differences in collection methods and analytical uncertainty could also contribute. In general, this comparison suggests that air particulate data for the remaining quarters of the baseline monitoring period are not likely to differ significantly from results to date, or with data from most nearby uranium recovery sites.

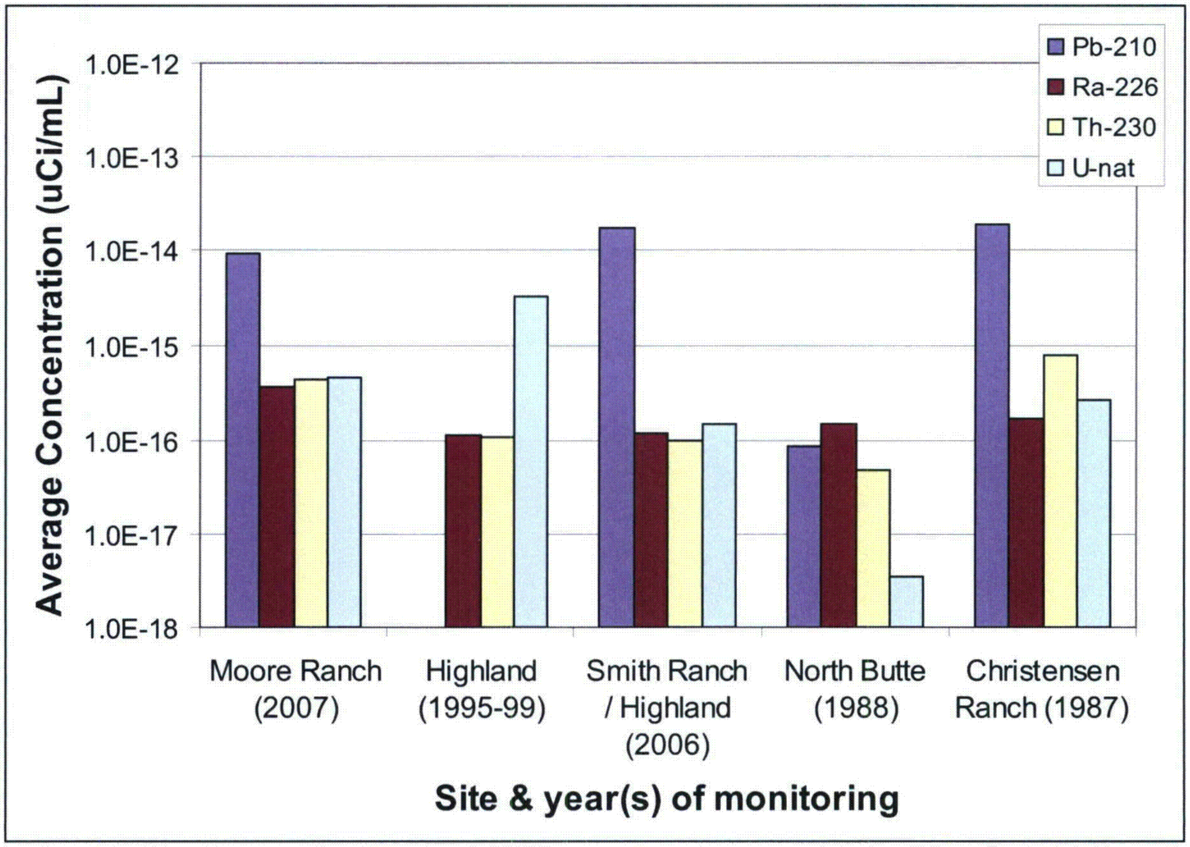


Figure 6.1-32: Average air particulate results to date for Moore Ranch compared to nearby uranium recovery sites in the region including Highland (NRC, 2004), Smith Ranch/Highland (NRC, 2004), North Butte (NRC, 2006) and Christensen Ranch (Cogema Mining, Inc 1996)

6.1.6.3 Conclusions

Baseline air particulate concentration data for the Moore Ranch Uranium Project has been collected and analyzed according to Regulatory Guide 4.14 protocols. The initial one quarter and one additional month of data are presented in this section and the remaining data for the monitoring program is contained in Addendum 6.1-A.

6.1.7 Radon Flux Measurements

Regulatory Guide 4.14 indicates that radon flux measurements should be conducted at eight locations within 1.5 km of the mill, during three separate months between spring and fall when the ground is thawed. Because there will be no tailings impoundments or evaporation ponds at the Moore Ranch Uranium Project, radon flux is unlikely to be an applicable radiological parameter for baseline characterization. There are historical data available from the Conoco study as provided below (Table 6.1-14 and Figure 6.1-33). Additional radon flux measurements are not planned at this time.

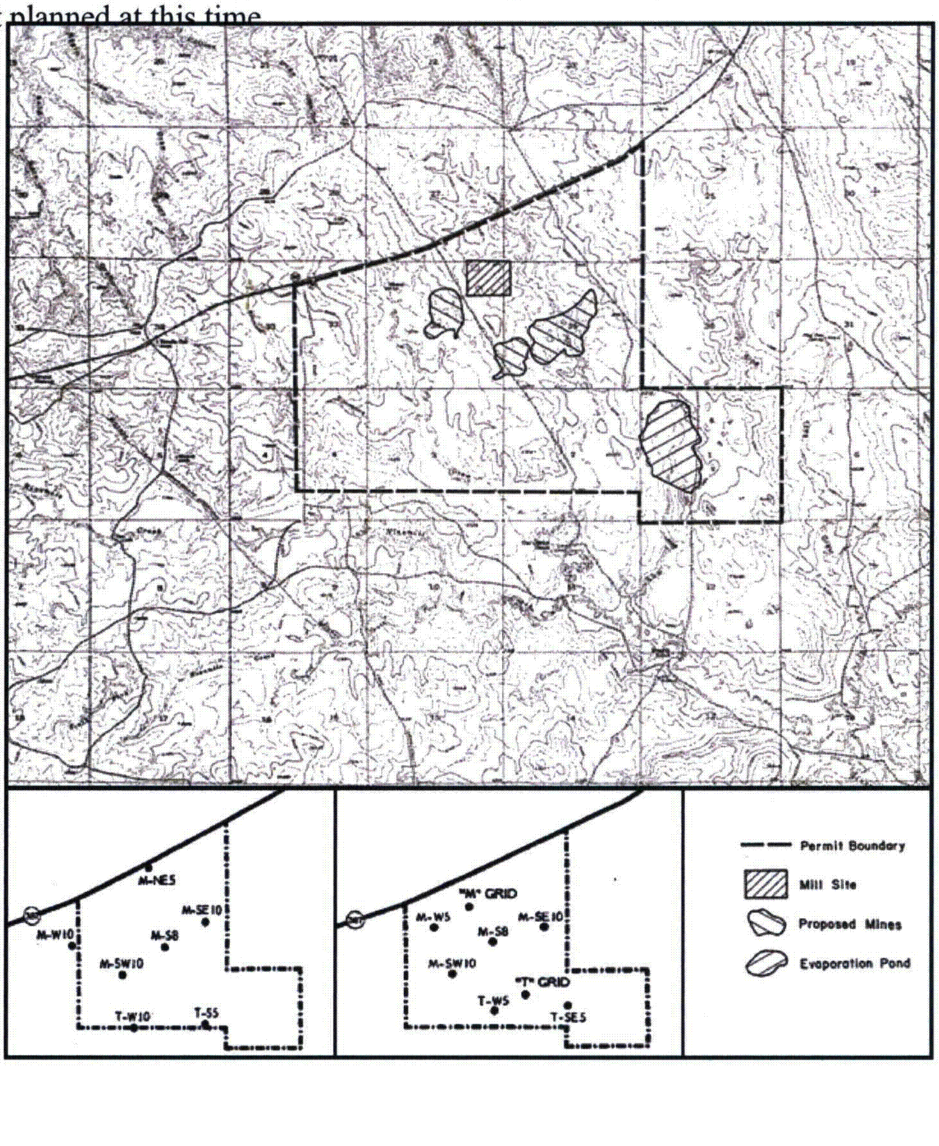


Figure 6.1-33: Historical radon flux measurement locations within the former mill site license area (adapted from Conoco, 1980).

Table 6.1-14: Historical radon flux data for the former Conoco mill site

Radon Emanation Charcoal Canister Technique [pCi/m²/sec[a]]

Location ID	Set 1 8/31/79-9/6/79	Set 2 9/6/79-9/25/79	Set 3 9/25/79-10/11/79	Set 4 10/11/79-10/26/79
M-SW 10	1.9	0.8	1.2	1.3
M-S 8	-	0.9	2.6	1.6
M-NE 5	1.5	0.9	1.8	2.1
M-SE 10	1.4	-	1.3	1.4
M-W 10	2.3	-	0.9	0.9
T-W 10	2.0	0.7	1.4	-
T-S 5	2.3	-	2.9	1.3

Radon Emanation Drum Method [pCi/m²/sec[a]]

Location ID	Set 1 8/31/79	Set 2 9/6/79	Set 3 9/15/79	Set 4 10/11/79
M-SW 10	1.25	-	0.7	0.7
M-W 5	0.8	-	0.8	0.7
M-SE 10	-	-	0.8	2.7
M-S 8	-	1.4	2.4	1.2
"M" Grid Center	1.4	-	2.2	0.4
T-W 5	0.9	0.4	0.4	0.4
T-SE 5	2.4	1.3	0.8	1.4
"T" Grid Center	0.6	1.0	0.8	1.2

(a) An overall uncertainty of ± 10% should be assigned at 2σ. Individual cumulative errors are less than this value.

6.1.8 Groundwater Sampling

Baseline groundwater sampling is being conducted at the Moore Ranch Uranium Project area in general accordance with Regulatory Guide 4.14 protocols (NRC, 1980). In this case, however, there are no tailings impoundments and respective guidance has been interpreted accordingly. Monitoring wells are located within mineralized areas, as well as at locations up and down hydrologic gradients from these areas. Wells that are or could be used for drinking, livestock watering, or crop irrigation have also been sampled. Quarterly sampling is continuing, with data for radiological parameters available to date presented in this section. A map of approximate well locations in the vicinity of proposed wellfields and the plant facility is shown in Figure 6.1-34. Comprehensive information on well locations and all water quality parameters is provided in sections of the licensing applications related specifically to groundwater (Section 3.4.3).

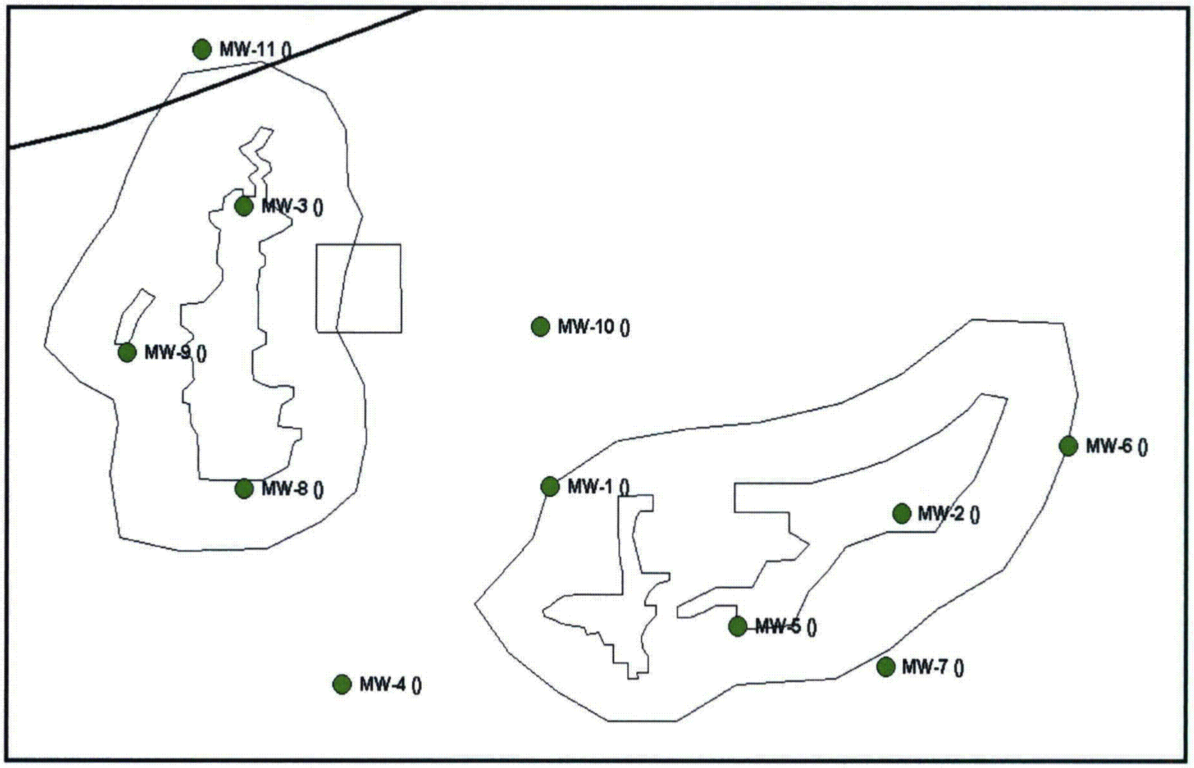


Figure 6.1-34: Groundwater monitoring wells at the Moore Ranch site near planned wellfields and central plant facilities.

With respect to historical groundwater monitoring, a map of well locations (Figure 6.1-35) and summary comparisons between radionuclide results from the current and historical data sets are presented..

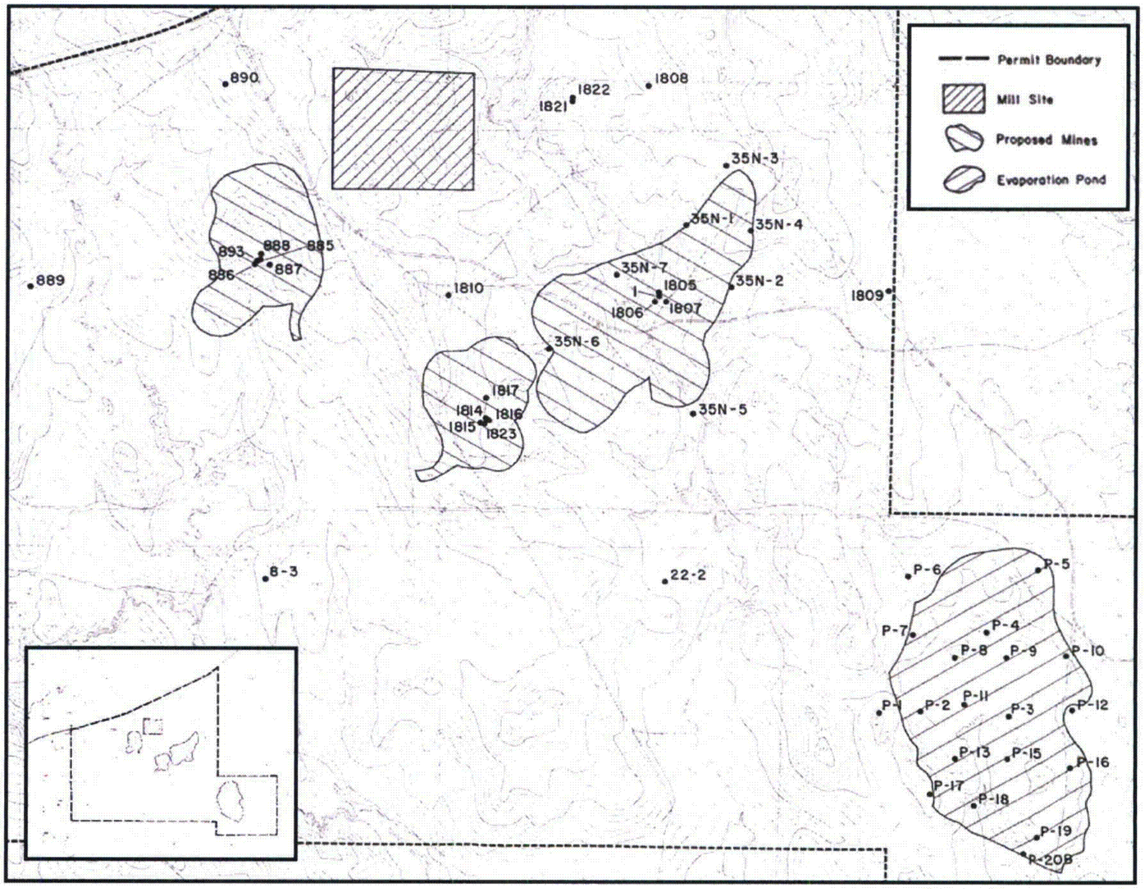


Figure 6.1-35: Historical groundwater monitoring wells at the Moore Ranch site near ore bodies (as estimated in 1980), and the formerly planned mill site and evaporation pond areas.

6.1.8.1 Methods

Prior to sampling a well, static water levels are monitored using an electrical measuring line (an "e-line"). All readings are reported to within at least one tenth of a foot and preferably to within a hundredth of a foot. After the static water level is measured, wells are purged at a sufficient volume induce the flow of formation water through the well screen. Wells with a high enough yield are purged for a minimum of three well volumes, and also until one or more indicator parameters are stable. Parameters monitored for stabilization include pH, temperature, and conductivity. For low yielding wells, the wells are pumped dry then allowed to recover. Samples are taken after sufficient well recovery. Accurate records of well purging are maintained to document the number of casing volumes purged from the well before sampling.

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

Section 3.4.3.2 (Figures 3.4.3-5a through 3.4.3-5e) provides a description of the hydraulic gradient of the Moore Ranch Project Area. In general, groundwater flow direction for the wells shown on Figure 2.9-34 is predominantly to the north. Therefore, wells on south side of the proposed development areas are up gradient and those wells on the north side are down gradient. Dates of all groundwater sampling and results can be found in Section 3.4.3.

6.1.8.2 Groundwater Sampling Radiological Results

Results to date for dissolved radiological groundwater parameters are shown in Table 6.1-15. Parameters in suspended form were also evaluated, but all were below analytical reporting limits and are not presented here (those data, reporting limits, and other details can be found in Section 3.4.3 of the application pertaining specifically to groundwater).

Table 6.1-15: Analytical results to date for radiological parameters in groundwater samples collected during 2007 baseline surveys. Values with less-than qualifiers were all below analytical reporting limits.

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

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

Some groundwater sampling in 2007 was conducted at or near historical wells as indicated in the 1980 Conoco study. All reported radiological analytes from the historical study, along with corresponding well ID location numbers from the current monitoring program, are shown in Table 6.1-16. To make comparisons between data sets, historical data were averaged in cases where multiple results at a given well location were provided for different sampling dates. In cases where reported results were listed as below reporting limits, the reporting limit was assigned to represent an approximate concentration.

In general, there is reasonable agreement among the two data sets, with the most notable exceptions being for uranium in historic wells 1808 and 8-3 (see Section 2.7). The results for these locations, corresponding to current wells MR-1808 and MR-8-3, suggest a two-orders-of-magnitude difference between current and historical samplings (Figure 6.1-36). Unless anthropogenic activities disturb groundwater system conditions, concentrations should not change significantly over a few decades as these systems are usually fairly well buffered geochemically.

Table 6.1-16: Historical analytical results for radiological parameters in groundwater samples as reported in the Conoco study (Conoco, 1980).

Historical Well No.	Pb-210 pci/L	Po-210 pci/L	Ra-226 pci/L	Th-230 pci/L	Uranium pCi/L	Corresponding 2007 Well No.
I			69 ± 10		338	MR-MW-2
I			27.6 ± 1.7		399	MR-MW-2
I	0 ± .2	0.2 ± .03	8.0 ± .4	0.0 ± .1	294 ± 15	MR-MW-2
1807			6.6 ± 2.3		3.4	MR-UMW-2
885			163 ± 20		38	MR-885
893			302		81	MR-885
893	10 ± .5	1.5 ± .1	126 ± 6	0.3 ± .1	58 ± 3	MR-885
1808	0 ± .6	0.12 ± .03	0.60 ± .07	0 ± .4	71 ± 4	MR-1808
8-3	0 ± 0.6	0.12 ± .03	0.60 ± .07	0 ± .4	71 ± 4	MR-8-3
T-1	0 ± .4	0.02 ± 0'01	0.41 ± 0.06	0.3 ± 0.1	44 ± 2	Stockwell #1
T-1			0.2 ± 0.2	0.6 ± 0.1	21 ± 2	Stockwell #1
P'-11						Stockwell #2
P'-9	1.6 ± 0.02	0.40 ± 0.05	2.0 ± 0.1	0.2 ± 0.1	32. ± 2.0	Stockwell #3
P'-9			2.1 ± 0.1	1.1 ± 0.1	22. ± 2.	Stockwell #3

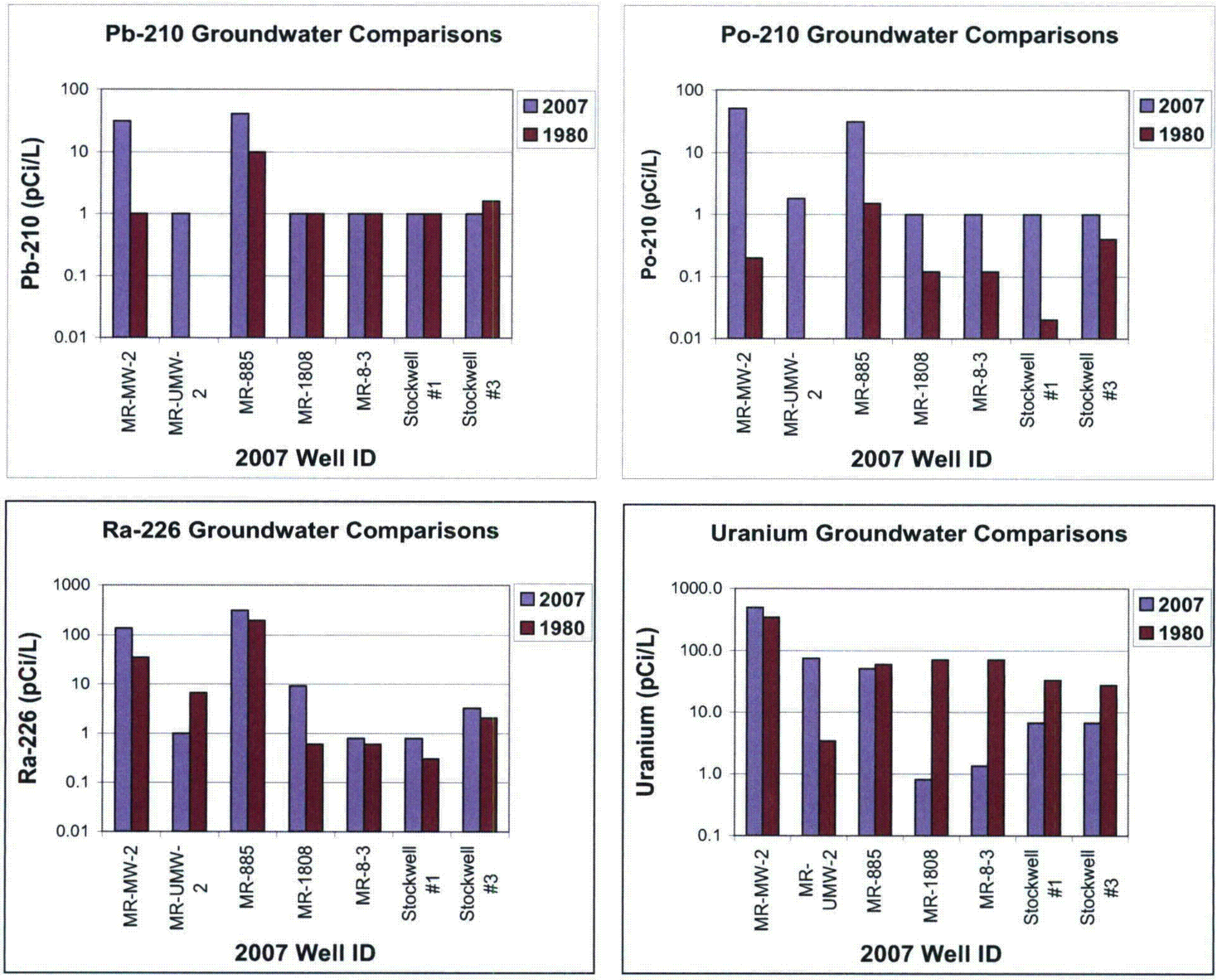


Figure 6.1-36: Comparisons of current (2007) and historical (1980) results for select radionuclide concentrations in groundwater samples collected at similar or identical well locations. The current well location ID numbers are given.

The most plausible explanation for the lack of agreement in uranium results for historic wells corresponding to current wells MR-8-3 and MR-1808 is error in data transcription in the historic Conoco report. Note that results for these two historic wells in Table 6.1-16 are listed as having identical results across all radionuclides. Clearly that is an analytical improbability. Thus it is suggested that these results are ignored and only the current data are considered valid at these two locations, particularly since both appear to be located well outside of currently estimated mineralized zones at the site (see Figure 6.1-35). Thorium-230 comparisons, not shown, were in good agreement as all results were near ELI's reporting limit of 0.2 pCi/g.

6.1.8.3 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 6.1-A.

6.1.9 Surface Water Sampling

Baseline surface water sampling is being conducted at the Moore Ranch Uranium Project area in accordance with Regulatory Guide 4.14 protocols (NRC, 1980). Beginning in 2000, coal bed methane (CBM) production was introduced to the site and many ponds are now primarily fed by CBM groundwater discharge. (The CBM gas recovery method is discussed extensively in Section 4.14). As a result, during much of the year, surface water quality is a reflection of CBM discharge water. Historical data have not been analyzed or presented for comparison since they may not accurately represent current baseline conditions.

The year-long baseline sampling program is complete; data available at the time of report submittal for radiological parameters is presented in this section. A map showing pond sampling locations relative to ore bodies and the proposed plant facility is presented in Figure 6.1-37. Comprehensive presentation of surface water sampling locations and all water quality parameters is provided in sections of licensing applications related specifically to surface water or groundwater (see Section 3.4).

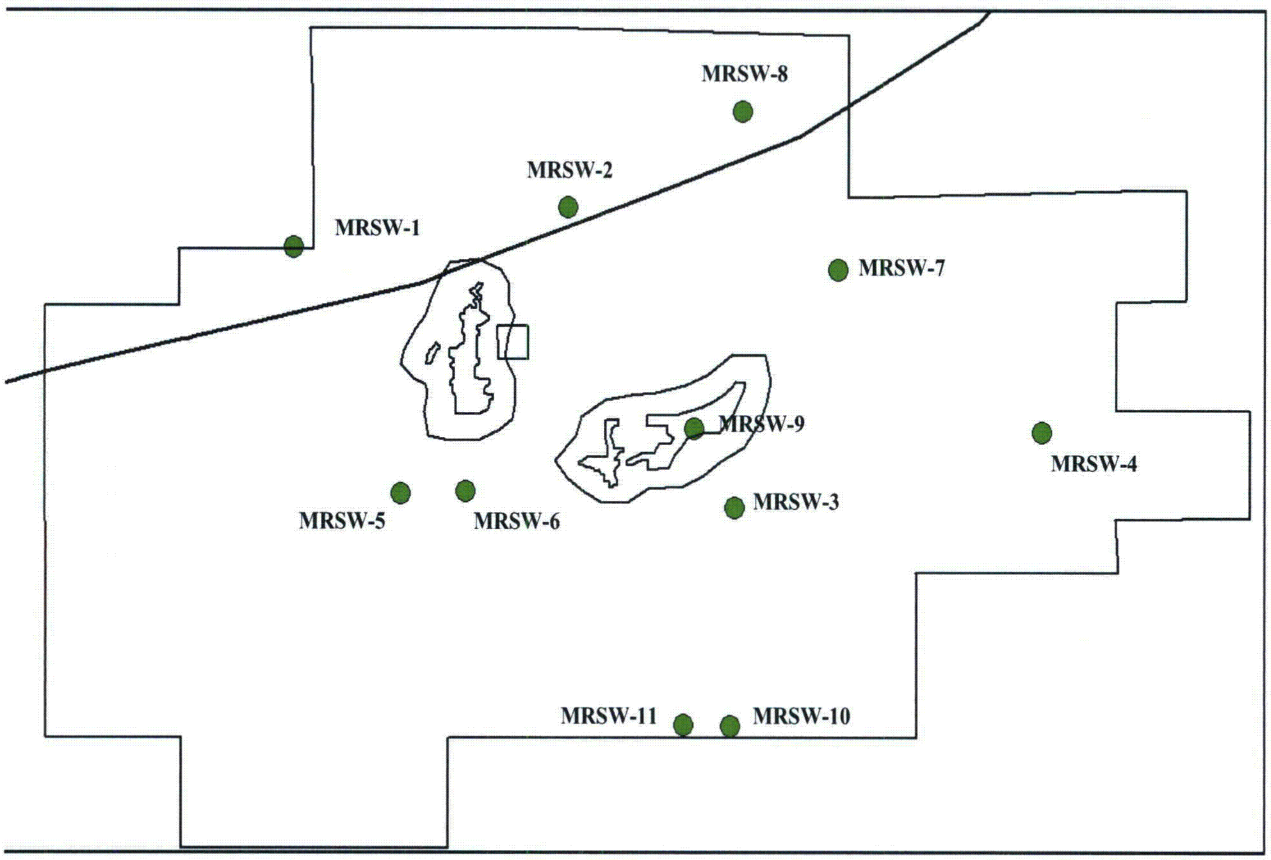


Figure 6.1-37: Surface water sampling locations at the Moore Ranch site.

6.1.9.1 Methods

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

6.1.9.2 Surface Water Sampling Results

Select results to date for dissolved radiological groundwater parameters are shown in Table 6.1-17. Parameters in suspended form were also evaluated, but virtually all were below analytical reporting limits and are not presented here (those data, reporting limits, and other details can be found in Section 3.4.2 of the application pertaining specifically to surface water)

Table 6.1-17: Analytical results to date for radiological parameters in surface water samples collected during 2007 baseline surveys. Values with less-than qualifiers were all below analytical reporting limits.

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

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

Locations MRSW-10 and MRSW-11 as shown in Figure 6.1-37 have not been sampled because surface water has yet to be observed in these impoundments. Most sample results to date for dissolved uranium are above analytical reporting limits, with a few values ranging between 40-70% of the U.S. Environmental Protection Agency's (EPA's) current 30 µg/L drinking water standard for uranium (EPA, 2000). Based on the conversion factor indicated in Table 6.1-17, an equivalent EPA uranium drinking water standard in units of specific activity is 20 pCi/L.

The fall 2006 sampling effort produced an unusually high result for Pb-210 in pond MRSW-1, as well as a slightly elevated Pb-210 result just downstream along the same drainage channel in pond MRSW-5. A second sampling of these two ponds in the spring of 2007 each had corresponding results below analytical reporting limits. In terms of drinking water standards, Pb-210 is not currently regulated by the EPA, though a standard of 1 pCi/L was proposed in 1999 (EPA, 2000). Most other radiological analytes specified in Regulatory Guide 4.14 have thus far been below analytical reporting limits across all sampling locations.

6.1.9.3 Conclusions

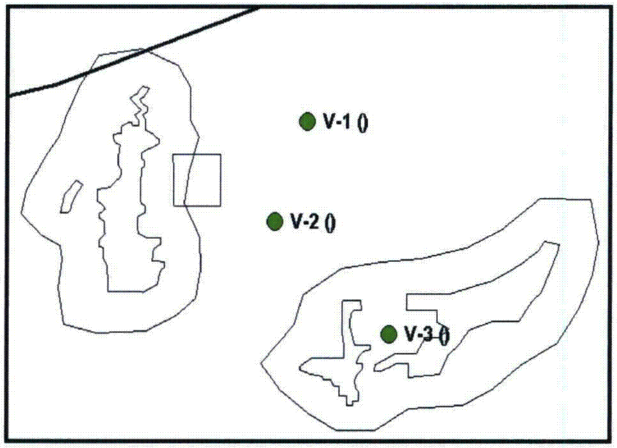
Radiological surface water data for the Moore Ranch Uranium Project area has been collected and analyzed according to Regulatory Guide 4.14 protocols. Results to date are presented in this section. Comparisons with historical surface water data from the Conoco study (Conoco, 1980) are not appropriate as baseline conditions may have changed due to the introduction of coal bed methane groundwater discharges to surface water systems. In general, surface water concentrations of most radiological analytes specified in Regulatory Guide 4.14 are low, though the data suggest that baseline uranium levels can approach the current EPA drinking water standard at some locations. A possible explanation for the one unusually high Pb-210 result at pond location MRSW-1 in 2006 is not apparent based on the available data.

EMC believes that the 2007 surface water data meets the completeness criteria for administrative review of the license application, particularly since NUREG-1569 states that "...where perennial surface-water sources are present, surface-water quality measurements should be taken on a seasonal basis for a minimum of 1 year before implementation of in situ leach operations." All drainages at the Moore Ranch Uranium Project are ephemeral. Furthermore, during much of the year, surface water quality is a reflection of CBM discharge water.

6.1.10 Vegetation Sampling

Vegetation sampling at the Moore Ranch site was initiated in April of 2007. Regulatory Guide 4.14 calls for three rounds of sampling during the growing season (NRC, 1980). Two of the three scheduled samplings are presented in this section. The remaining data is contained in Addendum 6.1-A .

Historical vegetation data from the 1980 baseline survey (Conoco, 1980) are also summarized and compared to the 2007 data. Both early and later months during the growing season are represented between the two data sets.



Vegetation sampling locations for the 2007 survey were selected based on Regulatory Guide 4.14 guidance including three different areas near proposed facilities which have potential to be impacted by ISR operations. Locations of vegetation sampling areas in relation to processing plant facilities and ore deposits are shown in Figure 6.1-38.

6.1.10.1 Methods

Vegetation samples were collected using ordinary gardening tools (hedge clippers, etc.) as mixed, above-ground growth across several hundred square meter areas at each sampling location. All varieties of vegetation present at each location were sampled and composited into a single sample. These varieties consisted mostly of short grasses and clover plants. At the first sampling event in April, new vegetation growth was limited resulting in difficulty in collecting sufficient volumes of sample for analysis (only 1-2 kilograms of total vegetation mass per sample were able to be collected). The second sampling event in June had considerably more vegetative growth and about 4-5 kilograms per sample were collected. All composited samples were collected in large plastic bags and hand delivered within 24 hours of collection, along with chain of custody forms, to ELI in Casper, WY. Analytes requested included all radiological parameters as recommended in Regulatory Guide 4.14.

6.1.10.2 Vegetation Sampling Results

For each Regulatory Guide 4.14 radionuclide, the second sampling had lower values than the first (Figure 6.1-39). The location with the highest average uranium content in vegetation was to the southeast of the proposed processing plant (V-3), otherwise, the location to the northeast of processing facilities (V-1) area had the highest mean radionuclide levels of the three sampling locations (Figure 6.1-40). 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 6.1.6 (note in Table 6.1-18 that Pb-210 concentrations are 1-2 orders of magnitude higher than other radionuclides evaluated).

Table 6.1-18: Summary statistics for all vegetation samples collected to date (two of three scheduled samplings) for all sampling locations.

Analyte	Mean (uCi/kg)	Std. Dev. (uCi/kg)	Median (uCi/kg)	Max (uCi/kg)	Min (uCi/kg)	n
Pb-210	9.6E-05	5.9E-05	5.8E-05	1.7E-04	4.3E-06	6
Po-210	8.9E-06	9.2E-06	6.0E-06	2.7E-05	1.5E-06	6
Ra-226	2.2E-05	1.6E-05	1.7E-05	5.1E-05	1.3E-06	6
Th-230	5.2E-06	3.1E-06	4.9E-06	9.8E-06	1.1E-06	6
U-nat	2.2E-05	2.3E-05	5.2E-06	6.0E-05	0.0E+00	6

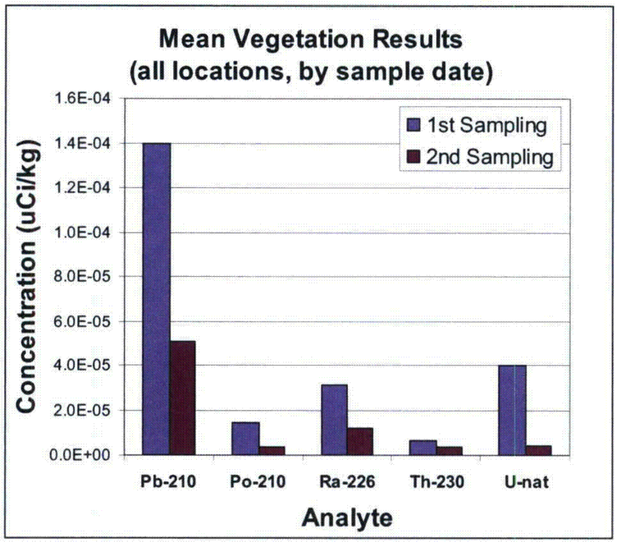


Figure 6.1-39: Analytical results for vegetation samples by sampling date for all locations.

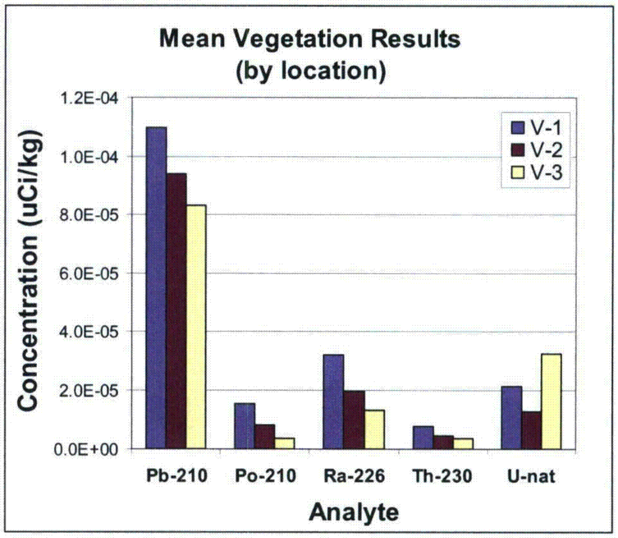


Figure 6.1-40: Analytical results for vegetation samples by sampling location.

Historical results consistently suggest higher radionuclide contents in vegetation at the site compared to the current data (Figure 6.1-41). 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 6.1-42). Thus, compositing of all vegetation types encountered at a given sampling location is likely to be generally representative of any given species.

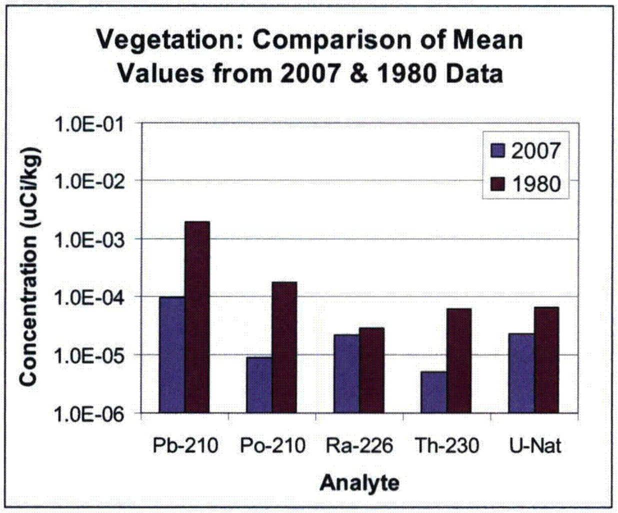


Figure 6.1-41: Mean results for vegetation samples from the 2007 survey compared to historical results (Conoco, 1980).

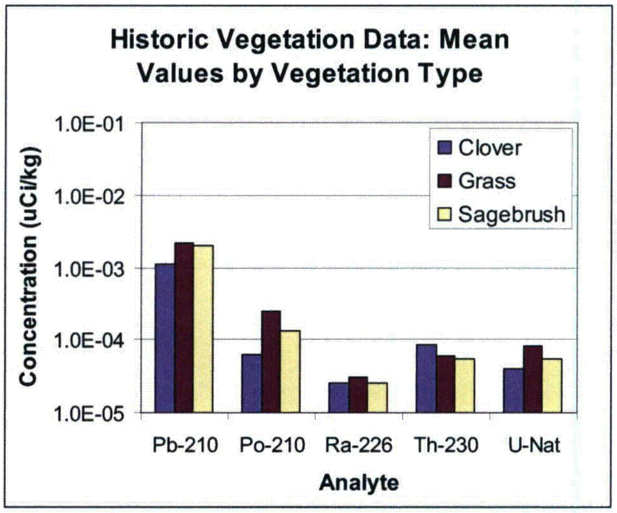


Figure 6.1-42: Mean historical results by vegetation type.

6.1.10.3 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 6.1-A.

6.1.11 Food Sampling

Sampling of food items from the site such as meat from local grazing livestock is planned for 2010. All radiological baseline parameters relevant to food chain dose pathways (e.g. soil, sediment, air particulate samples, water, and vegetation) are comprehensively characterized in this report. The historical Conoco baseline study included food pathway data for various locally raised agricultural products. Those data are provided in Table 6.1-19.

Table 6.1-19: Food sampling results from the historical baseline radiological survey (adapted from Conoco, 1980).

Sample Type	Collection Date	Analysis	Concentration (pCi/g)	± 2σ
Squash Composite	9/22/1979	Ra-226	0.014	± 0.002
		Th-230	0	± 0.02
		Pb-210	0	± 0.01
		Po-210	0.01	± 0.01
		Total U-Nat	0.0	± 0.02
Leafy Vegetables Composit	9/22/1979	Ra-226	0.20	± 0.002
		Th-230	0	± 0.02
		Pb-210	0.02	± 0.01
		Po-210	0.034	± 0.006
		Total U-Nat	0.18	± 0.06
Root Vegetable Composite	9/22/1979	Ra-226	0.027	± 0.003
		Th-230	0.030	± 0.01
		Pb-210	0	± 0.01
		Po-210	0.028	± 0.007
		Total U-Nat	0.05	± 0.02
Sheep I Meat	10/15/1979	Ra-226	0	± 0.001
		Th-230	0.010	± 0.005
		Pb-210	0	± 0.01
		Po-210	0.011	± 0.002
		Total U-Nat	0	± 0.1
Sheep I Bone	10/15/1979	Ra-226	0.70	± 0.03
		Th-230	0	± 0.06
		Pb-210	0.76	± 0.06
		Po-210	0.14	± 0.02
		Total U-Nat	0.04	± 0.01
Sheep II Meat	10/15/1979	Ra-226	0.001	± 0.0003
		Th-230	0	± 0.01
		Pb-210	0	± 0.001
		Po-210	0.021	± 0.002
		Total U-Nat	0.020	± 0.01
Sheep II Bone	10/15/1979	Ra-226	0.480	± 0.02
		Th-230	0.10	± 0.05
		Pb-210	0.72	± 0.05
		Po-210	0.16	± 0.02
		Total U-Nat	0.78	± 0.09
Steer I Meat	10/15/1979	Ra-226	0.001	± 0.0003
		Th-230	0	± 0.05
		Pb-210	0.009	± 0.005
		Po-210	0.003	± 0.001
		Total U-Nat	0.01	± 0.01
Steer I Kidney	10/15/1979	Ra-226	0.002	± 0.001
		Th-230	0	± 0.01
		Pb-210	0.54	± 0.03
		Po-210	0.131	± 0.01
		Total U-Nat	0.04	± 0.01
Steer II Meat	10/15/1979	Ra-226	< 0.01	
		Th-230	0	± 0.01
		Pb-210	0.050	± 0.005
		Po-210	0.023	± 0.005
		Total U-Nat	0.03	± 0.01
Steer II Kidney	10/15/1979	Ra-226	0	± 0.001
		Th-230	0	± 0.01
		Pb-210	0.32	± 0.02
		Po-210	0.09	± 0.01
		Total U-Nat	0.01	± 0.01
Steer I and II Bone Composite	10/15/1979	Ra-226	0.008	± 0.007
		Th-230	0	± 0.01
		Pb-210	0.99	± 0.08
		Po-210	0.30	± 0.05
		Total U-Nat	0.13	± 0.03

6.1.11.1 References

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

6.1.12 Crop Sampling

Crop sampling was not performed at the Moore Ranch Uranium Project because there are no crops currently being raised within the project area. Discussions with the land owner confirmed that crops have not been raised on pasture lands located within the project area since the late 1980's.

6.1.13 Summary and Overall Conclusions

Comprehensive baseline radiological surveys of the Moore Ranch Project area in Campbell County, Wyoming were conducted in accordance with Regulatory Guide 4.14 (NRC, 1980) as part of licensing/permitting application submittals to the USNRC and WDEQ/LQD.

The current gamma exposure rate survey data, collected in the fall of 2006 using the latest GPS scanning system technologies, represent much higher survey coverage than was practical or possible at the time Regulatory Guide 4.14 was published. These data, combined with established analysis techniques and new mapping approaches, provides a very detailed characterization of the magnitude and spatial variability in background gamma exposure rates and soil Ra-226 concentrations across the entire site (about 8,000 acres). Soil/sediment sampling results generally corroborate applicable radiological characterizations based on the gamma survey, and support a conclusion that this approach will provide significant benefits to all stakeholders.

Historical radiological survey data from the site (Conoco, 1980) have been compiled and compared to current data and where possible, incorporated into the overall assessment of baseline conditions across the site. The current data, when considered in conjunction with the historical data, provide a good characterization of baseline radiological conditions..

6.2 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAM

6.2.1 Air Particulate

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

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

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

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

Table 6.2-1Environmental Air Monitoring Dose Detection Limits

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

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

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

6.2.2 Radon

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

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

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

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

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

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

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

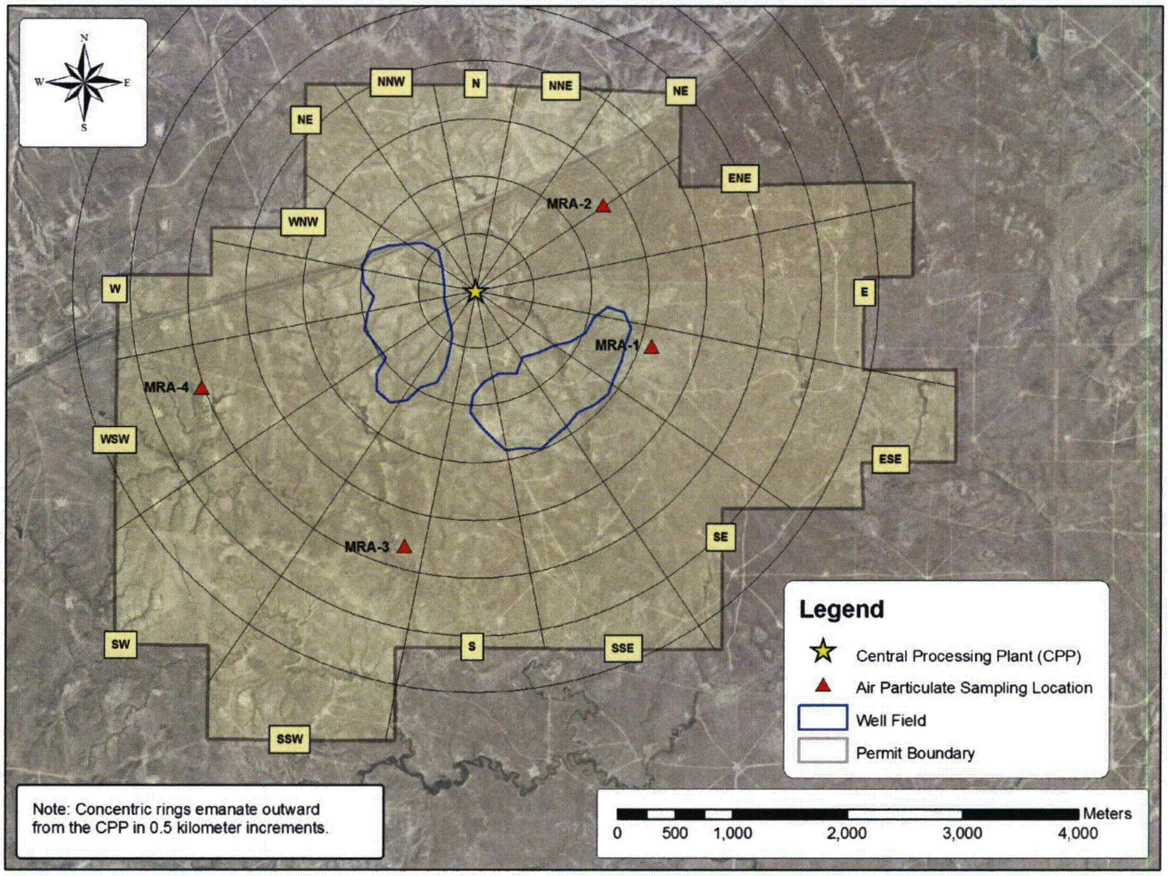
6.2.3 Surface Soil

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.

6.2.4 Sediment

Operational sediment sampling will be conducted on an annual basis. Locations will include each of the surface water sampling locations discussed in Section 6.3.3. Samples will be analyzed for U-nat, Th-230, Ra-226, and Pb-210.

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



6.2.5 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.

6.2.6 Vegetation

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

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

6.2.7 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.

6.2.8 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.

6.2.9 Fish Monitoring

Operational fish sampling is not planned because, as discussed in Section 2.8.5.5, the lack of habitat and persistent water sources surrounding the Moore Ranch site precludes the presence of fish.

6.3 PHYSIOCHEMICAL GROUNDWATER MONITORING

6.3.1 Program Description

During operations at the Moore Ranch 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 permit or licensed area and surface water on a regional and site specific basis.

6.3.2 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.

6.3.2.1 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.

6.3.2.2 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 6.3-1. 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 samplings, 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.

Table 6.3-1
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) @ 180ºF	*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*

6.3.2.3 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. Table 6.3-2 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.

Table 6.3-2
Sampling and Preservation

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.

6.3.2.4 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 A4, 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. In the areas of Wellfield 2 where a confining unit exists between the 70 and 68 sands, monitor wells will be placed in the 68 sand at the spacing described in this section (1 per 4 acres). Additional monitor wells may be placed around the area where the two sands coalesce to provide increased monitoring of any potential impacts to areas of the 68 sand outside of the coalescing area. Monitor wells will be placed in the underlying 60 sand in the areas where the 70 and 68 sand coalesce at a spacing of 1 well per 4 acres. The final number and location of these underlying wells will be determined during final wellfield planning.

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 6.2-1. 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.

6.3.2.5 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 discussed in Section 5 of the Technical Report. 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 License 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 A4 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.

6.3.2.6 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.

The currently proposed excursion indicator parameters should be adequate to identify that an impact has occurred to groundwater from either ISR or CBM activities. Once an indication of impacts is observed, additional investigation is triggered to determine the cause of the impact, whether it is from ISR activities, CBM activities or some other source. Once an impact has been identified, additional indicator parameters will be evaluated including, but not limited to, dissolved uranium.

Baseline uranium levels within the license area in the production, overlying and underlying aquifers are variable but generally less than 1 mg/L. More importantly, uranium levels within the 72 Sand tend to be very low, generally less than 0.01 mg/l. Average post mining uranium concentration at Irigaray (closest analog) was greater than 7 mg/l. Although CBM water quality does not typically include uranium as an analyte, it is unlikely that levels would approach ISR mining influenced waters. Once an impact is indicated based on changes to the indicator parameters, additional sampling for dissolved uranium could provide further identification as to the source of the change.

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.

6.3.2.7 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, 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, EMC 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%.

A numerical model has been developed to further demonstrate that an excursion could be recovered under hydrologic conditions present at Moore Ranch. The numerical model is used simulate the occurrence and recovery of an excursion using pumping rates that could be achieved and maintained at the site. The model results indicate that an excursion identified at the proposed monitor ring distance of 500 feet from the wellfield could be hydraulically controlled within 10 to 30 days. The model results also indicate that a 500-foot spacing between monitor ring wells should be adequate for detection of an excursion. Details of the model simulation are provided in Addendum 5.7.1 of the Technical Report which replaced Addendum 6.3-A of the Environmental Report.

6.3.3 Surface Water Monitoring

Pre-operational surface water quality monitoring was performed as discussed in Sections 3.4 and 6.1. 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.

6.4 ECOLOGICAL MONITORING

6.4.1 Wildlife

Wildlife studies on the Moore Ranch Project will include annual raptor surveys. It is not anticipated that mining related activities will adversely affect a raptor nest, or disturb a nesting raptor as there is a lack of nesting raptors on and near the license area due to the lack of trees and other nesting sites. Additionally, mining related activities are limited to relatively small areas for limited periods of time. According to surveys summarized in Section 3.5, eight raptor nests were observed within the proposed Moore Ranch License area including 5 ferruginous hawks, 2 great horned owls, and one red-tailed hawk. Seventy five other nests were observed within one mile of the license area,

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

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

Baseline monitoring studies have repeatedly demonstrated that sage-grouse do not inhabit the Moore Ranch area. As described previously in Section 3.5, those surveys encompassed most of the Moore Ranch Project and its one-mile perimeter for much of that period. No sage-grouse leks were observed in that region during any survey year. WGFD records and USDA-FS records also failed to document any sage-grouse leks within the approximately area that encompasses the general analysis area (i.e., proposed Moore Ranch license boundary and a one-mile perimeter). Given the lack of sage-grouse observations in the area, and the minimal quantity and marginal quality of potential sage-grouse habitat, EMC does not plan to conduct operational monitoring for sage-grouse at this time.

6.5 QUALITY ASSURANCE PROGRAM

A quality assurance program will be implemented at the Moore Ranch 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 6.5-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.

Policy and Signature Page

Uranium One Americas is committed to establishing, maintaining, and implementing an effective Quality Assurance program that achieves quality in all activities through planning, performing, assessing, and continually improving the process.

The achievement of quality is an interdisciplinary function led by management and is the responsibility of all personnel. Work is accomplished through the resources of people, equipment, and procedures. Managers are responsible for ensuring that people have the information, resources, and support necessary to complete the work in a safe, efficient, and quality manner. All work performed by Uranium One Americas at Wyoming In Situ Recovery (ISR) sites must comply with the requirements of this Quality Assurance Project Plan.

Prepared By: Date:

______________________________ ____________________

Approved By: Date:

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Table of Contents

1 INTRODUCTION

This Quality Assurance Plan is applicable to the environmental monitoring program implemented by Uranium One Americas at Wyoming ISR sites. The plan provides the quality requirements for field collection of samples and the subsequent analysis of those samples at a laboratory.

2 QUALITY PLAN REVIEW, REVISION AND DISTRIBUTION

This Quality Assurance Plan will be reviewed by affected project managers in accordance with the company policy for controlled documents. Revisions will be made at the direction of the Manager of Environmental and Regulatory Affairs, Wyoming to reflect changes in work scope, organizational interfaces or new regulatory requirements. This plan will be reviewed annually to ensure the content is valid and applicable to monitoring activities. Revisions to this plan will require approvals at the same level as the original document. At a minimum, copies of this QA Plan shall be available to all affected employees and support organizations.

3 REGULATORY REQUIREMENTS

This Quality Assurance Plan is designed to incorporate quality assurance/quality control requirements and guidance the following regulatory references:

– USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills*, Revision 1, April 1980.

– USNRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal Operations) – Effluent Steams and the Environment*, Revision 1, February 1979.

4 ORGANIZATION

Administration of the environmental monitoring programs in Wyoming is assigned to the Manager of Environmental and Regulatory Affairs, Wyoming. The Manager may delegate the day-to-day implementation of the environmental monitoring program to other EMC employees or to outside contractors, but he may not delegate the ultimate responsibility. Such assignment shall be in writing.

Key positions within the Uranium One Americas management system include:

<u>Senior Vice President, ISR Operations</u> – The Senior Vice President, ISR Operations has responsibility for overall management of Wyoming operations for Uranium One Americas. The Senior Vice President, ISR Operations reports to the Executive Vice President, Uranium One Americas.

Director of Environmental and Regulatory Affairs - The Director of Environmental and Regulatory Affairs has responsibility for preparation and oversight of environmental monitoring programs for Uranium One Americas. The Director of Environmental and Regulatory Affairs reports to the Executive Vice President, Uranium One Americas.

Mine Manager - The Mine Manager is responsible for all uranium production activity at the project site. All site operations, maintenance, construction, environmental health and safety, and support groups report directly to the Mine Manager. In addition to production activities, the Mine Manager is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with operations.

Manager of Environmental and Regulatory Affairs, Wyoming – The Manager of Environmental and Regulatory Affairs, Wyoming has responsibility for the overall management of the environmental monitoring programs for Uranium One Americas. The Manager of Environmental and Regulatory Affairs, Wyoming reports to the Senior Vice President, ISR Operations.

Radiation Safety Officer – The Radiation Safety Officer has responsibility for the overall management of the radiation safety program and the environmental monitoring programs for Uranium One Americas including implementation of QA Program requirements related to radiation safety and environmental programs. The Radiation Safety Officer reports to the Mine Manager and will coordinate with the Manager of Environmental and Regulatory Affairs, Wyoming.

5 QUALITY OBJECTIVES

Environmental data for the Wyoming ISR sites, derived through long-term monitoring and data interpretation, will be of sufficient quantitative and qualitative value to determine whether performance criteria are being met. The type and quality of data provided to the appropriate regulatory agencies will be used to document the performance of the uranium recovery operation and later attainment of reclamation and restoration goals.

Monitoring strategy for sampling and analytical QA objectives for data include:

– Data will be of sufficient quality to withstand scientific and legal scrutiny.
– Data will be acquired in accordance with procedures appropriate for their intended use.
– Data will be of known accuracy and precision.
– Data will be complete, representative, and comparable.

5.1 FIELD QUALITY OBJECTIVES

The field and analytical methods chosen for use in completing the work are industry standards and are consistent with accepted standards for conducting environmental investigations.

5.2 LABORATORY QUALITY OBJECTIVES

The quality of data generated by the analytical laboratory is dependent on method precision, accuracy, and sensitivity and the basic nature of the analysis and type of equipment used to perform an analysis. Precision is a measure of the reproducibility of an analytical measurement, and accuracy is the difference between a measured value and a true or known value. These considerations are dependent upon the sample matrix and performance criteria, and method sensitivity may not be achieved in all sample matrices.

5.2.1 Precision

Precision is the agreement between a set of replicate measurements without assumption about or knowledge of the true value. Precision is assessed on the basis of repetitive measurements. Replicate field measurements of ground water are not needed because they are sequentially recorded during well purging. Evaluations will be performed to judge the precision of both field and laboratory measurement processes.

Duplicate sample analyses are used to monitor the overall precision that can be expected for a particular environmental medium within an analytical sample batch. Requirements for the collection frequency of QA samples will be specified in the site-specific environmental planning document sample events.

In the laboratory, precision is a measure of reproducibility and may be determined by repeated analysis of laboratory control samples (LCSs) or reference standards or by duplicate analysis. The laboratory will demonstrate precision through analysis of replicate standards and performance samples prior to analysis of investigative samples as required by the particular analytical method.

5.2.2 Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. The analytical laboratory will analyze reference materials to verify that the analytical results are not biased. Calibration and operational checks of field instruments will verify that no bias is present in field measurements.

5.2.3 Accuracy

Accuracy is the nearness of a measurement or the mean of a set of measurements, to the true value and is usually expressed as the difference between the two values or the difference as a percentage of true value.

It is not possible to directly assess accuracy of field measurements and water levels because true values for these measurements are not known. To ensure accuracy of the field data, instruments and equipment used in surveying, sampling, or obtaining the measurements will be maintained and calibrated. Accuracy of surface water and ground water field measurements is addressed indirectly through instrument checks and calibrations, which will be documented in field logbooks or on field data sheets, as appropriate.

Accuracy will be assessed for analytical data by examining the results obtained from laboratory Quality Control (QC) samples. The primary means of determining the accuracy of an analytical method is to compare the results of repeated measurements of laboratory control samples and reference material with published known values. The secondary method of accessing accuracy is to analyze matrix spike samples. Accuracy requirements of routine analytical services are specified in the analytical methods. Accuracy for each analysis will be stated as a percent recovery in laboratory analytical reports.

5.2.4 Representativeness

Representativeness is generally ensured through the use of standard sampling protocols. Representativeness will be accomplished:

- Through extensive sampling that includes implementation of field QA/QC procedures.
- By careful and informed selection of sampling sites, sampling depths, and analytical parameters
- Through the proper collection and handling of samples to avoid interferences and to minimize constituent loss
- By monitoring field activities to ensure procedure compliance and adherence to sampling protocols
- By meeting sample care and custody requirements

5.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability is ensured by employing approved sampling plans, standardized field procedures, and experienced personnel using properly maintained and calibrated instruments. In the laboratory, sample handling and preparation procedures, analytical procedures, holding times, and QA protocols will be adhered to. All data in a particular data set will be obtained by the same methods and will use consistent units for reportable data. Prescribed QC procedures will be used to provide results of known quality. Data will be grouped and evaluated according to similar sampling methods, sampling media, and laboratory analytical methods.

5.2.6 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the analyte of interest. An evaluation of sensitivity is included in the analytical methods that are used to analyze samples.

6 PERSONNEL AND TRAINING

6.1 PERSONNEL REQUIREMENTS

6.1.1 Training

Personnel will be qualified to perform their assigned job through meeting basic job description requirements, education standards, experience, and ongoing performance reviews. Training will be provided when needed to maintain proficiency; to adapt to new technologies, equipment, or instruments; and to perform new assigned responsibilities.

The RSO is responsible for determining site-required training and communicating the requirements to appropriate managers. Managers are responsible for determining training needs of their staff. Personnel assigned to environmental monitoring activities are responsible for ensuring that their required training are documented and are maintained in a current status for their assignments. At a minimum, individual training requirements will be reviewed annually and updated as needed.

The RSO is responsible for ensuring that personnel assigned to environmental monitoring tasks are sufficiently familiar with the implementing documents (e.g., plans, procedures, and drawings) and the requirements established for environmental monitoring, sample collection, analysis, documenting and reporting activities, and demonstrating proficiency.

The RSO will ensure that personnel assigned to field sampling activities can demonstrate proficiency when performing the work or that they are properly supervised by a person who is proficient.

6.1.2 Certifications

QA staff that performs independent assessments of environmental monitoring activities or management systems will be qualified as lead assessors.

Laboratories used for analysis of samples collected for characterization, compliance, or other purposes will be required to pass an audit or be certified by the National Environmental Laboratory Accreditation Conference (NELAC).

7 DATA GENERATION AND ACQUISITION

This section addresses aspects of the measurement system design and implementation to ensure that appropriate methods for sampling, analysis, data handling, and QC are employed and will be thoroughly documented.

7.1 SAMPLING PROCESS DESIGN

The data obtained through monitoring site conditions will be of sufficient quantity and quality to achieve environmental monitoring objectives.

Monitoring procedures for the Wyoming ISR sites have been established. These monitoring programs are designed to ensure that monitoring data would satisfy applicable regulations and would ensure that there were no unacceptable risks to human health or the environment. The site-specific environmental monitoring plan defines the sample locations and sampling frequency and determines the types of analyses that will be conducted on the samples collected from these locations. The plans are reviewed every 5 years. Any updates to the monitoring plan that would eliminate or modify monitoring parameters, locations, or frequencies specified in the License Application will be made by license amendment. The RSO can initiate changes to environmental monitoring plans that do not require a license amendment. These changes will be managed as required by the Performance Based License Condition.

7.2 SAMPLING METHODS

Field measurements and sample collection will follow procedures attached to nationally recognized consensus standards such as EPA methods, American Society for Testing and Materials standards, or instrument manufacturer recommended procedures. Deviation from approved procedures requires approval by the RSO before the start of work.

7.2.1 Sample Collection Procedures

Sampling procedures used at Wyoming ISR sites will be managed as controlled documents and will be amended according to the requirements of this plan.

Procedures must be followed for documenting field activities and delivering the samples to the laboratory. Procedures will identify the methods employed to obtain representative field measurements and samples of specified media. The procedures will identify the equipment, instruments, and sampling tools that are needed and, where appropriate, performance criteria (e.g., special handling, operational checks, field calibrations) to ensure the quality of the field data.

The RSO is responsible for ensuring that inspections, operations and maintenance activities, field measurements, and specified samples are properly documented, occur at the prescribed frequency and locations, and are obtained in compliance with procedures and requirements specified in the project documents. Daily QC checks and data reviews will ensure that requirements have been met. If field conditions prevent inspections, required field measurements, and/or specified sample collection, the conditions will be fully documented in the field book as a field variance.

7.2.2 Field Measurements and Sampling Methods

Field measurements and sampling schedules are summarized in the environmental monitoring procedures. The data obtained through these activities will be used to monitor compliance with performance requirements. Field procedures used in well inspections, field measurements, sample collection methods, field data, equipment and supplies applicable to the field activities, sample preservation requirements, and QC sample requirements are described in the environmental monitoring procedures.

7.3 PREPARATION AND DECONTAMINATION REQUIREMENTS FOR SAMPLING EQUIPMENT

7.3.1 Requirements for Sample Containers, Preservation, and Holding Times

Nondedicated equipment used in obtaining samples will be visually inspected and cleaned before use at each sample location. Measures will be taken (e.g., storage in trays, plastic bags, or boxes) to protect clean or decontaminated equipment while it is not being used. Sample containers will be inspected for integrity and cleanliness before being used. Suspect containers will be discarded in a manner that will preclude their inadvertent use, or they will be tagged and segregated for return to the supplier.

7.3.2 Container Requirements

Sample containers will be will be provided by the analytical laboratory or purchased. Containers will be of an adequate size to contain the required sample volume and of an approved material (e.g., amber/clear glass or HDPE) that does not promote sample degradation. As appropriate, supplier provided certificates of cleanliness will be retained with the project documentation.

Water samples collected for analysis will be filled to near 90 percent of capacity to allow for expansion.

7.3.3 Preservation and Holding Times

Efforts to preserve the integrity of the samples through prescribed chemical additives and/or temperature-controlled storage will be maintained as appropriate from the time the containers are received, throughout the sample collection and shipping process, and will continue until all analyses are performed. Procedures that will be employed to collect and preserve the integrity of the samples are described in the procedures. Holding times begin at the time the sample is collected, not when the sample is received by the laboratory.

7.3.4 Decontamination Procedures and Materials

Where practical, dedicated pumps will be installed in monitor wells and disposable materials will be used to minimize the decontamination requirements. The final rinse following equipment decontamination will be collected as an equipment blank QC sample.

7.4 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Sample handling, custody, and shipping procedures are addressed in the environmental monitoring procedures. A minimum number of individuals should be involved in sample collection and handling to ensure integrity of the sample and compliance with custody procedures. To maintain evidence of authenticity, the samples collected must be properly identified and easily discernable from like samples. To maintain the integrity of the sample, proper preservation, storage, and shipping methods will be used.

Unused sampling equipment, sample containers, and coolers that have been shipped or transported to a sampling location will be kept in a clean, temperature-controlled, and secure location to minimize damage, tampering, degradation, and possible cross-contamination.

7.4.1 Identification, Handling, Packaging, and Storage

7.4.1.1 Sample Identification

Environmental samples and associated QC samples will be assigned a unique identification number. In addition to the unique number, QC samples will be assigned a fictitious location identifier that is consistent with the sample location identification scheme.

Samples will be identified by a label or tag attached to the sample container that specifies, as appropriate, the project, sample location, unique identification number, preservatives added, date and time collected, and the sampler's name. Sample labels, tags, and/or container markings should be completed with indelible (waterproof) ink. Clear tape may be placed over each sample label for added protection, if needed.

7.4.1.2 Sample Handling and Storage

During field collection, sample containers may be stored in boxes, trays, or coolers, as dictated by protection and preservation needs. Samples that require refrigeration will be stored in coolers with sufficient ice to maintain the required temperature controls during field collection, packaging, and shipping. Samples that are not transported to the laboratory the day of collection must be stored in containers that will prevent damage or degradation of the sample. In addition, samples must be stored in locked containers or buildings when they are out of the direct control of the responsible custodian. Samples stored overnight or at locations where access is not solely controlled by the custodian will have custody seals placed on the outside of the container (cooler or box) as a measure of security.

7.4.1.3 Sample Custody

To ensure the integrity of the sample, the field custodian is responsible for the care, packaging, and custody of the samples until they are transferred to the laboratory.

Chain of Custody forms will be used to list all samples and transfers of sample possession to provide documentation that the samples were in constant custody between collection and analysis. The filled-in Chain of Sample Custody form, a copy of which is retained by the originator, will accompany samples that are sent or transported to the analytical laboratory.

7.4.1.4 Sample Packaging and Shipping

All samples will be handled, packaged, and transported or shipped in accordance with applicable U.S. Department of Transportation requirements. Sample storage containers (e.g., boxes or coolers) and sample containers will be securely packaged to protect the contents from damage, spilling, leaking, or breaking. Void space in shipping containers should be filled with an inert material or additional ice, if appropriate, to further protect and secure the contents.

Custody seals are not required for containers or samples that are transported directly to the analytical laboratory for analysis or interim storage. Custody seals are required for shipping containers (e.g., coolers or boxes) that are sent by common carrier. Clear tape should be placed over the seals as protection against tearing during shipment.

Mailed sample packages will be registered with return receipt requested. If packages are sent by common carrier, receipts are retained as part of the chain of custody documentation. Other commercial carrier documents shall be maintained with the chain of custody records.

7.4.2 Laboratory Requirements

7.4.2.1 Laboratory Sample Receipt

The subcontract analytical laboratory personnel are responsible for the care and custody of samples from the time they are received until the time the sample is analyzed and archive portions are discarded. On arrival at the laboratory, laboratory personnel must examine the container and document the receiving condition, including the integrity of custody seals, when applicable. When opening the shipping container, laboratory personnel will examine the contents and record the condition of the individual sample containers (e.g., bottles broken or leaking), the temperature (when applicable), method of shipment, carrier name(s), and other information relevant to sample receipt and log-in. Laboratory personnel verify that the information on the sample containers matches the information on the Chain of Sample Custody form.

7.4.2.2 Discrepancies Identified During Sample Receipt

If discrepancies are identified during the sample receiving process, laboratory personnel will attempt to resolve the problem by checking all available information (e.g., other markings on sample containers and type of sample), recording appropriate notes on the Chain of Sample Custody form, and contacting the RSO to resolve any questions.

If the laboratory judges the sample integrity to be questionable (e.g., samples arrive damaged or leaking, or the temperature range is exceeded), the RSO will be contacted and will bring in appropriate technical staff to make a decision regarding rejecting or flagging the data and/or re-sampling the location. Damaged samples will be rescheduled for collection and analysis, if necessary.

Discrepancies noted during sample receiving at a subcontracted laboratory or testing facility will be resolved in accordance with the procurement documents. In general, the RSO will be contacted to facilitate resolution of a problem.

7.4.2.3 Sample Disposition

When sample analyses and necessary QA/QC checks have been completed in the laboratory, the residual sample material and wastes generated as a result of the analytical process will be treated, shipped, and disposed of in accordance with all applicable federal, state, and local transportation and waste management requirements. When samples are stored, they will be protected to prevent damage or degradation. At a minimum, samples shall not be removed from the laboratory sooner than 60 days after the delivery of laboratory data reports.

7.4.3 Analytical Methods

Laboratories involved in the analysis of samples will have a written QA/QC program that provides rules and guidelines to ensure reliability and validity of the work conducted at the laboratory.

The analytical procedures to be used by subcontracted laboratory services will be specified in the procurement documents. These procedures typically consist of EPA methods. The use of these methods will ensure that required method detection limits and project reporting limits are achieved for each of the requested analytes.

Required analytical methods will be documented in appropriate site-specific documents.

7.4.3.1 Subcontracted Laboratory Requirements

The subcontracted laboratory will have a documented QA program in place, the implementation of which may be independently verified through proposal reviews, prior history, and/or pre-award survey. As appropriate, subcontracted laboratories will use EPA or EPA-approved methods or other methods specified and approved within the provisions of the procurement documents. Subcontracted laboratories are required to pass an audit or be certified by NELAC. Internal method requirements for analysis of spikes, duplicates, or replicates will be followed and may be used as performance indicators for these services.

Data turnaround times, sample disposition, and other requirements of the analytical laboratory are identified in procurement documents. The laboratory must obtain authorization from the RSO for changes to the procurement documents.

Work submitted to the laboratory may not be subcontracted by the laboratory without the prior consent of Uranium One Americas.

7.4.4 Quality Assurance/Quality Control

7.4.4.1 Field QA/QC

A variety of instruments, equipment, sampling tools, and supplies will be used to collect samples and to monitor site conditions. Proper inspection, calibration, maintenance, and use of the instruments and equipment are required to ensure field data quality. In addition, field QA will be implemented through the use of approved procedures, proper cleaning and decontamination, protective storage of equipment and supplies, and timely data reviews during field activities. The QC objective of these data collection activities is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of the data.

QC samples will consist of field duplicates, equipment rinsate blanks, and trip blanks, as appropriate, for the matrix and analytes involved. An additional volume of ground water for selected analyses will be collected for matrix spike/matrix spike duplicate (MS/MSD) use, as requested by the laboratory. Field QC samples will be used to quantitatively and qualitatively evaluate the analytical performance of the laboratory and to assess external and internal effects on the accuracy and comparability of the reported results. Field QC samples will be uniquely identified.

Where applicable, field measurement data will be compared to previous measurements obtained at the same location. Large variations (greater than 30 percent) in field measurement data at a location will be examined to evaluate whether general trends are developing. Variations in data that cannot be explained will be assigned a lower level of confidence through assignment of qualifiers or will be flagged for additional sampling or evaluation.

7.4.4.2 Laboratory QA/QC

Laboratory QC checks are internal system checks and control samples introduced by the laboratory into the sample analysis stream. These checks are used to validate data and calculate the accuracy and precision of the data. The objectives of the laboratory QA/QC program should be to:

- Ensure that procedures and any revisions are documented
- Ensure that analytical procedures are conducted according to sound scientific principals and have been validated
- Monitor the performance of the laboratory by a systematic inspection program and provide for corrective measures, as necessary.
- Collaborate with other laboratories in establishing quality levels, as appropriate
- Ensure that data are properly recorded and archived

Internal QA procedures for analytical services will be implemented by the laboratory in accordance with the laboratory's standard operating procedures. Data sheets, which also report the blank and spiked sample checks that have been performed, will be provided and will indicate when a QC check was performed. Analytical data that do not meet acceptance criteria will be qualified and flagged in accordance with standard operating procedures.

Laboratory quality control procedures are defined within the particular analytical method or are defined in procurement documents.

7.4.5 Instrument/Equipment Testing, Inspection, Calibration, and Maintenance

A variety of equipment, instruments, and sampling tools will be used to collect data and samples for the Wyoming ISR sites. Proper maintenance, calibration, and use of equipment and instruments are imperative to ensure the quality of all the data that are collected.

Field and laboratory equipment, instruments, tools, gauges, and other items used in performing work tasks that require preventive maintenance will be serviced in accordance with manufacturers' recommendations and instructions. When applicable, technical procedures will identify the manufacturers' instructions and recommended frequency for servicing the equipment. Preventive maintenance for calibrated measuring and test equipment will be performed either by field or laboratory personnel who are knowledgeable of the equipment, or by manufacturer's authorized service center as part of routine calibration tasks. Records of equipment calibration, repair, or replacement of controlled instruments will be filed and maintained in accordance with the applicable records management requirements.

Instruments that are not calibrated to the manufacturers' specifications will display a warning tag to alert the sampler and analyst that the instrument has only limited calibration.

7.4.5.1 Field Equipment and Instruments

Field equipment, instruments, and associated supplies used to obtain field measurements and collect samples are specified in sampling procedures.

Field personnel will conduct visual inspections and operational checks of field equipment and instruments before they are shipped or carried to the field and before using the equipment or instruments in field data collection activities. Whenever any equipment, instrument, or tool is found to be defective or fails to meet project requirements, it will not be used, and as appropriate, it will be tagged defective and segregated to prevent inadvertent use. Backup equipment, instruments, and tools should be available on site or within 1-day shipment to avoid delays in the field schedule.

The RSO is responsible for the overall maintenance, operation, calibration, and repairs made to field equipment, instruments, and tools. He is also responsible for ensuring that the field book has adequate documentation that describes any maintenance, repairs, and calibrations performed in the field.

Equipment and instruments used to obtain data will be maintained and calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturers' specifications. Calibration of equipment and instruments will be performed at approved intervals, as specified by the manufacturer, or more frequently as conditions dictate. Calibration standards used as reference standards will be traceable to the National Institute of Standards and Technology or other recognized standards when available. Instruments found to be out of tolerance will be tagged defective and segregated to prevent inadvertent use.

In some instances, calibration periods will be based on usage rather than periodic calibration. Equipment will be calibrated or checked as a part of its operational use. Records of field calibration will be documented on forms provided for technical procedures or recorded in the field logbook. Calibration checks will be performed in accordance with procedures.

Procedures recommended by the manufacturer will be used for equipment preventive maintenance. Backup equipment, supplies, and critical spare parts (e.g., tape, bottles, filters, pH paper, tubing, probes, electrodes, and batteries) will be kept on site to minimize downtime. The RSO is responsible for ensuring that routine maintenance is performed and that tools and spare parts used to conduct routine maintenance are available.

7.4.5.2 Laboratory Equipment and Instruments

As part of the QA/QC program for the analytical laboratory, routine preventive maintenance is conducted to minimize the occurrence of instrument failure and other system malfunctions. The laboratory will maintain a schedule for servicing critical items and will perform routine maintenance, scheduled maintenance and repair, or coordinate with a vendor to arrange for maintenance and repair service, as required. All laboratory instruments will be maintained in accordance with the manufacturers' specifications and the requirements of the specific method employed. Equipment will be tested during routine calibration, and deficiencies will be corrected as specified in procedures.

The concentration of standards and frequency of initial and continuing calibration of analytical instruments will be as specified in the laboratory procedures. Calibration data will be provided with the analytical data package. Calibration records pertaining to subcontracted laboratory services will be filed and maintained by the laboratory in accordance with internal procedures.

7.4.6 Instrument/Equipment Calibration and Frequency

Calibration of analytical laboratory equipment will be based on approved written procedures. The concentration of standards and frequency of initial and continuing calibration of analytical instruments will be as specified in the laboratory SOPs. The analytical laboratory will maintain calibration records. Calibration data will be provided with the analytical data package, as specified in the procurement documents.