TABLE OF FIGURES

TABLE OF TABLES

LIST OF ADDENDUMS

2.9 BASELINE RADIOLOGICAL CHARACTERISTICS

2.9.1 Introduction

The Antelope and JAB Uranium Project areas comprise approximately 14,574 acres of Bureau of Land Management (BLM) land about 10-20 miles west of Bairoil, WY. These two sites are approximately 5 miles apart, involving about 10,531 acres for the Antelope project area and 4,043 acres for the JAB project area (Figures 2.9-1 and 2.9-2).

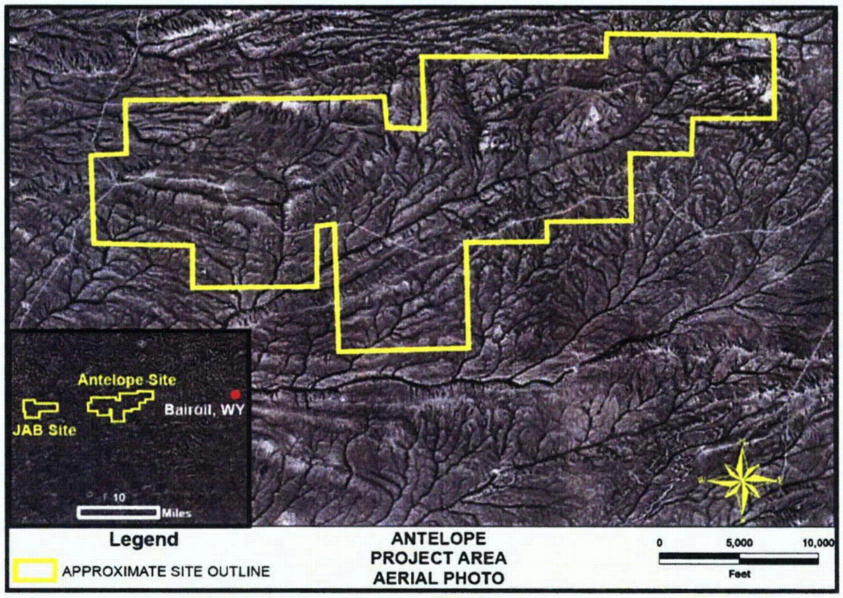


Figure 2.9-1: Aerial Photo of the Antelope Uranium Project area.

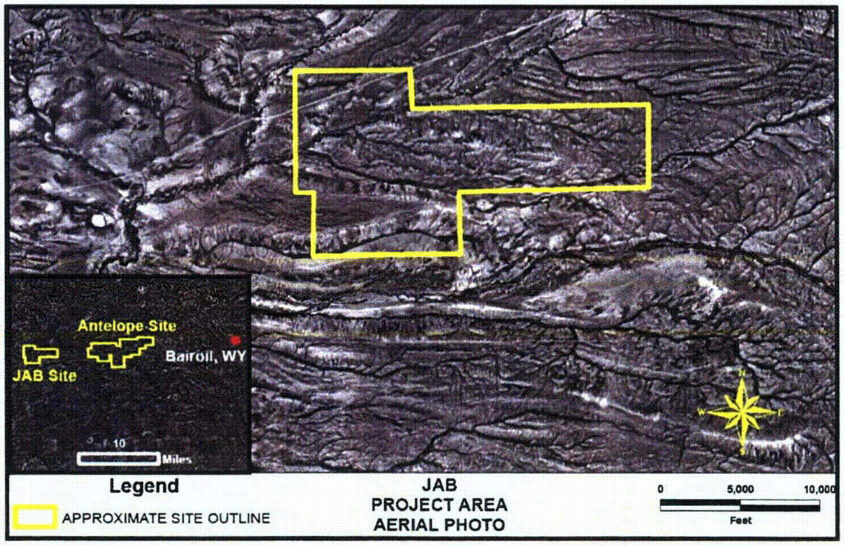


Figure 2.9-2: Aerial Photo of the JAB Uranium Project area.

Topography at both sites is comprised primarily of low rolling hills, relatively flat areas, and small ephemeral drainages (Figure 2.9-3). Sagebrush vegetation dominates these sites, with interspersed short grass prairie varieties. The sites are managed by the BLM with livestock grazing and wildlife habitat representing the predominant land use. There are no residents currently within the project areas.

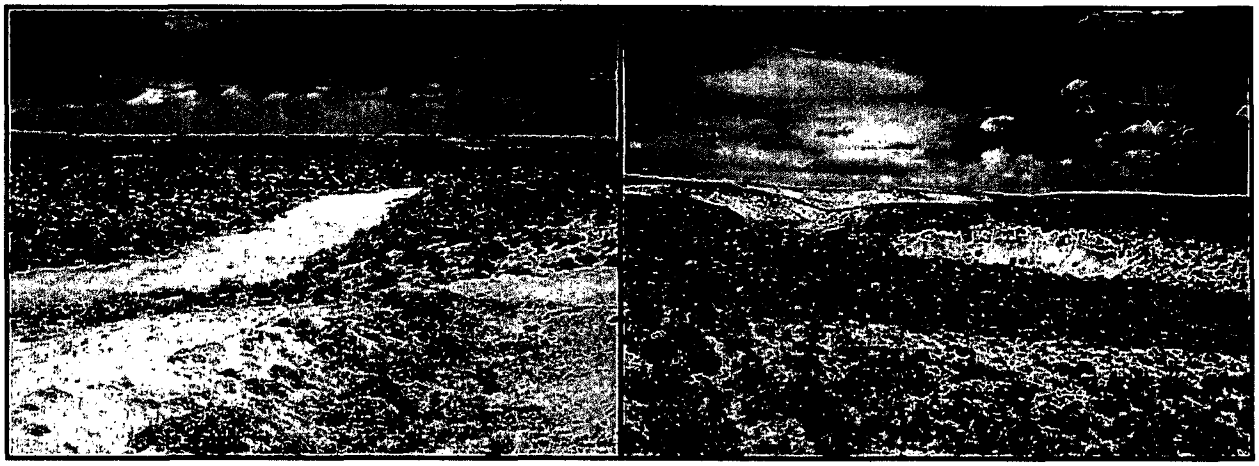


Figure 2.9-3: Photos of portions of the JAB (left) and Antelope (right) Uranium Project areas.

On behalf of Uranium One, Tetra Tech (Fort Collins, CO) conducted various radiological baseline survey measurements in 2007 and 2008 at the Antelope and JAB Uranium Project sites for proposed ISR operations. Radiological survey planning for this project was developed under the assumption that all phases of the uranium extraction and processing cycle could potentially be performed within either permit area.

Basic guidance for radiological baseline surveys at uranium recovery sites can be found in Regulatory Guide 4.14 (NRC, 1980). Although Regulatory Guide 4.14 does not address special considerations associated with ISR uranium recovery sites, the U.S. Nuclear Regulatory Commission (NRC) and the Wyoming Department of Environmental Quality / Land Quality Division (WDEQ/LQD) both currently recommend following Regulatory Guide 4.14 for conducting radiological baseline surveys of ISR sites (NRC, 1982; WDEQ/LQD, 2007).

Baseline surveys of these sites have been conducted based on Regulatory Guide 4.14 protocols. Some aspects of radiological survey activities have been further developed according to more recent NRC regulatory guidance documents as referenced in applicable sections of this report. Data from both study sites are presented in this report for consideration by the NRC and WDEQ/LQD with respect to licensing/permitting applications. The following sections describe methods, activities, and results to date of radiological baseline surveys for the Antelope and JAB Uranium Project areas.

2.9.1.1 References

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

U.S. Nuclear Regulatory Commission (NRC). 1982. Regulatory Guide 3.46. *Standard Format and Content of License applications, Including Environmental Reports, for In Situ Uranium Solution Mining*. Nuclear Regulatory Commission Office of Nuclear Regulatory Research. Washington, D.C.

Wyoming Department of Environmental Quality / Land Quality Division (WDEQ/LQD). 2007. In Situ Mining Permit Application Requirements Handbook. *Application Content Requirements – Adjudication and Baseline Information*. March, 2007

2.9.2 Gamma Survey

Regulatory Guide 4.14 calls for a pre-operational gamma survey covering a maximum area of 1750 acres with up to 80 individual gamma exposure rate measurements (NRC, 1980). The suggested sampling design includes higher density of measurements clustered near the mill location, with more dispersed measurements in a radial pattern at greater distances from the mill. Regulatory Guide 4.14 does not address differences or special considerations associated with ISR uranium mining and recovery operations.

Consistent with ISR permit application guidelines described in Regulatory Guide 3.46 (NRC, 1982) and NUREG-1569 (NRC, 2003), as well as radiological survey guidelines outlined in MARSSIM, the Multi-Agency Radiation Survey and Site Investigation Manual (NRC, 2000), Tetra Tech used GPS-based scanning technologies for this project. Versus Regulatory Guide 4.14 grid-based measurements, these scanning systems are capable of providing much higher density and more uniform gamma measurements across very large areas. The basic scanning system developed by Tetra Tech can be mounted in various configurations including backpacks, off-highway vehicles (OHVs), or trucks, and have been used for remedial support at a number of uranium mill site decommissioning projects as well as other radiological site characterization applications in the U.S. and abroad.

Tetra Tech has used OHV-mounted versions of this scanning system for previous ISR baseline surveys at several similar sites with results presented in licensing/permitting applications to the NRC and the WDEQ/LQD (EMC, 2007; Lost Creek ISR, LLC, 2007). The method should meet or exceed minimum guidelines outlined in Regulatory Guide 4.14 and other applicable regulatory guidance documents. This system is among current state-of-the-art technologies for conducting radiological site characterizations and can provide far more detailed information on baseline radiological conditions at ISR sites relative to past approaches such as grid-based measurements.

2.9.2.1 Methods

2.9.2.1.1 Baseline Gamma Survey

Figure 2.9-4: 3-detector GPS-based scanning systems mounted on Rhino OHVs.

For the Antelope and JAB surveys, the most recently developed Yamaha Rhino-mounted scanning system configuration was used (Figure 2.9-4). Given the large size of these sites, along with occasional rugged terrain and sagebrush vegetation, these two-seater Rhino OHVs with roll-bar cages and conventional driver control systems (i.e. steering wheel, foot-controlled gas and break pedals) were well suited for the project. Equipped with special extra-wide tires, these vehicles are well suited to safely

negotiating sites like Antelope and JAB while minimizing environmental impact.
In addition to addressing safety considerations, roll-bar cages on Rhino OHVs provides a support system for adjustable outriggers designed to mount three Ludlum 44-10 NaI gamma detectors and paired GPS receivers. The detectors are coupled to Ludlum 2350 rate meters housed in a cooler carried in the OHV cargo bed. Simultaneous GPS and gamma exposure rate data are recorded every 1-2 seconds using an onboard PC with data acquisition software developed by Tetra Tech.

System configuration involves about 8-foot spacing between detectors (measured perpendicular to direction of travel), with each detector positioned at 4.5 feet above the ground surface. A 3-foot detector height is generally accepted, but not mandated, by the NRC. This height was impractical at the site given the relatively frequent tall brush, ravines, or fence gate crossings. A detector height of 4.5 feet was the lowest practical height for the system under site conditions. Experimental measurements were later performed to determine statistically equivalent readings as measured by a high-pressure ionization chamber (HPIC) at 3 feet above the ground surface (discussed later).

Based on previous observations and experience in the field under similar scanning geometries, lateral NaI detector response to significantly elevated planar (non-point) gamma sources at the ground surface is estimated to be about 5 feet, giving each detector an estimated "field of view" of about 10 feet in diameter at the ground surface. This does not imply a system detector can pick up readings from a small point source 5 feet away, but does suggest that scattered photons from larger elevated source areas (e.g. 100 m^2) are likely to be detected at that distance. Within this conceptual framework, the scanning track width for each vehicle's scanning system is estimated to be about 25 feet across, perpendicular to the direction of travel. Vehicle scanning speeds ranged between 2 and 10 mph depending on the roughness of the terrain, with an estimated average speed of 4-6 mph.

Data were downloaded daily into a project database and mapped using Gamma Viewer software developed by Tetra Tech (Tetra Tech Inc., 2006). In addition to daily quality control (QC) measurements used to evaluate instrument performance and insure data quality (discussed later), daily scan results were evaluated in terms of general agreement between onboard detectors to help identify any problems that may have occurred during data acquisition throughout the day. Gamma Viewer field maps also helped to assess adequacy of scan coverage on a daily basis.

Initial results indicated that the range of gamma exposure rate readings across these sites was relatively broad (e.g. ranging from about 10 to 80 μR/hr), prompting use of fairly wide data mapping increments to best illustrate distributional patterns or trends. In areas near estimated subsurface ore bodies or areas of higher readings, attempts were made to achieve scanning coverages approaching 100%. Based on experience gained from scanning other sites, a distance of 15-30 feet between the adjacent detectors in both vehicles was deemed practical and sufficient to resolve smaller-scale variability in areas targeted for higher density scanning coverage. This vehicle spacing is estimated to provide effective ground scanning coverage of 75-90%.

In other portions of the claim area, 5-10% was the target scan coverage though practical considerations such as safety, terrain, and natural obstructions often dictated actual distances maintained between vehicles. For most areas of the site, a target distance of 300 feet between vehicles was a conservative goal employed during scanning as this is estimated to provide ground area coverages of about 15%. In terrain deemed unsafe for OHV scanning, efforts were made to scan as closely as possible along the perimeters of such terrain.

2.9.2.1.2 Cross-calibration of NaI Detectors against a High-Pressure Ionization Chamber

Gamma exposure rates measured by NaI detectors are only relative measurements as response characteristics of NaI detectors are energy dependent. True gamma exposure rates are best measured with a less energy dependent system such as a high-pressure ionization chamber (HPIC). Depending on the radiological characteristics of a given site, NaI detectors can have measurement values significantly different from corresponding HPIC measurement values.

NaI systems are useful for ISR mining sites because they can quickly and effectively demonstrate relative differences between pre- and post-operational gamma exposure rate conditions. Unless the same equipment and scanning geometry is used for both surveys, however, it is necessary to normalize the data to a common basis of comparison. This is the purpose of performing NaI/HPIC cross-calibration measurements. Cross-calibration insures that the results of future gamma scans, which are likely to use different detectors (and perhaps different detector heights, detector models, or measurement technologies) can be meaningfully compared against the results of pre-ISR gamma surveys.

To perform NaI/HPIC cross-calibrations, static measurements were taken at various discrete locations covering a range of exposure rates representative of the claim area. These locations were identical to those used for gamma/Ra-226 correlation plot measurements (discussed in the next section). At each cross-calibration measurement location, 10 individual HPIC readings were recorded and averaged. The center of the sensitive volume for the HPIC is about 3 feet above the ground surface. A pin flag was pushed into the ground directly below the HPIC to mark the exact measurement location for subsequent NaI measurements. The OHVs were then systematically positioned such that each NaI detector was located directly above the pin flag when taking measurements. For each NaI detector, 20 individual NaI readings at a 4.5-foot detector height were collected and averaged. Mean values were recorded. Pictures of this process are shown in Figure 2.9-5.

Figure 2.9-5: Static measurements at JAB (left) and Antelope (right) for cross-calibration of NaI detectors against the HPIC at a 4.5-foot NaI detector height.

2.9.2.1.3 Gamma / Ra-226 Correlation

Regulatory Guide 4.14 indicates that 40 baseline surface soil samples should be collected at 5-cm depths within 1.5 kilometers from the center of the milling area, with additional samples collected at air monitoring stations. NUREG-1569 suggests that 15-cm depths should also be sampled for consistency with decommissioning criteria. This guidance, combined with the large size of the Antelope and JAB Uranium Project areas, prompted a number of gamma/Ra-226 correlation plots to be sampled. Depending on the statistical strength of the relationship between gamma readings and Ra-226 concentrations in surface soils, such correlations can be used to estimate approximate Ra-226 soil concentrations (to a 15-cm depth) across the entire site based on gamma survey results.

Correlation soil sampling was conducted as composite sampling over 10×10 meter plots. Within each plot, 10 soil sub-samples were collected to a depth of 15 cm then composited into a single sample. GPS coordinates were taken at the center of each sampling plot and recorded. Samples were sent to Energy Laboratories Incorporated (ELI) in Casper, WY for analysis of Ra-226 concentrations. Samples were dried, crushed, and thoroughly homogenized prior to analysis to insure a representative average radionuclide concentration over each 100 m^2 plot. Samples were then canned, sealed, and held 21 days prior to counting to allow sufficient ingrowth of radon and short-lived progeny before Ra-226 analyses were performed using high-purity germanium (HPGe) gamma spectroscopy (method E901.1).

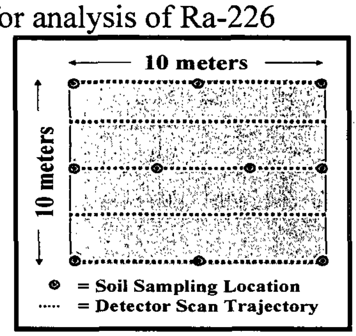


Figure 2.9-6: Diagram of correlation plot soil sampling and gamma measurement design.

Following methods described in Johnson et al. (2006), each 100 m^2 soil sampling plot was also scanned using the same OHV systems used to scan the entire site. The average NaI gamma reading over each plot was calculated and recorded to pair with the corresponding average Ra-226 concentration. A diagram depicting the sampling design for correlation plot measurements is shown in Figure 2.9-6.

2.9.2.1.4 Data Quality Assurance / Quality Control

Data quality assurance and quality control issues for gamma surveys of the Antelope and JAB Uranium Project areas are addressed in various ways. In general, quality assurance (QA) includes qualitative factors that provide confidence in the results, while quality control (QC) includes quantitative evidence that supports the validity of results (e.g. data accuracy and precision).

Quality control documentation for this project includes the following:

- Daily QC measurements were performed for each NaI detector used in gamma scanning activities and results were plotted on instrument control charts. Background as well as Cs-137 check-source QC measurements were taken each day indoors under a controlled geometry. For normally distributed count data, over 99% of measurements from a given detector are expected to fall within ± 3 standard deviations from the mean. Also, background gamma exposure rates at a given location can vary over successive days due to fluctuations in natural shielding factors for cosmic and/or terrestrial sources (NRC, 1994). Furthermore, in this application data from multiple detectors are used to measure overall site conditions. Response characteristics between individual detectors can vary even after proper calibration by the manufacturer.

  To help account for all potential sources of measurement variability for this application, any instrument with measurements falling outside ± 3 standard deviations from the mean of all QC measurements for all instruments on both background and check source charts indicates unacceptable instrument performance. Detectors performed within acceptable QC limits throughout the project. While meeting specified QC limits, one detector showed indications of a systematic low bias relative to other detectors (about 1 μR/hr at indoor background). This was further investigated and addressed as described in the following bullet point.

- Each day, the actual performance of each scanning system was tested in the field by scanning along a designated strip near the vehicle staging area. These "field strip" scans were conducted before and after each day's scanning. Under actual field conditions, scanning systems performed within acceptable QC limits throughout the project. While meeting specified QC limits, two of the scan system/detector combinations each showed indications of a systematic low bias relative to the other systems (one affected system involved the detector mentioned in the preceding bullet point).

  Based on careful assessment of all QC data and a statistical analysis of correlation plot data across a range of gamma exposure rates found at the sites, readings from the two low-biased system/detector combinations were determined to average about 86% of readings from the other systems. Using regression analysis techniques, the affected correlation plot data were normalized accordingly, resulting in excellent agreement between all detector readings at each correlation plot location. All site survey data collected from the two low-biased system/detector combinations were also normalized accordingly to create a final NaI-based gamma survey data set.

- Re-scanning is an important tool for verification and demonstrating reproducibility of measurements in the field. Part of re-scan verification involved comparing data from various discrete, stationary measurements across the site (collected as part of HPIC cross-calibration and gamma/Ra-226 correlation activities) with original scan data. In general, these stationary measurement data showed good agreement with original continuous scan data.
- With respect to soil sampling results from Energy Laboratories, final official reports indicated that all QC indicators (e.g. duplicate sample analyses, blanks, laboratory control samples, sample matrix spikes) "met EPA or laboratory specifications" for quality control. No flags or analytical problems were noted in the reports. Copies of these reports are available upon request.

Data quality assurance factors for this project include the following:

- All detectors used for gamma scanning at the claim area, along with the HPIC, were calibrated by the manufacturer within one year prior to the date of use on this project.
- A detailed field log book of daily activities was maintained.
- Chain-of-custody protocols were followed for soil sampling and contract laboratory analyses.
- Tetra Tech's Radiological Health Group staff has extensive qualifications and over 100 years worth of combined experience for performing radiological measurements and related site assessments (CV's provided on request).
- Scanning system methodologies and technology are published in peer-reviewed radiation protection and measurement research publications (Johnson et al., 2006; Meyer et al. 2005a; Meyer et al. 2005b; Whicker et al., 2008; Whicker et al., 2006).
- Daily scan results for each vehicle were reviewed for consistency along track paths for all onboard detectors. Obvious inconsistencies prompted further investigation and in cases where technical problems were discovered or where the data were otherwise clearly incorrect, the affected data were omitted from the project database.

2.9.2.2 Gamma Survey Results

2.9.2.2.1 Baseline Gamma Survey Results

NaI-based gamma survey results for each site are shown in Figures 2.9-7 and 2.9-8. In most areas of these sites, readings are below 30 μR/hr and gamma exposure rates are relatively homogeneous. There are several areas at each site with significantly higher readings indicative of elevated naturally occurring terrestrial radionuclides at or near the soil surface. The areas of higher density scanning shown in Figures 2.9-7 and 2.9-8 cover areas of interest with respect to estimated subsurface deposits or areas found to have higher exposure rate readings during initial scanning.

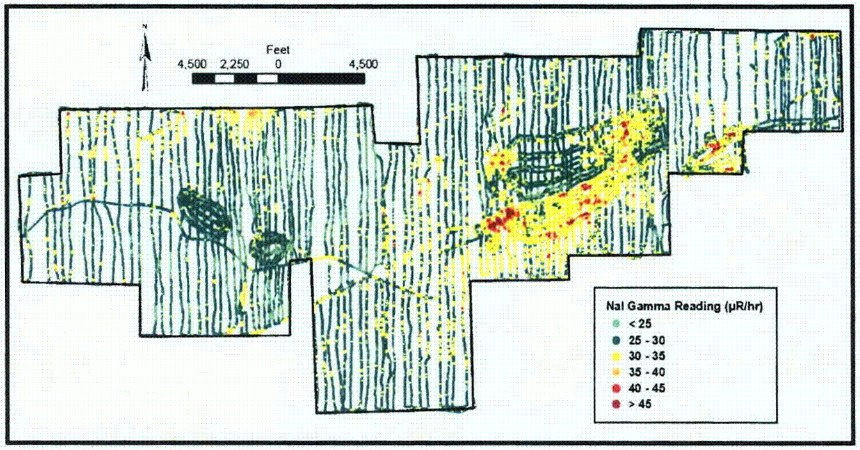


Figure 2.9-7: Raw, NaI-based gamma survey results for the Antelope Uranium Project area.

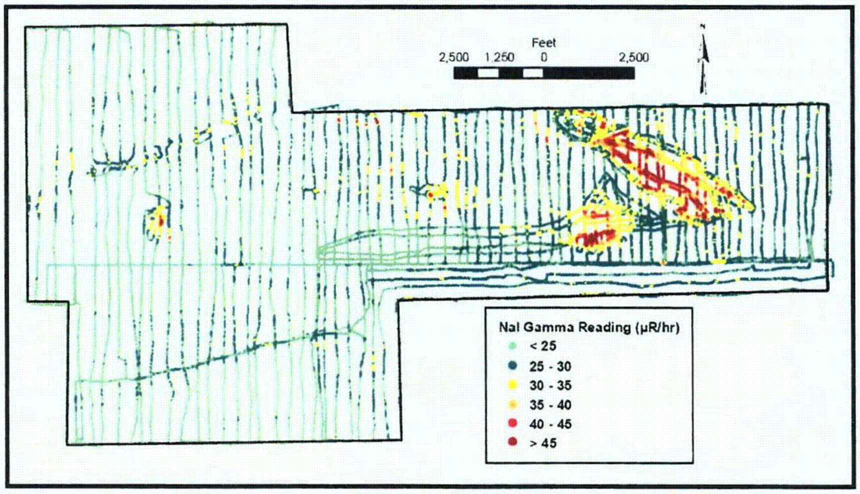


Figure 2.9-8: Raw, NaI-based gamma survey results for the JAB Uranium Project area.

Discrete, stationary measurements taken at correlation plot survey locations showed good agreement with the results of the continuous OHV survey data in corresponding locations. In some cases, areas at these sites with the higher readings have certain geomorphologic features that appear to be associated with higher gamma exposure rates (e.g. hill tops, eroded areas, outcrops of exposed rocks or unusually colored soils). Examples of such areas are shown in Figure 2.9-9. In many cases, transitions between areas of consistently higher and lower readings are relatively abrupt. Such transitions sometimes have visible features that appear to delineate distinct boundaries between areas of higher and lower readings (Figure 2.9-10). In other cases, there are no obvious features associated with areas of higher readings or with transition zones.

Figure 2.9-9: Photos of areas with higher readings: A) erosional depression at Antelope with exposed unusual soil layers (readings 30-35 μR/hr); B) knoll top correlation plot location at Antelope (readings 55-60 μR/hr); C) deep ravine at Antelope (readings 30-40 μR/hr); D) correlation plot soil sampling location at JAB with a yellowish-tinted soil layer just below the soil surface (readings 45-50 μR/hr).

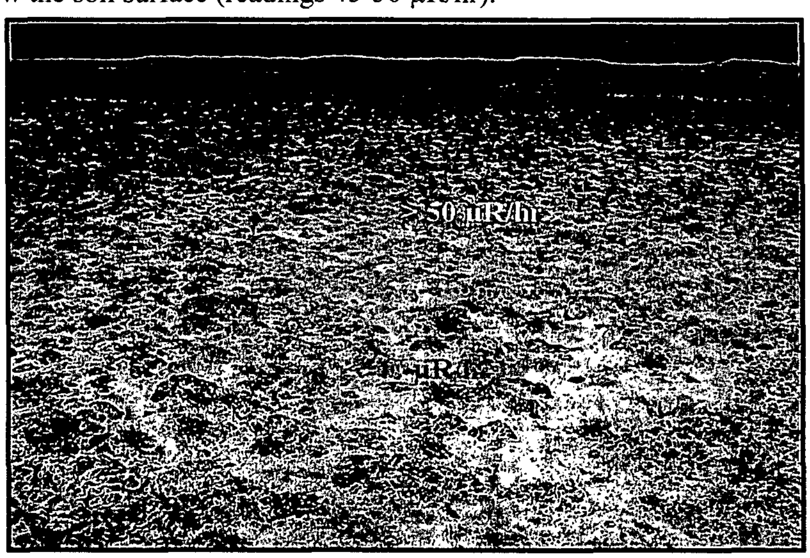


Figure 2.9-10: Area at JAB with an abrupt transition in gamma readings that appeared to coincide with a subtle, yet visible change in surface soil color.

2.9.2.2.2 HPIC / NaI Cross-calibration Results

Results of the cross-calibration between HPIC and NaI detectors positioned at 4.5-foot detector heights are shown in Figures 2.9-11 and 2.9-12. Regression coefficients are consistent with those measured by Tetra Tech at other uranium recovery sites, including nearby sites in this region of Wyoming. The ratio of HPIC to NaI readings was inversely proportional to the magnitude of exposure rates being measured. HPIC/NaI ratios across the two sites ranged from 0.65 to 0.98, roughly corresponding to locations with the highest and lowest respective measurement readings. Locations having NaI readings lower than about 18 μR/hr demonstrated little difference between HPIC and NaI measurements.

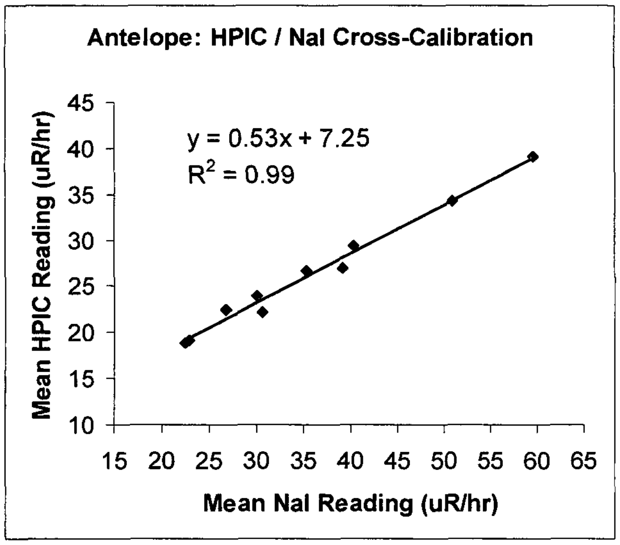


Figure 2.9-11: Antelope: cross-calibration curve for the HPIC versus NaI detectors positioned at a 4.5-foot detector height.

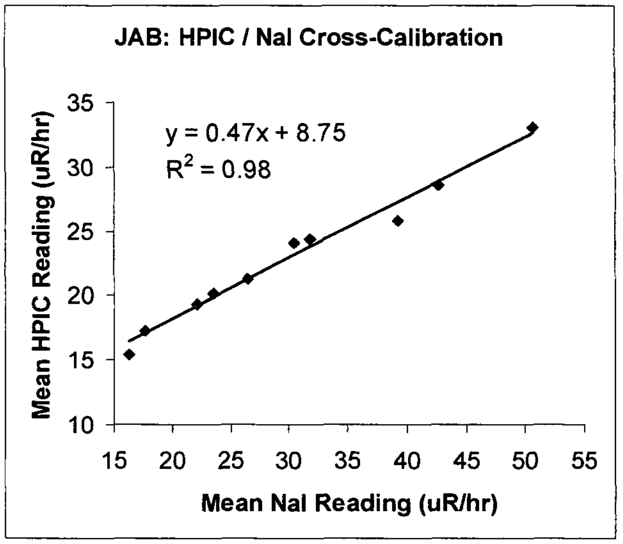


Figure 2.9-12: JAB: cross-calibration curve for the HPIC versus NaI detectors positioned at a 4.5-foot detector height.

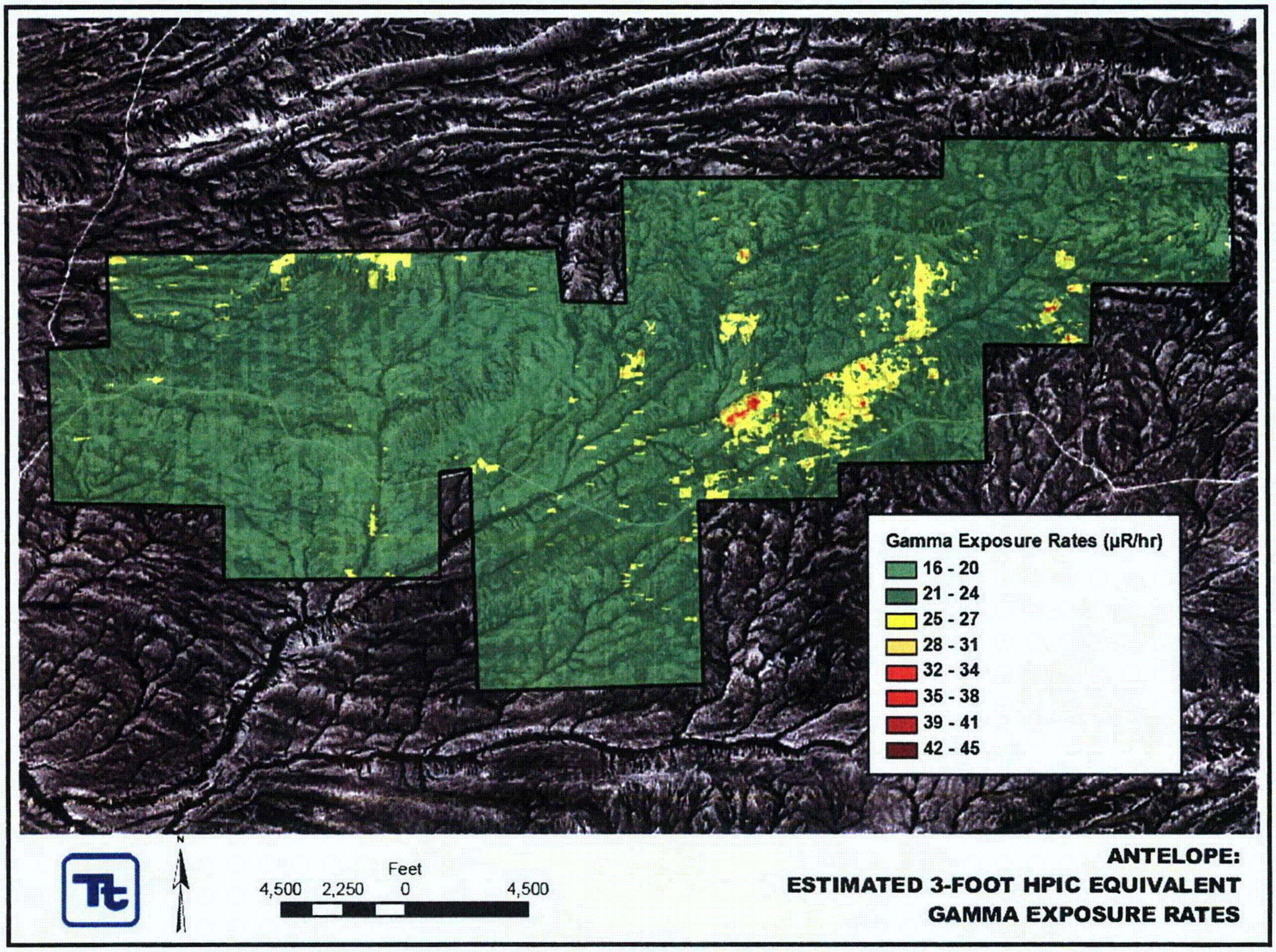
2.9.2.2.3 Final Gamma Exposure Rate Mapping

Using regression equations shown in Figures 2.9-11 and 2.9-12, baseline gamma survey data collected with NaI detectors at the Antelope and JAB Uranium Project sites were normalized to 3-foot HPIC equivalent gamma exposure rates to create final respective data sets. Using a kriging program in ArcGIS, these final data sets were used to develop continuous estimates of 3-foot HPIC equivalent gamma exposure rates across each site.

Kriging is a geostatistical interpolation procedure that fits a mathematical function to a specified number of nearest points within a defined radius to determine an output value for each location. A given "location" is represented by a cell of specified areal dimensions that may or may not include any measured data points. Values closer to the cell are given more weight than values further away and distances, directions, and overall variability in the data set are all considered in the predictive semivariogram model. Approximate input parameters used for this application were as follows:

Cell size:	10 feet × 10 feet
Max search radius:	500 feet
Semivariogram model:	Exponential
Number of nearest data points:	10

Maps of estimated 3-foot HPIC equivalent gamma exposure rates across each site are shown in Figures 2.9-13 and 2.9-14, with E-sized versions included at the end of Section 2.9.



2.9-13: Continuous, kriged estimates of 3-foot HPIC equivalent gamma exposure rates at the Antelope Uranium Project site.

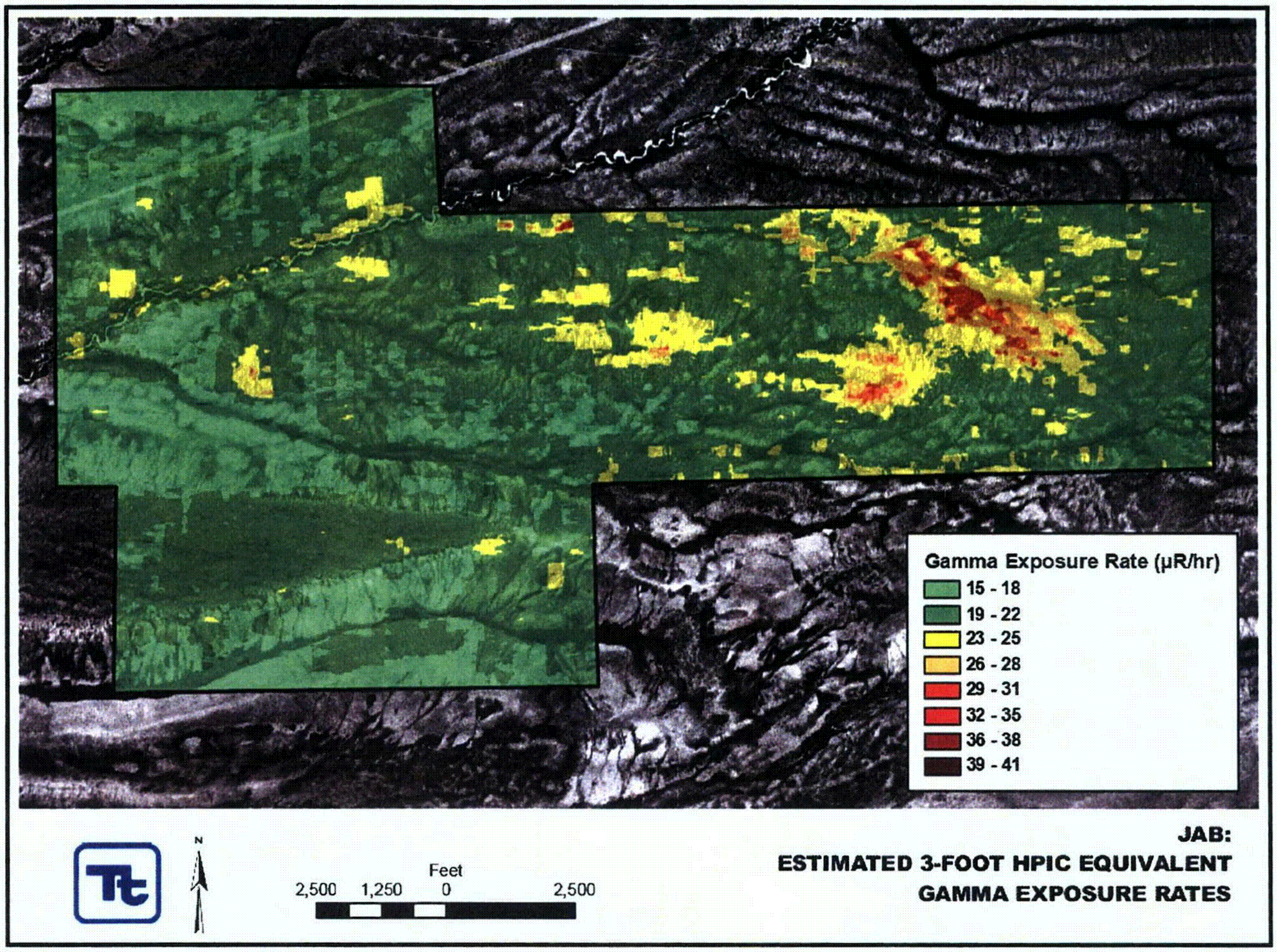


Figure 2.9-14: Continuous, kriged estimates of 3-foot HPIC equivalent gamma exposure rates at the JAB Uranium Project site.

Note that gamma scale legend increments differ between the raw, NaI-based gamma scan track maps shown in Figures 2.9-7 and 2.9-8 of this report and final official maps of gamma survey results provided as Figures 2.9-13 and 2.9-14. This is because the data in final maps of official gamma survey results have been converted to 3-foot HPIC equivalent values and more respective mapping increments have been added to final maps to better resolve small changes in gamma exposure rate distributions.

2.9.2.2.4 NaI/Ra-226 Correlation Results

Overlays of correlation plot sampling locations, color-coded and annotated to show soil Ra-226 results on raw NaI gamma scan maps, are shown in Figures 2.9-15 and 2.9-16. Soil sampling results represent average 15-cm depth Ra-226 concentrations over 100 m^2 sampling plots.

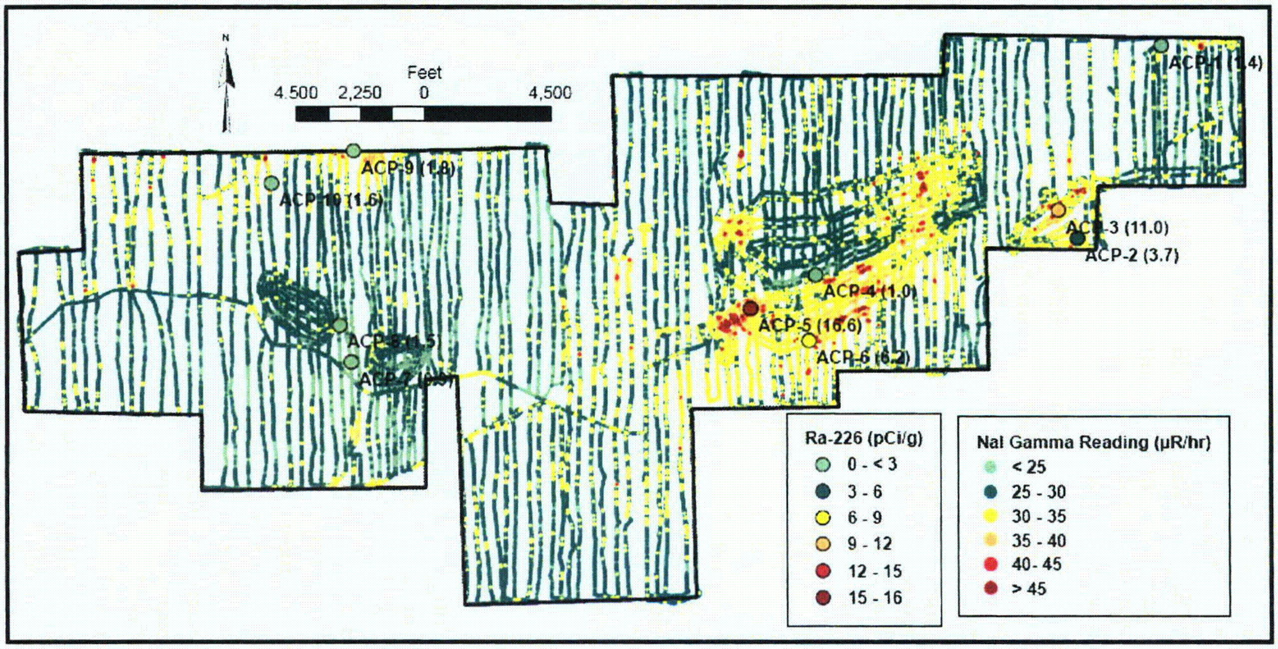


Figure 2.9-15: Antelope: correlation plot measurement locations and annotated soil Ra-226 concentration results (pCi/g, in parentheses) overlain on the NaI scan track map.

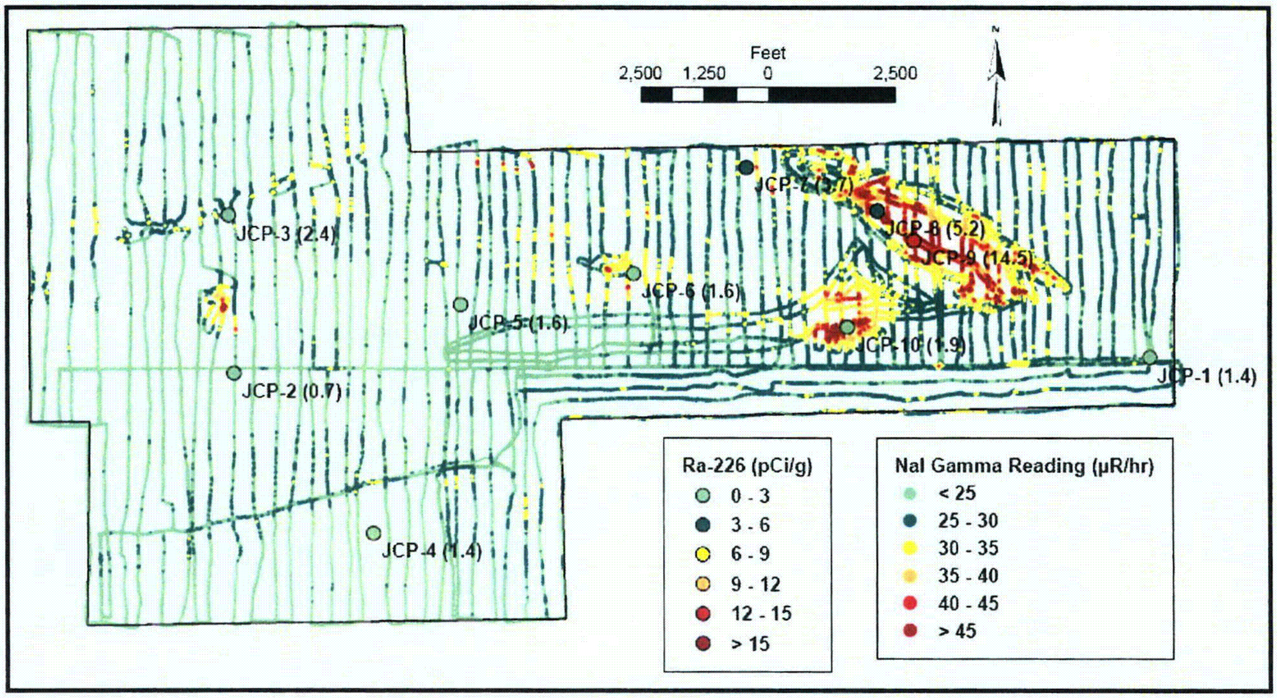


Figure 2.9-16: JAB: correlation plot measurement locations and annotated soil Ra-226 concentration results (pCi/g, in parentheses) overlain on the NaI scan track map.

Correlation plot data contained one location at each site having unusually low soil Ra-226 concentrations relative to gamma readings, possibly due to scattered photons from areas adjacent to these plots and/or from subsurface layers of elevated Ra-226 concentrations. Excluding these two locations, correlation plots at each site demonstrated a significant linear relationship between mean Ra-226 soil concentration and mean NaI gamma reading (Figures 2.9-17 and 2.9-18).

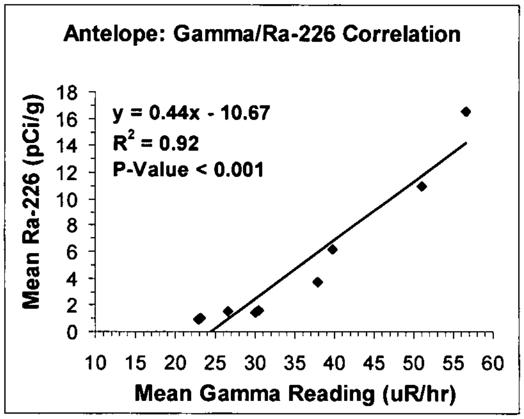


Figure 2.9-17: Antelope: linear correlation between Ra-226 soil concentration and NaI-based gamma exposure rate reading.

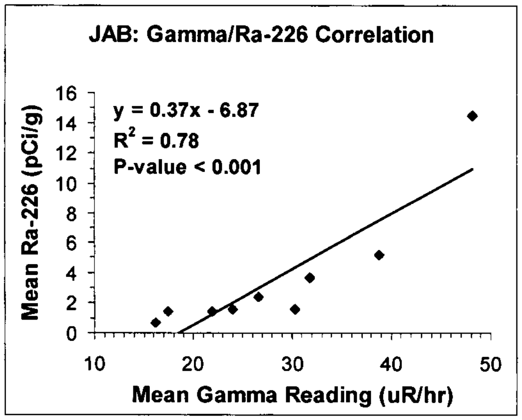


Figure 2.9-18: JAB: linear correlation between Ra-226 soil concentration and NaI-based gamma exposure rate reading.

Although linear regressions for correlation plot data from each site were statistically significant, the data from both sites appear somewhat nonlinear. Nonlinear models were fitted to each set of correlation data (Figures 2.9-19 and 2.9-20), significantly improving respective R-squared values and suggesting the potential for reduced error in predicting Ra-226 concentrations based on NaI gamma readings.

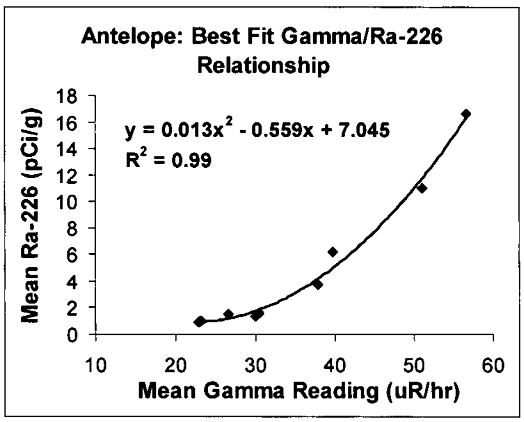


Figure 2.9-19: Antelope: nonlinear "best fit" relationship between Ra-226 soil concentration and NaI-based gamma exposure rate reading.

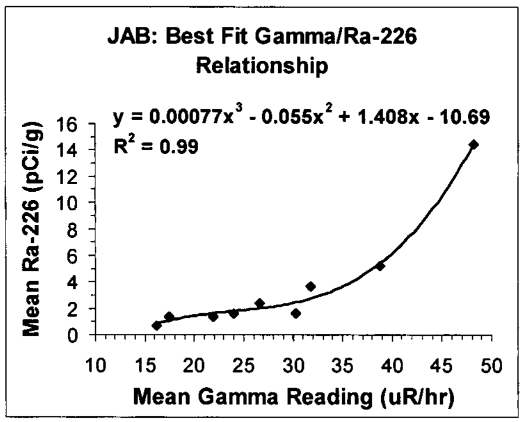


Figure 2.9-20: JAB: nonlinear "best fit" relationship between Ra-226 soil concentration and NaI-based gamma exposure rate reading.

2.9.2.2.5 Soil Ra-226 Concentration Mapping

The nonlinear gamma/Ra-226 equations shown in Figures 2.9-19 and 2.9-20 were used to convert raw NaI gamma readings from each site into estimates of Ra-226 concentrations in surface soils. These converted data sets were then kriged to provide continuous estimates of Ra-226 in surface soils across each site (Figures 2.9-21 and 2.9-22). E-sized versions of the maps shown in Figures 2.9-21 and 2.9-22 are included at the end of Section 2.9. The kriged maps of estimated soil Ra-226 concentrations will be evaluated for predictive accuracy against actual soil sample results (see Section 2.9.3).

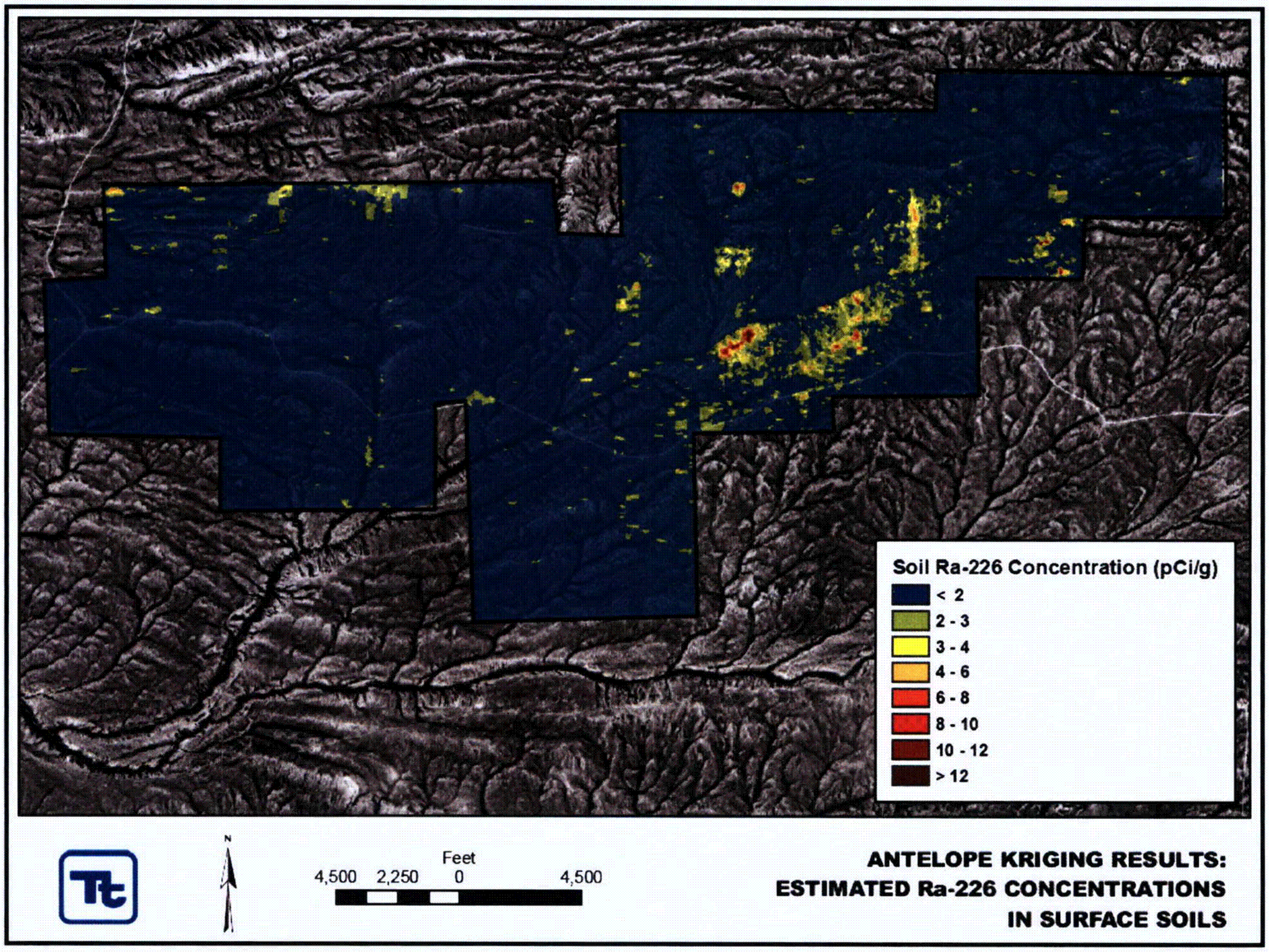


Figure 2.9-21: Antelope: continuous, kriged estimates of Ra-226 concentrations in surface soils based on gamma survey results.

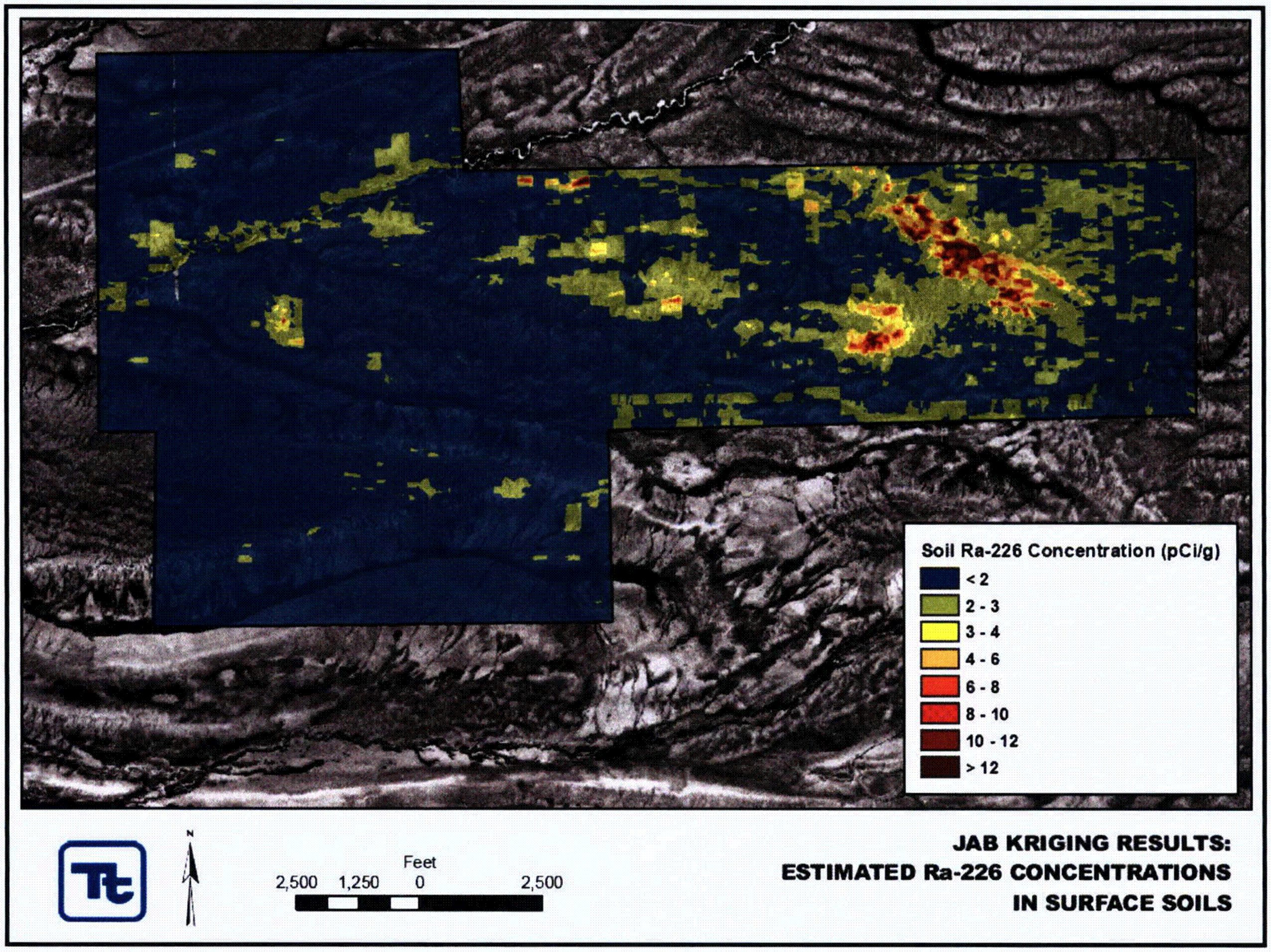


Figure 2.9-22: JAB: continuous, kriged estimates of Ra-226 concentrations in surface soils based on gamma survey results.

2.9.2.2.6 Data Uncertainty

For comparison of pre- and post-operational measurements, converting raw gamma survey data to a 3-foot HPIC equivalent is only one important consideration. It is also necessary to take into account the degree of uncertainty in measurements. Sources of measurement uncertainty include instrument variability, spatial variability in gamma exposure rates (differences in readings due to small differences in measurement geometry or location), and temporal variability in gamma exposure rates (e.g. differences over time due to changes in natural shielding factors for terrestrial or cosmic sources such as soil moisture or barometric pressure).

In general, QC measurements along field strips at each site provide an indication of total measurement uncertainty including spatial, temporal and instrument sources of variability in background gamma exposure rate readings. Based on control charts maintained over the course of the project, the total amount of potential uncertainty in NaI scanning measurements at field strip locations ranged up to about ± 2 μR/hr. Approximately the same amount of uncertainty should be applicable to 3-foot HPIC equivalent data at these locations. The field strips were located in areas having average background gamma readings in the range of 22 – 24 μR/hr (at the lower end of the ranges of values found at the sites). In areas of higher gamma exposure rates, the degree of uncertainty in measurements may be higher.

Finally, the kriging process for continuous estimation of overall baseline conditions is believed to smooth out some variability associated with certain sources of data uncertainty (e.g. variability in response characteristics of different detectors). In areas scanned at lower ground coverage densities, only larger-scale distributional characteristics are inferred as smaller-scale spatial variability in exposure rates between scan tracks from each survey vehicle is not captured.

2.9.2.3 Conclusions

The 2007 baseline gamma surveys of the Antelope and JAB Uranium Project areas in Sweetwater County, WY provide detailed characterizations of natural background gamma exposure rates and associated Ra-226 soil concentrations that exist at these sites. The data collected are of high quality and should meet or exceed regulatory guidelines for baseline surveys. These data will help insure that any potential radiological contamination that could result from ISR mining activities at each site can be effectively identified for remedial action. Extensive gamma survey data sets, HPIC cross-calibrations, gamma/Ra-226 correlations, comprehensive quality control measurements, and advanced spatial analysis techniques provide the most thorough and accurate documentation possible of these baseline radiological parameters. This is important for helping to insure that the land will be returned to its pre-operational state during site decommissioning. The technology and methods used, while relatively new to the ISR licensing/permitting process, are likely to benefit all stakeholders.

2.9.2.4 References

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2.9.3 Soil Sampling

Due to early onset of snow storms and prolonged snow cover conditions at these sites in the fall of 2007 through the spring of 2008, soil sampling according to Regulatory Guide 4.14 protocols was delayed at these sites until late May of 2008. As a result, respective results are not yet available. Estimates of Ra-226 concentrations in surface soils (to a depth of 15 cm) across each entire site, based on gamma scanning and gamma correlations with soil Ra-226 concentrations, are provided in Section 2.9.2.2.5. Full results of the Regulatory Guide 4.14 soil sampling and analyses, along with corresponding revisions to this section and assessments of implications for estimates of soil Ra-226 across these sites as presented in Section 2.9.2.2.5, will be provided to the NRC and the WDEQ/LQD as soon as they are available (expected in June of 2008).

Comprehensive baseline soil sampling and analyses were conducted in May of 2008 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 will also be represented in the final survey data sets. Surface soil radionuclide concentration data from both 5-cm and 15-cm soil depths will be presented in revisions to this section in accordance with Regulatory Guide 4.14 protocols and NUREG-1569 application review recommendations (NRC, 2003).

2.9.3.1 Methods

2.9.3.1.1 Surface Soil Sampling

Soil sampling activities at the Antelope and JAB Uranium Project sites were conducted in August, 2007 (correlation sampling, discussed earlier), and May, 2008 (Regulatory Guide 4.14 soil sampling). The Regulatory Guide 4.14 surface soil sampling design involves a radial grid pattern with the approximate location of proposed ISR processing plant facilities 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 (Figures 2.9-23 and 2.9-24). 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 sent to ELI (Casper, WY) for analysis of all analytes specified in Regulatory Guide 4.14 for soil samples.

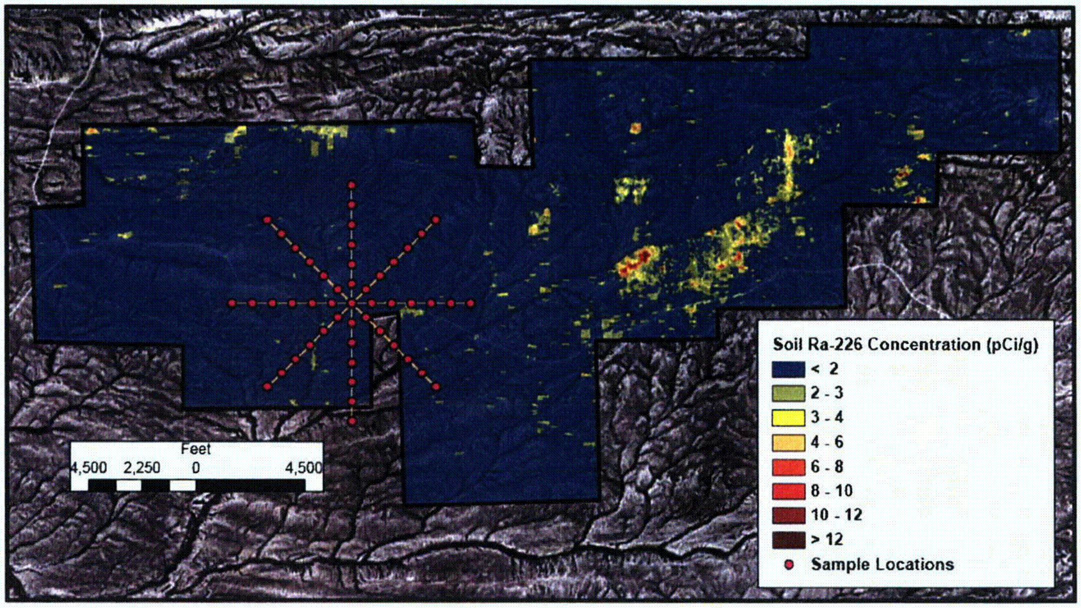

Figure 2.9-23: Regulatory Guide 4.14 radial grid surface soil sampling locations for Antelope (pink dots), overlain on the gamma survey-based map of estimated soil Ra-226 concentrations across the site.

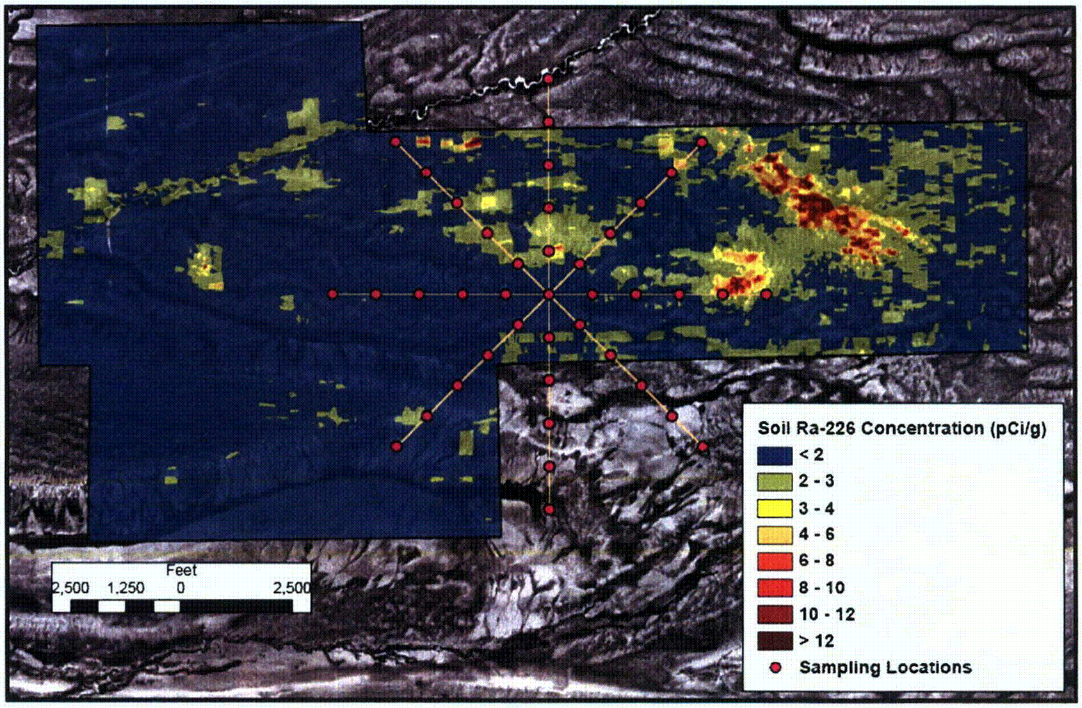

Figure 2.9-24: Regulatory Guide 4.14 radial grid surface soil sampling locations for JAB (pink dots), overlain on the gamma survey-based map of estimated soil Ra-226 concentrations across the site.

Soil sampling analytes include Ra-226, with 10 percent of samples were further analyzed for natural uranium (U-nat), Th-230, and Pb-210. Additional surface soil samples were collected and analyzed from each air particulate monitoring station per Regulatory Guide 4.14 specifications.

All radial 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 sent to ELI in Casper, WY along with chain of custody / analysis request forms. After receipt by ELI, 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.

2.9.3.1.2 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 ISR processing plant facilities, with the other four locations located along radial transects used for surface soil sampling, but at 750 meters from the plant and in four primary compass directions.

Subsurface soil samples were collected with a hand-coring soil sample collector in 15-cm increments to a depth of 105 cm or until rock prevented further coring device penetration. Sample collection, lab delivery, chain of custody, sample preparation, and analysis protocols were the same as those described in above in Section 2.9.3.1.1 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-nat, Th-230, and Pb-210 by wet radiochemical methods.

2.9.3.2 Soil Sampling Results

Estimates of Ra-226 concentrations in surface soils (to a depth of 15 cm) across each entire site, based on gamma scanning and gamma correlations with soil Ra-226, are provided in Section 2.9.2.2.5. Individual soil sample results for Ra-226 from the correlation plots are provided in Section 2.9.2.4. A complete tabulation of all soil analysis results, including Regulatory Guide 4.14 sampling, will be provided to the NRC and the WDEQ/LQD in a supplement to this report as soon as remaining analytical results are available (expected in June, 2008). Summary statistics, graphical presentations, color-coded mapping, and comparative analyses of results will also be provided in the supplementary report.

2.9.3.3 Conclusions

Baseline soil radionuclide data from the Antelope and JAB site surveys were collected and analyzed according to Regulatory Guide 4.14 protocols. These data sets, combined with the correlation soil sampling data and continuous kriged estimates of Ra-226 concentrations across these sites based on comprehensive gamma scanning as presented in Sections 2.9.2.4 and 2.9.2.5, provide a thoroughly detailed and reliable characterization of existing soil radionuclide concentrations across the site. This information should meet respective baseline characterization requirements as indicated by the U.S. Nuclear Regulatory Commission and the Wyoming Department of Environmental Quality / Land Quality Division for ISR licensing/permitting applications.

2.9.3.4 References

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

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2.9.4 Sediment Sampling

In August of 2007 and May of 2008, baseline sediment sampling was conducted at the Antelope and JAB Uranium Project areas in accordance with Regulatory Guide 4.14 protocols (NRC, 1980). Only ephemeral stream drainage channels (Figure 2.9-25) were sampled as no significant surface water impoundments were identified. At each site, sediments were collected at 4-5 locations along stream drainage channels, including (where possible) locations roughly upstream and downstream from proposed processing plant facility locations.

Figure 2.9-25: Sediment sampling: examples of ephemeral stream drainage channels at the Antelope and JAB sites.

These two sampling events are intended to characterize radionuclide content in stream sediments during seasonal runoff (spring) and low-flow (fall) conditions (NRC, 1980). Analytical results for the 2007 sampling event are presented in this section. Data from the 2008 sampling event are still pending. A complete tabulation of all sediment sampling results will be provided to the NRC and the WDEQ/LQD in a supplement to this report as soon as all analytical results are available (expected in June, 2008). Based on results of sediment sampling at other ISR sites in Wyoming, major differences in analytical results between the 2007 and 2008 sampling events at these sites are not anticipated.

2.9.4.1 Methods

Stream sediment sampling locations were selected to be generally representative of primary drainages found at these sites. 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 sent to Energy Laboratories, Inc. 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, 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

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ingrowth of short-lived Ra-226 progeny and approximate equilibrium conditions to become established. Separate aliquots were used for analyses requiring wet radiochemical methods.

2.9.4.2 Sediment Sampling Results

Descriptive summary statistics of stream sediment data for the August 2007 sampling event are provided in Tables 2.9-1 and 2.9-2. Individual stream drainage channel sampling locations and respective Ra-226 results for the August 2007 sampling event are shown in Figures 2.9-26 and 2.9-27. In general, stream sediment baseline results to date for Ra-226 at each site are similar to those for surface soils across most areas of these sites as estimated in Section 2.9.2.2.5.

Table 2.9-1: Antelope: Stream Sediment Sample Statistics (August, 2007).

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.4	0.17	1.4	1.6	1.2	4
Pb-210	3.1	0.73	3.3	3.7	2.1	4
Th-230	3.1	0.73	3.3	3.7	2.1	4
U-nat	2.1	0.24	2.0	2.4	1.8	4

Table 2.9-2: JAB: Stream Sediment Sample Statistics (August, 2007).

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.5	0.72	1.3	2.6	0.9	5
Pb-210	0.7	1.52	0.0	3.4	0.0	5
Th-230	0.8	0.80	0.4	2.2	0.3	5
U-nat	1.3	0.74	0.9	2.4	0.7	5

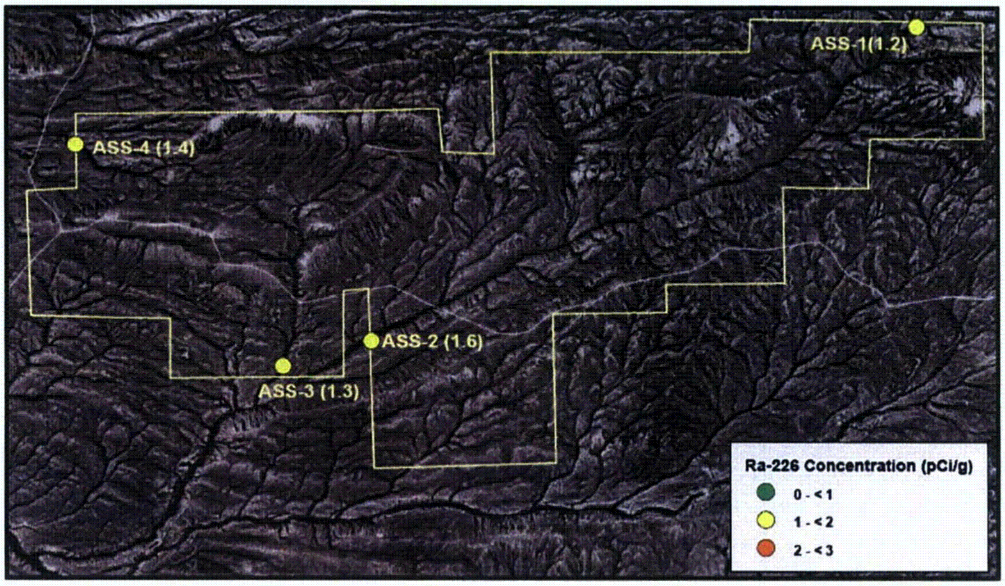

Figure 2.9-26: Antelope: sediment sampling locations and August 2007 Ra-226 concentration results for ephemeral stream drainage channels.

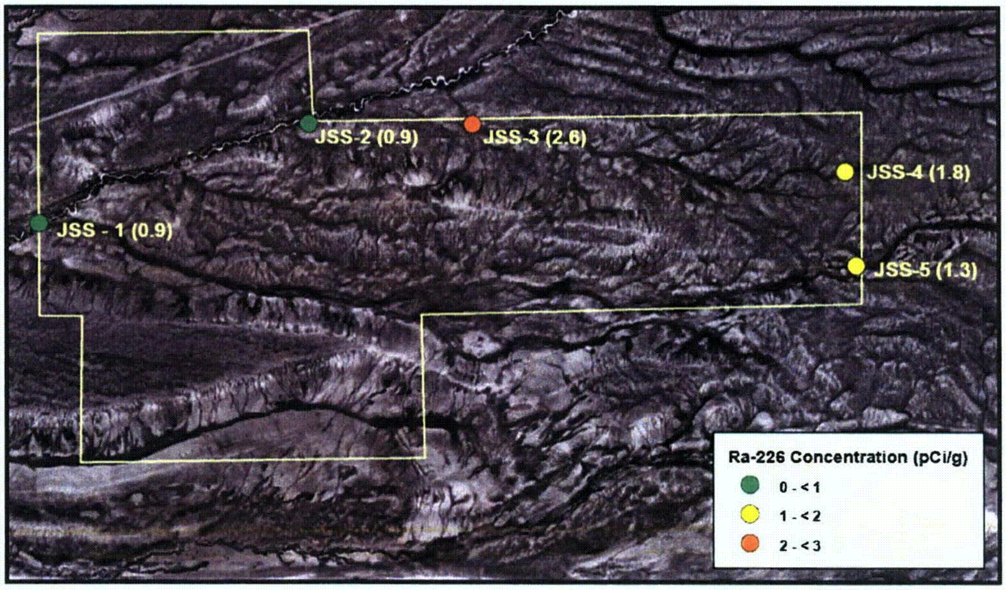

Figure 2.9-27: JAB: sediment sampling locations and respective Ra-226 concentration results for ephemeral stream drainage channels.

2.9.4.3 Conclusions

Baseline sediment radionuclide data for the Antelope and JAB Uranium Project sites were collected and analyzed according to Regulatory Guide 4.14 protocols. Once analytical results from the May 2008 round of stream sediment sampling are available in the supplemental report (Addendum 2.9-A). This section will be updated accordingly in a supplemental report to the NRC and WDEQ/LQD. This information should be sufficient to meet the minimum respective baseline survey requirements as indicated by the U.S. Nuclear Regulatory Commission and the Wyoming Department of Environmental Quality / Land Quality Division with respect to ISR licensing/permitting applications.

2.9.4.4 Reference

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

2.9.5 Ambient Gamma and Radon Monitoring

Continuous passive monitoring of ambient gamma dose rates and radon concentrations within the Antelope and JAB Uranium Project areas was initiated in March 2007. 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 were collected and reported on a quarterly basis.

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 at each site, 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 Figures 2.9-28 and 2.9-29.

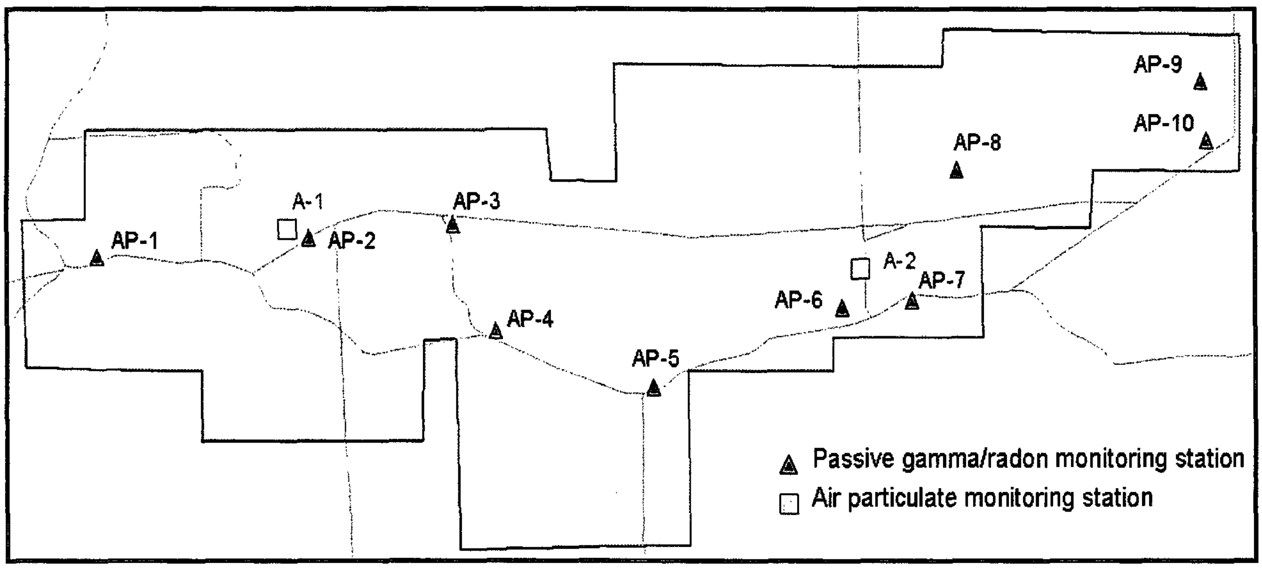

Figure 2.9-28: Antelope: approximate passive gamma/radon and air particulate monitoring station locations.

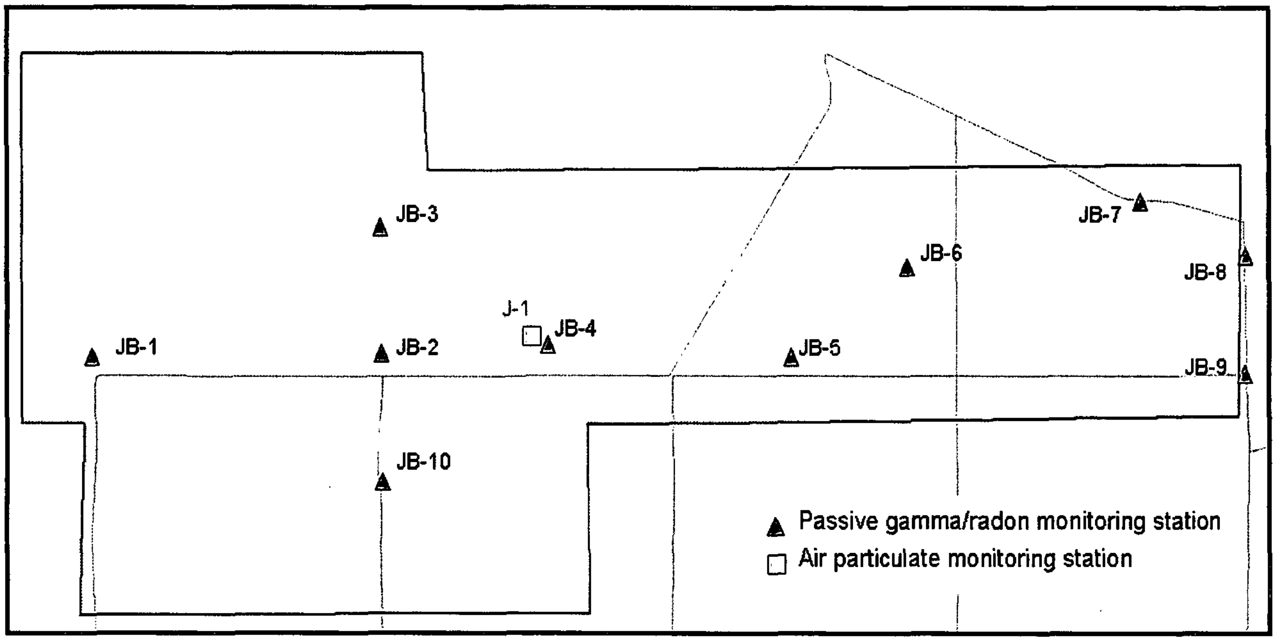

Figure 2.9-29: JAB: approximate passive gamma/radon and air particulate monitoring station locations.

2.9.5.1 Methods

2.9.5.1.1 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 2.9-30). Radon monitoring devices are also housed in these spigot covers.

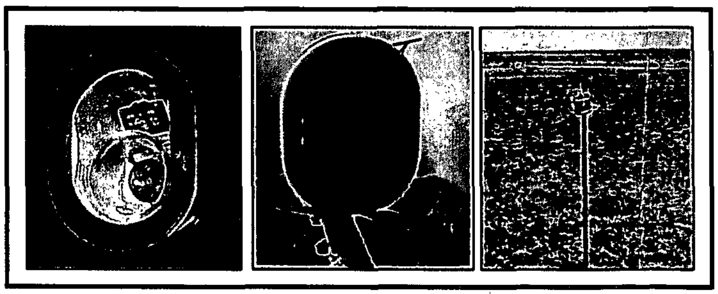

Figure 2.9-30: Photos of passive gamma/radon monitoring station equipment.

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 (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 representing the amount of time the field badges are not actually deployed at the site. For this project, 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 sites to begin the gamma monitoring program, begin/end dates for the first two quarters of TLD data for these sites were out of sync with Landauer's normal quarterly schedule. The third quarterly change out was delayed one month to synchronize the TLD monitoring

2.9.5.1.2 Ambient Radon-222 Monitoring

Passive monitoring of Rn-222 air concentrations at these sites 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 2.9-30. 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 the sites, it was necessary to open the first quarter's batch of detectors prior to traveling to the sites 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) until deployment to the site two days later.

2.9.5.2 Ambient Gamma and Radon Results

2.9.5.2.1 Ambient Gamma Dose Rate Monitoring Results

Passive gamma dose monitoring results are presented graphically in Figure 2.9-31 and in tabular format in Tables 2.9-3 and 2.9-4. In general, measured dose rates at each site typically ranged between 0.015 and 0.025 mrem/hr. Assuming a conventional radiation weighting factor of 1, these dose rates are consistent with the gamma survey results at these sites, which mostly ranged between 15 and 25 μR/hr (see Figures 2.9-13 and 2.9-14).

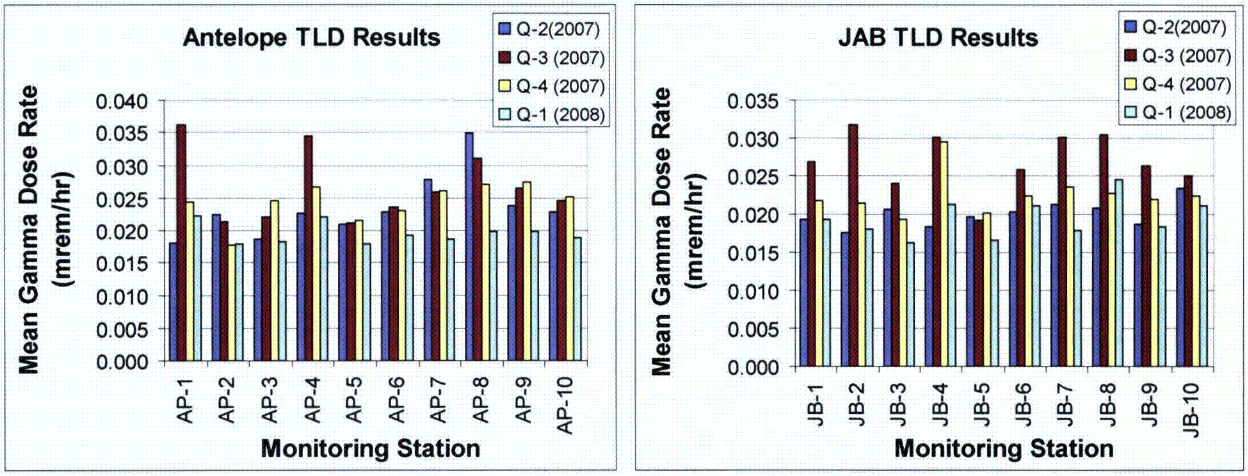

Figure 2.9-31: Gamma dose rate results for quarters 1 and 2 at Antelope (left) and JAB (right).

Table 2.9-3: Antelope: environmental gamma dose rate monitoring data for four consecutive quarters.

Passive Monitoring Station ID	TLD Issue Date	Field Installation Date	Monitoring End Date	Landauer GROSS Result (mrems)	Estimated Quarterly Field Dose (mrem)	Estimated Daily Field Dose (mrem)	Estimated Field Dose Rate (mrem/hr)
QUARTER 2 (2007)							
AP-1	1/1/2007	3/6/2007	6/5/2007	62.8	39.3	0.432	0.018
AP-2	1/1/2007	3/6/2007	6/5/2007	72.7	49.2	0.541	0.023
AP-3	1/1/2007	3/6/2007	6/5/2007	64.2	40.7	0.447	0.019
AP-4	1/1/2007	3/6/2007	6/5/2007	73.0	49.5	0.544	0.023
AP-5	1/1/2007	3/7/2007	6/5/2007	69.1	45.6	0.501	0.021
AP-6	1/1/2007	3/7/2007	6/5/2007	73.3	49.8	0.547	0.023
AP-7	1/1/2007	3/7/2007	6/5/2007	84.3	60.8	0.668	0.028
AP-8	1/1/2007	3/7/2007	6/5/2007	99.8	76.3	0.839	0.035
AP-9	1/1/2007	3/7/2007	6/5/2007	75.6	52.1	0.573	0.024
AP-10	1/1/2007	3/7/2007	6/5/2007	73.3	49.8	0.547	0.023
Transit control	1/1/2007	-	6/5/2007	54.0	-	-	-
Deploy control	1/1/2007	-	6/5/2007	54.2	-	-	-
QUARTER 3 (2007)							
AP-1	4/1/2007	6/5/2007	10/8/2007	104.7	79.0	0.868	0.036
AP-2	4/1/2007	6/5/2007	10/8/2007	72.5	46.8	0.514	0.021
AP-3	4/1/2007	6/5/2007	10/8/2007	73.8	48.1	0.528	0.022
AP-4	4/1/2007	6/5/2007	10/8/2007	101.1	75.4	0.828	0.035
AP-5	4/1/2007	6/5/2007	10/8/2007	71.7	46.0	0.505	0.021
AP-6	4/1/2007	6/5/2007	10/8/2007	77.1	51.4	0.565	0.024
AP-7	4/1/2007	6/5/2007	10/8/2007	82.4	56.7	0.623	0.026
AP-8	4/1/2007	6/5/2007	10/8/2007	93.6	67.9	0.746	0.031
AP-9	4/1/2007	6/5/2007	10/8/2007	83.5	57.8	0.635	0.026
AP-10	4/1/2007	6/5/2007	10/8/2007	79.3	53.6	0.589	0.025
Transit control	4/1/2007	-	10/8/2007	67.2	-	-	-
Deploy control	4/1/2007	-	10/8/2007	68.8	-	-	-
QUARTER 4 (2007)							
AP-1	10/1/2007	10/8/2007	1/2/2008	57.8	50.5	0.587	0.024
AP-2	10/1/2007	10/8/2007	1/2/2008	43.8	36.5	0.424	0.018
AP-3	10/1/2007	10/8/2007	1/2/2008	57.9	50.6	0.588	0.025
AP-4	10/1/2007	10/8/2007	1/2/2008	62.2	54.9	0.638	0.027
AP-5	10/1/2007	10/8/2007	1/2/2008	51.8	44.5	0.517	0.022
AP-6	10/1/2007	10/8/2007	1/2/2008	54.8	47.5	0.552	0.023
AP-7	10/1/2007	10/8/2007	1/2/2008	61.0	53.7	0.624	0.026
AP-8	10/1/2007	10/8/2007	1/2/2008	63.1	55.8	0.649	0.027
AP-9	10/1/2007	10/8/2007	1/2/2008	63.9	56.6	0.658	0.027
AP-10	10/1/2007	10/8/2007	1/2/2008	59.1	51.8	0.602	0.025
Transit control	10/1/2007	-	1/2/2008	52.4	-	-	-
Deploy control	10/1/2007	-	1/2/2008	53.3	-	-	-
QUARTER 1 (2008)							
AP-1	1/1/2008	1/2/2008	4/22/2008	62.5	59.2	0.533	0.022
AP-2	1/1/2008	1/2/2008	4/22/2008	50.8	47.5	0.428	0.018
AP-3	1/1/2008	1/2/2008	4/22/2008	51.9	48.6	0.438	0.018
AP-4	1/1/2008	1/2/2008	4/22/2008	62.4	59.1	0.533	0.022
AP-5	1/1/2008	1/2/2008	4/22/2008	50.9	47.6	0.429	0.018
AP-6	1/1/2008	1/2/2008	4/22/2008	54.6	51.3	0.462	0.019
AP-7	1/1/2008	1/2/2008	4/22/2008	53.2	49.9	0.450	0.019
AP-8	1/1/2008	1/2/2008	4/22/2008	56.1	52.8	0.476	0.020
AP-9	1/1/2008	1/2/2008	4/22/2008	56.0	52.7	0.475	0.020
AP-10	1/1/2008	1/2/2008	4/22/2008	53.6	50.3	0.453	0.019
Transit control	1/1/2008	-	4/22/2008	46.5	-	-	-
Deploy control	1/1/2008	-	4/22/2008	47.4	-	-	-

Table 2.9-4: JAB: environmental gamma dose rate monitoring data for four consecutive quarters.

Passive Monitoring Station ID	TLD Issue Date	Field Installation Date	Monitoring End Date	Landauer GROSS Result (mrems)	Estimated Quarterly Field Dose (mrem)	Estimated Daily Field Dose (mrem)	Estimated Field Dose Rate (mrem/hr)
QUARTER 2 (2007)							
JB-1	1/1/2007	3/6/2007	6/5/2007	65.8	42.3	0.465	0.019
JB-2	1/1/2007	3/6/2007	6/5/2007	61.8	38.3	0.421	0.018
JB-3	1/1/2007	3/6/2007	6/5/2007	68.5	45.0	0.495	0.021
JB-4	1/1/2007	3/6/2007	6/5/2007	63.7	40.2	0.442	0.018
JB-5	1/1/2007	3/7/2007	6/5/2007	66.6	43.1	0.474	0.020
JB-6	1/1/2007	3/7/2007	6/5/2007	67.9	44.4	0.488	0.020
JB-7	1/1/2007	3/7/2007	6/5/2007	69.9	46.4	0.510	0.021
JB-8	1/1/2007	3/7/2007	6/5/2007	68.9	45.4	0.499	0.021
JB-9	1/1/2007	3/7/2007	6/5/2007	64.3	40.8	0.448	0.019
JB-10	1/1/2007	3/7/2007	6/5/2007	74.6	51.1	0.562	0.023
Transit control	1/1/2007	-	6/5/2007	54.0	-	-	-
Deploy control	1/1/2007	-	6/5/2007	54.2	-	-	-
QUARTER 3 (2007)							
JB-1	4/1/2007	6/5/2007	10/8/2007	84.5	58.8	0.646	0.027
JB-2	4/1/2007	6/5/2007	10/8/2007	95.2	69.5	0.763	0.032
JB-3	4/1/2007	6/5/2007	10/8/2007	78.3	52.6	0.578	0.024
JB-4	4/1/2007	6/5/2007	10/8/2007	91.5	65.8	0.723	0.030
JB-5	4/1/2007	6/5/2007	10/8/2007	67.5	41.8	0.459	0.019
JB-6	4/1/2007	6/5/2007	10/8/2007	82.4	56.7	0.623	0.026
JB-7	4/1/2007	6/5/2007	10/8/2007	91.4	65.7	0.722	0.030
JB-8	4/1/2007	6/5/2007	10/8/2007	92.2	66.5	0.731	0.030
JB-9	4/1/2007	6/5/2007	10/8/2007	83.3	57.6	0.633	0.026
JB-10	4/1/2007	6/5/2007	10/8/2007	80.5	54.8	0.602	0.025
Transit control	4/1/2007	-	10/8/2007	67.2	-	-	-
Deploy control	4/1/2007	-	10/8/2007	68.8	-	-	-
QUARTER 4 (2007)							
JB-1	10/1/2007	10/8/2007	1/2/2008	52.5	45.2	0.525	0.022
JB-2	10/1/2007	10/8/2007	1/2/2008	51.8	44.5	0.517	0.022
JB-3	10/1/2007	10/8/2007	1/2/2008	47.4	40.1	0.466	0.019
JB-4	10/1/2007	10/8/2007	1/2/2008	68.1	60.8	0.707	0.029
JB-5	10/1/2007	10/8/2007	1/2/2008	48.9	41.6	0.484	0.020
JB-6	10/1/2007	10/8/2007	1/2/2008	53.6	46.3	0.538	0.022
JB-7	10/1/2007	10/8/2007	1/2/2008	56.0	48.7	0.566	0.024
JB-8	10/1/2007	10/8/2007	1/2/2008	54.2	46.9	0.545	0.023
JB-9	10/1/2007	10/8/2007	1/2/2008	52.6	45.3	0.527	0.022
JB-10	10/1/2007	10/8/2007	1/2/2008	53.7	46.4	0.539	0.022
Transit control	10/1/2007	-	1/2/2008	52.4	-	-	-
Deploy control	10/1/2007	-	1/2/2008	53.3	-	-	-
QUARTER 1 (2008)							
JB-1	1/1/2008	1/2/2008	4/22/2008	55.1	51.8	0.467	0.019
JB-2	1/1/2008	1/2/2008	4/22/2008	51.4	48.1	0.433	0.018
JB-3	1/1/2008	1/2/2008	4/22/2008	46.5	43.2	0.389	0.016
JB-4	1/1/2008	1/2/2008	4/22/2008	60.3	57.0	0.514	0.021
JB-5	1/1/2008	1/2/2008	4/22/2008	47.5	44.2	0.398	0.017
JB-6	1/1/2008	1/2/2008	4/22/2008	59.8	56.5	0.509	0.021
JB-7	1/1/2008	1/2/2008	4/22/2008	50.9	47.6	0.429	0.018
JB-8	1/1/2008	1/2/2008	4/22/2008	68.7	65.4	0.589	0.025
JB-9	1/1/2008	1/2/2008	4/22/2008	52.4	49.1	0.442	0.018
JB-10	1/1/2008	1/2/2008	4/22/2008	59.6	56.3	0.507	0.021
Transit control	1/1/2008	-	4/22/2008	46.5	-	-	-
Deploy control	1/1/2008	-	4/22/2008	47.4	-	-	-

The TLD data for both sites suggest that quarterly differences in average gamma dose rates at a given location can vary significantly, exceeding ± 0.01 mrem/hr in some cases. However, a number of passive station housings were found lying on the ground after being rubbed off the fence posts by pronghorns or cattle. This circumstance was particularly prevalent during the third quarter of 2007, with 13 of the 20 housings at the two sites found on the ground. In most cases affected housings were found relatively close to the posts, but in some cases housings were found at distances on the order of 50 meters or more away. Whether or not this might have influenced TLD results is unknown – assessment of the data in this regard was inconclusive. In addition to actual temporal variability in background sources of gamma radiation, spatial variation and/or measurement error may also have contributed to cases of significant variation.

2.9.5.2.2 Ambient Rn-222 Monitoring Results

A comparative summary of average Rn-222 results by quarter for the two sites is shown in Figure 2.9-32. Tabular data for individual stations are presented in Tables 2.9-5 and 2.9-6. The problem of animals rubbing passive station housings off of fence posts caused significant data loss in the third quarter 2007 monitoring period, with many detectors being damaged by water infiltration and rendered unreadable. Despite this problem, the available data provide a good indication of the magnitude of ambient Rn-222 air concentrations that exist at these sites. Measured ambient radon concentrations were generally slightly higher than the national average value of approximately 0.4 pCi/L (Foster, 1993). The highest quarterly values at both sites were observed in the third quarter of 2007. Slightly higher radon readings during summer months are consistent with findings at another ISR site in Wyoming (Moore Ranch; EMC, 2007). For each quarter, mean values at the JAB site were slightly higher than values measured at the Antelope site. The annual average Rn-222 concentrations measured at Antelope and JAB were 0.87 and 0.52 pCi/L respectively.

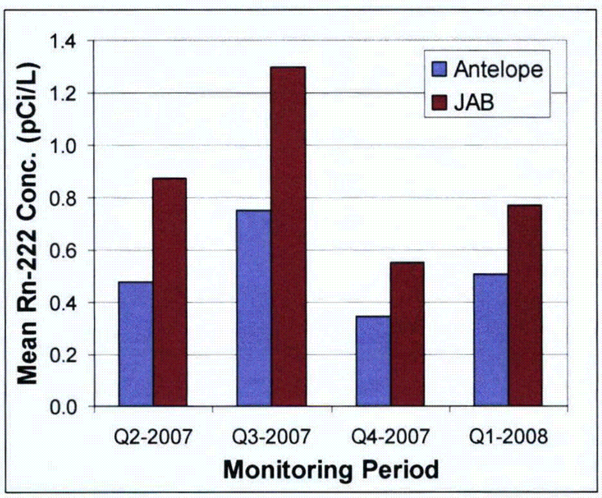

Figure 2.9-32: Average ambient Rn-222 results by quarter at Antelope and JAB.

Table 2.9-5: Antelope: ambient radon-222 monitoring data for four consecutive quarters.

Passive Monitoring Station ID	Radon Detector ID	Package Open Date	Field Installation Date	Quarter End (seal) Date	Quarterly Result (pCi-days/L)	Quarterly Result (pCi/L)
QUARTER 2 (2007)						
AP-1	4680343	3/4/2007	3/6/2007	6/5/2007	39.1	0.4
AP-2	4680344	3/4/2007	3/6/2007	6/5/2007	47.1	0.5
AP-3	4680353	3/4/2007	3/6/2007	6/5/2007	23.2	0.2
AP-4	4680354	3/4/2007	3/6/2007	6/5/2007	102.9	1.1
AP-5	4680355	3/4/2007	3/6/2007	6/5/2007	21.3	0.2
AP-6	4680356	3/4/2007	3/6/2007	6/5/2007	55.7	0.6
AP-7	4680345	3/4/2007	3/6/2007	6/5/2007	35.8	0.4
AP-8	4680346	3/4/2007	3/6/2007	6/5/2007	44.4	0.5
AP-9	4680347	3/4/2007	3/6/2007	6/5/2007	33.2	0.4
AP-10	4680347	3/4/2007	3/6/2007	6/5/2007	50.4	0.5
QUARTER 3 (2007)						
AP-1	4680419	6/5/2007	6/5/2007	10/8/2007	92.2	0.7
AP-2	4680420	6/5/2007	6/5/2007	10/8/2007	-	-
AP-3	4680421	6/5/2007	6/5/2007	10/8/2007	-	-
AP-4	4680422	6/5/2007	6/5/2007	10/8/2007	-	-
AP-5	4680437	6/5/2007	6/5/2007	10/8/2007	-	-
AP-6	4680438	6/5/2007	6/5/2007	10/8/2007	-	-
AP-7	4680430	6/5/2007	6/5/2007	10/8/2007	-	-
AP-8	4680471	6/5/2007	6/5/2007	10/8/2007	94.9	0.8
AP-9	4680469	6/5/2007	6/5/2007	10/8/2007	-	-
AP-10	4680470	6/5/2007	6/5/2007	10/8/2007	-	-
QUARTER 4 (2007)						
AP-1	4680389	10/8/2007	10/8/2007	1/2/2008	6.0	0.1
AP-2	4680390	10/8/2007	10/8/2007	1/2/2008	51.4	0.6
AP-3	4680391	10/8/2007	10/8/2007	1/2/2008	6.0	0.1
AP-4	4680398	10/8/2007	10/8/2007	1/2/2008	78.6	0.9
AP-5	4680397	10/8/2007	10/8/2007	1/2/2008	26.2	0.3
AP-6	4680393	10/8/2007	10/8/2007	1/2/2008	13.0	0.2
AP-7	4680400	10/8/2007	10/8/2007	1/2/2008	40.8	0.5
AP-8	4680392	10/8/2007	10/8/2007	1/2/2008	38.2	0.4
AP-9	4680396	10/8/2007	10/8/2007	1/2/2008	13.0	0.2
AP-10	4680395	10/8/2007	10/8/2007	1/2/2008	24.2	0.3
QUARTER 1 (2008)						
AP-1	4680362	1/2/2008	1/2/2008	4/22/2008	6.0	0.1
AP-2	4680363	1/2/2008	1/2/2008	4/22/2008	104	0.9
AP-3	4680364	1/2/2008	1/2/2008	4/22/2008	58.1	0.5
AP-4	4680365	1/2/2008	1/2/2008	4/22/2008	103.3	0.9
AP-5	4680411	1/2/2008	1/2/2008	4/22/2008	46.9	0.4
AP-6	4680412	1/2/2008	1/2/2008	4/22/2008	73.4	0.7
AP-7	4680414	1/2/2008	1/2/2008	4/22/2008	52.8	0.5
AP-8	4680413	1/2/2008	1/2/2008	4/22/2008	40.9	0.4
AP-9	4680410	1/2/2008	1/2/2008	4/22/2008	43.6	0.4
AP-10	4680408	1/2/2008	1/2/2008	4/22/2008	33	0.3

Red font = result below analytical reporting limits

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Table 2.9-6: JAB: ambient radon-222 monitoring data for four consecutive quarters.

Passive Monitoring Station ID	Radon Detector ID	Package Open Date	Field Installation Date	Quarter End (seal) Date	Quarterly Result (pCi-days/L)	Quarterly Result (pCi/L)
			QUARTER 2 (2007)			
JB-1	4680384	3/4/2007	3/6/2007	6/5/2007	82.9	0.9
JB-2	4680385	3/4/2007	3/6/2007	6/5/2007	91.6	1.0
JB-3	4680386	3/4/2007	3/6/2007	6/5/2007	-	-
JB-4	4680388	3/4/2007	3/6/2007	6/5/2007	-	-
JB-5	4680357	3/4/2007	3/6/2007	6/5/2007	106.8	1.1
JB-6	4680358	3/4/2007	3/6/2007	6/5/2007	144.1	1.5
JB-7	4680359	3/4/2007	3/6/2007	6/5/2007	48.4	0.5
JB-8	4680361	3/4/2007	3/6/2007	6/5/2007	36.5	0.4
JB-9	4680340	3/4/2007	3/6/2007	6/5/2007	94.9	1.0
JB-10	4680341	3/4/2007	3/6/2007	6/5/2007	59.0	0.6
			QUARTER 3 (2007)			
JB-1	4680372	6/5/2007	6/5/2007	10/8/2007	223	1.8
JB-2	4680373	6/5/2007	6/5/2007	10/8/2007	158	1.3
JB-3	4680374	6/5/2007	6/5/2007	10/8/2007	-	-
JB-4	4680383	6/5/2007	6/5/2007	10/8/2007	-	-
JB-5	4680382	6/5/2007	6/5/2007	10/8/2007	-	-
JB-6	4680381	6/5/2007	6/5/2007	10/8/2007	-	-
JB-7	4680380	6/5/2007	6/5/2007	10/8/2007	114	0.9
JB-8	4680402	6/5/2007	6/5/2007	10/8/2007	156	1.2
JB-9	4680403	6/5/2007	6/5/2007	10/8/2007	-	-
JB-10	4680371	6/5/2007	6/5/2007	10/8/2007	-	-
			QUARTER 4 (2007)			
JB-1	4680399	10/8/2007	10/8/2007	1/2/2008	70.0	0.8
JB-2	4680367	10/8/2007	10/8/2007	1/2/2008	48.1	0.6
JB-3	4680366	10/8/2007	10/8/2007	1/2/2008	48.1	0.6
JB-4	4680370	10/8/2007	10/8/2007	1/2/2008	44.1	0.5
JB-5	4680369	10/8/2007	10/8/2007	1/2/2008	57.4	0.7
JB-6	4680418	10/8/2007	10/8/2007	1/2/2008	79.9	0.9
JB-7	4680394	10/8/2007	10/8/2007	1/2/2008	34.8	0.4
JB-8	4680416	10/8/2007	10/8/2007	1/2/2008	20.9	0.2
JB-9	4680417	10/8/2007	10/8/2007	1/2/2008	57.4	0.7
JB-10	4680415	10/8/2007	10/8/2007	1/2/2008	13.0	0.2
			QUARTER 1 (2008)			
JB-1	4680474	1/2/2008	1/2/2008	4/22/2008	83.4	0.8
JB-2	4680472	1/2/2008	1/2/2008	4/22/2008	86.7	0.8
JB-3	4680331	1/2/2008	1/2/2008	4/22/2008	132.6	1.2
JB-4	4680332	1/2/2008	1/2/2008	4/22/2008	-	-
JB-5	4680334	1/2/2008	1/2/2008	4/22/2008	75.4	0.7
JB-6	4680333	1/2/2008	1/2/2008	4/22/2008	97.3	0.9
JB-7	4680330	1/2/2008	1/2/2008	4/22/2008	61.5	0.6
JB-8	4680406	1/2/2008	1/2/2008	4/22/2008	100.6	0.9
JB-9	4680409	1/2/2008	1/2/2008	4/22/2008	87.3	0.8
JB-10	4680473	1/2/2008	1/2/2008	4/22/2008	44.9	0.4

Red font = result below analytical reporting limits

2.9.5.3 Conclusions

Baseline ambient gamma dose rate and radon-222 air concentration data for the Antelope and JAB Uranium Projects were collected and analyzed according to Regulatory Guide 4.14 protocols. Gamma dose rate results are generally consistent with gamma exposure rate survey data. In general, ambient radon concentration results were slightly higher than the reported national average. Measured values at JAB were slightly higher than values measured at the Antelope site.

2.9.5.4 References

EMC (Energy Metals Corporation US). 2007. *Application for US NRC Source Material License, Moore Ranch Uranium Project.* Technical Report, Volume II. NRC website, ADAMS accession number ML072851268

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

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

2.9.6 Air Particulate Monitoring

Continuous monitoring of baseline air particulate radionuclide concentrations was initiated in late May 2007 at the Antelope site and early June at the JAB site. 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. An off-site location is also part of the air particulate monitoring program.

Low-volume air particulate sampling station locations were selected based on Regulatory Guide 4.14 guidance, including consideration for the locations of plant facilities, prevailing wind directions, and practical access. Given the remote nature of the sites and lack of existing power supply, these stations were set up using solar/wind generation equipment to supply electrical power to the air samplers. Locations of air particulate monitoring stations at each site are shown in Figures 2.9-28 and 2.9-29 of the previous section of this report.

Given the prevailing wind directions in the region (WSW), the JAB station serves as a location upwind of proposed plant operations the JAB site. Antelope 1 serves as a location generally downwind of proposed plant operations at JAB, and an upwind location for Antelope. Antelope 2 serves as a location generally downwind of proposed plant operations at Antelope. Located about 10-20 miles east of these sites, the town of Bairoil, WY is the nearest location with known residences and an air monitoring station has been set up at the western edge of this community.

2.9.6.1 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 2.9-33). 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 2.9-34). This is intended to approximate an average breathing zone height.

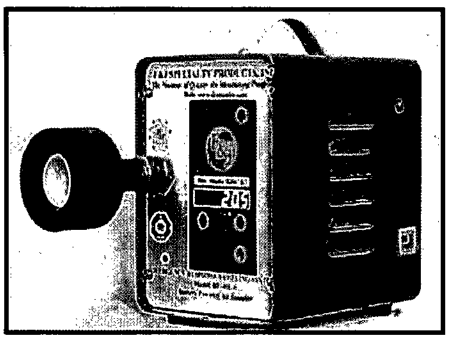

Figure 2.9-33: F&J air particulate sampler.

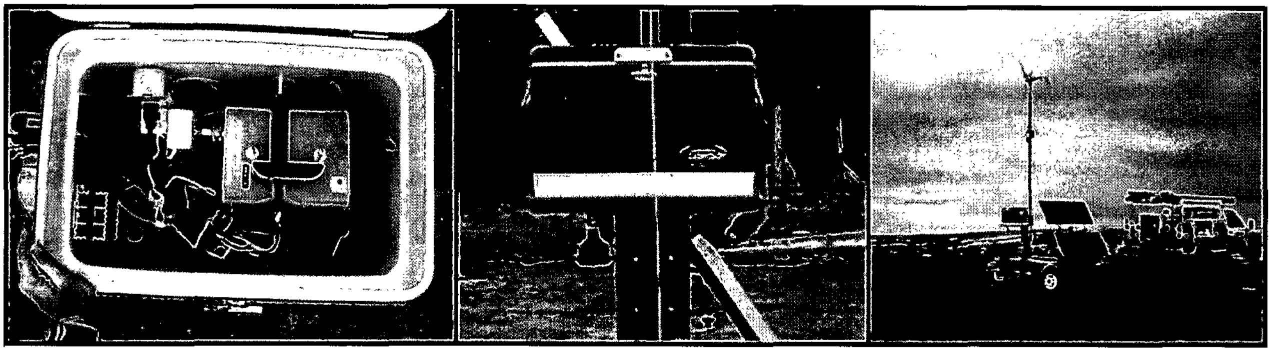

Figure 2.9-34: Air sampling station equipment and solar/wind powered system setup.

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.

2.9.6.2 Air Particulate Sampling Results

Baseline air particulate sampling results are presented in Table 2.9-7 and graphically illustrated in Figures 2.9-35 and 2.9-36. In most cases, analytical results are above the lower limits of detection (LLD). The LLD values listed in Table 2.9-7 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.

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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
Antelope-1	5/24/07 - 7/10/07	1.08E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	<1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	<3.33E-01
			Ra-226	1.48E-15	8.33E-16	1.00E-16	9.00E-13	1.65E-01
			Pb-210	3.76E-14	4.35E-15	2.00E-15	6.00E-13	6.27E+00
	7/10/07 - 9/28/07	2.23E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	<1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	<3.33E-01
			Ra-226	4.04E-16	3.14E-16	1.00E-16	9.00E-13	4.48E-02
			Pb-210	9.10E-15	1.48E-15	2.00E-15	6.00E-13	1.52E+00
	9/28/07 - 1/9/08	2.90E+09	U-nat	3.45E-16	N/A	1.00E-16	9.00E-14	3.83E-01
			Th-230	1.86E-15	5.86E-16	1.00E-16	3.00E-14	6.21E-02
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-02
			Pb-210	1.44E-14	1.69E-15	2.00E-15	6.00E-13	2.40E+00
	1/9/08 - 4/22/08	2.51E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	<1.11E-01
			Th-230	1.59E-16	1.99E-16	1.00E-16	3.00E-14	5.31E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-02
			Pb-210	1.64E-14	2.91E-15	2.00E-15	6.00E-13	2.73E+00
Antelope-2	5/24/07 - 7/10/07	1.29E+09	U-nat	2.33E-16	N/A	1.00E-16	9.00E-14	2.58E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	<3.33E-01
			Ra-226	2.09E-15	9.30E-16	1.00E-16	9.00E-13	2.33E-01
			Pb-210	2.27E-14	3.10E-15	2.00E-15	6.00E-13	3.79E+00
	7/10/07 - 9/28/07	2.39E+09	U-nat	2.09E-15	N/A	1.00E-16	9.00E-14	2.32E+00
			Th-230	1.09E-15	5.02E-16	1.00E-16	3.00E-14	3.63E+00
			Ra-226	5.02E-16	3.35E-16	1.00E-16	9.00E-13	5.58E-02
			Pb-210	1.20E-14	1.63E-15	2.00E-15	6.00E-13	1.99E+00
	9/28/07 - 1/8/08	1.68E+09	U-nat	1.19E-16	N/A	1.00E-16	9.00E-14	1.32E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	<3.33E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-02
			Pb-210	1.57E-14	2.37E-15	2.00E-15	6.00E-13	2.61E+00
	1/8/08 - 4/22/08	2.01E+09	U-nat	7.91E-15	N/A	1.00E-16	9.00E-14	8.79E+00
			Th-230	2.81E-14	2.59E-15	1.00E-16	3.00E-14	9.35+01
			Ra-226	2.99E-16	4.48E-16	1.00E-16	9.00E-13	3.32E-02
			Pb-210	1.12E-14	2.69E-15	2.00E-15	6.00E-13	1.87E+00
JAB	6/11/07 - 7/10/07	2.58E+08	U-nat	7.75E-15	N/A	1.00E-16	9.00E-14	8.61E+00
			Th-230	1.90E-14	5.43E-15	1.00E-16	3.00E-14	6.33E+01
			Ra-226	3.10E-15	2.71E-15	1.00E-16	9.00E-13	3.45E-01
			Pb-210	1.09E-13	1.51E-14	2.00E-15	6.00E-13	1.82E+01
	7/10/07 - 9/28/07	2.56E+09	U-nat	9.77E-16	N/A	1.00E-16	9.00E-14	1.09E+00
			Th-230	2.58E-15	7.42E-16	1.00E-16	3.00E-14	8.59E+00
			Ra-226	1.17E-15	5.08E-16	1.00E-16	9.00E-13	1.30E-01
			Pb-210	1.71E-14	1.88E-15	2.00E-15	6.00E-13	2.86E+00
	9/28/07 - 1/24/08	3.29E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	< 1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	< 3.33E-01
			Ra-226	1.25E-15	5.47E-16	1.00E-16	9.00E-13	1.38E-01
			Pb-210	1.59E-14	1.67E-15	2.00E-15	6.00E-13	2.66E+00
	1/24/08 - 4/22/08	2.31E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	< 1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	< 3.33E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-01
			Pb-210	3.38E-14	4.37E-15	2.00E-15	6.00E-13	5.63E+00
Bairoil	7/20/07 - 9/28/07	4.20E+09	U-nat	1.78E-14	N/A	1.00E-16	9.00E-14	1.98E+01
			Th-230	6.02E-15	8.81E-16	1.00E-16	3.00E-14	2.01E+01
			Ra-226	4.50E-15	7.86E-16	1.00E-16	9.00E-13	5.00E-01
			Pb-210	6.12E-15	8.81E-16	2.00E-15	6.00E-13	1.02E+00
	9/28/07 - 1/8/08	3.33E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	< 1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	< 3.33E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-01
			Pb-210	1.32E-14	1.50E-15	2.00E-15	6.00E-13	2.19E+00
	1/8/08 - 4/22/08	3.48E+09	U-nat	<1.00E-16	N/A	1.00E-16	9.00E-14	< 1.11E-01
			Th-230	<1.00E-16	N/A	1.00E-16	3.00E-14	< 3.33E-01
			Ra-226	<1.00E-16	N/A	1.00E-16	9.00E-13	< 1.11E-01
			Pb-210	9.91E-15	1.93E-15	2.00E-15	6.00E-13	1.65E+00

Table 2.9-7: Air particulate radionuclide data to date for the Antelope and JAB Uranium Project sites, along with data collected at Bairoil, WY.

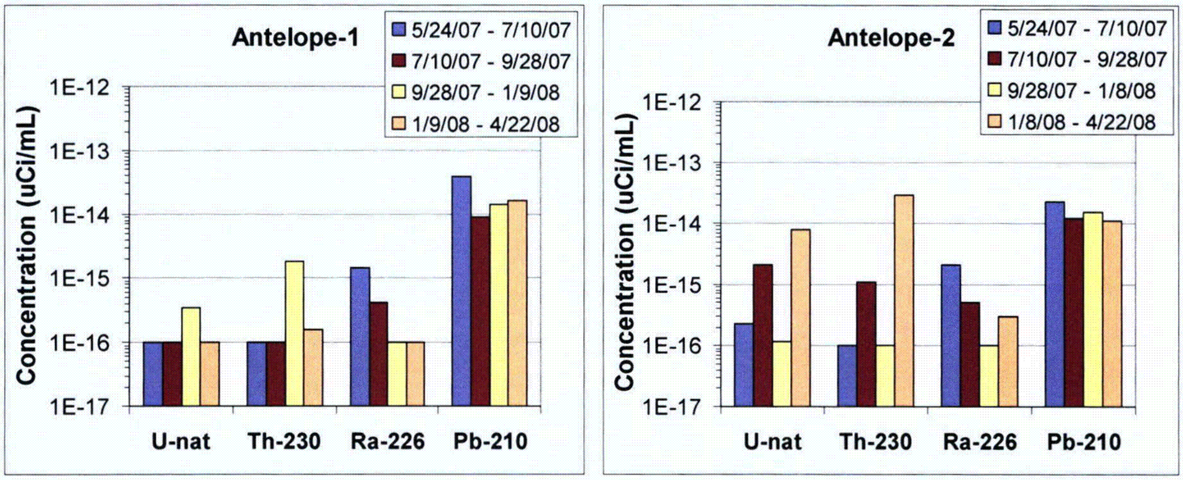


Figure 2.9-35: Antelope: monitoring station results for radionuclides in air particulate samples.

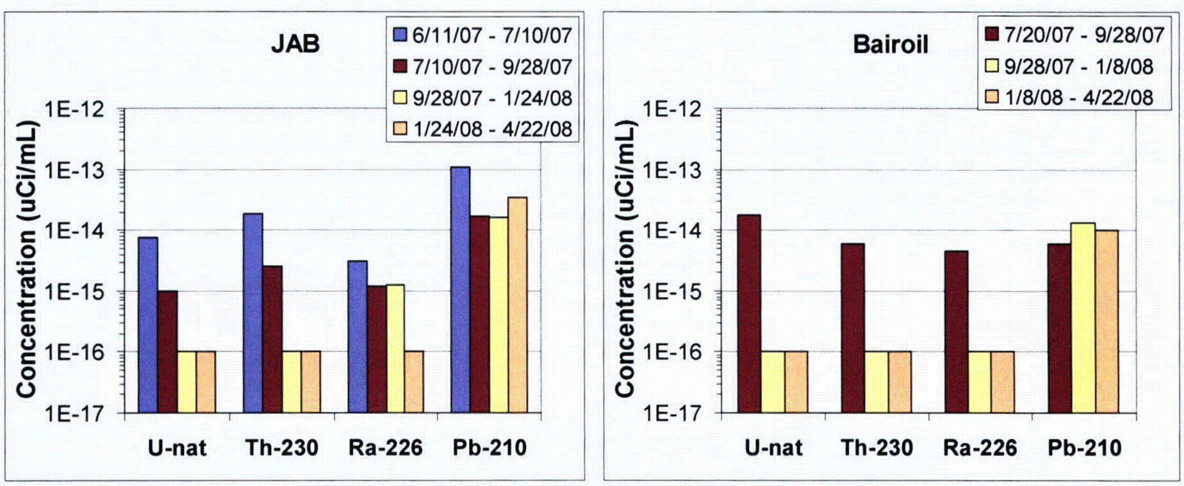


Figure 2.9-36: JAB and Bairoil: monitoring station results for radionuclides in air particulate samples.

2.9.6.3 Conclusions

Baseline air particulate concentration data for the Antelope and JAB Uranium Project areas were collected and analyzed according to Regulatory Guide 4.14 protocols. Four quarters of data are presented in this section of the overall report. Three quarters of data for the nearby community of Bairoil are also presented.

2.9.6.4 Reference

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

2.9.7 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 (NRC, 1980). Because there will be no tailings impoundments or evaporation ponds at these ISR sites, radon flux is unlikely to be an applicable radiological parameter for baseline characterization. Radon flux measurements are not planned at this time.

2.9.7.1 Reference

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

2.9.8 Groundwater Sampling

Baseline groundwater sampling was conducted at the Antelope and JAB Uranium Project areas in general accordance with Regulatory Guide 4.14 protocols (NRC, 1980). In this case, there are no tailings impoundments and respective guidance has been interpreted accordingly. Wells that are or could be used for drinking, livestock watering, or crop irrigation have also been sampled. A map of approximate well locations is shown in Figures 2.9-37 and 2.9-38. Comprehensive information on well locations and all water quality parameters is provided in sections of ISR licensing applications related specifically to groundwater (section 2.7.2).

Figure 2.9-37: Antelope: groundwater monitoring well locations.

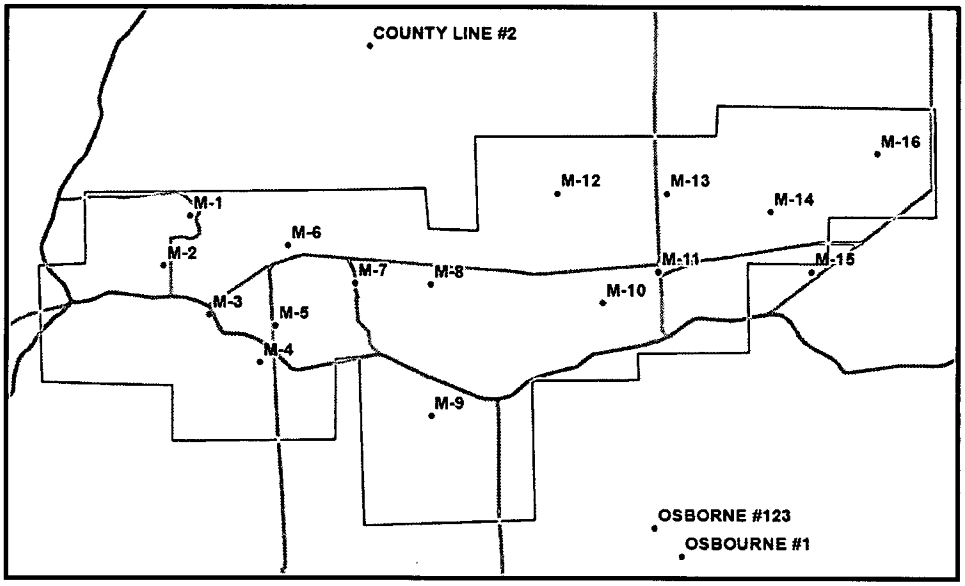
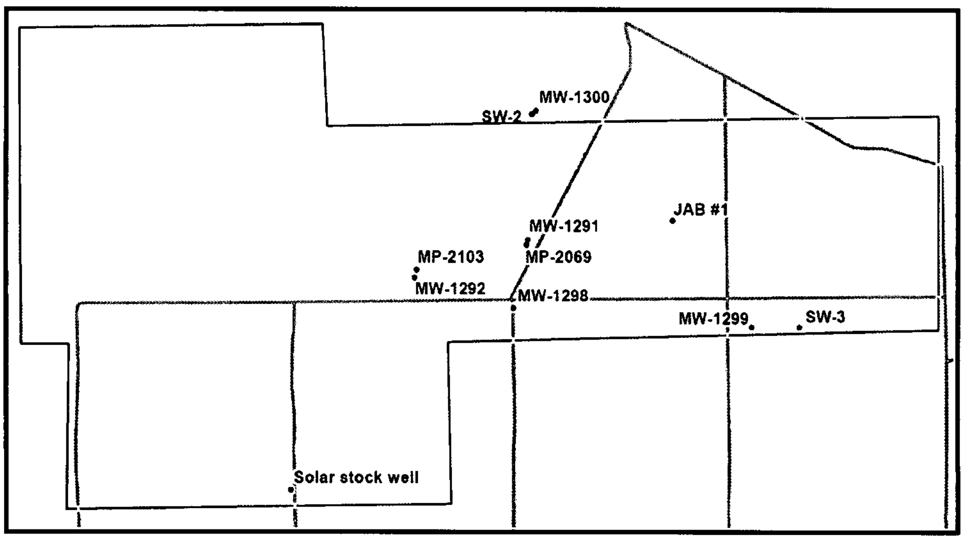


Figure 2.9-38: JAB: groundwater monitoring well locations.



2.9.8.1 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.

9.2.8.2 Groundwater Sampling Results

Results to date for dissolved radiological groundwater parameters are shown in Tables 2.9-8 and 2.9-9. Parameters in suspended form were also evaluated, but many were below analytical reporting limits and are not presented here (those data, reporting limits, and other details can be found in Section 2.7.2 of the application pertaining specifically to groundwater).

Table 2.9-8: Antelope: analytical results to date for radiological parameters in groundwater samples. Values with less-than qualifiers were below analytical reporting limits.

Well ID	Pb-210 pCi/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	Th-230 pCi/L	U-nat mg/L
Quarter 4, Calendar Year 2007						
M-4	4.1	1.5	22.8	2.9	<0.2	0.0116
M-5	<1.0	<1.0	7.2	4.9	<0.2	0.0058
M-8	-	-	4.1	4.3	-	0.0015
M-9	-	-	6.1	6.8	-	0.0208
M-10	<1.0	<1.0	14.1	<1.0	<0.2	0.0305
M-12	-	-	204	2.5	-	0.129
M-13	-	-	1.8	2.5	-	0.1
M-14	-	-	142	<1.0	-	0.0734
M-16	-	-	223	<1.0	-	0.639
Quarter 1, Calendar Year 2008						
M-1	7	1	1.7	2.9	0	0.235
MU-2	-10.3	0.9	5.1	5.8	0.1	0.0014
M-4	14	0.2	24.3	6.3	0.1	0.037
M-5	3.2	1.6	5.6	5.9	0	0.007
M-6	102	20	269	3.3	0.1	0.366
M-7	7	1.1	1.9	3.2	0	<0.0003
M-8	14.8	1.1	2.3	3.7	0	0.0023
M-9	19.6	2.3	5.2	6.8	0.5	0.016
M-10	-3.6	0.9	13.2	3	0	0.0313
M-11	-4.2	0.5	3.8	2.5	0	0.12
M-12	62.3	3	194	3	0	0.108
M-13	10.9	0.7	4.8	1.5	0	0.0994
MU-13	-3.3	1.9	6.3	1.6	0	0.0734
M-14	32.1	3.6	143	3	0.1	0.0588
M-15	2.8	0.8	3.3	5.9	0	0.0004
M-16	78.1	38	231	2.5	0.4	0.809
MP-16	45.7	3.3	129	3.7	0.3	0.0072
MU-16	11.2	-0.1	4.1	4.2	0	0.0703

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Table 2.9-9: JAB: analytical results to date for radiological parameters in groundwater samples. Values with less-than qualifiers were below analytical reporting limits.

Well ID	Pb-210 pCi/L	Po-210 pCi/L	Ra-226 pCi/L	Ra-228 pCi/L	Th-230 pCi/L	U-nat mg/L
Quarter 2, Calendar Year 2007						
JAB #1	<1.0	<1.0	5.3	6.4	<0.2	0.192
MW1291	16	24	155	4.1	<0.2	0.309
MW1292	<1.0	<1.0	3.3	<1.0	<0.2	0.106
MW1298	<1.0	<1.0	2.8	<1.0	<0.2	0.0918
MW1299	<1.0	<1.0	2.6	3.4	<0.2	0.418
MW 1300	<1.0	<1.0	2.5	<1.0	<0.2	0.0009
Quarter 3, Calendar Year 2007						
JAB #1	11	<1.0	4.2	<1.0	0.8	0.115
MW1291	<1.0	38	143	5.1	<0.2	0.324
MW1292	<1.0	<1.0	2.7	<1.0	<0.2	0.108
MW1298	<1.0	<1.0	1.6	6.4	<0.2	0.431
MW1299	<1.0	<1.0	2.2	5.2	<0.2	0.0553
MW 1300	<1.0	<1.0	5.1	<1.0	<0.2	0.0004
Quarter 4, Calendar Year 2007						
JAB #1	<1.0	1.4	4.0	7.0	<0.2	0.0983
MW1291	-	-	139	8.1	-	0.348
MW1292	-	-	5	2.1	-	0.164
MW1298	-	-	4	2.9	-	0.0956
MW1299	-	-	2.3	5.7	-	0.412
MW 1300	-	-	3	2.3	-	0.0011

9.2.8.3 Conclusions

Radiological baseline groundwater data for the Antelope and JAB Uranium Project areas presented in this section provide a characterization of baseline radionuclide concentrations in groundwater for review by the NRC and WDEQ/LQD with respect to licensing/permitting applications.

9.2.8.4 Reference

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

2.9.9 Surface Water Sampling

Although significant anthropogenic surface water impoundments were not observed at either of these sites, surface waters from areas of natural ephemeral ponding were sampled (primarily at JAB) during the short snowmelt/runoff period in the spring of 2007. Data for radiological parameters are presented in this section. Data for all surface water quality parameters are provided in the section of ISR licensing applications related specifically to surface water (Section 2.7.1). Approximate surface water sampling locations are shown in Figure 2.9-39.

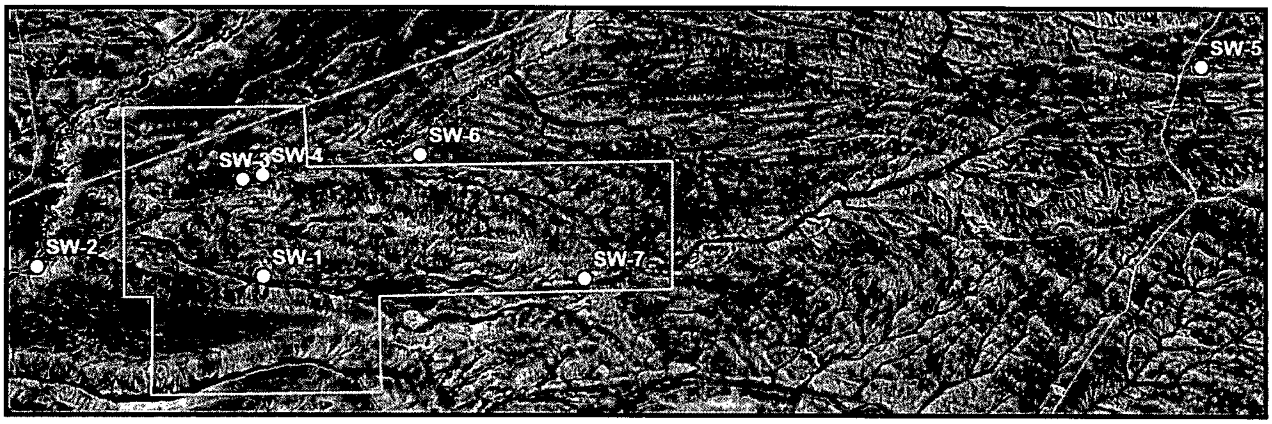

Figure 2.9-39: Surface water sampling locations.

2.9.9.1 Methods

Surface water samples were 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 directed in the Owner's Manual. Sample containers are flushed with the sample water in order to remove potential contaminants from the container. The bottle is then filled directly from the stream or pond with the with the sample bottle in a manner to prevent collecting debris or filled by using an alternate clean container. All samples analyzed by a contract laboratory are accompanied by a chain of custody to ensure proper analysis is performed and the sample is tracked.

2.9.9.2 Surface Water Sampling Results

Results for dissolved radiological water quality parameters are shown in Table 2.9-10. Most sample results for uranium are at or below analytical reporting limits, and all are well below the U.S. Environmental Protection Agency's (EPA's) 30 μg/L drinking water standard for uranium (EPA, 2000). Based on the conversion factor indicated in Table 2.9-10, an equivalent EPA uranium drinking water standard in units of specific activity is 20 pCi/L. Though well below this standard, the highest levels of radiological water quality parameters were found along the Arapahoe Creek drainage that runs through the JAB site (locations SW-2 and SW-4). One surface water sample was obtained from a location near the Antelope site (location SW-5). Respective results were consistent with those from the JAB vicinity samples. Given similarities in radiological surface soil and sediment concentrations between the Antelope and JAB sites (see Sections 2.9.2.2.4, 2.9.2.2.5, and 2.9.4.2), occasionally ponded surface runoff water at either site is likely to have generally similar radiological characteristics to those measured during the 2007 spring runoff event.

Table 2.9-10: Analytical results for baseline radiological parameters in surface water samples collected in spring, 2007. Values with less-than qualifiers were below analytical reporting limits.

Surface Water Sampling ID	Sampling Date	Uranium* (pCi/L)	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	Ra-226 (pCi/L)	Ra-228 (pCi/L)
SW-1	5/9/2007	<0.2	5.8	5.8	<0.2	1.5
SW-2	5/9/2007	3.0	19.5	14.4	5.2	<1.0
SW-3	5/9/2007	<0.2	5.6	5.7	<0.2	<1.0
SW-4	5/9/2007	2.8	16.8	11	2.2	<1.0
SW-5	5/9/2007	<0.2	1.6	2.1	<0.2	<1.0
SW-6	5/14/2007	0.2	3.8	4.2	<0.2	<1.0
SW-7	5/14/2007	<0.2	1.2	2.3	<0.2	<1.0

***Converted from units of mg/L to activity units of pCi/L using a conversion factor of 677 pCi/mg**

2.9.9.3 Conclusions

Radiological surface water data collected as part of baseline characterizations for these sites were limited due to the relatively infrequent occurrence of ponded surface water existing at these sites. The data obtained should nevertheless provide adequate characterization of baseline radionuclide concentrations in surface waters for review by the NRC and WDEQ/LQD with respect to licensing/permitting applications.

2.9.9.4 Reference

U.S. Environmental Protection Agency (EPA). 2000. *National Primary Drinking Water Regulations; Radionuclides; Final Rule*. Federal Register: December 7, 2000 (Volume 65, Number 236).

2.9.10 Vegetation Sampling

Vegetation sampling at the Antelope and JAB Uranium Project sites was initiated in August of 2007. Regulatory Guide 4.14 calls for several sampling events during the growing season (NRC, 1980). Vegetation at these sites is primarily comprised of sagebrush. Sagebrush has spring/fall cycles of growth and reproductive activity (Welch, 2005). Vegetation samples were collected in the August of 2007 and late May of 2008. Data from the fall 2007 sampling event are presented in this section. Data from the spring 2008 sampling event are contained in the supplementary baseline data report in Addendum 2.9-A. Vegetation sampling locations (Figure 2.9-40) were selected based on proximity to potential wellfield areas or plant facilities, along with consideration for prevailing wind directions and practical access.

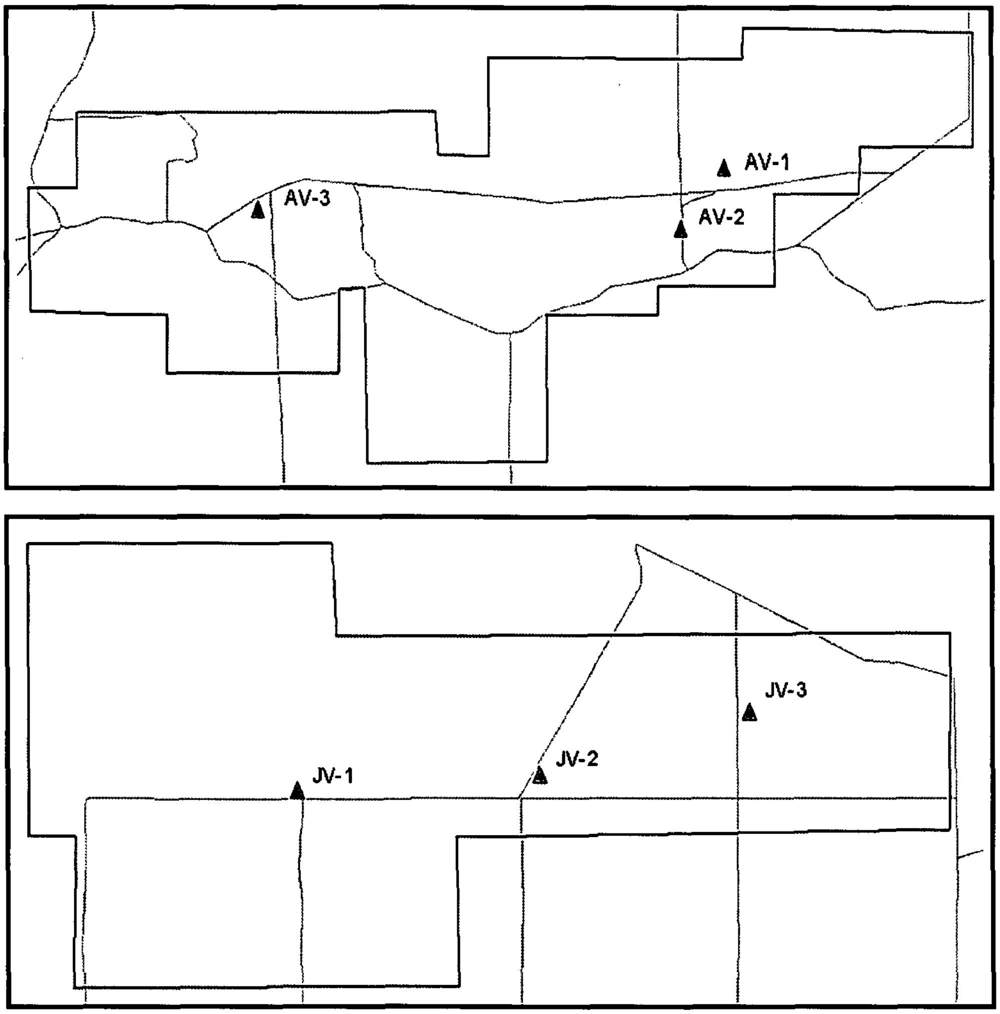

Figure 2.9-40: Vegetation sampling locations at the Antelope (top) and JAB (bottom).

2.9.10.1 Methods

Vegetation samples were collected using ordinary gardening tools (pruning shears, etc.) as mixed, above-ground growth across several hundred square meter areas at each sampling location. Though all varieties of vegetation at each location that could be practicably sampled were collected and composited into a single sample, sagebrush was by far the predominant species present, easily accounting for over 95% of the biomass that was able to be effectively sampled. An estimated 3-5 kilograms of total vegetation biomass per sample was collected. Samples were collected in large plastic bags and were sent to ELI in Casper, WY along with chain of custody forms. Analytes requested included all radiological parameters as recommended in Regulatory Guide 4.14.

2.9.10.2 Vegetation Sampling Results

Summary statistics for baseline vegetation sampling results to date are presented in Tables 2.9-11 and 2.9-12 and graphically in Figures 2.9-41 and 2.9-42. At Antelope, measured radionuclide levels are similar at each sampling location (Figure 2.9-42), though locations AV-1 and AV-2 show slightly higher values. Locations AV-1 and AV-2 were in the vicinity of areas with higher measured gammas and estimated Ra-226 concentrations (see Figures 2.9-13 and 2.9-21). Similarly at JAB, vegetation at location JV-3 had noticeably higher concentrations of Po-210, Ra-226, and Th-230 relative to other samples, and this sample was collected in the vicinity of higher measured gammas and estimated Ra-226 concentrations (see Figures 2.9-14 and 2.9-22). The higher radionuclide concentrations in vegetation samples at locations noted above may be related to plant uptake and/or dust loading on vegetation.

Table 2.9-11: Summary statistics for all vegetation samples collected in August 2007 for all sampling locations.

Analyte	Mean (uCi/kg)	Std. Dev. (uCi/kg)	Median (uCi/kg)	Max (uCi/kg)	Min (uCi/kg)	n
Pb-210	1.3E-03	4.2E-04	1.4E-03	1.7E-03	8.7E-04	3
Po-210	1.6E-04	5.9E-05	1.9E-04	2.0E-04	9.4E-05	3
Ra-226	2.3E-04	1.4E-04	2.3E-04	3.7E-04	1.0E-04	3
Th-230	5.1E-05	2.6E-05	5.8E-05	7.3E-05	2.3E-05	3
U-nat	1.0E-04	5.9E-05	1.1E-04	1.6E-04	4.3E-05	3

Table 2.9-12: Summary statistics for all vegetation samples collected in August 2007 for all sampling locations.

Analyte	Mean (uCi/kg)	Std. Dev. (uCi/kg)	Median (uCi/kg)	Max (uCi/kg)	Min (uCi/kg)	n
Pb-210	1.6E-03	1.7E-04	1.7E-03	1.7E-03	1.4E-03	3
Po-210	4.9E-04	2.3E-04	4.0E-04	7.5E-04	3.1E-04	3
Ra-226	6.2E-04	7.7E-04	1.9E-04	1.5E-03	1.6E-04	3
Th-230	1.1E-04	1.0E-04	5.7E-05	2.3E-04	5.4E-05	3
U-nat	9.0E-05	4.5E-05	7.6E-05	1.4E-04	5.4E-05	3

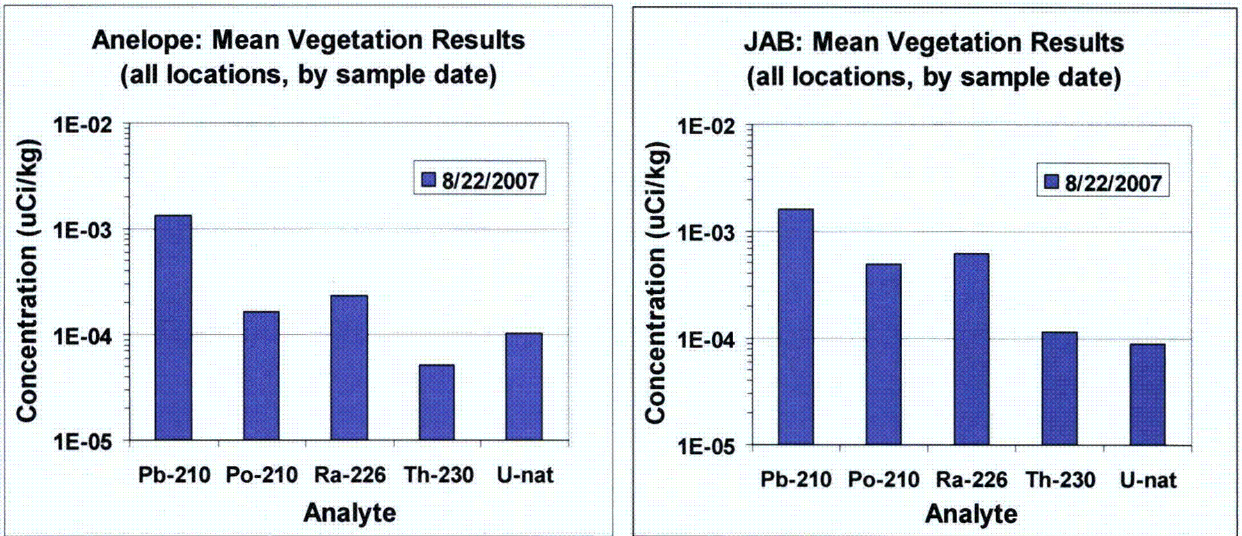

Figure 2.9-41: Analytical results for vegetation samples by sampling date for all locations at Antelope (left) and JAB (right).

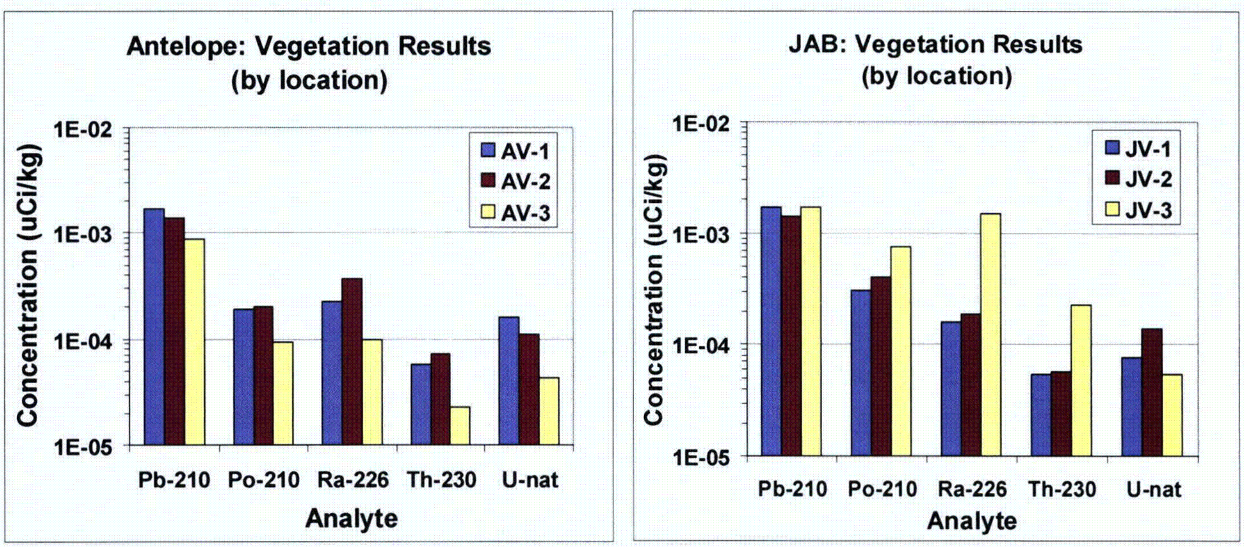

Figure 2.9-42: Analytical results for vegetation samples by sampling location at Antelope (left) and JAB (right).

Across all vegetation samples collected to date, lead-210 has the greatest activity levels of the five radionuclides analyzed, which is likely due to a higher relative abundance of Pb-210 in air particulates from radon decay products. This latter observation is supported by the air particulate data presented in Section 2.9.6 (note in Figures 2.9-35 and 2.9-36 that Pb-210 concentrations are consistently higher than other radionuclides evaluated).

2.9.10.3 Conclusions

Baseline vegetation sampling data for the Antelope and JAB Uranium Project areas are being collected and analyzed according to Regulatory Guide 4.14 protocols. To date, data from the fall 2007 sampling event are available and those results are presented in this section. Data from the May 2008 sampling events are contained in the supplemental baseline data report (Addendum 2.9-A). Samples to date with higher results may be a reflection of plant uptake and/or dust loading on vegetative surfaces due to locally higher soil radionuclide concentrations.

2.9.10.4 References

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

Welch, B.L. 2005. *Big sagebrush: A sea fragmented into lakes, ponds, and puddles*. General Technical Report RMRS-GTR-144. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 210 p.

2.9.11 Food Sampling

Sampling of food items from the site such as meat from local grazing livestock is not planned at this time. 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. Changes in these parameters due to site operations could be used to model corresponding radiological changes in food items such as meat or milk from agricultural livestock. Respective radionuclide transfer factors can be found in the literature (e.g. IAEA, 1994; Yu, 2001). Larger game animals such as deer or pronghorn have extensive ranges and potential for bioaccumulation of radionuclides in these animals due to site operations is unlikely to be significant as they would likely derive only a small fraction of total sustenance from the site.

2.9.11.1 References

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

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

2.9.12 Summary and Overall Conclusions

Comprehensive baseline radiological surveys of the Antelope and JAB Uranium Project areas in the Great Divide Basin of Sweetwater County, Wyoming have been conducted in a manner consistent with Regulatory Guide 4.14 guidance (NRC, 1980) as part of licensing/permitting application submittals to the U.S. Nuclear Regulatory Commission and Wyoming Department of Environmental Quality / Land Quality Division. As of the effective date of this report, results for certain environmental baseline samples collected in May of 2008 are still pending at the laboratory. Respective sample results include Regulatory Guide 4.14 soil sampling and final sampling events for stream sediments and vegetation. These data will be provided to the NRC and WDEQ/LQD in a supplemental baseline data report as soon as they are available (expected in June, 2008).

The gamma exposure rate survey data, collected in the spring and summer of 2007 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 state-of-the-art mapping approaches, provides a very detailed characterization of the magnitude and spatial variability in background gamma exposure rates and soil Ra-226 concentrations across these sites (about 14,700 acres in total area). The approach of high-density gamma scanning, gamma/Ra-226 correlations, HPIC cross-calibrations, and integrated use of GIS for spatial analyses and data presentation should meet or exceed regulatory guidelines for baseline characterizations and is expected to provide significant benefits to all stakeholders.

2.9.12.1 Reference

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

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ADDENDUM 2.9-A

SUPPLEMENTAL ANALYTICAL MONITORING DATA:

ADDITIONAL BASELINE RADIOLOGICAL SURVEY RESULTS FOR THE ANTELOPE AND JAB URANIUM PROJECT SITES

SUPPLEMENTAL ANALYTICAL MONITORING DATA:

ADDITIONAL BASELINE RADIOLOGICAL SURVEY RESULTS FOR THE ANTELOPE AND JAB URANIUM PROJECT SITES

Prepared for:

Uranium One Americas

August 21, 2008

Prepared by:

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Fort Collins, CO 80525

TABLE OF CONTENTS

FIGURES

TABLES

2.9A.1(s) Introduction

This document contains additional baseline radiological monitoring results to supplement data presented in Section 2.9A of the radioactive source materials license application for the Antelope and JAB Uranium Project sites as submitted by Uranium One Americas (Uranium One Americas, 2008) to the U.S. Nuclear Regulatory Commission (NRC), as well as a permit application submitted to the Wyoming Department of Environmental Quality / Land Quality Division (WDEQ/LQD). These regulatory agencies are currently reviewing licensing/permitting applications with respect to proposed in-situ recovery (ISR) operations at the Antelope/JAB Uranium Project sites in Sweetwater County, WY.

The additional data presented in this supplemental report pertain to baseline radiological parameters as indicated in NRC Regulatory Guide 4.14 as part of pre-operational site monitoring (NRC, 1980). Due to scheduling issues associated with a prolonged winter season in this part of Wyoming (including early and late season snow cover), certain data in the license/permit applications were incomplete at the time of submission (as of June, 2008). This report was prepared in accordance with intent stated in licensing/permitting applications to provide all additional baseline monitoring data to the NRC and WDEQ/LQD once available.

This supplemental report, in conjunction with the applicable (corresponding) sections of original licensing/permitting applications, completes baseline radiological measurements and monitoring data for the Antelope/JAB Uranium Project sites as indicated in Regulatory Guide 4.14. Subsequent section headings and numberings in this supplemental report correspond to those used in the original NRC license application (Uranium One Americas, 2008), but with an added "(s)" notation to indicate supplemental material.

2.9A.1.1(s) References

Uranium One Americas. 2008. Antelope and JAB Uranium Project. USNRC Source Materials License and WDEQ Class III UIC Permit Application, Sweetwater County, Wyoming. Volume III Technical Report, Sections 2.9A through 10.

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

2.9A.3(s) Soil Sampling

In accordance with Regulatory Guide 4.14 protocols, surface and subsurface soil sampling at the Antelope/JAB Uranium Project sites was conducted May, 2008). This section supplements section 2.9A.3 of the original NRC license application (Uranium One Americas, 2008) and completes a final baseline characterization of radiological parameters in surface and subsurface soils at the site.

2.9A.3.1(s) Methods

Surface and subsurface soil sampling methods were conducted according to Regulatory Guide 4.14 as described in sections 2.9A.3.1.1 and 2.9A.3.1.2 of the original NRC license application (Uranium One Americas, 2008).

2.9A.3.2(s) Soil Sampling Results

Estimates of Ra-226 concentrations in surface soils (to a depth of 15 cm) across each entire site, based on gamma scanning and gamma correlations with soil Ra-226, were provided in Section 2.9A.2.2.5 of the original NRC application, with individual soil sample results for Ra-226 from the correlation plots provided in Section 2.9A.2.4 (Uranium One Americas, 2008). Color-coded maps of Ra-226 concentration results from all surface soil samples collected at each site, including recommended Regulatory Guide 4.14 samples, as well as earlier correlation plot samples, are shown in Figures 2.9A-S1 and 2.9A-S2 below. Detailed versions of select subsets of these maps with numerically annotated surface soil results are provided in the next section.

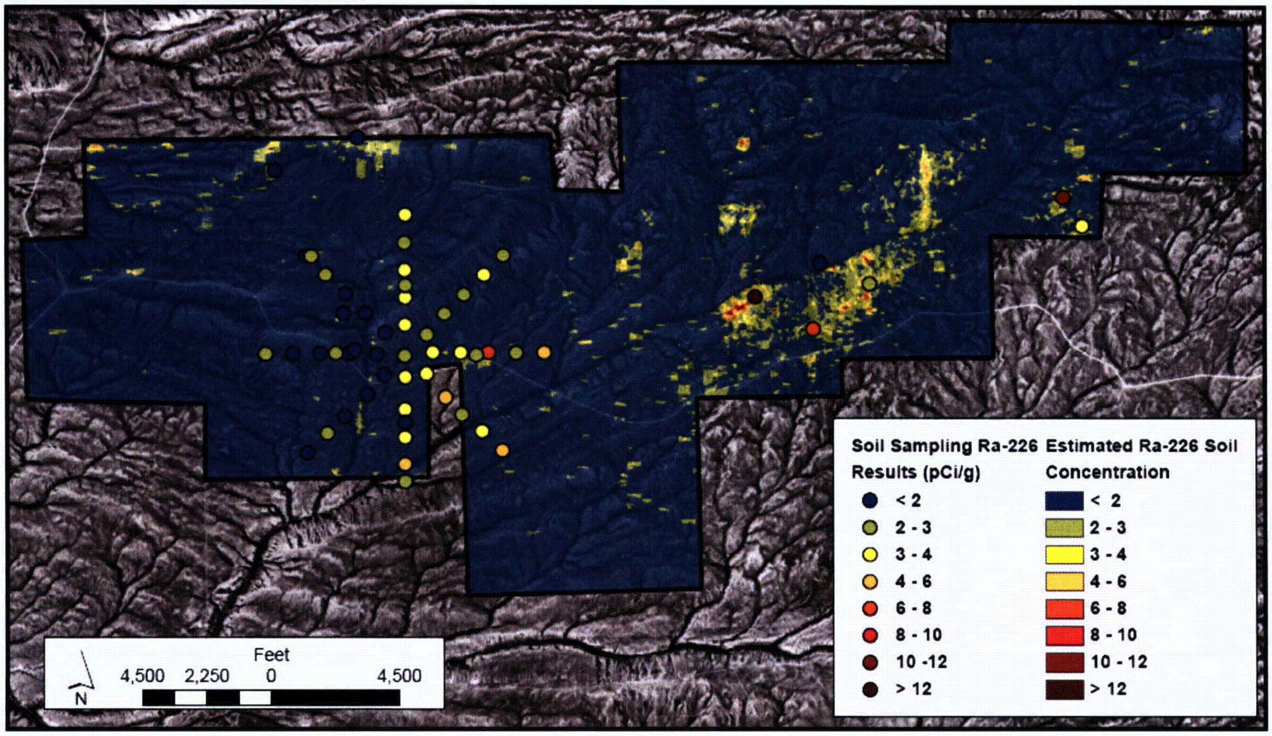


Figure 2.9A-S1: Antelope: color-coded overlay of Ra-226 results for all surface soil samples on the kriged map of estimated Ra-226 concentrations across the entire site based on gamma survey data.

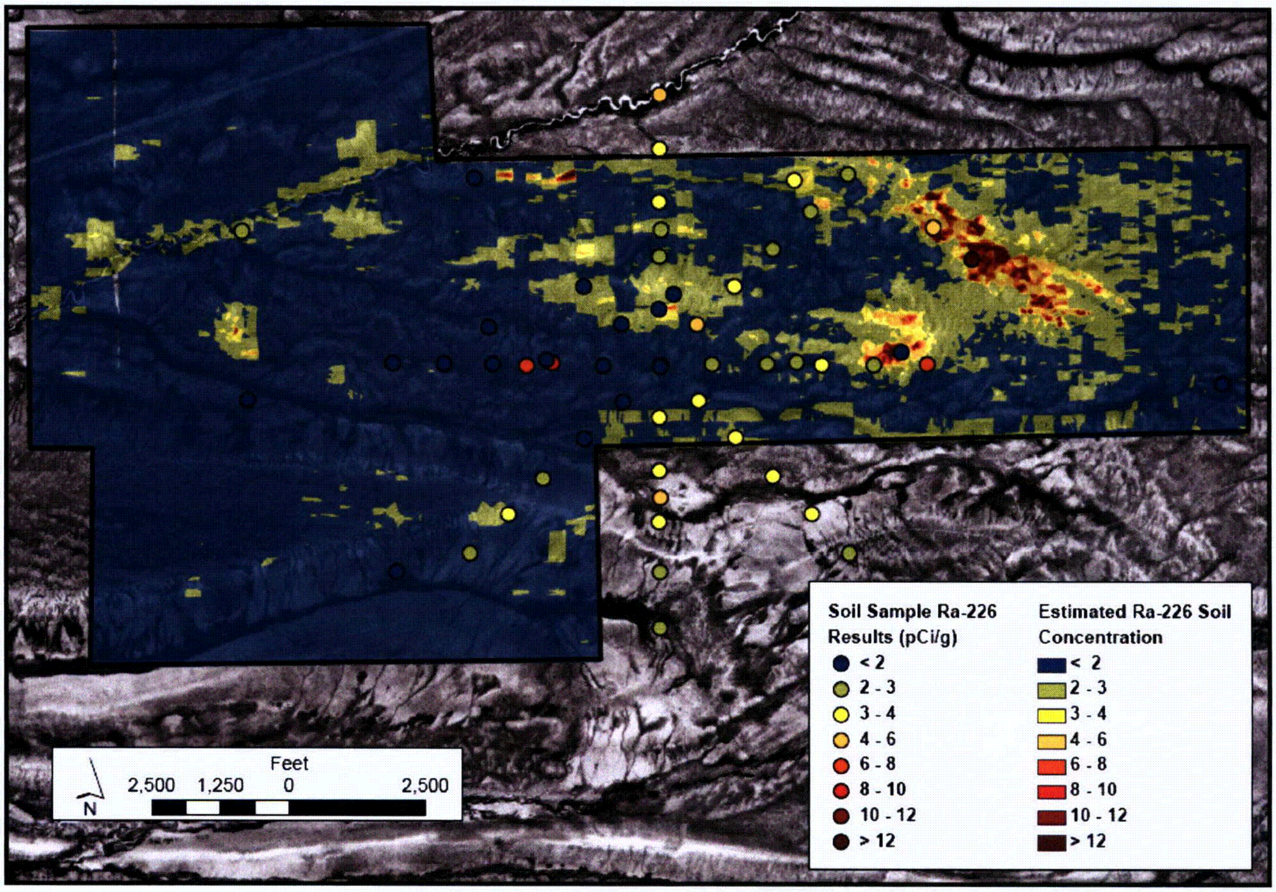


Figure 2.9A-S2: JAB: color-coded overlay of Ra-226 results for all surface soil samples on the kriged map of estimated Ra-226 concentrations across the entire site based on gamma survey data.

2.9A.3.2(supplement-A) Surface Soil Sampling Results

Summary statistics for surface soils at each site are shown in Table 2.9A-S1. Sample series categories include Regulatory Guide 4.14 radial grid sampling locations (SG) and air particulate sampling stations (AS).

Table 2.9A-S1: Summary statistics for Regulatory Guide 4.14 radial grid surface soil samples and air station soil samples (all discrete samples collected to a 5-cm soil depth).

Antelope Surface Soils

Sample Series	Sample Depth (cm)	Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
SG+AS	0-5	Ra-226	2.9	1.2	2.9	6.6	1.1	43
		Pb-210	2.2	0.9	2.0	3.6	1.1	7
		Th-230	0.7	0.3	0.5	1.3	0.4	7
		U-nat	1.5	0.6	1.4	2.2	0.9	7

JAB Surface Soils

Sample Series	Sample Depth (cm)	Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
SG+AS	0-5	Ra-226	2.9	1.5	2.6	9.7	1.1	40
		Pb-210	1.0	0.5	1.0	1.6	0.5	6
		Th-230	1.4	0.9	1.1	3.2	0.7	6
		U-nat	1.4	1.2	0.8	3.7	0.6	6

Select subsets of surface soil results shown in Figures 2.9A-S1 and 2.9A-S2 are provided with numerical annotations below in Figures 2.9A-S3, 2.9A-S4, 2.9A-S5, and 2.9A-S6. In many cases at these sites, Regulatory Guide 4.14 surface soil samples had slightly higher than expected analytical results for Ra-226 compared to estimates at corresponding locations based on correlations with gamma survey data (Figures 2.9A-S1 and 2.9A-S2). In most of these cases the magnitude of differences between estimated Ra-226 concentrations based on the gamma survey and actual analytical results for surface soil samples in corresponding locations was on the order of ± 1-2 pCi/g or less. In several cases at each site, differences were greater than this.

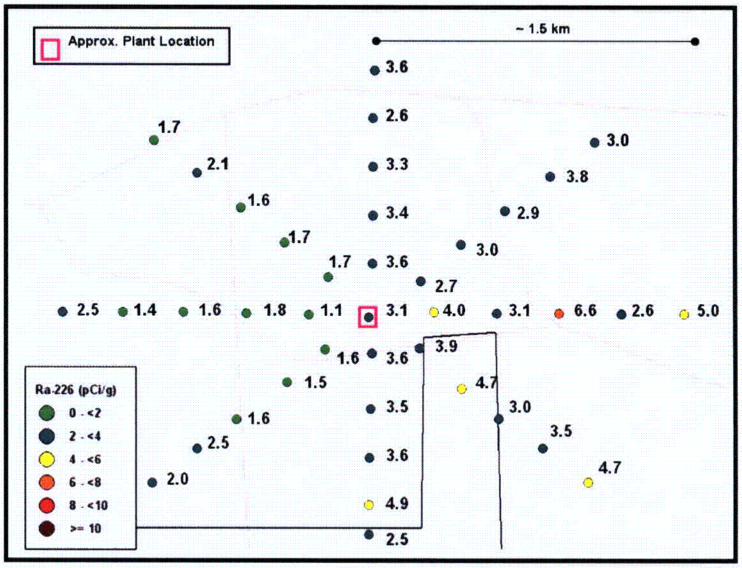


Figure 2.9A-S3: Antelope: Numerically annotated Ra-226 results (pCi/g) for Regulatory Guide 4.14 radial grid surface soil samples (discrete samples collected to a 5-cm soil depth).

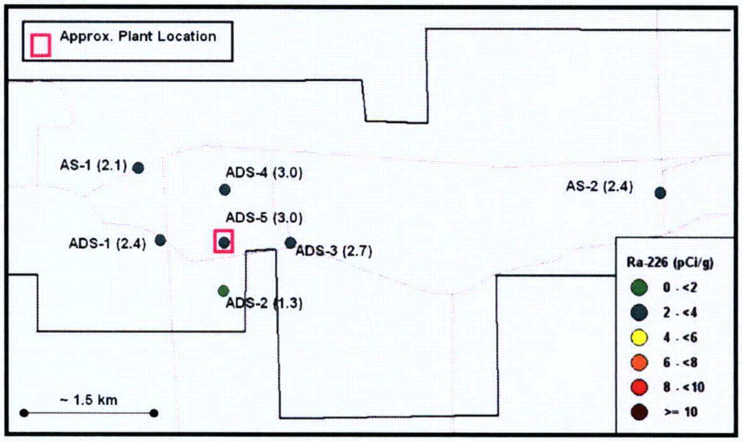


Figure 2.9A-S4: Antelope: Numerically annotated Ra-226 results (pCi/g, in parentheses) for surface soil increments from Regulatory Guide 4.14 radial grid depth profile sampling locations (Locations with sample prefixes "ADS", collected as discrete samples to a 15-cm soil depth), along with surface soil samples collected from air sampling station locations (locations with sample prefixes "AS", collected as discrete samples to a 5-cm depth).

There are several possible explanations for such differences. First, correlation samples are collected as composites across 100 m^2 plots to a depth of 15 cm, while radial grid surface samples collected according to Regulatory Guide 4.14 protocols involve discrete locations and 5-cm sampling depths. It is possible that small-scale spatial variability in Ra-226 concentrations (e.g. to within a few feet or less) is relatively high in some of the areas sampled. Composite soil samples from 100 m^2 plots are more likely to correlate well with gamma readings at given locations, versus single discrete soil samples (which by chance may be taken from small pockets of slightly higher or lower concentration in a heterogeneous soil environment). Also, in areas prone to significant wind erosion and deposition, average depth-integrated concentrations may tend to be higher in the top 5 cm of the soil profile versus the top 15 cm of the soil profile.

Secondly, the analytical uncertainty reported by Energy Laboratories for Ra-226 analyses of surface soil samples by gamma spectroscopy was relatively high (averaging ± 1.4 pCi/g and ranging up to ± 2.4 pCi/g) in relation to differences between estimated Ra-226 concentration based on the gamma survey and actual soil sampling results.

Finally, the correlation itself may not have been very representative of the specific areas in question. The areas sampled according to Regulatory Guide 4.14 radial grid protocols had only a few correlation plots sampled in those particular areas – correlation plot locations were selected in an attempt to be as representative as possible of the range of values found across the entire site rather than only within regions close to anticipated plant locations.

In terms of comparing post-operational radiological survey data against these baseline data to assess possible radiological impacts from site activities, total estimation uncertainty due to environmental variability and potential sources of analytical error as mentioned above must be considered. In addition to comparisons between post-operational data and baseline soil sampling and gamma-based Ra-226 estimates, 3-foot HPIC-equivalent gamma exposure data should also be used for such assessments. Statistical criteria based on MARSSIM principles or other accepted methods can be developed to assess potential changes in radiological conditions due to site operations, utilizing all available baseline data and taking into account environmental

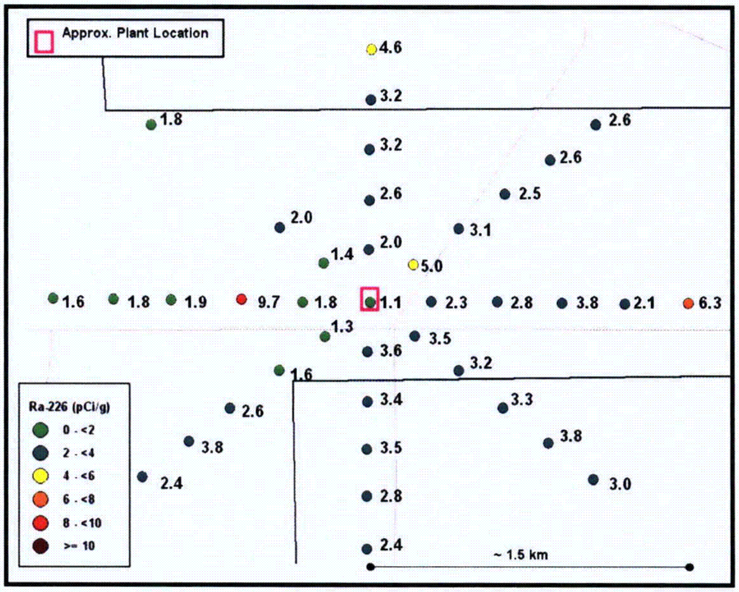


Figure 2.9A-S5: JAB: Numerically annotated Ra-226 results (pCi/g) for Regulatory Guide 4.14 radial grid surface soil samples (discrete samples collected to a 5-cm soil depth).

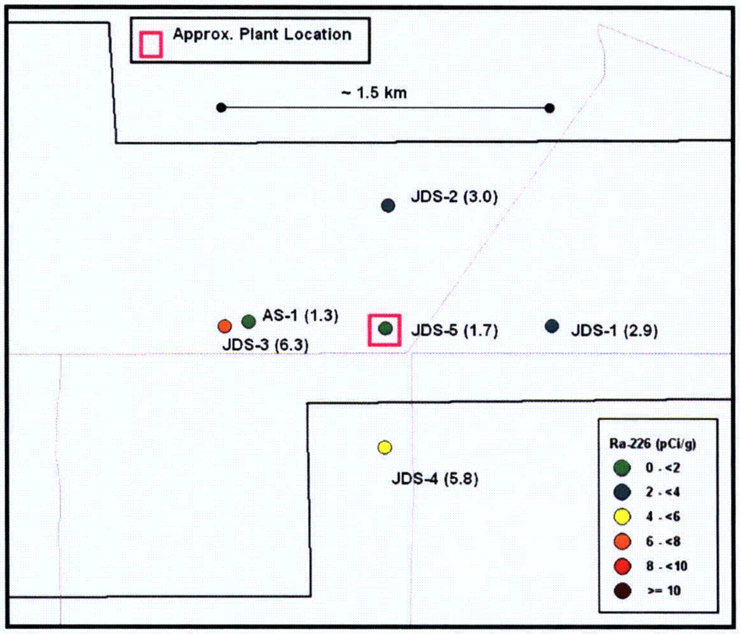


Figure 2.9A-S6: JAB: Numerically annotated Ra-226 results (pCi/g, in parentheses) for surface soil increments from Regulatory Guide 4.14 radial grid depth profile sampling locations (Locations with sample prefixes "JDS", collected as discrete samples to a 15-cm soil depth), along with a surface soil sample collected from the air sampling station location (location with sample prefix "AS", collected as a discrete sample to a 5-cm depth).

variability as well as measurement and estimation uncertainties.

2.9A.3.2(supplement-B) Subsurface Soil (Depth Profile) Sampling Results

Summary statistics for subsurface (depth profile) samples at each site are shown in Table 2.9A-S2. Sample series prefixes "DS" pertain to Regulatory Guide 4.14 subsurface sampling locations with alphanumeric labels in parentheses to signify individual depth increment layers.

Table 2.9A-S2: Summary statistics for Regulatory Guide 4.14 radial grid subsurface (depth profile) soil samples from Antelope (top table) and JAB (bottom table).

Antelope Depth Profile 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	2.5	0.7	2.7	3.0	1.3	5
		Pb-210	1.0	0.4	1.0	1.5	0.5	5
		Th-230	1.2	0.6	1.5	1.7	0.6	5
		U-nat	1.3	0.7	1.0	2.4	0.8	5
DS (B)	15-30	Ra-226	2.6	0.8	2.7	3.7	1.5	5
DS (C)	30-45	Ra-226	2.8	1.2	3.1	4.4	1.5	5
DS (D)	45-60	Ra-226	2.5	0.8	2.7	3.4	1.5	5
DS (E)	60-75*	Ra-226	2.8	1.1	2.7	4.0	1.8	4
DS (F)	75-90*	Ra-226	2.7	0.7	2.6	3.6	1.9	4
DS (G)	90-105*	Ra-226	2.6	0.8	2.6	3.5	1.5	4
		Pb-210	1.0	0.6	1.0	1.7	0.2	4
		Th-230	0.7	0.3	0.7	1.1	0.3	4
		U-nat	1.4	0.2	1.4	1.8	1.2	4
DS (A-G)	All depths	Ra-226	2.6	0.8	2.7	4.4	1.3	32
		Pb-210	1.0	0.46	1.0	1.7	0.2	9
		Th-230	1.0	0.52	0.7	1.7	0.3	9
		U-nat	1.3	0.49	1.2	2.4	0.8	9

*One sample was truncated at 60 cm due to rock - Layer (D) for that sample was analyzed for all 4.14 radionuclides but Pb, Th, and U-nat data are not included in this table

JAB Depth Profile 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	3.9	2.0	3.0	6.3	1.7	5
		Pb-210	1.7	0.9	1.5	3.3	1.0	5
		Th-230	1.3	1.1	1.0	3.2	0.5	5
		U-nat	1.9	1.5	1.3	4.5	0.9	5
DS (B)	15-30	Ra-226	2.9	0.9	2.5	4.0	2.2	5
DS (C)	30-45	Ra-226	4.0	1.7	4.0	6.0	2.1	5
DS (D)	45-60	Ra-226	4.5	2.2	4.1	7.6	1.9	5
DS (E)	60-75	Ra-226	4.6	2.0	4.4	7.4	2.5	5
DS (F)	75-90	Ra-226	4.4	2.3	2.9	7.2	2.6	5
DS (G)	90-105	Ra-226	4.4	2.7	3.4	7.4	1.7	5
		Pb-210	3.1	1.5	2.2	5.4	1.8	5
		Th-230	2.5	2.6	0.9	5.5	0.5	5
		U-nat	6.8	8.2	1.1	17.9	0.8	5
DS (A-G)	All depths	Ra-226	4.1	1.9	3.4	7.6	1.7	35
		Pb-210	2.4	1.38	2.0	5.4	1.0	10
		Th-230	1.9	1.99	1.0	5.5	0.5	10
		U-nat	4.3	6.15	1.2	17.9	0.8	10

An interesting feature of the statistics shown in Table 2.9A-S2 is that mean and median radionuclide concentrations at Antelope do not appear to change much with increasing depth in the soil profile, but at JAB, there appears to be a generally increasing trend in these statistics with increasing soil depth. To further explore vertical and horizontal spatial variability in baseline subsurface soil characteristics at each site, graphical depth profiles were developed for each respective sampling location (Figures 2.9A-S7 and 2.9A-S8). These data indicate that the apparent trend of increasing concentration with depth at JAB is partially an artifact of statistics due to several notable instances of this attribute at specific locations. At both sites, there appears to be considerable variability, both vertically and horizontally in Ra-226 concentrations. At JAB, however, the range of variability in Ra-226 values with soil depth was more pronounced. This may be a result of the fact that the plant location and respective radial sampling grid at JAB is located in the vicinity of subsurface ore bodies, portions of which are known to be quite shallow. The gamma survey at JAB indicated significant areas with surface expression of elevated radionuclides within or just outside of the radial sampling grid area. At Antelope, ore bodies nearest to the plant location and radial sampling grid are significantly deeper and radionuclide concentrations in the top one meter of the soil profile generally appear to be more uniform with depth.

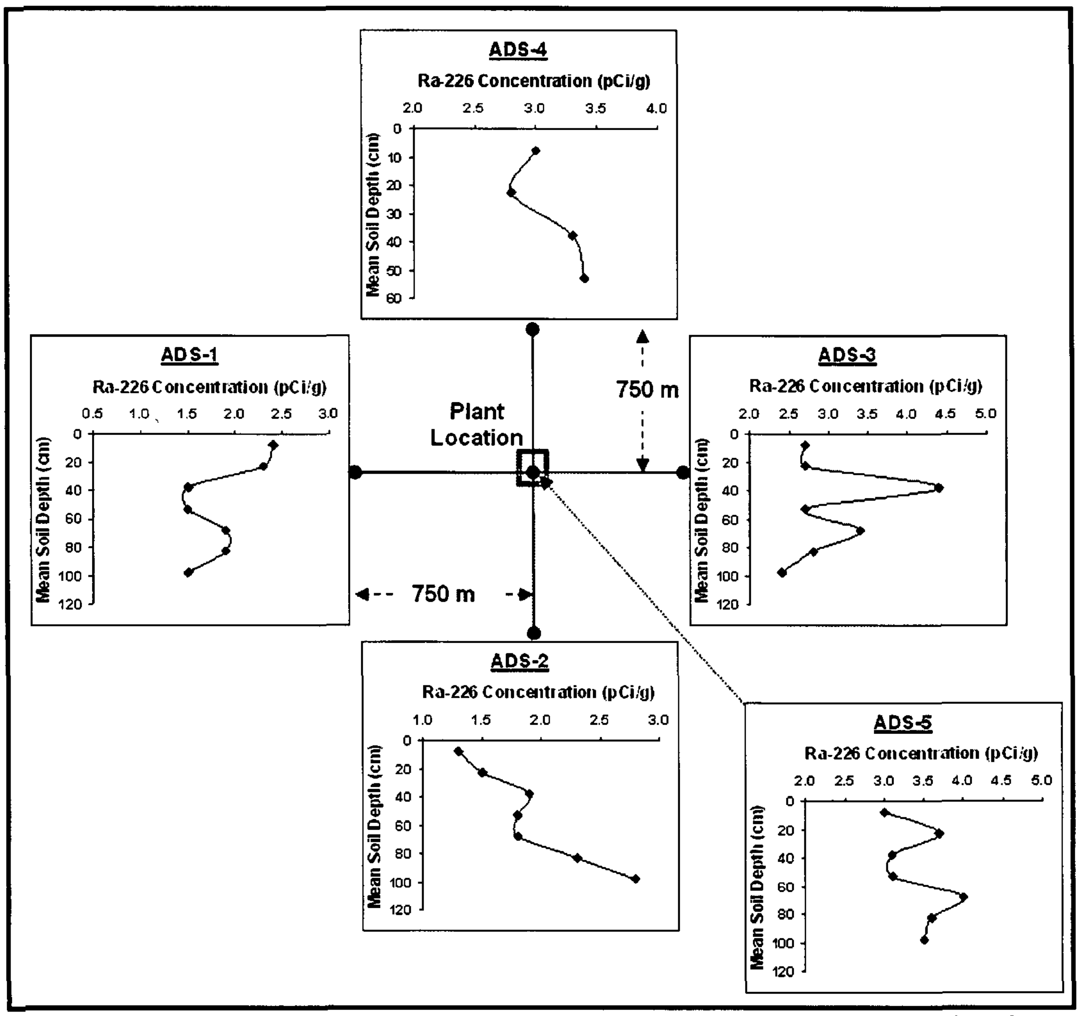


Figure 2.9A-S7: Antelope: diagram depicting Ra-226 depth profiles at each subsurface soil sampling location relative to the proposed plant location.

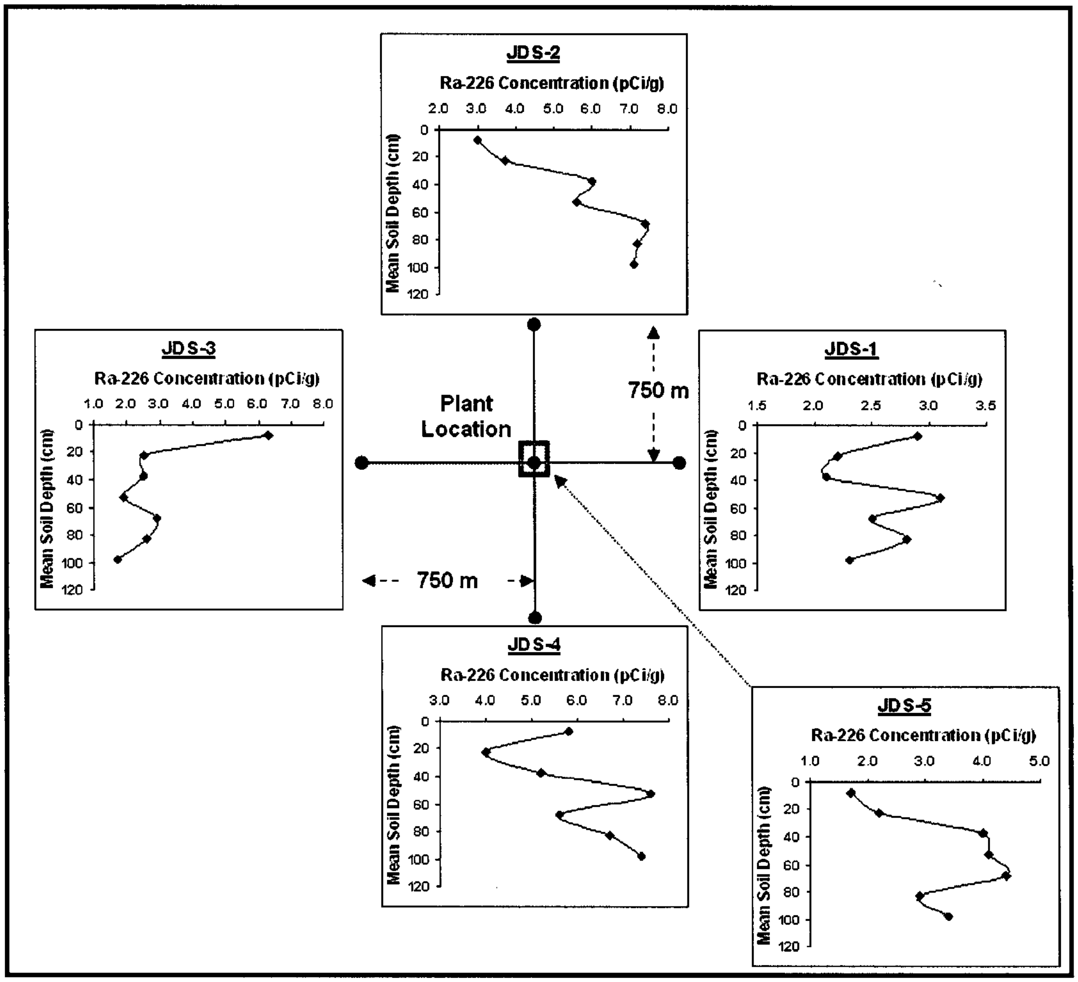


Figure 2.9A-S8: JAB: diagram depicting Ra-226 depth profiles at each subsurface soil sampling location relative to the proposed plant location.

2.9A.3.3(s) Conclusions

Baseline soil radionuclide data from the Antelope and JAB site surveys were collected and analyzed according to Regulatory Guide 4.14 protocols. These data sets as presented in this supplemental report, combined with the earlier correlation soil sampling data and continuous kriged estimates of Ra-226 concentrations across these sites based on comprehensive gamma scanning as presented in Sections 2.9A.2.4 and 2.9A.2.5 of the original NRC license application, provide a thorough characterization of existing soil radionuclide concentrations across these sites. This information should meet respective baseline characterization requirements as indicated by the U.S. Nuclear Regulatory Commission and the Wyoming Department of Environmental Quality / Land Quality Division for ISR licensing/permitting applications.

2.9A.3.4(s) References

Uranium One Americas. 2008. Antelope and JAB Uranium Project. USNRC Source Materials License and WDEQ Class III UIC Permit Application, Sweetwater County, Wyoming. Volume III Technical Report, Sections 2.9A through 10.

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

2.9A.4(s) Sediment Sampling

In accordance with Regulatory Guide 4.14 protocols, baseline stream sediment sampling at the Antelope/JAB Uranium Project sites was conducted in fall (August, 2007) and spring (May, 2008). Stream sediment sampling locations were identical for both sampling events. This section supplements corresponding sections of the original NRC license application (Uranium One Americas, 2008) and completes a final baseline characterization of radiological parameters in stream sediments at the site.

2.9A.4.1(s) Methods

Stream sediment sampling methods for the spring 2008 sampling event were identical to those described for the fall 2007 sampling event in the original NRC license application (Uranium One Americas, 2008).

2.9A.4.2(s) Sediment Sampling Results

Final descriptive summary statistics of stream sediment data for each indicated Regulatory Guide 4.14 analyte are provided in Tables 2.9A-1(s) and 2.9A-2(s). In general, stream sediment baseline results are similar to those found for both surface and subsurface soils at the site. Although average sediment results for the fall 2007 sampling event are in some cases slightly different from the spring 2008 sampling event, the differences appear to be within a range consistent with normal sampling and measurement variability. Note that U-nat statistics for the August, 2007 sampling event have been slightly revised from the original report because unit conversion of lab data from mg/kg to units of pCi/g was inadvertently not reflected in the original table.

Table 2.9A-1(s): Summary statistics for radionuclide concentrations in stream sediment samples from the Antelope Uranium Project Area (spring and fall sampling events).

Antelope: Stream Sediment Sample Summary Statistics (August, 2007)

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.4	0.17	1.4	1.6	1.2	4
Pb-210	3.1	0.73	3.3	3.7	2.1	4
Th-230	3.1	0.73	3.3	3.7	2.1	4
U-nat	1.4	0.16	1.4	1.6	1.2	4

Antelope: Stream Sediment Sample Summary Statistics (May, 2008)

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.8	0.56	1.9	2.3	1.2	4
Pb-210	2.2	0.45	2.1	2.8	1.8	4
Th-230	0.5	0.08	0.5	0.6	0.4	4
U-nat	1.1	0.08	1.1	1.2	1.0	4

Table 2.9A-2(s): Summary statistics for radionuclide concentrations in stream sediment samples from the JAB Uranium Project Area (spring and fall sampling events).

JAB: Stream Sediment Sample Summary Statistics (August, 2007)

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	1.5	0.72	1.3	2.6	0.9	5
Pb-210	0.7	1.52	0.0	3.4	0.0	5
Th-230	0.8	0.80	0.4	2.2	0.3	5
U-nat	0.9	0.50	0.6	1.6	0.5	5

JAB: Stream Sediment Sample Summary Statistics (May, 2008)

Analyte	Mean (pCi/g)	Std. Dev. (pCi/g)	Median (pCi/g)	Max (pCi/g)	Min (pCi/g)	n
Ra-226	2.5	0.95	2.6	3.7	1.5	5
Pb-210	1.2	0.55	1.4	1.8	0.4	5
Th-230	1.4	0.92	1.2	2.8	0.6	5
U-nat	1.3	0.82	1.2	2.4	0.4	5

2.9A.4.3(s) Conclusions

Baseline sediment radionuclide data were collected and analyzed according to Regulatory Guide 4.14 protocols. The data set is now complete per the regulatory guidance recommended by the NRC and WDEQ/LQD.

2.9A.4.4(s) References

Uranium One Americas. 2008. Antelope and JAB Uranium Project. USNRC Source Materials License and WDEQ Class III UIC Permit Application, Sweetwater County, Wyoming. Volume III Technical Report, Sections 2.9A through 10.

2.9A.10(s) Vegetation Sampling

Vegetation sampling at the Antelope and JAB Uranium Project sites was initiated in August of 2007. Regulatory Guide 4.14 calls for several sampling events during the growing season (NRC, 1980). Vegetation at these sites is primarily comprised of sagebrush. Sagebrush has spring/fall cycles of growth and reproductive activity (Welch, 2005). Vegetation samples were collected in the August of 2007 and late May of 2008. Data from the both sampling events are presented in this section to complete a baseline radiological characterization of vegetation. Vegetation sampling was conducted in the same general locations for each sampling event as shown in Figure 2.9A-40 of the original application. The locations were selected based on proximity to potential wellfield areas or plant facilities, along with consideration for prevailing wind directions and practical access.

2.9A.10.1(s) Methods

Vegetation sampling methods for the spring 2008 sampling event were identical to those described for the fall 2007 event in the original NRC license application (Uranium One Americas, 2008).

2.9A.10.2(s) Vegetation Sampling Results

Final (updated) summary statistics for baseline vegetation sampling results at the Antelope and JAB sites are shown in Tables 2.9A-11(s) and 2.9A-12(s), with graphical breakdowns by date and location shown in Figures 2.9A-41(s) and 2.9A-42(s).

Table 2.9A-11(s): Antelope - summary statistics of radionuclides in vegetation for all sampling dates and locations.

Analyte	Mean (uCi/kg)	Std. Dev. (uCi/kg)	Median (uCi/kg)	Max (uCi/kg)	Min (uCi/kg)	n
Pb-210	1.3E-03	4.5E-04	1.2E-03	1.9E-03	8.7E-04	6
Po-210	1.6E-04	6.5E-05	2.0E-04	2.1E-04	5.8E-05	6
Ra-226	2.3E-04	8.9E-05	2.2E-04	3.7E-04	1.0E-04	6
Th-230	6.5E-05	2.8E-05	6.4E-05	1.1E-04	2.3E-05	6
U-nat	1.2E-04	4.0E-05	1.3E-04	1.6E-04	4.3E-05	6

Table 2.9A-12(s): JAB - summary statistics of radionuclides in vegetation for all sampling dates and locations.

Analyte	Mean (uCi/kg)	Std. Dev. (uCi/kg)	Median (uCi/kg)	Max (uCi/kg)	Min (uCi/kg)	n
Pb-210	1.6E-03	8.6E-04	1.6E-03	3.2E-03	8.6E-04	6
Po-210	3.3E-04	2.3E-04	2.9E-04	7.5E-04	6.3E-05	6
Ra-226	6.7E-04	7.6E-04	2.0E-04	1.8E-03	1.6E-04	6
Th-230	1.4E-04	1.2E-04	9.4E-05	3.3E-04	4.3E-05	6
U-nat	1.7E-04	1.8E-04	1.1E-04	5.3E-04	5.4E-05	6

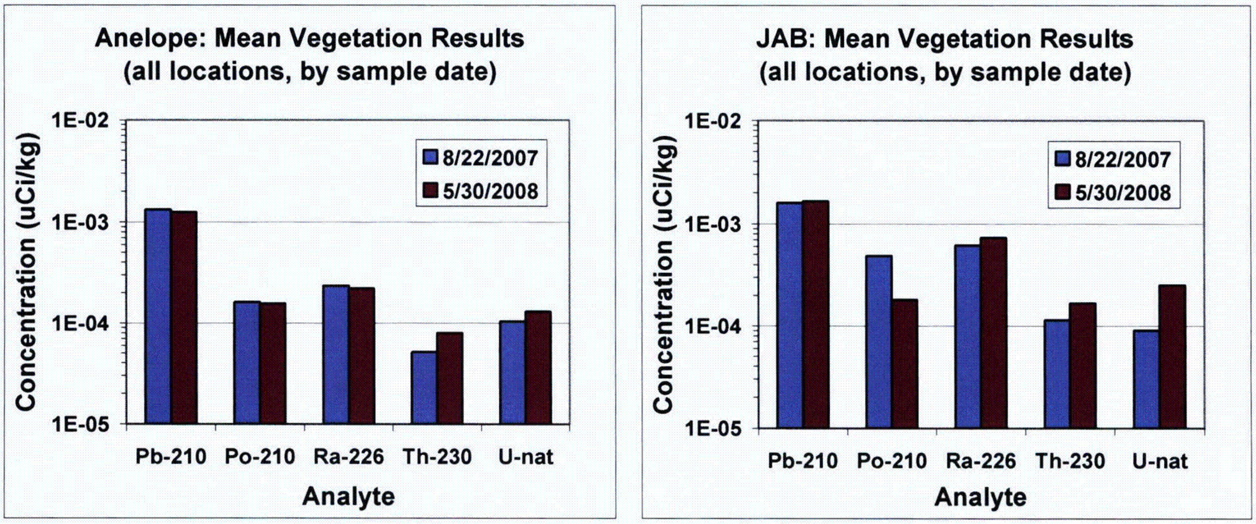


Figure 2.9A-41(s): Mean analytical results for vegetation samples by sampling date for all locations at Antelope (left) and JAB (right).

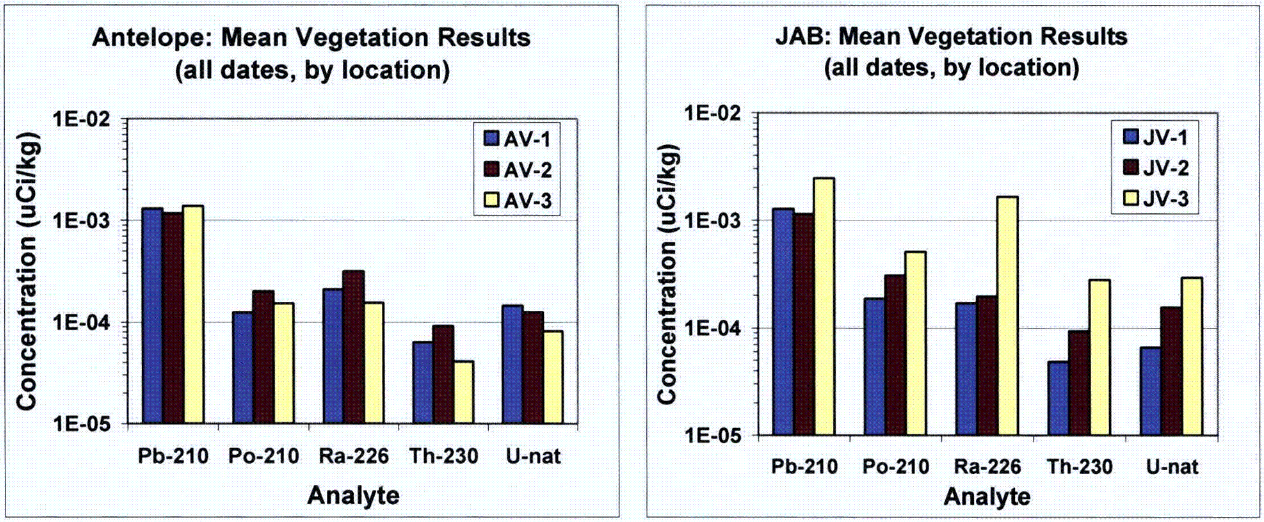


Figure 2.9A-42(s): Analytical results for vegetation samples by sampling location at Antelope (left) and JAB (right).

Significant differences or trends in radionuclide concentrations in vegetation at either site between spring and fall sampling events are not apparent [Figure 2.9A-41(s)]. The small differences in mean concentration by sampling date for some radionuclides appear to be within normal ranges of sampling and measurement variability. After inclusion of the spring 2008 sampling data, formerly noted potential trends by location in relation to areas of measured gammas and estimated Ra-226 soil concentration are less apparent [Figure 2.9A-42(s)]. A notable exception is for sample JV-3 at the JAB site, where average concentrations for all radiological analytes in vegetation samples from this location were higher. Location JV-3 is in the vicinity of areas with significantly higher measured gammas and estimated Ra-226 concentrations (see Figures 2.9A-14 and 2.9A-22 in the original application). The higher radionuclide concentrations in vegetation samples at this location may be related to plant uptake and/or dust loading on vegetation.

2.9A.10.3(s) Conclusions

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

2.9A.10.4(s) References

Uranium One Americas. 2008. Antelope and JAB Uranium Project. USNRC Source Materials License and WDEQ Class III UIC Permit Application, Sweetwater County, Wyoming. Volume III Technical Report, Sections 2.9A through 10.

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

Welch, B.L. 2005. *Big sagebrush: A sea fragmented into lakes, ponds, and puddles*. General Technical Report RMRS-GTR-144. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 210 p.

TABLE OF CONTENTS

3 DESCRIPTION OF PROPOSED FACILITY

TABLE OF FIGURES

Table of Tables

3 DESCRIPTION OF PROPOSED FACILITY

The Antelope and JAB Uranium Project will be developed by constructing wellfields and mining support facilities including a satellite ion exchange (IX) facility at the JAB site and a central process facility at the Antelope site. These facilities are designed to provide chemical makeup of recovery solutions, recovery of uranium by ion exchange, resin loading/unloading, elution and precipitation circuits, yellowcake drying capabilities, and groundwater restoration capabilities.

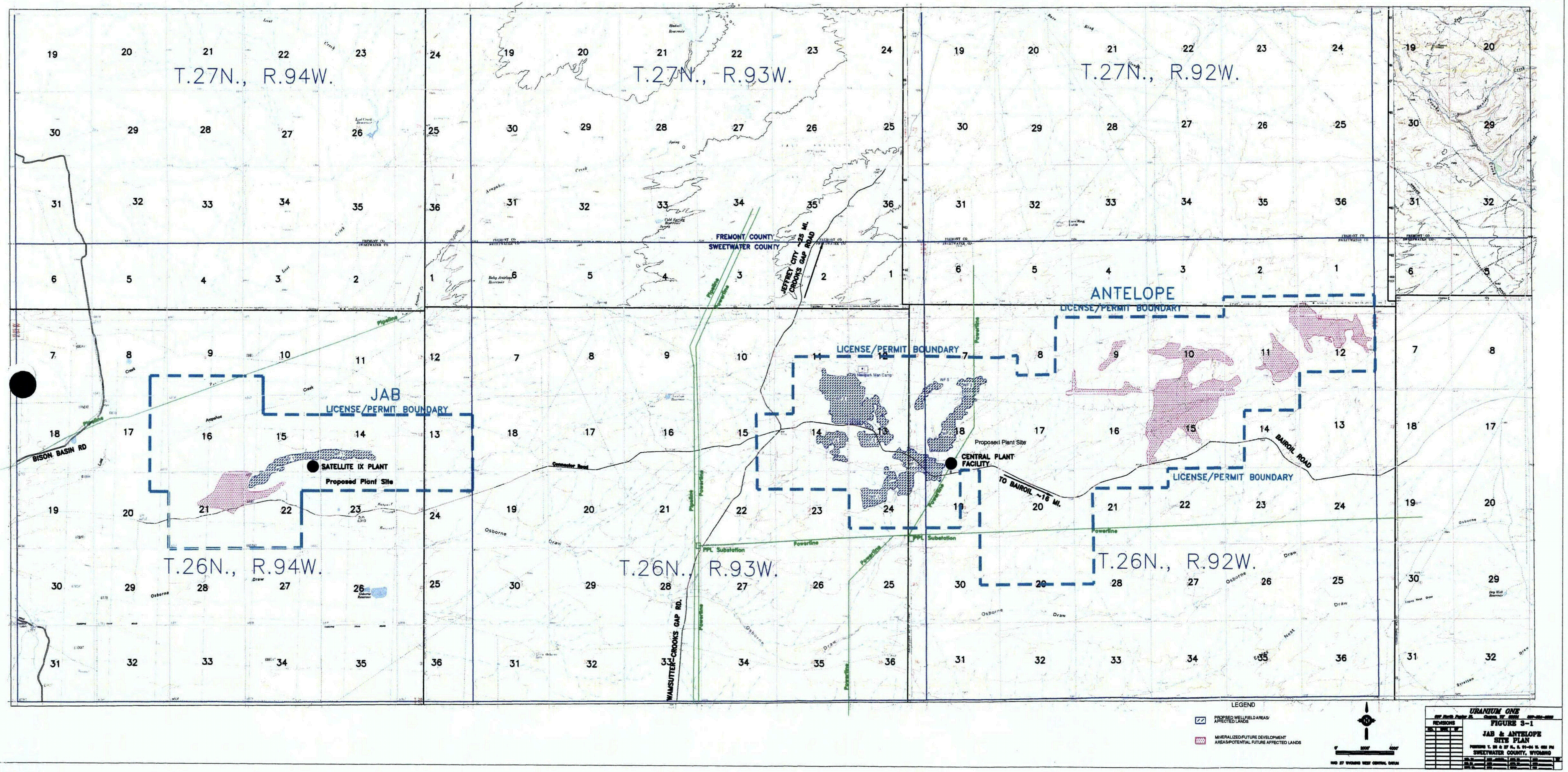
The proposed License Area contains approximately 10,531 acres for the Antelope site and 4,043 acres for the JAB site. The total surface area to be affected by the proposed operation within the License Area will total a maximum of 1,400 acres for both areas combined (approximately 10% of the License Area). The wellfields, central plant/offices/shop facilities, satellite ion exchange plant, wastewater disposal wells, and improved roads are the primary surface features associated with the proposed ISR operations. There are no evaporation or holding ponds planned for the Antelope or JAB project areas at this time. Section 2.1 of this Technical Report provides a description of the site and facilities layout for the Antelope and JAB Project Areas. Figure 3-1 shows the License boundaries, facility locations, access roads, and wellfield and mineralized areas. Rawlins is the closest major community approximately 55 miles south east of the proposed Antelope Central Plant location.

The proposed wellfield areas to be used for the injection and recovery operations over the 20-year mine life will encompass a maximum of 1,400 acres. The wellfield areas will be fenced to limit access by livestock.

Other mineralized trends within the current proposed license area have not been extensively explored. As a result, additional development areas may be determined as exploration and delineation activities continue.

3.1 IN SITU RECOVERY PROCESS

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


T.27N., R.94W.
T.27N., R.93W.
T.27N., R.92W.
T.26N., R.94W.
T.26N., R.93W.
T.26N., R.92W.
FREMONT COUNTY
SWEETWATER COUNTY
JEFFREY CITY ~25 MI.
CROOKS GAP ROAD
ANTELOPE
LICENSE/PERMIT BOUNDARY
JAB
LICENSE/PERMIT BOUNDARY
LICENSE/PERMIT BOUNDARY
LICENSE/PERMIT BOUNDARY
SATELLITE IX PLANT
Proposed Plant Site
CENTRAL PLANT FACILITY
Proposed Plant Site
BISON BASIN RD
BAIROIL ROAD
TO BAIROIL ~16 MI.
WAMSUTTER-CROOKS GAP RD.
PPL Substation
PPL Substation
Pipeline
Powerline
Connector Road
Osborne
Draw
LEGEND
PROPSED WELLFIELD AREAS/ AFFECTED LANDS
MINERALIZED/FUTURE DEVELOPMENT AREAS/POTENTIAL FUTURE AFFECTED LANDS
NAD 27 WYOMING WEST CENTRAL DATUM
URANIUM ONE
REVISIONS
FIGURE 3-1
JAB & ANTELOPE SITE PLAN
SWEETWATER COUNTY, WYOMING

3.1.1 Antelope Project Orebody

The mineralization at the western portion of the Antelope property varies from 300-600 feet deep and averages 430 feet. Mineralization is primarily contained within the 240-200 Sand, 190-150 Sand and the 140-100 Sand units, although potential for deeper mineralization exists. The thickness of the mineralization averages 7.5 feet with an average grade of .089% U3O8.

The mineralization at the eastern portion of the Antelope property varies from 200-400 feet deep averaging 300 feet. It is primarily contained within the 190-150 Sand and 140-100 Sand units, again with deeper potential.

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

3.1.2 JAB Project Orebody

At JAB the primary deposit is from 150-310 feet deep and averages approximately 225 feet deep. The mineralization at JAB averages approximately 10 feet thick with an average grade of .065% U3O8. Additional mining targets may exist in the area at greater depths. Additional future delineation will be needed to fully define any deeper targets.

3.1.3 Delineation Drilling

3.1.3.1 General

The irregular shape, distribution and grade of uranium deposits requires several phases of drilling to determine ore reserves, injection, production and monitor well locations and to allow for wellfield engineering and design. Geophysical logging is performed in all drill holes. The most common logs used are resistivity, spontaneous potential (SP) and natural gamma. The resistivity and SP logs are used to determine the lithology of the hole, and the natural gamma log is used to estimate the uranium grade. Additionally, deviation logs are commonly used to determine the amount of hole drift between the surface and bottom of the hole.

Drilling will be primarily performed with standard truck mounted mud rotary drilling rigs. Down hole hammers may be required in areas where boulder conglomerates are encountered.

Preliminary ore reserve estimates and project feasibility analyses are typically completed after a substantial portion of a deposit has been drilled on centers as close as 100 feet (i.e., one hole per 10,000 square feet). The information provided by this phase of drilling allows preliminary facility and wellfield engineering and design and monitor well locations.

To determine the lateral extent of the economically recoverable uranium ore, additional drilling on centers as close as 50 feet (i.e., one hole per 2,500 square feet) is typically required. The information obtained from this phase of drilling is used to map the ore body both in plan and cross-section and locate potential injection and production wells. These data are also used to finalize the locations of monitor wells which are typically installed prior to installation of mine unit patterns.

The final phase of ore body delineation consists of drilling pilot holes for injection and production wells. Prior to installation of casing, the geophysical logs of each pilot hole in a pattern are reviewed to determine the screen interval and confirm that the pattern contains sufficient reserves to recover uranium economically. If it is determined that a pilot hole (or holes) does not contain enough mineral reserves to provide for economic production, the hole will not be cased, but will be plugged and abandoned in accordance with the procedures outlined in Section 6 of this application.

Delineation drilling will occur throughout each year, depending on production and development needs. Typically, 200 to 500 delineation drill holes will be completed each year, as necessary, to adequately define future wellfield pattern areas.

3.1.4 Well Construction and Integrity Testing

3.1.4.1 Well Materials of Construction

The well casing material will be polyvinyl chloride (PVC) with a nominal 5-inch outside diameter and schedule 40 wall thickness (0.248-inch wall thickness) or typical SDR-17 (0.291-inch wall thickness). However, if a larger pump size is necessary for production wells, larger diameter casing may be utilized. The table below shows the range of casing sizes that could be used at the Antelope and JAB projects, and the corresponding drill hole size to ensure adequate annular sealing. Each joint of the PVC casing will normally have a length of approximately 20 feet. Each joint will be connected either with glue and self-tapping screws or joined mechanically (with pipe threads or a water tight o-ring seal with a high strength nylon spline). Schedule 40 casing is rated (unsupported) for 133 psi burst pressure and 158 psi collapse pressure, and SDR-17 is rated for 160 psi burst pressure and 224 psi collapse pressure (unsupported).

Sch. 40 Casing	I.D.	O.D.	Bit size
4.5"	4.454	4.950	7-7/8
5.0"	5.047	5.563	8-3/4
6.0"	6.065	6.625	9-7/8

SDR-17 Casing	I.D.	O.D.	Bit size
4.5"	4.368	4.950	7-7/8
5.0"	4.909	5.563	8-3/4
6.0"	5.845	6.625	9-7/8

3.1.4.2 Well Construction Methods

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

Typical well completion schematics for recovery wells, injection wells, and monitor wells are shown on Figure 3-2.

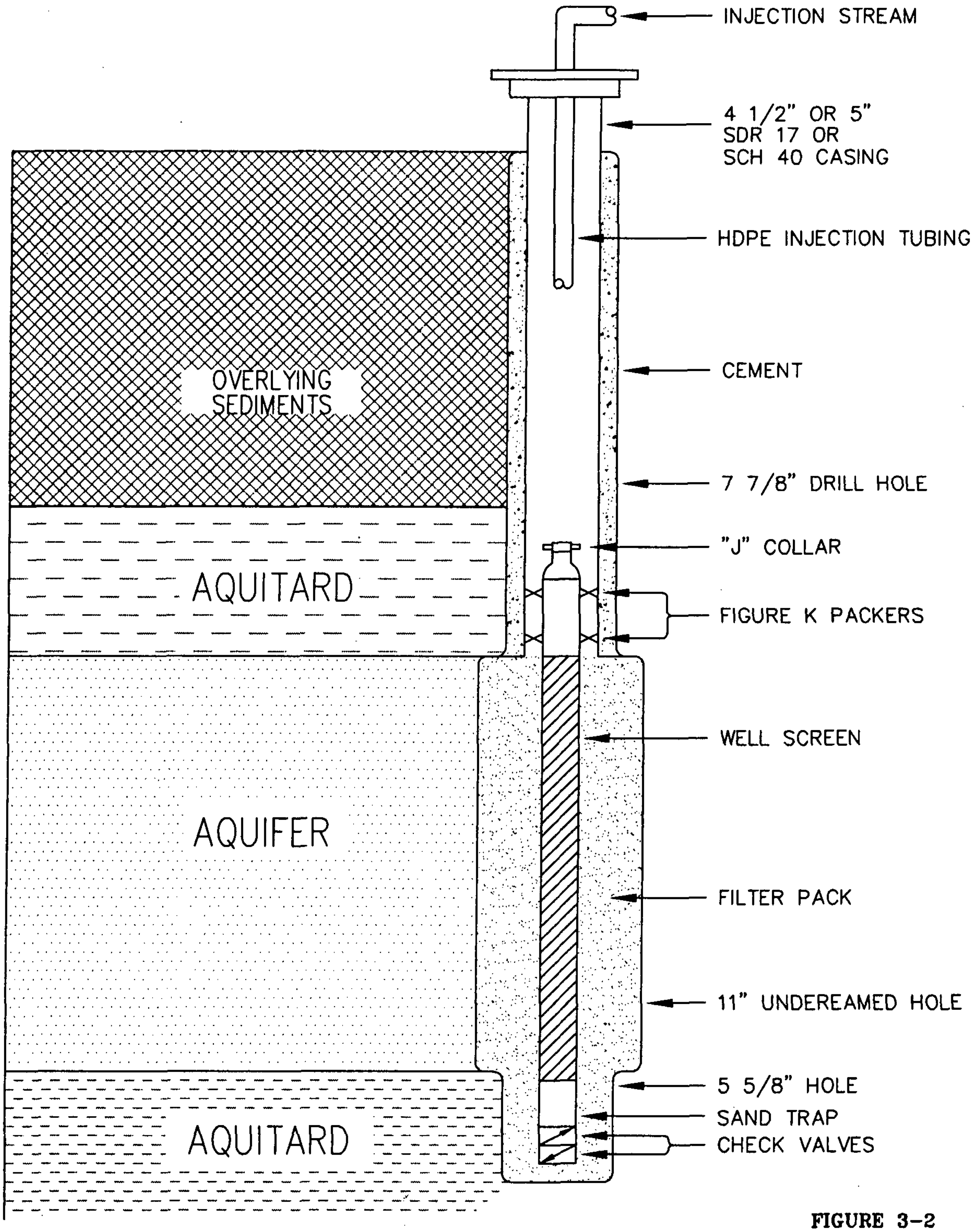


FIGURE 3-2

URANIUM ONE

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ANTELOPE & JAB

TYPICAL WELL COMPLETION

SWEETWATER COUNTY, WYOMING

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

After the well is cemented to the surface and the cement has set, the well is completed. This involves drilling out the internal cement plug, underreaming the desired completion interval to a diameter of up to 11 inches, and then installing a screen assembly (slotted liner), which may have a sand filter pack installed between the screen and the underreammed formation. The well is then air lifted to remove any remaining drilling mud and/or cuttings until well fluids are clear. A small submersible pump is frequently run in the well for final clean-up and sampling (where necessary).

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

3.1.4.3 Well Development

Following construction (and before baseline water quality samples are taken for restoration and monitoring wells), the wells must be developed to restore the natural hydraulic conductivity and geochemical equilibrium of the aquifer. All wells are initially developed immediately after construction using air lifting, swabbing, pumping, or other accepted development techniques. Well development removes water and drilling fluids from the casing and borehole walls along the screened interval. The primary goal for well development is to allow formation water to enter the well screen. This process is necessary to allow representative samples of groundwater to be collected, and to ensure efficient injection and recovery operations. Before obtaining baseline samples from monitor or restoration wells, monitoring for pH and conductivity is performed during this process to ensure that development activities have been effective. The field parameters must be stable at representative formation values before baseline sampling will begin.

3.1.4.4 Well Integrity Testing

Field-testing of all (i.e., injection, recovery, and monitor) wells is performed to demonstrate the mechanical integrity of the well casing. This mechanical integrity test (MIT) is performed using pressure tests. In the MIT, the bottom of the casing adjacent to or below the confining layer above the production zone is sealed with a plug, downhole packer, or other suitable device. The top of the casing is then sealed in a similar manner or with a threaded cap, and a calibrated pressure gauge is installed to monitor the pressure inside the casing. The pressure in the sealed casing is then increased to 120% of the maximum operating pressure. A well must maintain 90% of this pressure for 10 minutes to pass the test. Uranium One will test all well casings at the maximum operating pressure as determined pursuant to Section 3.1.5, plus the 20% safety factor.

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

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

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

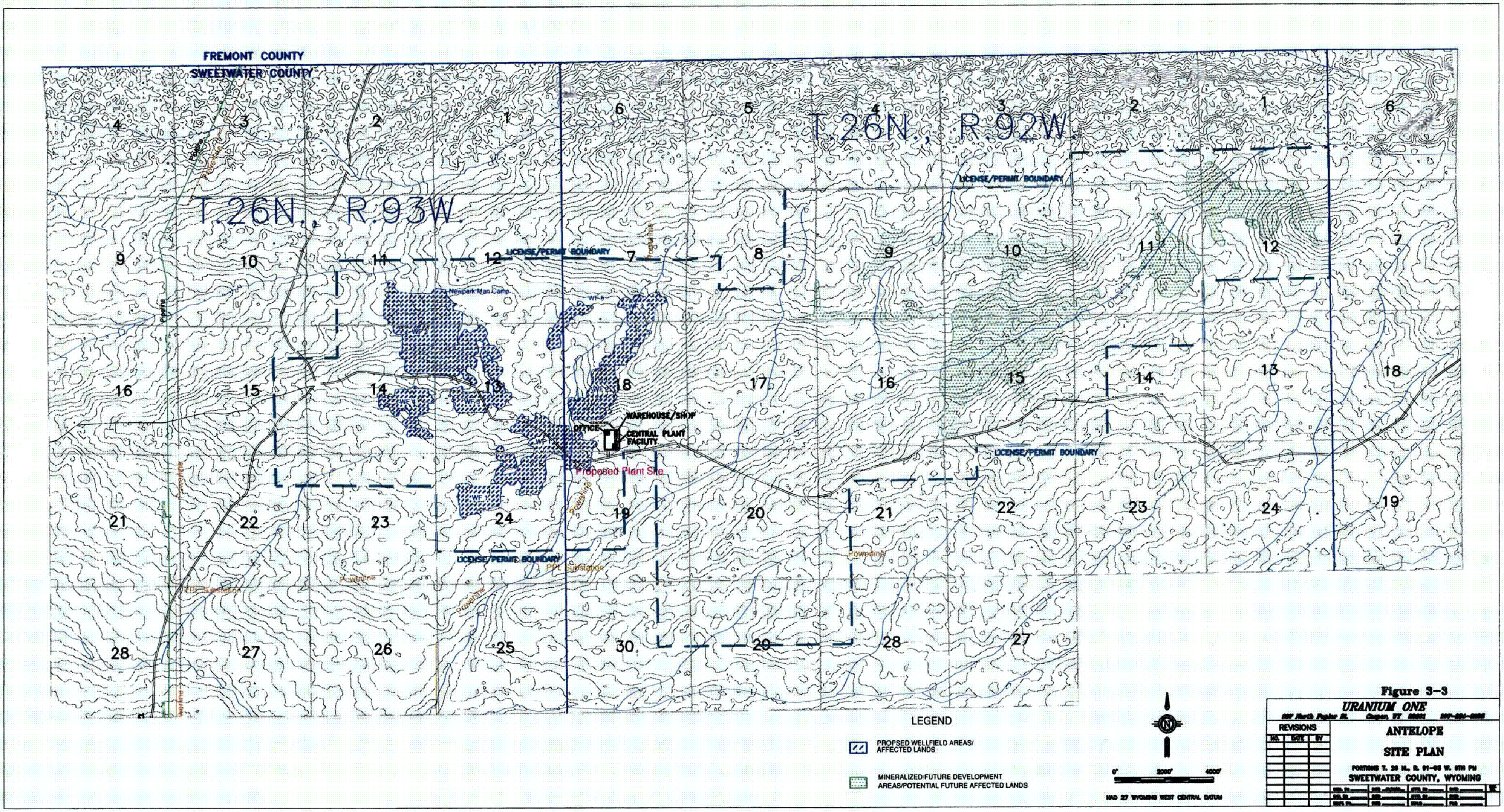
The MIT of a well will be documented to include the well designation, date of the test, test duration, beginning and ending pressures, and the signature of the individual responsible for conducting the test. Results of the MITs are maintained on site and are available for inspection by NRC and WDEQ.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

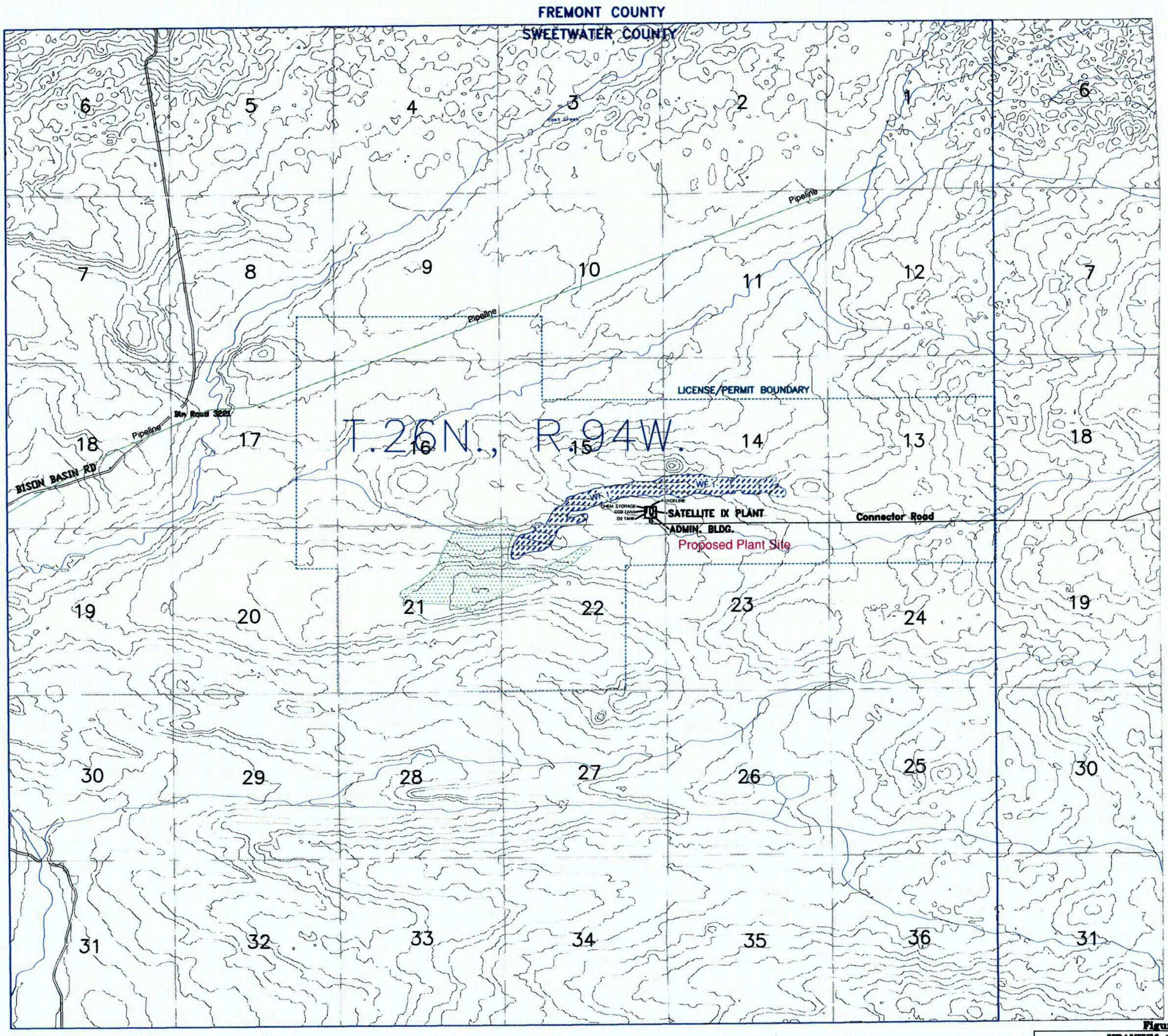
3.1.5 Wellfield Design and Operation

The proposed Antelope and JAB potential wellfield area maps are shown in Figures 3-3 and 3-4. The maps are preliminary based on Uranium One's current knowledge of the area. The final wellfield footprints will be developed after wellfield delineation is completed and submitted to the WDEQ-LQD in the wellfield package information described in Section 5.

The wellfield injection/recovery pattern employed is based on the conventional square five spot pattern which is modified as needed to fit the characteristics of the orebody (see Figure 3-5). The standard five spot pattern contains four injection wells surrounding a centrally located recovery well. The pattern dimensions vary depending on the formation and the characteristics of the orebody. The injection wells in a normal pattern are expected to be between 75 feet and 150 feet apart. All wells will be completed so they can be used as either injection or recovery wells, so that wellfield flow patterns can be changed as needed to improve uranium recovery and restore the groundwater in the most efficient manner. Other wellfield designs include alternating or single line drives.

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


FREMONT COUNTY
SWEETWATER COUNTY
T.26N., R.93W.
T.26N., R.92W.
LICENSE/PERMIT BOUNDARY
WAREHOUSE/SHOP
OFFICE
CENTRAL PLANT FACILITY
Proposed Plant Site
LEGEND
PROPSED WELLFIELD AREAS/ AFFECTED LANDS
MINERALIZED/FUTURE DEVELOPMENT AREAS/POTENTIAL FUTURE AFFECTED LANDS
0' 2000' 4000'
NAD 27 WYOMING WEST CENTRAL DATUM
Figure 3-3
URANIUM ONE
REVISIONS
ANTELOPE
SITE PLAN
SWEETWATER COUNTY, WYOMING



LEGEND

PROPSED WELLFIELD AREAS/ AFFECTED LANDS

MINERALIZED/FUTURE DEVELOPMENT AREAS/POTENTIAL FUTURE AFFECTED LANDS

Figure 3-4

URANIUM ONE

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NO.	DATE	BY

JAB

SITE PLAN

SWEETWATER COUNTY,

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

Each injection well and recovery well is connected to the respective injection or recovery manifold in a wellfield headerhouse building. The manifolds deliver the recovery solutions to the pipelines carrying the solutions to and from the ion exchange facilities. Flow meters and control valves are installed in the individual well lines to monitor and control the individual well flow rates and pressures. Wellfield piping is primarily constructed of high density polyethylene (HDPE), with some polyvinyl chloride (PVC), and/or steel. The wellfield piping will typically be designed for an operating pressure of 150 psig or higher, and it will be operated at pressures equal to or less than the rated operating pressure of the pipe and other in-line equipment. The typical pressure rating, for both the PVC and HDPE piping is between 160 and 300 psig. If a higher design pressure is needed, the pressure rating of the materials will be evaluated and if necessary, materials with a higher pressure rating will be used.

The individual well lines and the trunk lines to the ion exchange facility are buried to prevent freezing. The use of wellfield headerhouses and buried lines is a proven method for protecting pipelines.

Monitor wells will be placed in the production zone and in the first significant water-bearing sand above (overlying) the mining zone and below (underlying) the mining zone. All monitor wells will be completed using the well construction and testing methods discussed above and developed prior to recovery solution injection. Typical locations of the monitor well rings for the proposed wellfields are approximately 500 feet from the pattern area and 500 feet spacing between monitor wells.

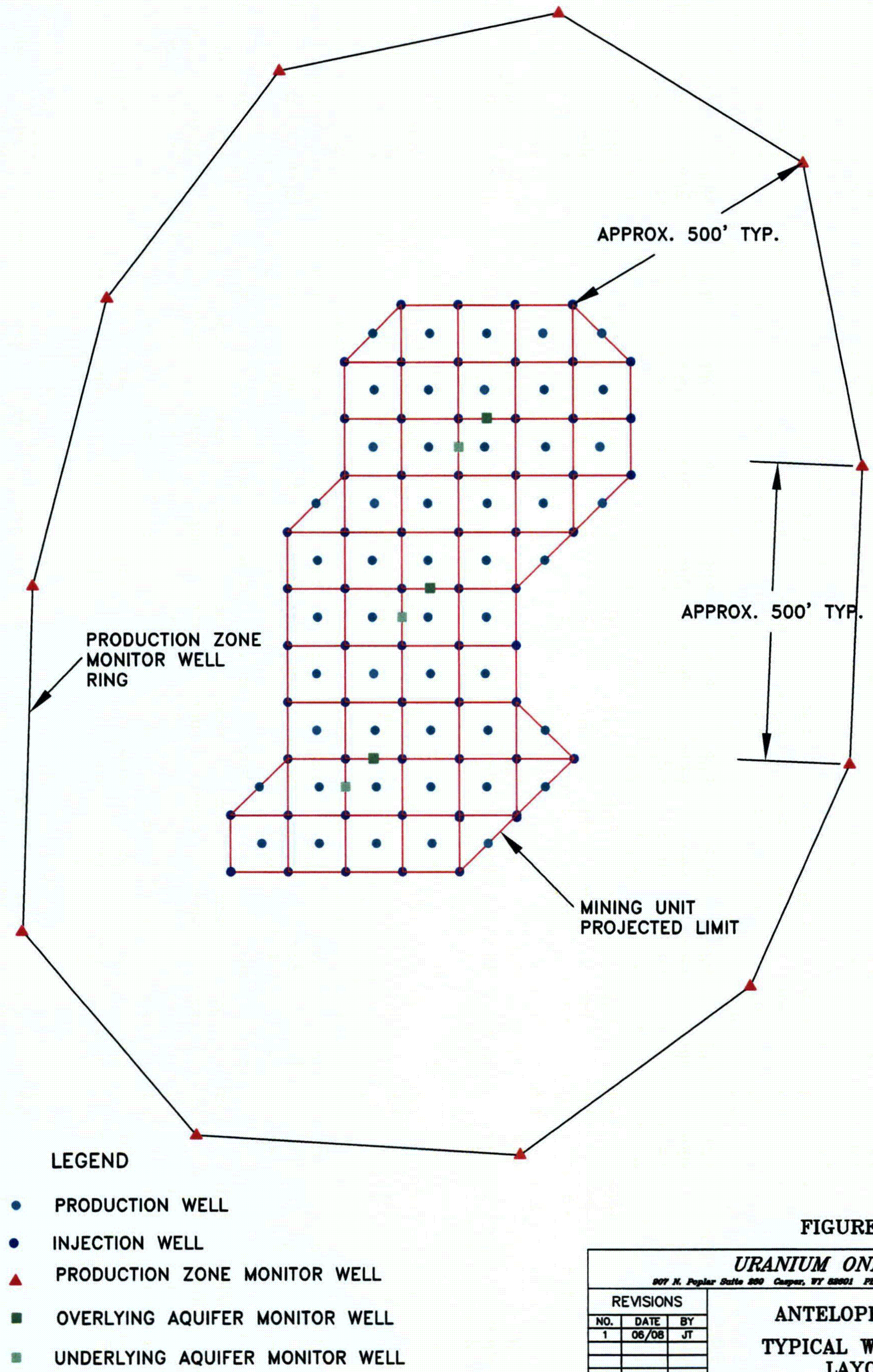

FIGURE 3-5

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ANTELOPE & JAB

TYPICAL WELLFIELD LAYOUT

SWEETWATER COUNTY, WYOMING

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

Injection of solutions for mining will be at a maximum rate of approximately 3,000 gpm for each project area. Water balances for the proposed Antelope and JAB Projects are shown on Figures 3-6 and 3-7. The liquid waste generated at the central plant will be primarily the production bleed which is estimated to range from 0.5% to 1.5%, and may average 1% of the production flow. At 3,000 gpm, the average volume of liquid waste generated by production bleed is 30 gpm from each project. Uranium One proposes to dispose of the liquid waste through deep disposal well injection as discussed in Section 4.

Restoration flow capacity (reverse osmosis treatment) will be approximately 1,000 gpm for the Antelope Central Plant and 500 gpm at the JAB Satellite facility. The typical rate for brine waste water produced during restoration is approximately 20%. This results in an RO brine rate of approximately 200 gpm at the Antelope Central Plant and approximately 100 gpm at the JAB Satellite during restoration at full capacity. Additional bleed will be encountered if groundwater sweep is utilized as a first stage of restoration. However, Uranium One does not anticipate utilizing groundwater sweep in significant amounts due to the limited success groundwater sweep has shown at other in situ operations.

As demonstrated from the limited drawdown during the regional aquifer testing (maximum radius of influence seen during testing was 0.5 miles), this amount of consumptive use will generate negligible drawdown outside of the project boundaries. As a result, no impact to other users of groundwater is expected since there is very limited use of groundwater within the immediate proximity to the wellfield areas. For the same reasons, no impacts to water users outside and downgradient of the proposed license boundary are expected. Impacts to groundwater from consumptive use are also discussed in detail in Section 7.2.

Downhole injection pressures will be maintained below the formation fracture pressure. The formation fracture pressure gradient commonly used is 1.0 psi for every 1 foot of depth[1] to the top of the screened interval. At the Antelope Project area, the depth to the top of the anticipated screened interval varies from approximately 300-600 feet in the western side to 200-400 feet in eastern side, and the JAB Project area, the depth to the top of the anticipated screened interval varies from approximately 150-310 feet. Accordingly, the maximum operating injection wellhead pressures will not exceed 90 percent of the production zone fracture pressure based on the top of the screened intervals, or 95 percent of the casing and piping materials used for wellfield construction.

3.1.5.1 Wellfield Operational Monitoring

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

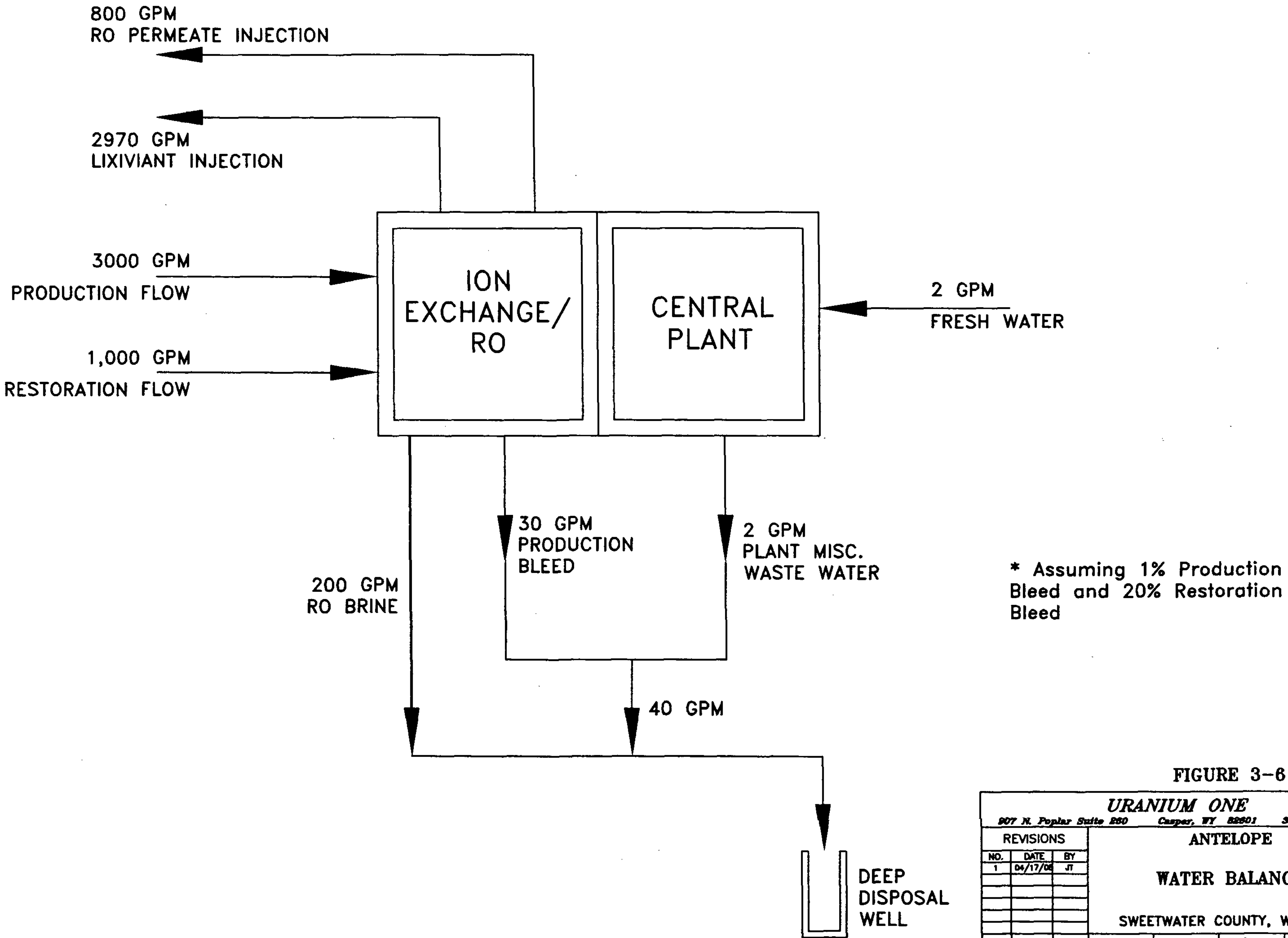

FIGURE 3-6

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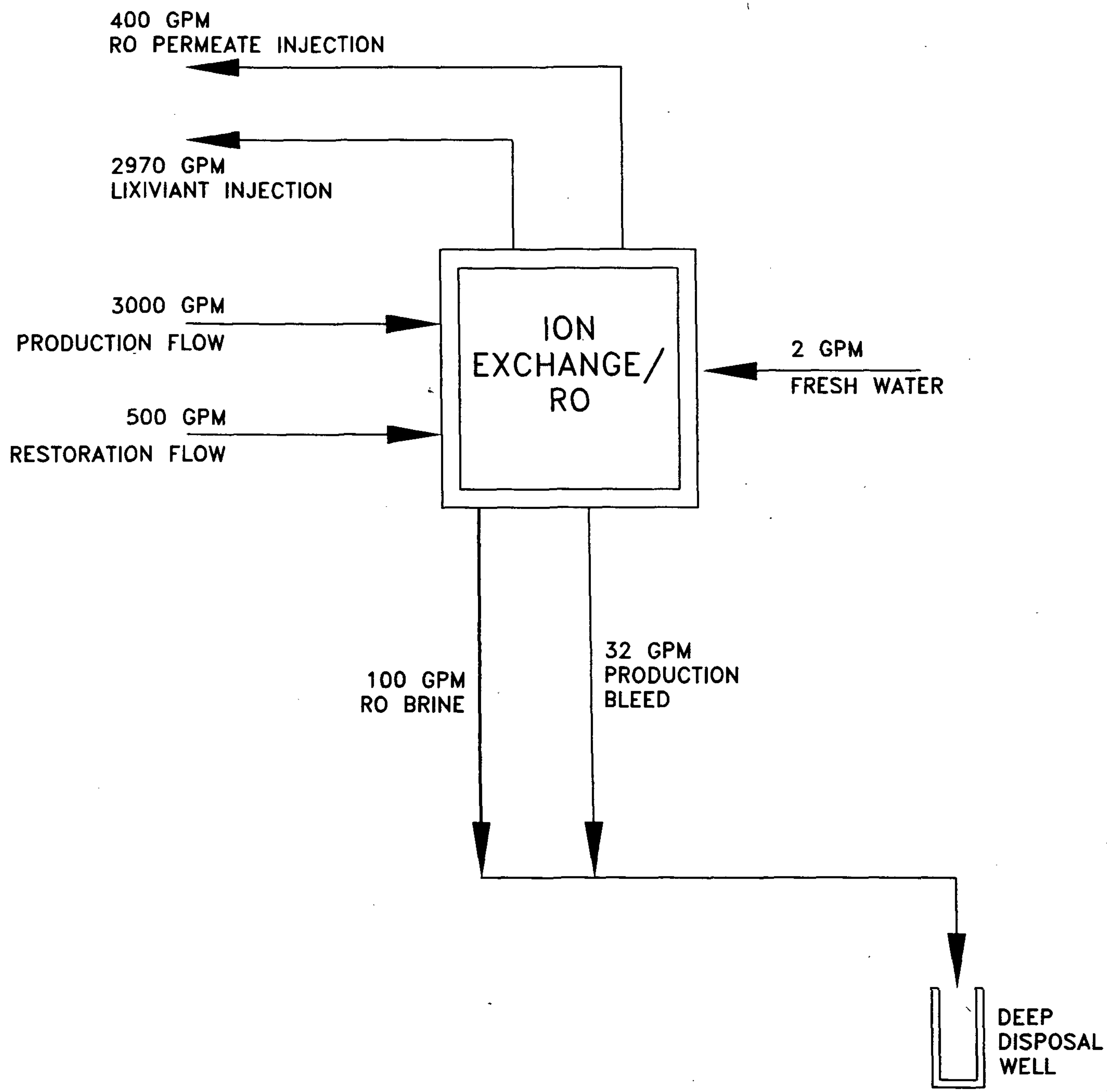
NO.	DATE	BY
1	04/17/08	JT

ANTELOPE

WATER BALANCE

SWEETWATER COUNTY, WYOMING



* Assuming 1% Production Bleed and 20% Restoration Bleed

FIGURE 3-7

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NO.	DATE	BY
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2	08/08	JT

JAB

WATER BALANCE

SWEETWATER COUNTY, WYOMING

3.1.6 Process Description

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

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

3.1.6.1 In Situ Reactions

The lixiviant is the recovery solution which is used to solubilize the uranium from the ore deposit. The composition is designed to reverse the natural geochemical conditions which led the to original uranium deposition. The project will use a carbonate and/or bicarbonate recovery solution consisting of varying concentrations and combinations of sodium carbonate (Na_2CO_3), sodium bicarbonate ($NaHCO_3$), oxygen, and carbon dioxide (CO_2) added to the native groundwater to promote the dissolution of uranium as a uranyl carbonate complex. The lixiviant is typically made up on a batch basis in the plant and added continuously to the injection stream. The expected or typical lixiviant concentration and composition is shown in Table 3-1.

Table 3-1: Typical Lixiviant Concentrations

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

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

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

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

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

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

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

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

3.1.6.2 Uranium Extraction

The process flow sheet depicting the uranium extraction process as planned for the Antelope central plant and JAB Satellite is shown in Figures 3-8 and 3-9. The recovery of uranium from the pregnant lixiviant in the Antelope and JAB ion exchange facilities will take place in the ion exchange columns. The uranium bearing recovery solution enters the pressurized downflow ion exchange column and passes through the resin bed. A uranium specific ion exchange resin, such as Dowex 21K or equivalent, is used. The uranium complexes in solution are loaded onto the ion exchange resin in the column. This loading process is represented by the following chemical reaction:

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

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

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

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

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

3.1.6.3 Bleed Treatment

To control the movement of lixiviant within the ore zone, a fraction of the barren lixiviant will continuously be removed from the volume being pumped back to the injection wells, resulting in more lixiviant being pumped from the ore zone than injected. This bleed will create a cone of depression within the ore zone causing natural groundwater from the surrounding area to be drawn toward the wellfield. This negative pressure gradient holds or contains the lixiviant within the desired ore-bearing region. This prevents the excursion of lixiviant away from the wellfield and minimizes the dilution of lixiviant by uncontrolled fluid movement. It is expected that the bleed rates will range approximately from 0.5 percent to 1.5 percent of the production flow rate, and average around 1.0 percent. The bleed fluid will be contained in the wastewater system tankage located in the central and satellite plant facilities and disposed via the waste disposal well(s) as described in Section 4.

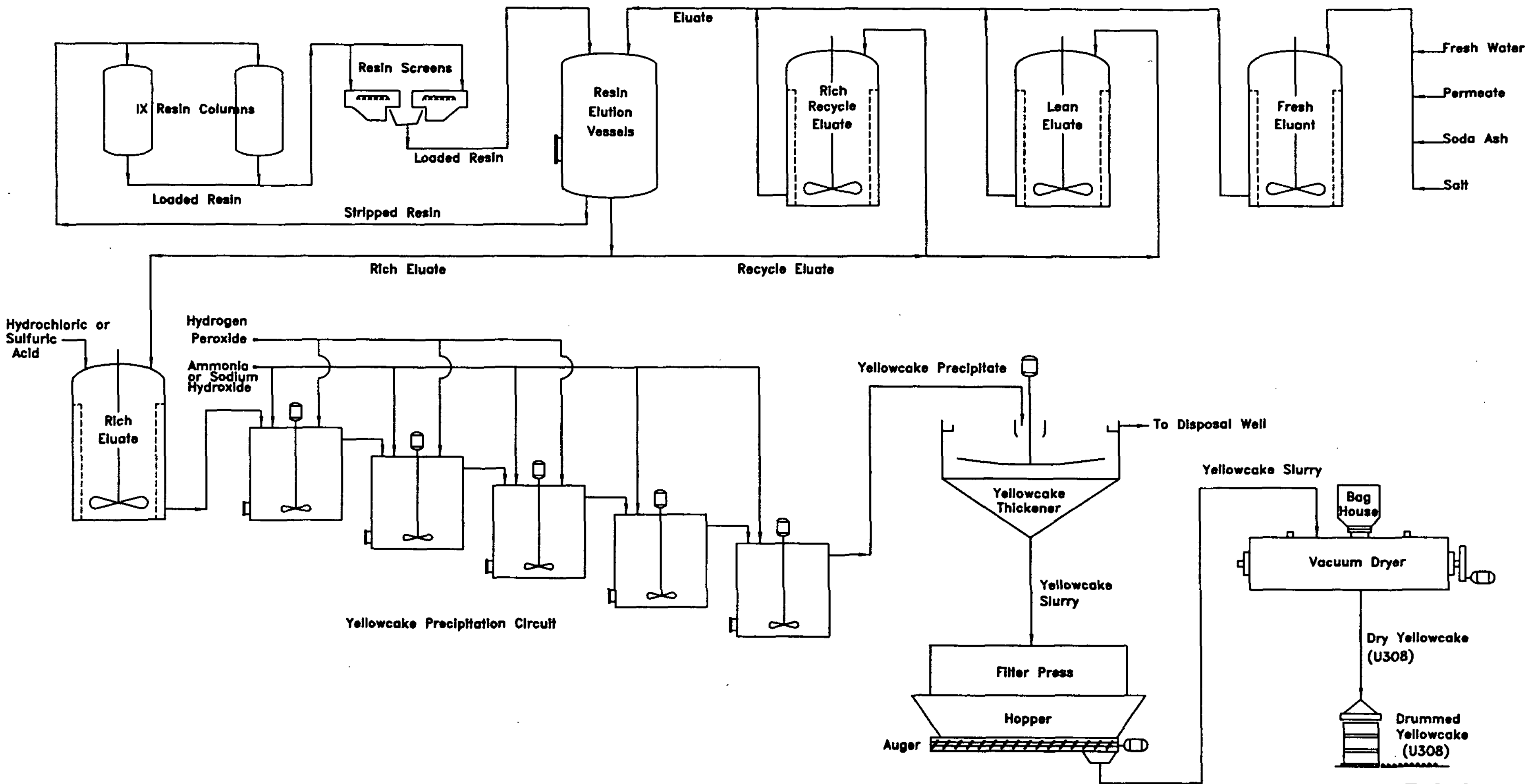
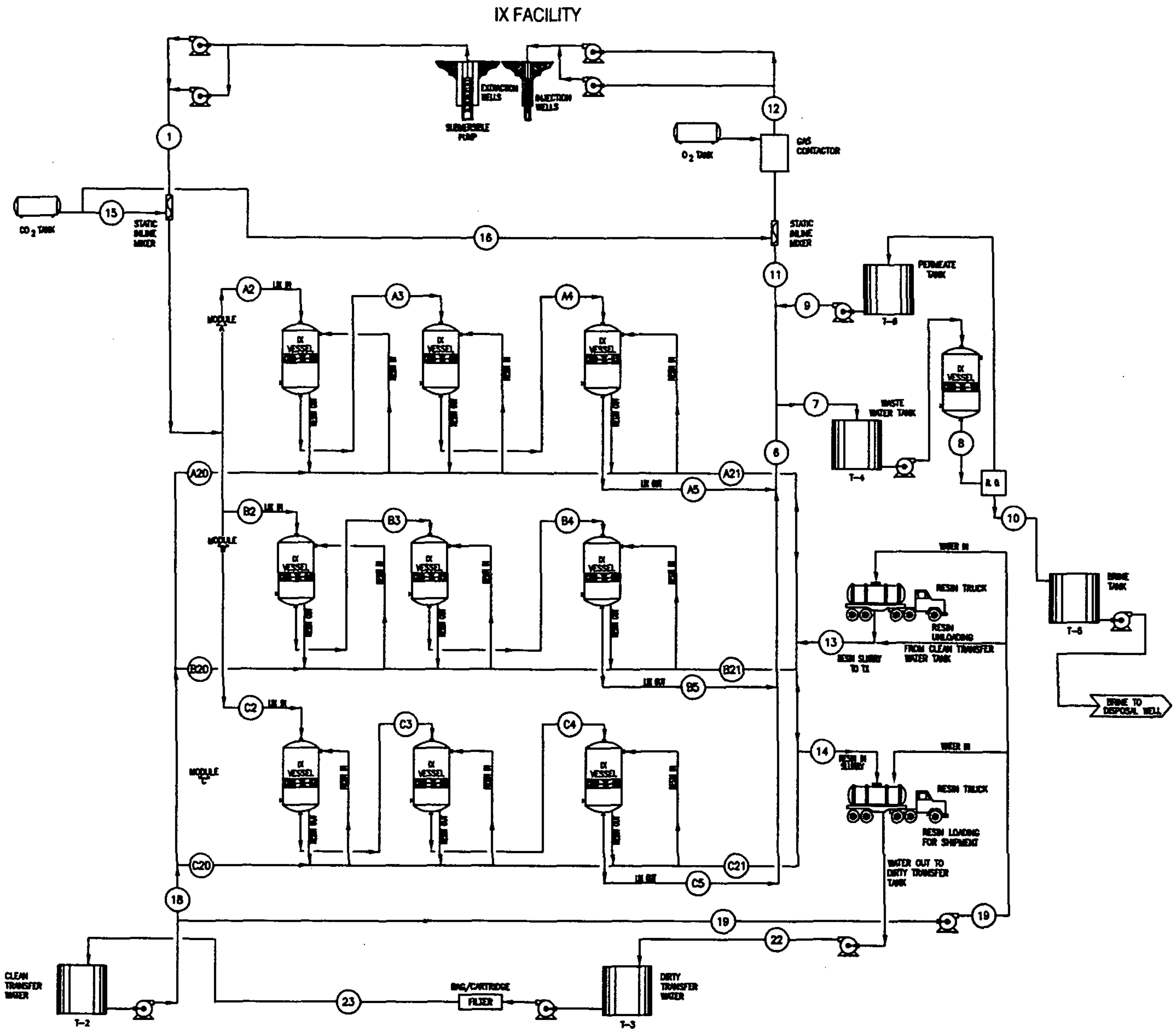


FIGURE 3-8

URANIUM ONE
907 N. Poplar St. Casper, WY 82601 307-234-8235

REVISIONS		
NO.	DATE	BY
1	06/08	JT

ANTELOPE
CENTRAL PLANT
PROCESS FLOW DIAGRAM
SWEETWATER COUNTY, WYOMING



MASS BALANCE TABLE

Stream Number	Description	Continuous or Intermittent	Flow Rate (gpm)	Uranium Conc. PPM	U3O8 Mass Flow Rate, st/hr	U3O8 Mass Flow Rate, st/yr
1	Pregnant Lixiviant	C	3267	75.00	0.061	529.93
A2, B2, C2	IX Feed	C	1089	75.00	0.020	176.64
A3, B3, C3	IX Stage 1 Discharge	C	1089	18.75	0.005	44.16
A4, B4,C4	IX Stage 2 Discharge	C	1089	5.63	0.002	13.24
A5, B5, C5	IX Stage 3 Discharge	C	1089	1.97	0.001	4.63
6	Barren Lixiviant	C	3267	1.97	0.002	13.91
7	Barren Lixiviant Bleed	C	82	1.97	0.000016	0.14
8	RO Feed	C	82	0.50	0.000010	0.006
9	RO Permeate	C	49	0.00	0.00000	0.00
10	RO Concentrate	C	33	1.25	0.000010	0.006
11	Net Barren Lixiviant	C	3235	1.97	0.002	13.77
12	Net Barren Lixiviant to Well Field	C	3235	1.97	0.002	13.77
13	Barren Resin From Truck	I	2 xfer/day	0.10 lb/ft3	N/A	0.00
14	Loaded Resin to Truck	I	2 xfer/day	3 lb/ft3	N/A	0.00
15	CO2 Boost to Pregnant Lixiviant	C	2.73	lb/min		
16	CO2 to Barren Lixiviant	C	3.03	lb/min		
17	O2 to Barren Lixiviant	C	4.05	lb/min		
18	Resin to Truck Water	I	280	2 xfer/day		
19	Resin to Column Water	I	280	2 xfer/day		
A20, B20, C20	Educt to Truck	I	280	2 xfer/day		
A21, B21, C21	Educt to Column	I	280	2 xfer/day		
22	Dirty water From Truck	I	280	2 xfer/day		
23	Filtrate to Tank	I	28	Between transfers		

FIGURE 3-9

URANIUM ONE

REVISIONS

JAB SATELLITE

PROCESS FLOW DIAGRAM

SWEETWATER COUNTY, WYOMING

Resin Transfer and Elution

Once the ion exchange resin in an IX column is loaded to capacity with uranium complexes, the column will be taken out of service. The resin loaded with uranium will be either transferred straight from the IX column to the elution circuit at the Antelope Central Plant or transferred from the JAB Satellite plant to the Antelope Central Plant via tanker truck. Once the resin has been stripped of the uranium by the process of elution, the resin will be returned to the appropriate column for reuse in the ion exchange circuit. In the elution circuit the loaded resin will be stripped of uranium by a process based on the following chemical reaction:

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

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

3.1.6.5 Precipitation

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

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

Sodium hydroxide (caustic soda) or anhydrous ammonia is then added to raise the pH to a level conducive for precipitating uranium crystals.

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

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

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

3.1.7 Proposed Operating Schedule

The proposed Antelope Project mine schedule is shown in Figure 3-10. The mine schedule is preliminary based on Uranium One's current knowledge of the area and potential for future wellfield development. The schedule shows potential development of six wellfields and the Central Plant on the western portion of the project. As shown on Figure 3-1, the eastern portion of the project area contains significant areas of mineralization which will be further delineated and potential wellfield areas will be defined. As development of these potential wellfield areas progress, the mine schedule will be updated accordingly. The schedule shows operation of the Central Plant through 2030 as it is currently planned to be utilized to process resin from potential future satellite areas in the region.

The proposed mine schedule for the JAB Project is shown on Figure 3-11. As with the Antelope Project, the mine schedule is also preliminary and based on Uranium One's current knowledge of the area and potential for future wellfield development. As shown on Figure 3-1, the southwestern portion of the project area contains additional areas of mineralization which will be further delineated. As potential additional wellfield areas are defined at the JAB Project, the mine schedule will be updated accordingly.

Figure 3-10: Proposed Antelope Project Operations Schedule

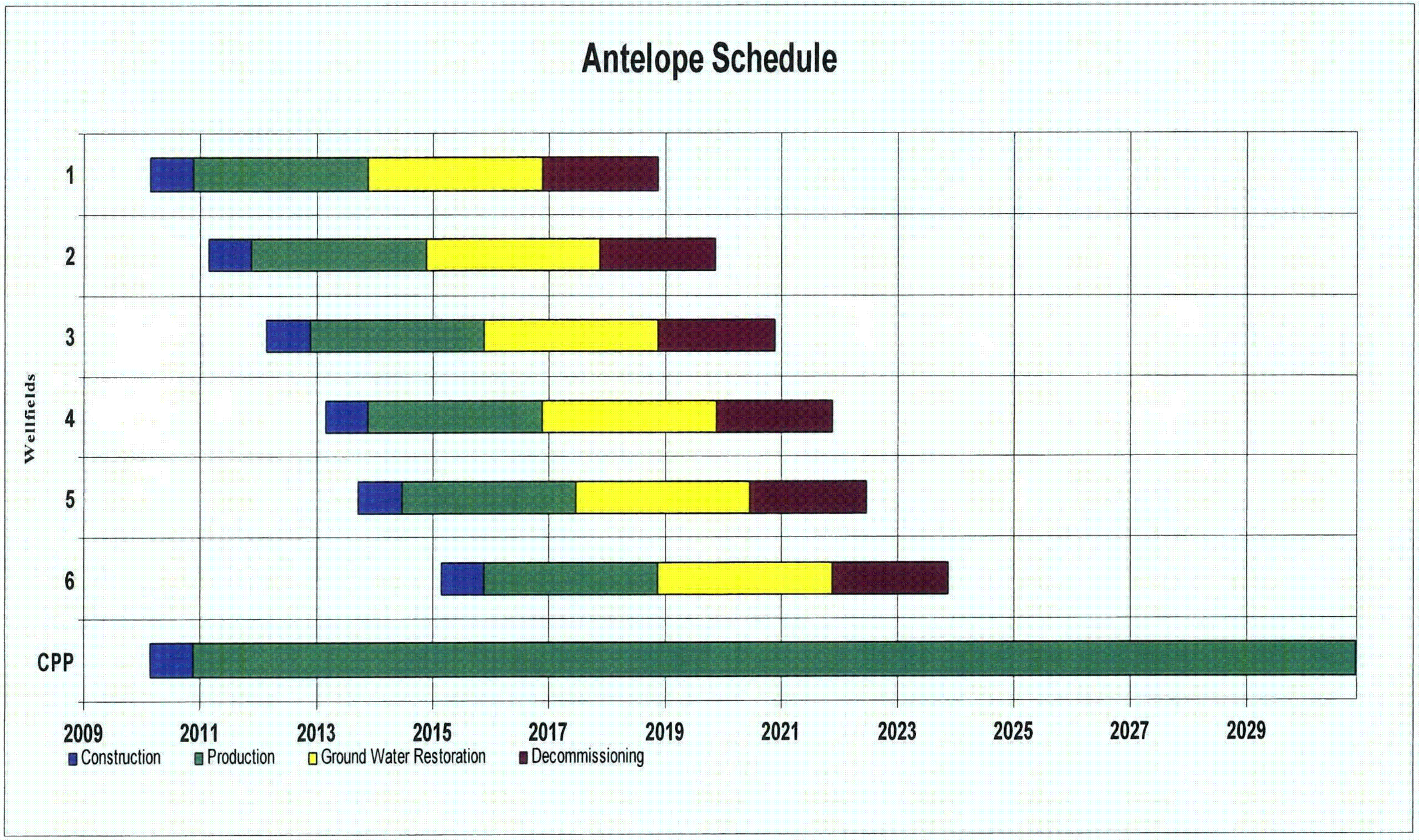
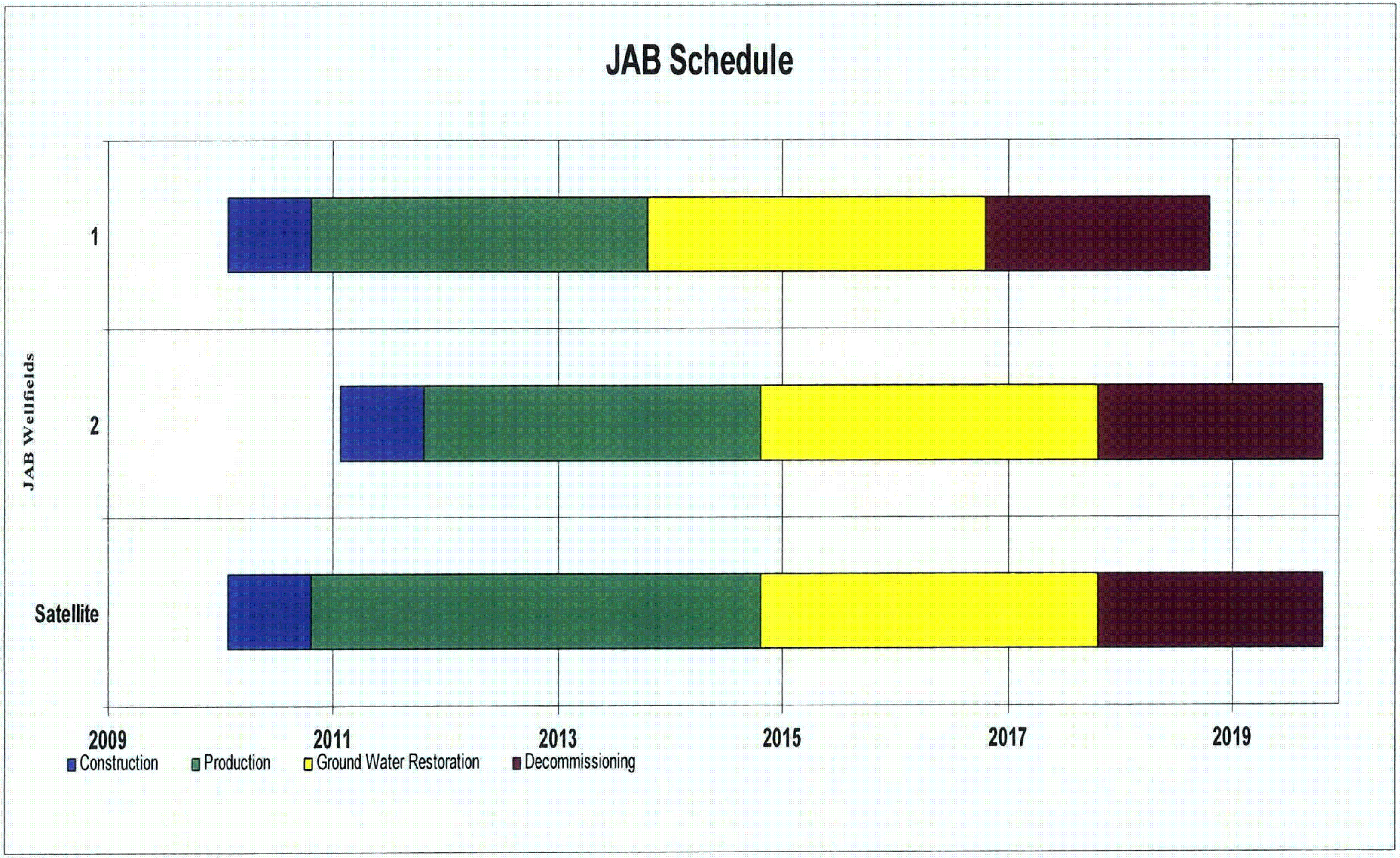


Figure 3-11: Proposed JAB Project Operations Schedule



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

The uranium recovery process described in the preceding section will be accomplished in several steps. Uranium recovery from the solution by ion exchange, subsequent processing of the loaded ion exchange resin to remove the uranium (elution), the precipitation of uranium, and the dewatering and packaging of solid uranium (yellowcake) will be performed at the central plant located at the Antelope Project (42° 13' 10.81" N 107°51' 46.17" W) (see Figure 3-12)..

The central plant will not only serve production from ISR operations within the Antelope Project boundaries, but will also process resin from the JAB satellite area, and other future satellites in the region. The central plant will initially be designed and constructed to produce 2 million pounds of U_3O_8 per year (see Figure 3-13 for layout). Capacity may be expanded to 4 million pounds per year as other potential satellite projects in the surrounding area are licensed and production increases (see Figure 3-14 for potential expanded facility layout).

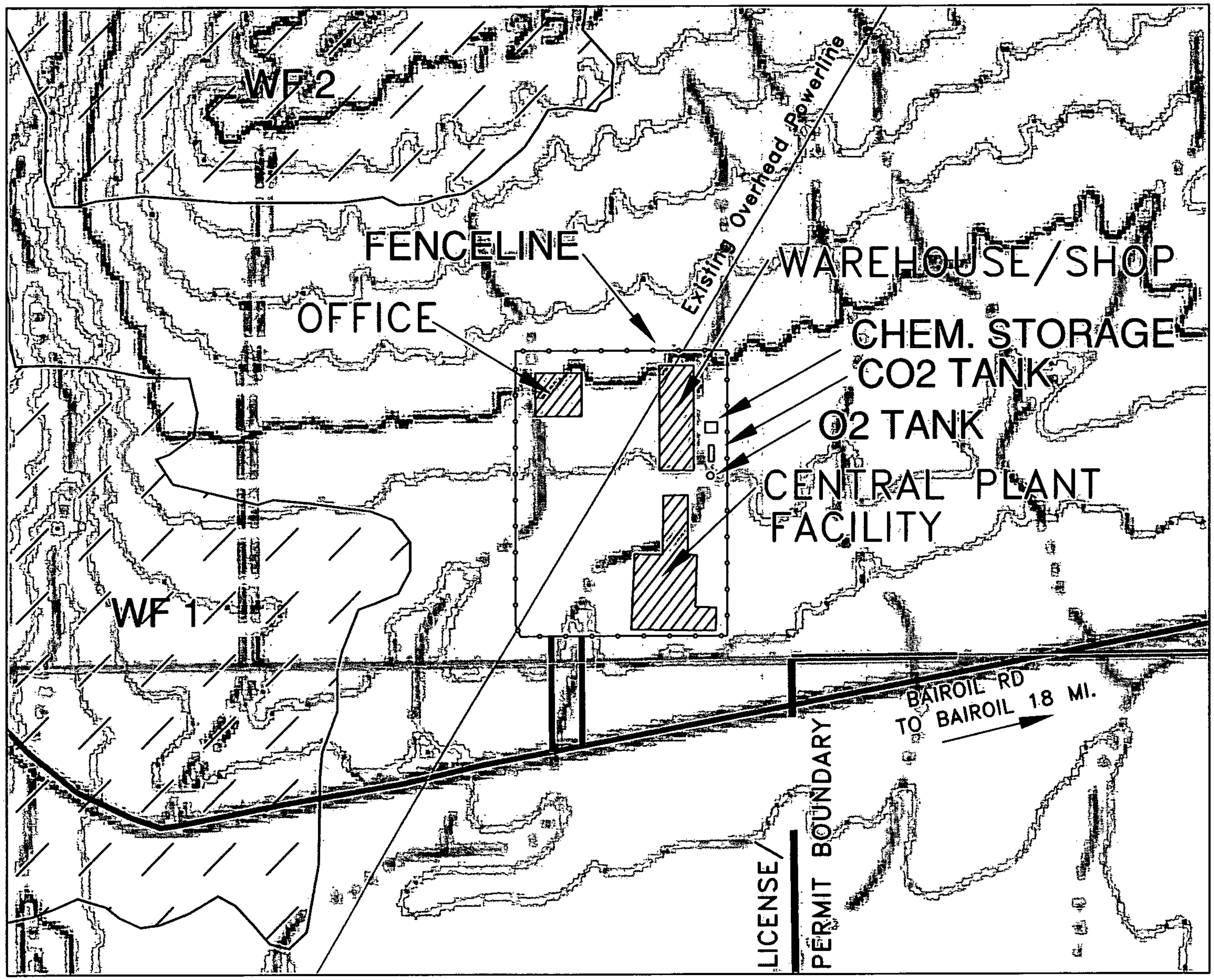


Figure 3-12

LEGEND

PROPSED WELLFIELD AREAS/
AFFECTED LANDS

0' 500'

WYOMING WEST CENTRAL DATUM

URANIUM ONE

907 North Poplar St. Casper, WY 82601 307-234-8235

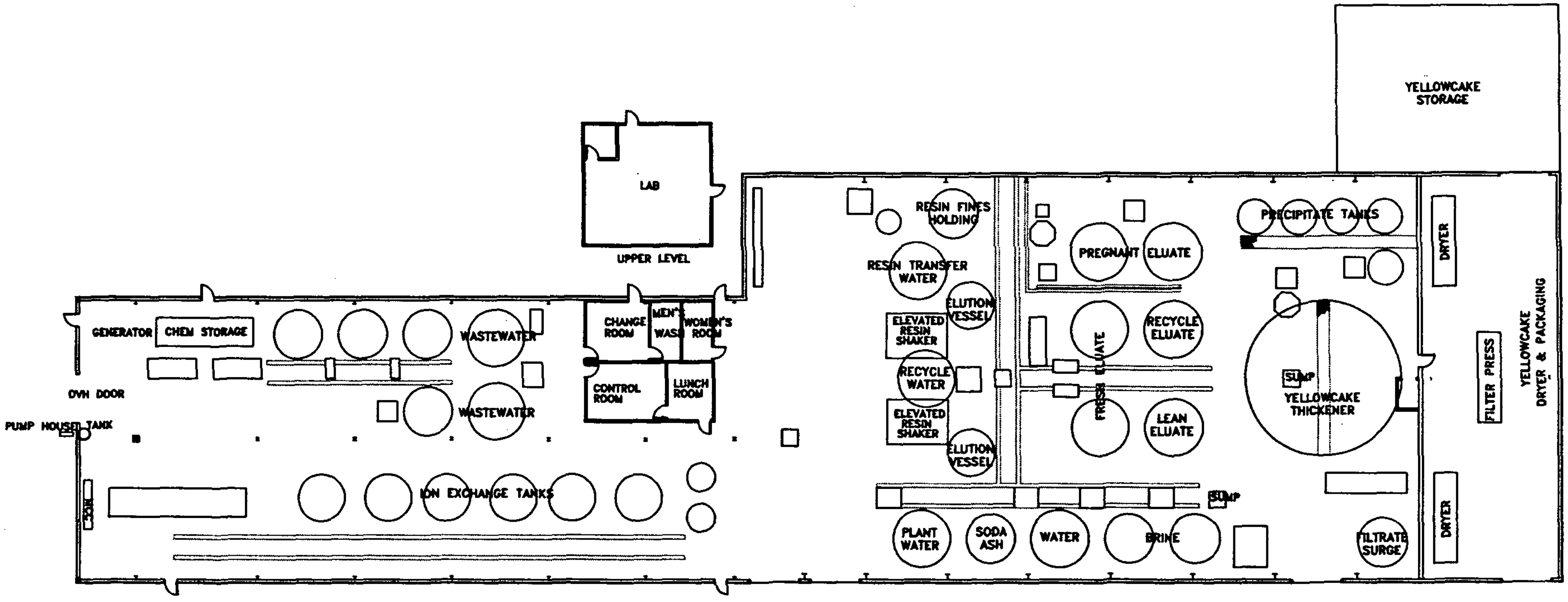
REVISIONS		
NO.	DATE	BY

ANTELOPE

SITE PLAN

PORTIONS SECT. 14, 15, 22 & 23, T.26N., R.94W.
SWEETWATER COUNTY, WYOMING

GEOL. BY:	DATE:	APPR. BY:	DATE:
ENG. BY:	DATE:	APPR. BY:	DATE:
DRAFT. BY:	DATE:	SCALE:	FILE:



0 20 40

FIGURE 3-13

URANIUM ONE 907 N. Poplar Suite 260 Casper, WY 82601 307-234-8235			
REVISIONS			ANTELOPE
NO.	DATE	BY	CENTRAL PLANT LAYOUT
1	04/20/06	JT	SWEETWATER COUNTY, WYOMING

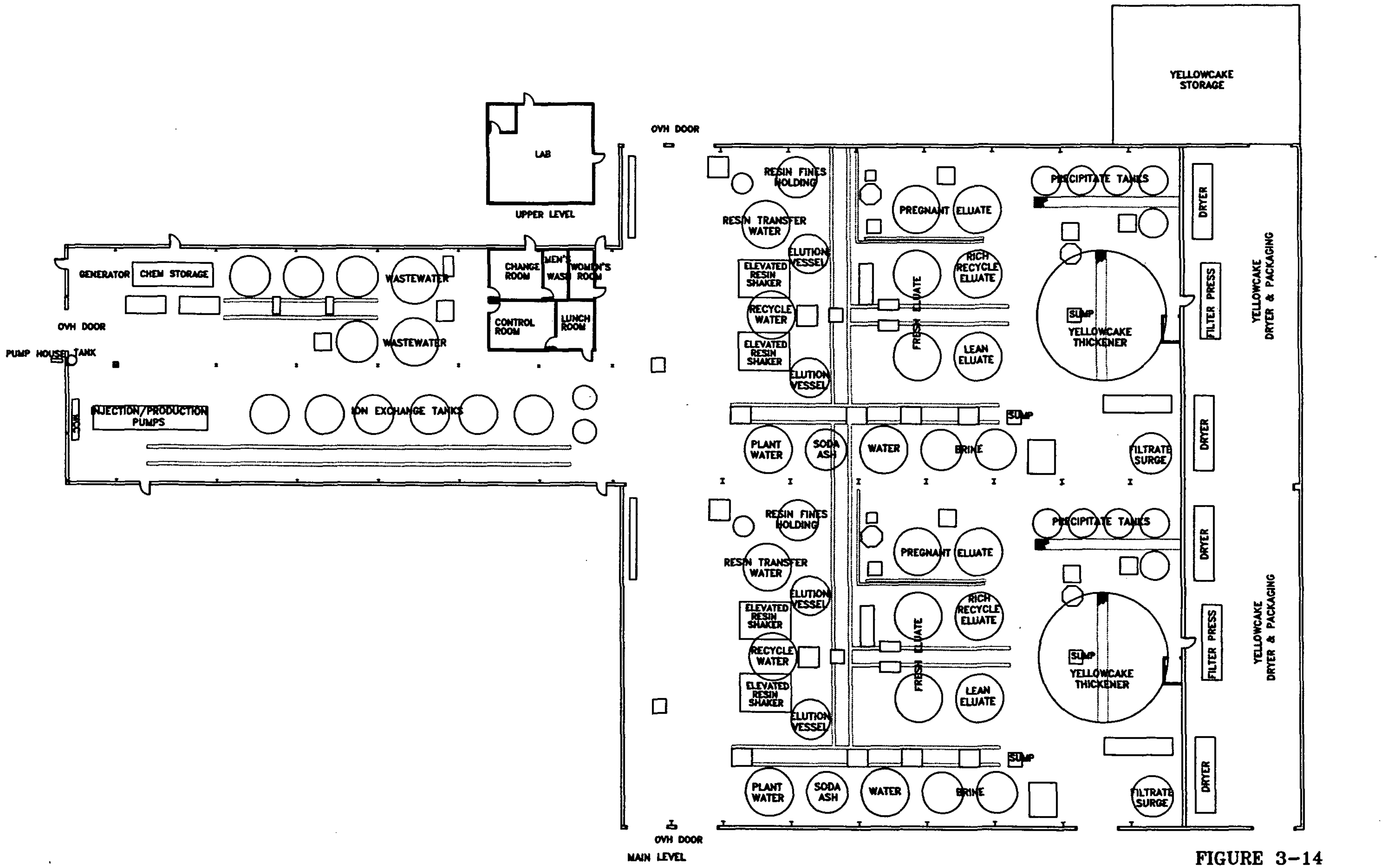


FIGURE 3-14

URANIUM ONE
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ANTELOPE

EXPANDED CENTRAL PLANT LAYOUT

SWEETWATER COUNTY, WYOMING

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NO.	DATE	BY
1	04/20/06	JT

3.2.1.1 Antelope Project Central Plant Equipment

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

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

Based on preliminary design and site geotechnical evaluations, the central plant will be located within a 10 acre fenced area in the SW ¼¼, Section 18, T26N, R92W. This area may also contain at least one of the waste water disposal well(s) and the chemical storage area.

3.2.1.2 Flow and Material Balance – Ion Exchange

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

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

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

3.2.1.3 Flow and Material Balance – Elution System

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

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

3.2.1.4 Flow and Material Balance – Precipitation System

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

3.2.1.5 Yellowcake Drying

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

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

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

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

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

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

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

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

what about the monitoring

7. Effluent Monitoring: The vacuum pump discharges to the atmosphere. The water that is collected from the condenser will be recycled to the precipitation circuit, eluant

makeup or disposed with other process water. Room air will be monitored routinely for airborne dust.

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

3.2.2 Yellowcake Packaging, Storage, and Shipment

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

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

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

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

3.2.3 Antelope Central Plant Facility Chemical Storage Facilities

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

3.2.3.1 Process Related Chemicals

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

- Carbon Dioxide

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

- Oxygen

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

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

- Chemical Reductants

Hazardous materials typically used during groundwater restoration activities include the addition of a chemical reductant (i.e., sodium sulfide or hydrogen sulfide gas). To minimize the potential for accidents involving process chemicals to impact areas where licensed material is handled, these materials are stored outside of process areas. These chemicals induce a reducing action that causes dissolved uranium and other heavy metals to stabilize at acceptable levels. When used, bulk inventories of these materials will be stored at the Central Plant facility area in a dry, clean isolated environment. It is important to prevent contact with any material that may react with the reductant chemicals. In the event that hydrogen sulfide is used, proper worker safety precautions will be taken.

- Sodium Hydroxide or Ammonia

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

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

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

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

- Acid Storage

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

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

- Hydrogen Peroxide

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

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

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

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

3.2.3.2 Antelope Project Non-Process Related Chemicals

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

3.3 JAB SATELLITE IX PLANT, CHEMICAL STORAGE FACILITIES; EQUIPMENT USED AND MATERIAL PROCESSED

The major facilities at the JAB project site are shown on Figure 3-15 including associated structures and wellfields. The JAB satellite facility is designed to operate at a throughput of 3,000 gpm. The JAB IX processing facility will be located within an approximate 5-acre fenced area in the SE¼SE¼ of Section 15, T26N, R94W, as shown on Figure 3-15. The processing facility includes the IX facilities and resin loading and transfer areas. This area will also contain the administration building, chemical storage, CO_2 and O_2 tank storage, storage yard, temporary byproduct storage area, and employee parking. The main satellite building will be approximately 100 feet in width by 180 feet in length and will be entirely contained within a concrete curb designed to contain the volume of the largest tank in the facility. Figure 3-16 shows the general layout of the process equipment in the IX facility.

The resin loading circuit at the IX facility will consist of six pressurized vessels, each containing anionic ion exchange resin. The vessels will be configured as three parallel trains for two-stage down-flow loading for operational uranium recovery. One parallel train will be installed for uranium removal and recovery during restoration. Booster pumps are located upstream and downstream of the column trains. Other systems include fresh water, resin transfer water, waste water storage, and reverse osmosis unit.

As the pregnant lixiviant enters the IX facility from the wellfield, a booster pump upstream of the IX columns will pressurize the fluid to approximately 100 psig. The dissolved uranium in the pregnant lixiviant is chemically adsorbed onto the ion exchange resin in the IX columns as described in previous sections.

Any sand or silt contained in the pregnant lixiviant will be trapped by the resin bed as with a traditional sand filter. The barren lixiviant exiting the third stage IX vessel will normally contain less than 2 ppm of uranium. This fluid will be pressurized by booster pumps prior to return to the wellfield for re-injection.

When resin in a first stage IX vessel is loaded and removing very little additional uranium, the vessel is isolated from the normal process flow, which is shunted to another vessel in the train. The loaded resin will be transferred in 500 cubic foot lots to a trailer for transport to the Antelope Project Central Plant. After processing, the resin is returned to the JAB satellite facility via truck and placed back into an IX vessel for continued uranium recovery.

The lixiviant is composed of native groundwater, carbon dioxide, sodium carbonate/bicarbonate, and oxygen. Carbon dioxide will be added in the IX facility, both upstream and downstream of the resin vessels. Oxygen is added to the barren lixiviant at the wellfield piping manifolds at the injection manifold or at the satellite plant. If sodium carbonate/bicarbonate is added to boost the carbonate levels in the lixiviant, this will be mixed and added at the satellite plant. The lixiviant concentration of carbon dioxide will be maintained at approximately 1800 ppm while the oxygen concentration will be approximately 300 ppm.

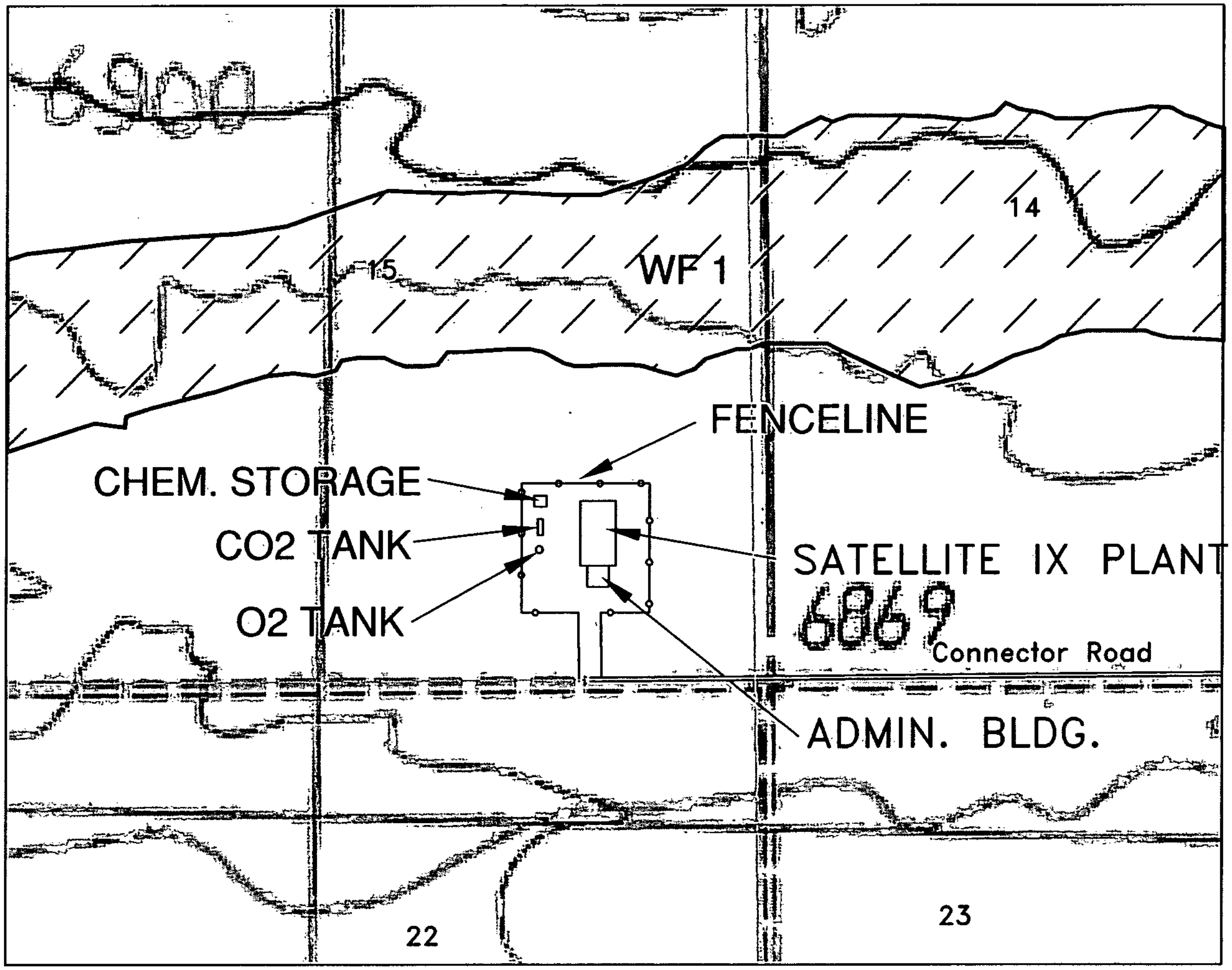
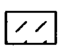
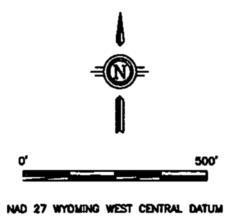


Figure 3-15

LEGEND



PROPSED WELLFIELD AREAS/
AFFECTED LANDS



URANIUM ONE

907 North Poplar St. Casper, WY 82601 307-234-8235

REVISIONS		
NO.	DATE	BY

JAB

SITE PLAN

PORTIONS SECT. 14, 15, 22 & 23, T.26N., R.94W.
SWEETWATER COUNTY, WYOMING

3.3.1 JAB Satellite Facility Chemical Storage

Chemical storage facilities at the JAB Satellite facility will be designed to store and contain each specific material used. Carbon dioxide typically will be stored adjacent to the IX facility where it is added to the lixiviant prior to being pumped back to the wellfields. Oxygen typically will be stored at the IX wellfields, but could be stored at the IX facility. The proposed locations of the carbon dioxide and oxygen storage tanks at the IX facility are described in Section 2.1 and shown on Figure 3-15. Materials storage areas will be constructed and maintained according to best practices. Proper signage will be installed in the storage areas. Appropriate handling procedures will be instituted and observed, and a hazard communication program in accordance with OSHA standards will be in place to deal with potential hazards associated with all materials stored at the site.

Chemical reductant may be utilized during groundwater restoration. Materials commonly used in ISR mining include sodium sulfide and hydrogen sulfide. These chemicals induce a reducing action that causes dissolved uranium and other heavy metals to stabilize at acceptable levels. When used, bulk inventories of these materials will be stored at the IX facility area in a dry, clean isolated environment. It is important to prevent contact with any material that may react with the reductant chemicals. In the event that hydrogen sulfide is used, proper worker safety precautions will be taken.

Byproduct storage at the IX facility will consist of large covered bins or trailers placed in an accessible area beside the satellite facility. These will be used for temporary storage of material including used production pipe, resin fines, and expended filter media. The byproduct storage area will be inspected as described in Section 5

3.3.1.1 JAB Project Non-Process Related Chemicals

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

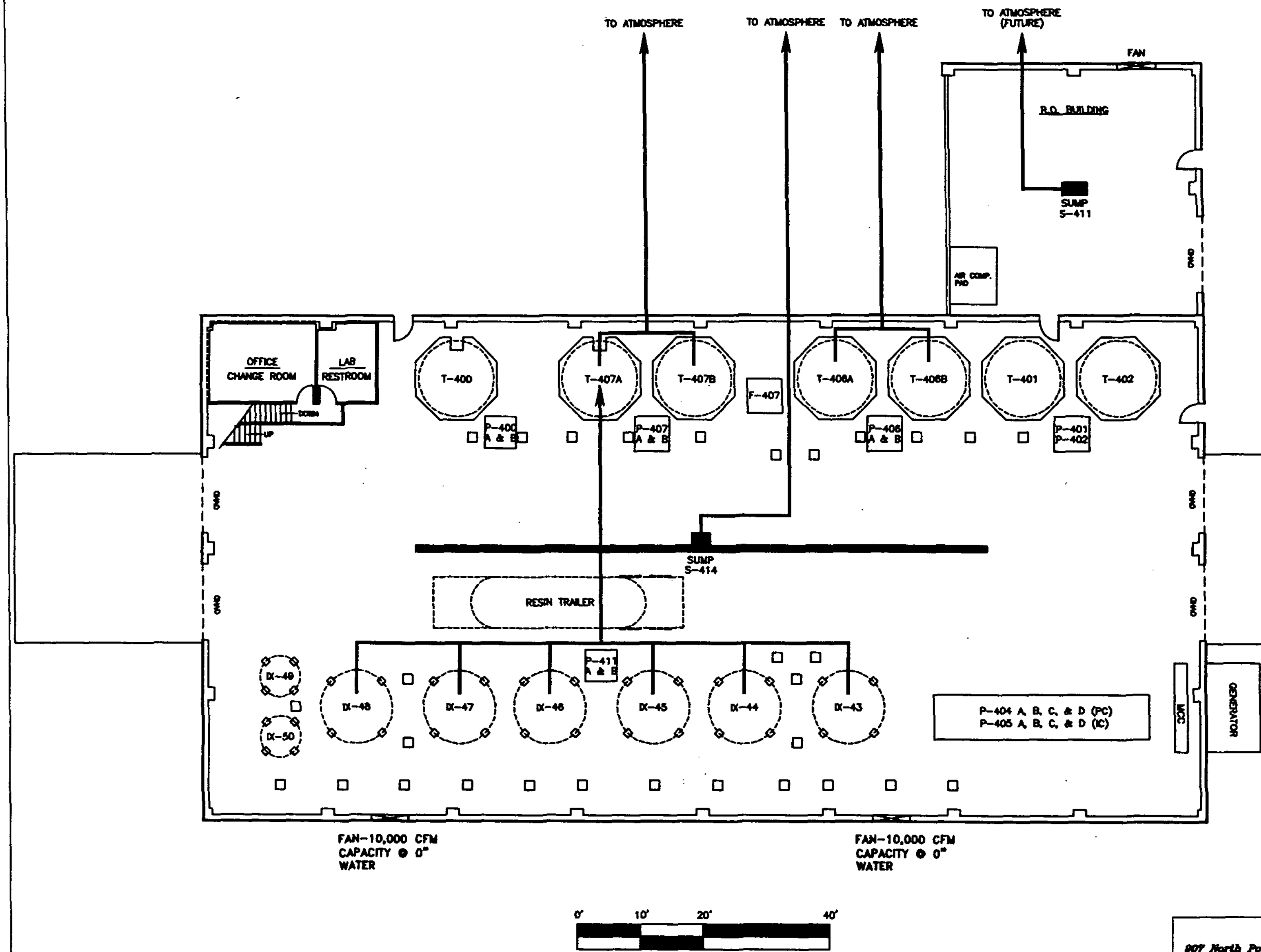


FIGURE 3-16

URANIUM ONE

907 North Poplar Suite 260 Casper, WY 82601 307-234-8235

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JAB

SATELLITE LAYOUT

SWEETWATER COUNTY, WYOMING

3.4 INSTRUMENTATION AND CONTROL

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

Instrumentation will be provided to monitor the total recovery flow into the central plant, the total injection flow leaving the plant, and the total waste flow leaving the plant. Instrumentation will be provided on each injection and production well to record an alarm in the event of a change in flow that might indicate a leak or rupture in the system.

In the process areas, tank levels are measured in chemical storage tanks as well as process tanks.

Two separate control systems will be provided for control and monitoring purposes. Each system is designed and instrumented to accommodate the steady state or batch flow characteristics of particular process flow streams or unit operations.

This distinction is highlighted as follows:

Steady State

- Wellfield/Resin Loading Circuit
- Wellfield Waste Water Disposal
- Wellfield Bleed Waste Water

Batch

- Bleed Treatment
- Process Waste Water Disposal

The wellfield and resin loading circuits operate at a steady state, and deviations from the normal operating flow rates and pressure profiles (±10 percent or greater) are indicative of operating upsets. An automatic Emergency Shut Down (ESD) system consisting of pressure and flow rate switches will be provided for this circuit. In the event of an automatic shutdown, an alarm notifies the operator of the situation. Once the upset (broken piping, leaking vessels, etc.) is identified and corrective action taken, only then can the circuit be manually restarted. This type of control system provides the best protection against fluid spills to the environment. Back-up for the automatic ESD system is provided by local displays of the same flow rates and pressures that the ESD system monitors.

Waste water treatment and disposal circuits operate under semi-continuous, steady state conditions which require control systems that integrate components of both steady state and batch operations. The control systems will employ state-of-the-art hardware with demonstrated process logic. Like all elements of the facility design, instrumentation and control systems are based on modern practices and proven techniques.

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

3.5 ACCESS ROADS CONSTRUCTION AND MAINTENANCE

3.5.1 Primary Access Roads

Primary access to the site is from State Highway 287 and State Highway 73 (Bairoil to Lamont), then via the Bairoil road from the east and/or the Wamsutter-Crooks Gap road from the north (Figure 3-1). These roads will be the primary routes for material shipments, employee commute, and transportation by project vehicles. These roads will be maintained as needed to provide safe and timely access and vehicle use.

Current access to the JAB project area is by two-track roads that branch from the existing county roads. A primary access route to JAB will be constructed from the junction of the Wamsutter-Crooks Gap and Bairoil roads also shown on Figure 3-1. This road is proposed to follow an existing two-track road to the JAB Satellite Plant area. The location of the proposed road was chosen due to relatively flat terrain, low number of drainages to cross, the existing two track road, and it is the shortest route to the Antelope Central Plant area. Uranium One will apply for a Right Of Way for this proposed road under BLM 3809 regulations, and accept the maintenance and reclamation responsibility for that portion of the road.

Uranium One believes the proper classification of this proposed road is BLM Local. Construction of this road will be done in accordance with BLM standards, such as those found in BLM Manual 9113- Roads Manual. The proposed road will be approximately 24 feet in width and will be graded, drained, surfaced, and are capable of carrying highway loads. Professional engineering design and construction oversight will be utilized as needed. Designs and plans for the Antelope and JAB area connecting road will be submitted to the BLM and WDEQ-LQD for approval prior to commencement of road construction.

Design, field survey, and plans requirements for a BLM Local Road include the following.

3.5.1.1 Design Requirements

- Design speed is generally 15 to 50 miles per hour.
- Travelway minimum is 14 feet (single lane) and 24 feet (double lane) with intervisible turnouts, as may be required.
- Recommended minimum horizontal curve radius is 220 feet. Where terrain will not allow 220-foot curve radii, curve widening is necessary.
- Vertical curves should be designed with an appropriate "k" value (rate of vertical curvature length per percent of "A", the algebraic difference in grade) based on design speed.
- Maximum grades should not exceed 8 percent. Pitch grades for lengths not to exceed 300 feet may be allowed to exceed 8 percent in some cases.
- All culverts will be sized in accordance with accepted engineering practices and any special environmental concerns. The minimum size culvert in any installation is 18 inches. Drainage crossings and culverts should be designed for a 25-year or greater storm frequency and allow fish passage in perennial streams where fish are present.
- Turnouts are required on all single-lane roads. Turnouts must be located at 1000-foot intervals or be intervisible, whichever is less. The length should not be less than 100 feet, with additional 50-foot transitional tapers at each end.
- Surfacing will be required to provide all-weather access. Aggregate size, type, amount, and application method will be specified in road plans and submitted to the BLM for approval.

3.5.1.2 Field Survey Requirements

- A flagline is established along the construction route. Flags should be placed approximately every 100 feet, or be intervisible, whichever is less. Construction control staking may be required depending on conditions of the site.

- Culvert installations are located and staked.

- A transit survey with preliminary center line staking and cross-sectioning is usually required on steep terrain and in areas requiring special engineering.

3.5.1.3 Design Drawings and Templates

- Generally, a plan and profile view would be the minimum required drawings for the BLM Local road class. This would identify grade, location, stationing, turnouts, culvert locations, and drainage dip spacing.

- Standard templates of the proposed road cross-section(s), and drainage dip design are required for these roads.

- Additional information may be required in areas of environmental or engineering concern.

3.5.2 Secondary Access Roads

Secondary access roads at the Antelope and JAB Projects will be used to access wellfield headerhouses and will be designed for one way traffic and light use. Secondary access roads will branch off of primary access roads when possible to keep the length of secondary access roads as small as reasonable. The anticipated road classification for secondary access roads is BLM Resource. Construction of secondary roads will be done in accordance with BLM standards, such as those found in BLM Manual 9113- Roads Manual. Design, field survey, and plans requirements for a BLM Resource Road include the following:

3.5.2.1 Secondary Road Design Requirements

- Design speed is 10 to 30 miles per hour.

- Preferred travelway width is 14 feet with turnouts.

- Recommended minimum horizontal curve radii is determined by the design vehicle and design speed. Where terrain will not allow the proper curve radii, curve widening is necessary.

- Road gradient should fit as closely as possible to the natural terrain, considering vehicle operational limitations, soil types, environmental constraints, and traffic service levels. The gradient should not exceed 8 percent except for pitch grades (300 feet or less in length) in order to minimize environmental effects.

- On roads open to the public, turnouts must be located at 1,000-foot intervals or be intervisible, whichever is less.

- Drainage control must be ensured over the entire road through the use of drainage dips, insloping, natural rolling topography, ditch turnouts, ditches, or culverts. Ditches and culverts may be required in some situations, depending on grades, soils, and local hydrology. The minimum size culvert in any installation is 18 inches. If culverts or drainage crossings are needed, they should be designed for a 25-year or greater storm frequency, without development of a static head at the pipe inlet.

- Gravel surfacing will be required for all weather access.

3.5.2.2 Field Survey Requirements

- A flagline should be established along the construction route. Flags should be placed approximately every 100 feet, or be intervisible, whichever is less.

- Construction control staking may be required depending on conditions of the site.

- Culvert installations are located and staked.

3.5.2.3 Design Drawings and Templates

- On side slopes of 0 to 20 percent, where horizontal and vertical alignment can be worked out on the ground, a plan and profile drawing may not be required. Standard templates, drainage dip spacing, culvert locations, and turnout spacing guides would be acceptable.

- A plan and profile view would be the minimum drawing required on steeper slopes and in areas of environmental concern. The drawing should identify grade, alignment, stationing, turnouts, and culvert locations.

- Standard templates of road cross-sections and drainage dips are required for all resource, local, and higher-class roads.

- Additional information may be required in areas of environmental or engineering concern.

3.5.3 Construction

The roads will be designed and constructed to allow for successful interim and eventual final reclamation. Revegetation of road ditches and cut and fill slopes will help stabilize exposed soils and reduce sediment loss, reduce the growth of noxious weeds, reduce maintenance costs, maintain scenic quality and forage, and protect habitat. To ensure successful growth of plants and forbs, topsoil must be salvaged where available during road construction and re-spread to the greatest degree practical on cut slopes, fill slopes, and borrow ditches prior to seeding. To ensure the stability of freshly topsoiled slopes during revegetation, the application of mulch or other sediment control measures may be appropriate.

Construction with saturated or frozen soils results in unstable roads and will be avoided. Vehicular travel under wet conditions can produce significant rutting of unsurfaced roads resulting in soil loss and safety concerns. Therefore, excessive use of usurfaced roads will be avoided to the extent possible during saturated soil conditions.

3.5.4 Road Drainage Design

The proper design and construction of structures for the drainage of water from or through the roadway often contributes the most to the long-term success of the structure and minimizes the maintenance and adverse environmental effects, such as erosion and sediment production.

The most economical control measure will be designed to meet resource and road management objectives and constraints. The economic considerations will include construction and maintenance costs. The need for drainage structures can be minimized by proper road location. However, adequate drainage is essential for a stable road. A proper drainage system will be the best combination of various design elements, such as ditches, culverts, drainage, dips, crown, in-slope or out-slope, low-water crossings, subsurface drains, and bridges.

3.5.4.1 Surface Drainage

Surface drainage provides for the interception, collection, and removal of water from the surface of roads and slope areas. The design may need to allow for debris passage, mud flows, and water heavily laden with silt, sand, and gravel.

3.5.4.2 Drainage Structures

Proper location and design can provide economical and efficient drainage in many cases. However, structural measures are often required to ensure proper and adequate drainage. Some of the most common structures are drainage dips, ditches, culverts, and bridges.

3.5.4.2.1 Drainage Dips

The primary purpose of a drainage dip is to intercept and remove surface water from the traveled way and shoulders before the combination of water volume and velocity begins to erode the surface materials. Drainage dips should not be confused with water bars which are normally used for drainage and erosion protection of closed or blocked roads. Spacing of drainage dips depends upon local conditions such as soil material, grade, and topography.

3.5.4.2.2 Ditches

The geometric design of ditches must consider there source objectives for soil, water, and visual quality, maintenance capabilities and associated costs, and construction costs. Ditch grades should be no less than 0.5 percent to provide positive drainage and to avoid siltation. The types of ditches normally used are: drainage, trap, interception, and outlet.

3.5.4.2.3 Road Crowning

Roads which use crowning and ditching are common and can be used with all road classes. This design provides good drainage of water from the surface of the road. Drainage of the inside ditch and side hill runoff is essential if the traveled way is to be kept dry and passable during wet weather. Snow removal becomes a simple task for common road maintenance equipment. Because the roadbed is raised, wind often blows the snow off the travel way.

3.5.4.2.4 Culverts

Culverts are used in two applications on access roads; (1) in streams and gullies to allow normal drainage to flow under the traveled way, and (2) to drain inside road ditches. The latter may not be required if drainage dips are used. The location of each culvert will be shown on the plan and profile or similar drawings submitted to the BLM in the right of way application. All culverts should be laid on natural ground or at the original elevation of any drainage crossed. Culverts should be placed on a 3 percent minimum grade; reverse camber is not allowed.

The outlet of all culverts will extend at least one foot beyond the toe of any slope. All culverts used in construction of access roads will be concrete or corrugated metal pipe (CMP) made of steel or aluminum. Only undamaged culverts will be used, and any culvert will be inspected for damage prior to installation. All spots on the pipes where the zinc coating has been injured should be painted with two coats of zinc-rich paint or otherwise repaired as approved by the surface managing agency. Excavation, bedding and backfilling of culverts will be conducted according to BLM requirements and good engineering practices.

3.5.4.2.5 Ditch Relief Culverts

Ditch relief culverts are installed to periodically relieve the ditch line flow by piping water to the opposite side of the road where the flow can be dispersed away from the roadway. The spacing of ditch relief culverts is dependent on the road gradient, soil types, and runoff characteristics. A culvert with an 18-inch diameter is the minimum for ditch relief to prevent failure from debris blockage. The depth of culvert burial must be sufficient to ensure protection of the culvert barrel for the design life of the culvert. This requires anticipating the amount of material that may be lost due to road use and erosion. Ditch relief culverts can provide better flow when skewed 15 to 30 degrees downgrade from a line perpendicular to the centerline of the road. This improves the flow hydraulics and reduces siltation and debris plugging the culvert inlet. Culverts placed in natural drainages can also be utilized for ditch relief. The design of culverts for later removal may be beneficial for intermittent use roads that will be closed for extended periods of time.

3.5.4.2.6 Bridges and Major Culverts

The BLM Manuals require that all single or multiple culvert installations with end- or aperture-openings totaling more than 35-square feet have engineering approval at Regional or State Offices. This is also true of all bridge installations. Uranium One does not anticipate any multiple culvert or bridge installations will be needed for constructed access roads.

3.5.4.2.7 Low-Water Crossings

Roads commonly cross small drainages and intermittent streams. Here culverts and bridges are often unnecessary. The crossing can be effectively accomplished by dipping the road down to the bed of the drainage. Material moved from the banks of the crossing should be stockpiled near the right-of-way. Gravel, riprap, or concrete bottoms may be required in some situations. In no case will the drainage be filled so that water will be impounded.

3.5.5 Road Maintenance

Uranium One will carry out maintenance activities on all primary and secondary roads as necessary. The activities normally required include blading, surface replacement, dust abatement, spot repairs, slide removal, ditch cleaning, culvert cleaning, brush removal, litter cleanup, weed control, and snow removal.

3.6 REFERENCES

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

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

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

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

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

TABLE OF CONTENTS

4 EFFLUENT CONTROL SYSTEMS

This section describes the effluent control systems used at the Antelope and JAB Uranium Projects. The effluents of concern at ISR operations include the release or potential release of radon gas (radon-222) and dried yellowcake. Radon gas is primarily released from ion exchange processes that will take place at the Antelope Central Plant and JAB Satellite facilities. Yellowcake processing and drying operations will be conducted at the Antelope Central Plant.

The yellowcake drying facilities at the central plant will be comprised of vacuum dryers. By design, vacuum dryers do not discharge any uranium when operating. Effluent controls for yellowcake drying at the Antelope Central Plant are discussed in this section and in detail in the process description in Section 3.2 of this Technical Report.

4.1 GASEOUS AND AIRBORNE PARTICULATES

The primary radioactive airborne effluent at the Antelope and JAB Facilities will be radon-222 gas. Radon-222 is found in the pregnant lixiviant that comes from the wellfield into the facility for separation of uranium. The uranium will be separated from the groundwater by passing the solution through fixed bed ion exchange (IX) units operated in a pressurized downflow mode. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted to atmosphere outside the building via an induced draft fan. Venting any released radon-222 gas to atmosphere outside the plant minimizes employee exposure. Small amounts of radon-222 may be released via solution spills, filter changes, IX resin transfer, reverse osmosis (RO) system operation during groundwater restoration, and maintenance activities. These are minimal radon gas releases on an infrequent basis. The exhaust system in the JAB satellite IX plant and Antelope Central Plant will further reduce employee exposure. The air in the plant is sampled for radon daughters (see Section 5.7) to assure that concentration levels of radon and radon daughters are maintained as low as reasonably achievable (ALARA).

This section describes the gaseous effluent control systems that will be installed in the Antelope and JAB Facilities.

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

A separate ventilation system will be installed for all indoor non-sealed process tanks and vessels where radon-222 or process fumes would be expected. The system will consist of an air duct or piping system connected to the top of each of the process tanks. Redundant exhaust fans will direct collected gases to discharge piping that will exhaust fumes to the outside atmosphere. The venting system from all tanks and sumps consists of 4 to 6-inch PVC piping and function to vent radon gas to the outside atmosphere (see Figures 3-13 and 3-16 for schematic of ventilation systems for Antelope Central Plant and the JAB Satellite). The design of the fans will be such that the system will be capable of limiting employee exposures with the failure of any single fan. Discharge stacks will be located away from building ventilation intakes to prevent introducing exhausted radon into the facility as recommended in Regulatory Guide 8.31[1]. Airflow through any openings in the vessels will be from the process area into the vessel and into the ventilation system, controlling any releases that occur inside the vessel. Separate ventilation systems may be used as needed for the functional areas within the plant. Tank ventilation systems of this type have been successfully utilized at other ISR facilities and have proven to be an effective method for minimizing employee exposure.

The work area ventilation systems will be designed to force air to circulate within the JAB Satellite and Antelope Central Plant process areas. The ventilation system exhausts will be located on the north or leeward side of the buildings and will exhaust outside the building, drawing fresh air in from the upwind side of the building. During favorable weather conditions, open doorways and convection vents in the roof will provide satisfactory work area ventilation. The design of the ventilation system will be adequate to ensure that radon daughter concentrations in the facility are maintained below 25 percent of the derived air concentration (DAC) from 10 CFR Part 20. The systems for the ion exchange areas and for the precipitation areas will include a minimum of two exhaust fans each. These fans will operate at a minimum rate of 10,000 cfm (at 0" of water) each. Increased operation of these systems will provide adequate ventilation during unfavorable weather conditions. Radon effluent monitoring will be conducted as described in Section 5.7.7.

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

4.1.2 Air Particulate Effluents

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

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

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

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

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

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

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

App A criterion 8 required hourly

4.2 LIQUID WASTE

4.2.1 Sources of Liquid Waste

As a result of in-situ recovery mining, there are several sources of liquid waste that are collected. The potential water sources that will exist at the Antelope and JAB Facilities include the following.

4.2.1.1 Liquid Process Waste

The operation of the ion exchange process generates production bleed, the primary source of liquid waste as previously discussed in Section 3.1. This bleed will be routed to the deep disposal well(s) for disposal. Other liquid waste streams from the Antelope Central Plant and JAB Satellite IX Plant include plant wash down water and bleed stream from the elution and precipitation circuits. However, these other liquid waste streams make up a very small portion of the total liquid waste stream.

4.2.1.2 Aquifer Restoration

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

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

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

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

Groundwater sweep may not be extensively utilized due to its limited success in reducing ion concentrations in post mining groundwater.

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

4.2.1.3 Water Collected from Wellfield Releases

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

4.2.1.4 Stormwater Runoff

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

4.2.1.5 Domestic Liquid Waste

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

4.2.2 Liquid Waste Disposal

Uranium One expects that the liquid waste stream generated at the Antelope and JAB Facilities will be chemically and radiologically similar to the waste disposed in the current disposal wells in operation at existing ISR sites in Wyoming and Nebraska. It is anticipated that the maximum volume of liquid waste stream for disposal at the Antelope project will be approximately 40 gpm during normal operations and approximately 200 gpm of additional flow from maximum restoration. The average disposal waste stream over the Antelope project (operations and restoration) will be approximately 150 gpm. The anticipated maximum volume of liquid waste stream for disposal at the JAB Satellite Project will be approximately 35 gpm during normal operations and approximately 100 gpm of additional flow from restoration. The average disposal waste stream over the JAB project (operations and restoration) will be approximately 90 gpm

Feasibility studies conducted in the Antelope and JAB areas to date indicate several deep sand units exist with favorable porosity and water quality that are potential target zones adequate for deep disposal of liquid effluent. Further seismic data evaluations are currently being conducted to determine the best disposal zone related to storage and faulting. Uranium One plans to install several deep disposal wells at the Antelope Project and the JAB Project as the primary liquid waste disposal method. An adequate number of wells will be installed to provide enough capacity for peak flow conditions plus a backup well to be utilized during maintenance or periods of shutdown of operating wells. Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds or land application methods. All compatible liquid wastes at both project areas will be disposed in the planned deep wells. An application is currently in development and will be submitted to the WDEQ-WQD for the appropriate UIC Permits for deep disposal wells for both facilities in the third quarter of 2008.

4.2.2.1 Liquid Waste Monitoring and Reporting

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

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

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

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

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

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

4.2.2.2 Disposal Well Mechanical Integrity

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

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

4.2.3 Potential Pollution Events Involving Liquid Waste

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

Potential sources of pollution include the following:

4.2.3.1 Spills from Wellfield Buildings, Pipelines, and Well Heads

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

How many pipe spills have historically occurred?

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

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

4.2.3.2 Spills from the Antelope Central Plant and JAB Satellite IX Plant

The Antelope Central Plant and JAB Satellite IX Plant will serve as a central hub for the mining operations at both project areas. Therefore, the central plant area will have the greatest potential for spills or accidents resulting in the release of potential pollutants. Spills could result from a release of process chemicals from bulk storage tanks, piping failure, or a process storage tank failure.

The design of the Antelope Central Plant and JAB Satellite IX Plant buildings will be such that any release of liquid waste would be contained within the structure. A concrete curb will be built around each process building. These pads will be designed to contain the contents of the largest tank within the building in the event of a rupture. In the event of a piping failure, the pump system will immediately shut down, limiting any release. Liquid inside the buildings, both from a spill or from washdown water, will be drained through a sump and sent to the liquid waste system.

4.2.3.3 Spills from Deep Well Pumphouses and Wellheads

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

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

4.3 TRANSPORTATION VEHICLES

The release of pollutants to the environment could occur due to accidents involving transportation vehicles. This could involve either vehicles delivering bulk chemical products, transporting resin to the Antelope Central Plant from the JAB satellite plant, transporting radioactive contaminated waste from the Antelope and JAB facilities to an approved disposal site, or from vehicles carrying yellowcake slurry or dried yellowcake product from the Antelope Central Plant.

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

4.4 SOLID WASTE AND CONTAMINATED EQUIPMENT

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

4.4.1 Uncontaminated Solid Waste

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

Uranium One estimates that the proposed Antelope and JAB Projects will produce approximately 4,000 cubic yards (yd^3) of uncontaminated solid waste combined per year. Uncontaminated solid waste will be collected on the sites on a regular basis and disposed of in the nearest sanitary landfill.

4.4.2 Byproduct Material

All contaminated items that cannot be decontaminated to meet release criteria will be properly packaged, transported, and disposed at a disposal site licensed to accept 11e.(2) byproduct material. Solid wastes generated by this project that may become contaminated with radioactive materials consist of items such as rags, trash, packing material, worn or replaced parts from equipment, piping, filters, protective clothing, and solids removed from process pumps and vessels. Radioactive solid waste that has a contamination level requiring controlled disposal will be isolated in drums or other suitable containers. Uranium One estimates that the proposed Antelope and JAB Projects will produce approximately 500 yd^3 of 11e.(2) byproduct material combined per year. These materials will be stored on site inside the restricted area until such time that a full shipment can be shipped to a licensed waste disposal site or mill tailings facility.

4.4.3 Septic System Solid Waste

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

4.4.4 Hazardous Waste

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

4.4.5 Soil Contaminated as a Result of Wellfield Releases

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

Each wellfield will have a number of header houses where injection and production wells will be continuously monitored for pressure and flow. Individual wells, along with main trunk lines, may have high and low flow alarm limits set in the header house. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each wellfield building will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures (e.g., failed fusion weld).

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

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

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

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

4.4.6 Reporting Procedures

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

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

The NRC will be verbally notified (per telephone or email) within 48 hours of discovery of a spill of ISR process fluids exceeding 420 gallons. A written report will be provided to the NRC within 30 days of discovery containing the information required per NRC License Conditions.

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

Other operational reporting and applicable requirements include the following:

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

4.4.7 References

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

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

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TABLE OF CONTENTS

TABLE OF FIGURES

ADDENDUM 5-A – Quality Assurance Plan

TABLE OF TABLES

5 OPERATIONS

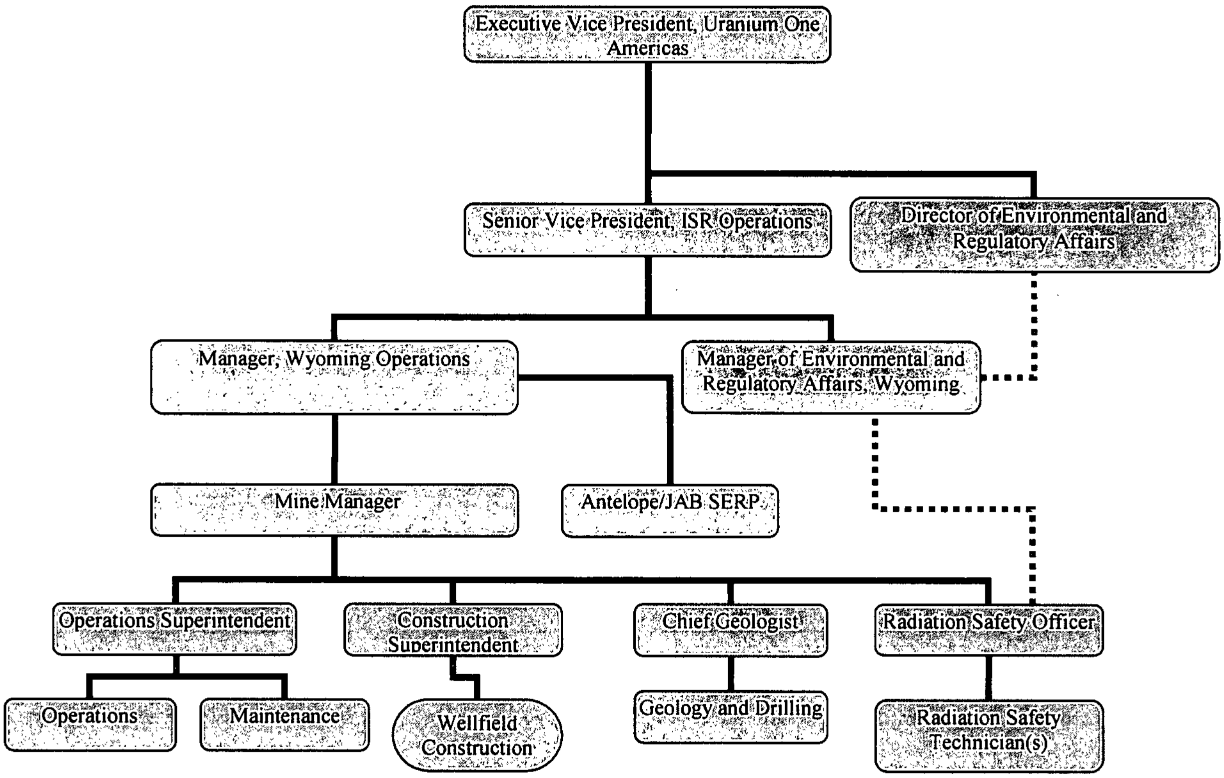
Uranium One is committed to conducting all operations in conformance with applicable laws, regulations and requirements of the NRC and other regulatory agencies. The responsibilities described below have been designed to ensure compliance and further implement Uranium One's policy for providing a safe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

5.1 CORPORATE ORGANIZATION AND ADMINISTRATIVE PROCEDURES

Uranium One will maintain a performance-based approach to the management of the environment and employee health and safety, including radiation safety. Figure 5-1 is a partial organization chart for Uranium One with respect to the operation of the Antelope and JAB Uranium Projects and associated operations and represents the management levels that play a key part in the Radiation Protection Program (RPP). The personnel identified are responsible for the development, review, approval, implementation, and adherence to operating procedures, programs, environmental and groundwater monitoring programs as well as routine and non-routine maintenance activities. These individuals may also serve a functional part of the Safety and Environmental Review Panel (SERP) described under Section 5.2.5.

Specific responsibilities in the organization are provided below.

Figure 5-1: URANIUM ONE Antelope and JAB Projects Organizational Chart



5.1.1 Board of Directors

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

5.1.2 Executive Vice President

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

5.1.3 Senior Vice President, ISR Operations

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

5.1.4 Director of Environmental and Regulatory Affairs

The Director of Environmental and Regulatory Affairs is responsible for all radiation protection, health and safety, and environmental programs for Uranium One. The Director is responsible for ensuring that all company operations comply with all applicable regulatory requirements. The Director of Environmental and Regulatory

Affairs reports directly to the Executive Vice President. This position is responsible for the development and review of radiological, health and safety, and environmental protection programs.

5.1.5 Manager of Wyoming Operations

The Manager of Wyoming Operations is responsible for all ISR uranium production activity at the Wyoming project sites. All site operations, maintenance, construction, environmental health and safety, and support groups report directly to the Manager of Wyoming Operations. In addition to production activities, the Manager of Wyoming Operations is also responsible for implementing any industrial and radiation safety and environmental protection programs associated with Wyoming operations. The Manager of Wyoming Operations is authorized to immediately implement any action to correct or prevent hazards. The Manager of Wyoming Operations reports directly to the Senior Vice President.

5.1.6 Manager of Environmental and Regulatory Affairs, Wyoming

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

5.1.7 Antelope and JAB Mine Manager

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

5.1.8 Radiation Safety Officer

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

5.1.9 Radiation Safety Technician

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

5.1.10 Site Department Supervisors

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

5.1.11 ALARA Program Responsibilities

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

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

5.1.12 Management Responsibilities

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

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

5.1.12.1 Radiation Safety Officer ALARA Responsibility

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

1. The responsibility for the development and administration of the ALARA program;
2. Enforcement of regulations and administrative policies that affect the Radiological Protection Program;

3. Assist with the review and approval of new equipment, process changes or operating procedures to ensure that the plans do not adversely affect the Radiological Protection Program;
4. Maintain equipment and surveillance programs to assure continued implementation of the ALARA program;
5. Assist with conducting an Annual ALARA Audit as discussed in Section 5.3.2 to determine the effectiveness of the program and make any appropriate recommendations or changes as may be dictated by the ALARA philosophy;
6. Review annually all existing operating procedures involving or potentially involving any handling, processing, or storing of radioactive materials to ensure the procedures are ALARA and do not violate any newly established or instituted radiation protection practices; and
7. Conduct daily inspections of pertinent facility areas to observe that general radiation control practices, hygiene, and housekeeping practices are in line with the ALARA principle.

5.1.12.2 Supervisor Responsibility

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

1.

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

5.1.12.3 Worker Responsibility

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

1. Adherence to all rules, notices, and operating procedures as established by management and the RSO through the Radiological Protection Program;

2. Making valid suggestions which might improve the radiation protection and ALARA programs;
3. Reporting promptly, to immediate supervisor, any malfunction of equipment or violation of procedures which could result in an increased radiological hazard;
4. Proper use of protective equipment;
5. Proper performance of required contamination surveys when leaving restricted areas.

5.2 MANAGEMENT CONTROL PROGRAM

5.2.1 Operating Procedures

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

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

5.2.2 Radiation Work Permits

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

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

5.2.3 Record Keeping and Retention

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

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

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

5.2.4 Performance Based License Condition

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

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

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

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

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

5.2.5 Safety and Environmental Review Panel (SERP)

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

The SERP will be responsible for reviewing and approving any proposed change in the facility or process, changes in procedures, and the conduct of tests or experiments not contained in the NRC license. As such, the SERP will be responsible for insuring that any such changes result in no degradation in the essential safety or environmental commitments of Uranium One.

5.2.5.1 Safety and Environmental Review Panel Review Procedures

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

- Current NRC License Requirements

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

- Ability to Meet NRC Regulations

The SERP will determine if the change, test, or experiment conflicts with applicable NRC regulations (example: 10 CFR Parts 20 and 40 requirements). If the SERP action conflicts with NRC regulations, the change, test, or experiment cannot be approved.

- Licensing Basis

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

- Financial Surety

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

- Essential Safety and Environmental Commitments

The SERP will assure that there is no degradation in the essential safety or environmental commitment in the license application.

5.2.5.2 Documentation of SERP Review Process

After the SERP conducts the review process for a proposed action, it will document its findings, recommendations, and conclusions in a written report format. All members of the SERP shall sign concurrence on the final report. If the report concludes that the action meets the appropriate PBL or PBLC requirements and does not require a license amendment, the proposed action may then be implemented. If the report concludes that a license amendment is necessary before implementing the action, the report will document the reasons why, and what course Uranium One plans to pursue. The SERP report shall include the following:

- A description of the proposed change, test, or experiment (proposed action);
- A listing of all SERP members conducting the review and their qualifications (if a consultant or other member not previously qualified);

- The technical evaluation of the proposed action including all aspects of the SERP review procedures listed above;

- Conclusions and recommendations;

- Signatory approvals of the SERP members; and

- Any attachments such as all applicable technical, environmental, or safety evaluations, reports, or other relevant information including consultant reports.

All SERP reports and associated records of any changes made pursuant to the PBL will be maintained through termination of the NRC license.

On an annual basis, Uranium One will submit a report to the NRC that describes all changes, tests, or experiments made pursuant to the PBL. The report will include a summary of the SERP evaluation of each change. In addition, Uranium One will annually submit replacement pages of the License Application or supplementary information. Each replacement page will include both a change indicator for the area of change, (e.g., bold marking vertically in the margin adjacent to the portion actually change), and a page change identification, (date of change or change number, or both).

5.3 MANAGEMENT AUDIT AND INSPECTION PROGRAM

The following internal inspections, audits and reports will be performed for the Antelope and JAB Uranium Project operations.

5.3.1 Radiation Safety Inspections

5.3.1.1 Daily Inspections

The RSO, RST or a qualified designee will conduct a daily walkthrough inspection of the plant areas. The inspection will entail a visual examination of compliance or other problems, which will reviewed with the Manager, Wyoming Operations.

5.3.1.2 Weekly RSO Inspections

On a weekly basis, the RSO and Manager, Wyoming Operations (or designees in their absence) will conduct an inspection of all facility areas to observe general radiation control practices and review required changes in procedures and equipment.

5.3.1.3 Monthly RSO Reports

The RSO will provide a written summary of the month's radiological activities at the Antelope and JAB Uranium Project facilities. The report will include a review of all monitoring and exposure data for the month, a summary of worker protection activities, a summary of all pertinent radiation survey records, a discussion of any trends in the ALARA program, and a review of adequacy of the implementation of the NRC license conditions. Recommendations will be made for any corrective actions or improvements in the process or safety programs.

5.3.2 Annual ALARA Audits

Uranium One will conduct annual audits of the radiation safety and ALARA programs. The Director of Environmental and Regulatory Affairs will be responsible for coordinating and may conduct these audits. Alternatively, Uranium One may use qualified personnel from other uranium recovery facilities or an outside radiation protection auditing service to conduct these audits. The purpose of the audits will be to provide assurance that all radiation health protection procedures and license condition requirements are being conducted properly at the Antelope and JAB Uranium Project. Any outside personnel used for this purpose will be qualified in radiation safety procedures as well as environmental aspects of solution mining operations. Whether conducted internally or through the use of an independent audit service, the auditor will meet the minimum qualifications for education and experience for the RSO as described in Section 5.4.

The audit of the radiation protection and ALARA program will be conducted in accordance with the recommendations contained in Regulatory Guide 8.31. A written report of the results will be submitted to the Executive Vice President, Uranium One Americas. The RSO may accompany the auditor but may not participate in the conclusions.

The annual ALARA audit report will summarize the following data:

1. Employee exposure records
2. Bioassay results
3. Inspection log entries and summary reports of mine and process inspections
4. Documented training program activities

5. Applicable safety meeting reports
6. Radiological survey and sampling data
7. Reports on any overexposure of workers
8. Operating procedures that were reviewed during this time period

The ALARA audit report will specifically discuss the following:

1. Trends in personnel exposures
2. Proper use, maintenance and inspection of equipment used for exposure control
3. Recommendations on ways to further reduce personnel exposures from uranium and its daughters.

The ALARA audit report will be submitted to and reviewed by the Executive Vice President, the Senior Vice President, ISR Operations and the Manager of Wyoming Operations. Implementation of the recommendations to further reduce employee exposures, or improvements to the ALARA program, will be reviewed with the ALARA auditor.

An audit of the Quality Assurance/Quality Control (QA/QC) program will also be conducted on an annual basis. An individual qualified in analytical and monitoring techniques who does not have direct responsibilities in the areas being audited will perform the audit. The results of the QA/QC audit will be documented with the ALARA Audit.

5.4 RADIATION SAFETY STAFF QUALIFICATIONS

The Uranium One project staff is highly experienced in the management of uranium project development, mining and operations. The following minimum personnel specifications and qualifications for the radiation safety staff will be strictly adhered to.

5.4.1 Radiation Safety Officer Qualifications

The minimum qualifications for the Radiation Safety Officer (RSO) are as follows:

- Education - A Bachelor's Degree or an Associate Degree in the physical sciences, industrial hygiene, environmental technology or engineering from an accredited college or university or an equivalent combination of training and relevant experience in uranium mill/solution mining radiation protection. Two years of relevant experience are generally considered equivalent to 1 year of academic

- study. For example, an RSO candidate with an Associates Degree would also require an additional 4 years of relevant experience to meet this education requirement.

- Health Physics Experience - A minimum of 1 year of work experience relevant to uranium mill/solution mining operations in applied health physics, radiation protection, industrial hygiene or similar work.

- Specialized Training - A formalized, specialized course(s) in health physics specifically applicable to uranium milling/solution mining operations, of at least 4 weeks duration. The RSO attends refresher training on uranium mill health physics every two years.

- Specialized Knowledge - The RSO, through classroom training and on-the-job experience, possesses a thorough knowledge of the proper application and use of all health physics equipment used in the operation, the procedures used for radiological sampling and monitoring, methods used to calculate personnel exposures to uranium and its daughters, and a thorough understanding of the solution mining process and equipment used and how hazards are generated and controlled during the process.

5.4.2 Radiation Safety Technician Qualifications

The RST will have one of the following combinations of education, training and experience:

1. Education - An associate degree or 2 years or more of study in the physical sciences, engineering or a health-related field, or high school diploma and a combination of experience and training.

Training - At least a total of 4 weeks of generalized training in radiation health protection applicable to uranium mills/solution mining operations.

Experience - One year of work experience using sampling and analytical laboratory procedures that involve health physics, industrial hygiene, or industrial safety measures to be applied in a uranium mill/solution mining operation.

2. Education - A high school diploma.

Training - A total of at least 3 months of specialized training in radiation protection relevant to uranium mills of which up to 1 month may be on-the-job training.

Experience - Two years of relevant work experience in applied radiation protection.

5.5 RADIATION SAFETY TRAINING

All site employees and contractor personnel at the Antelope and JAB Uranium Project will participate in a training program covering radiation safety, radioactive material handling, and radiological emergency procedures. The training program will be administered in keeping with standard radiological protection guidelines and the guidance provided in USNRC Regulatory Guide 8.29[2], USNRC Regulatory Guide 8.31, and USNRC Regulatory Guide 8.13[3]. The technical content of the training program will be under the direction of the RSO. The RSO or a qualified designee will conduct all radiation safety training.

5.5.1 Radiation Safety Training Program Content

5.5.1.1 Visitors

Visitors to the Antelope and JAB Uranium Project facilities who have not received training will be escorted by on site personnel properly trained and knowledgeable about the hazards of the facility. At a minimum, visitors will be instructed specifically on what they should do to avoid possible hazards in the area of the facilities that they are visiting.

5.5.1.2 Contractors

Any contractors having work assignments at the Antelope and JAB Uranium Project will be given appropriate radiation safety training. Contract workers who will be performing work on heavily contaminated equipment will receive the same training normally required of Antelope and JAB workers as discussed in Section 5.5.1.3.

5.5.1.3 Radiation Worker Training

All Uranium One employees (and some contractors as noted in Section 5.5.1.2) will receive training as radiation workers. The program will incorporate the following topics recommended in USNRC Regulatory Guide 8.31:

Fundamentals of health protection

- Using respirators when appropriate.
- Eating, drinking and smoking only in designated areas.
- Using proper methods for decontamination.

Facility-provided protection

- Cleanliness of working space.
- Safety designed features for process equipment.
- Ventilation systems and effluent controls.
- Standard operating procedures.
- Security and access control to designated areas.

Health protection measurements

- Measurements of airborne radioactive material.
- Bioassay to detect uranium (urinalysis and in vivo counting).
- Surveys to detect contamination of personnel and equipment.
- Personnel dosimetry.

Radiation protection regulations

- Regulatory authority of NRC, OSHA and Wyoming.
- Employee rights in 10 CFR Part 19.
- Radiation protection requirements in 10 CFR Part 20.

Emergency procedures

All new workers, including supervisors, will be given instruction on the health and safety aspects of the specific jobs they will perform. This instruction will be done in the form of individualized on-the-job training. Retraining will be performed annually and documented.

5.5.2 Testing Requirements

A written test with questions directly relevant to the principals of radiation safety and health protection in the facility covered in the training course will be given to each worker. The instructor will review the test results with each worker and discuss incorrect answers to the questions with the worker until worker understanding is achieved. Workers who fail the exam will be retested and the test results will remain on file.

5.5.3 On-The-Job Training

5.5.3.1 Health Physics Technician

On-the-job training will be provided to RSTs in radiation exposure monitoring and exposure determination programs, instrument calibration, plant inspections, posting requirements, respirator programs and radiation safety procedures.

5.5.4 Refresher Training

Following initial radiation safety training, all permanent employees and long-term contractors will receive on-going radiation safety training as part of the annual refresher training program and, if determined necessary by the RSO, during monthly safety meetings. This on-going training will be used to discuss problems and questions that have arisen, any relevant information or regulations that have changed, exposure trends and other pertinent topics.

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5.5.5 Training Records

Records of training will be kept until license termination for all employees trained as radiation workers (i.e., occupationally exposed employees).

5.6 SECURITY

Uranium One is committed to:

- Providing employees with a safe, healthful, and secure working environment;
- Maintaining control and security of NRC licensed material;
- Ensuring the safe and secure handling and transporting of hazardous materials; and
- Managing records and documents that may contain sensitive and confidential information.

The NRC requires licensees to maintain control over licensed material (i.e., natural uranium ("source material") and byproduct material defined in 10 CFR §40.4). 10 CFR 20, Subpart I, *Storage and Control of Licensed Material*, requires the following:

§20.1801 Security of Stored Material

The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

§20.1802 Control of Material not in Storage

The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Stored material at the Antelope and JAB Uranium Projects would include uranium packaged for shipment from the facility or byproduct materials awaiting disposal. Examples of material not in storage would include yellowcake slurry or loaded ion exchange resin removed from the restricted area for transfer to other areas.

5.6.1 License Area and Plant Security

The active mining areas will be controlled with fences and appropriate signs. All areas where source or byproduct materials are handled will be fenced. The main access road will be equipped with a locking gate. A 24-hour per day 7-day per week staff will be on duty at the Antelope and JAB facilities.

Plant operators will perform an inspection to ensure the proper storage and security of licensed material at the beginning of each shift. The inspection will determine whether all licensed material is properly stored in a restricted area or, if in controlled or unrestricted areas, is properly secured. In particular, operators will ensure that loaded ion exchange resin, slurry, drummed yellowcake, and byproduct material is properly secured. If licensed material is found outside a restricted area, the operator will ensure that it is secured, locked, moved to a restricted area, or kept under constant surveillance by direct observation by site personnel. The results of this inspection will be properly documented.

There will be a reception area located at the main entrance into the office building. All other entrances will be locked during off-shift hours. Visitors entering the office during normal working hours will be greeted by a receptionist. All visitors will be required to sign the access log and indicate the purpose of their visit and the employee to be visited. The person being visited will be responsible to supervise the visitor(s) at all times when they are on site. Visitors will only be allowed at the facility during regular working hours unless prior approval is obtained from the Manager of Wyoming Operations or the Manager of Environmental and Regulatory Affairs, Wyoming.

5.6.2 Transportation Security

Uranium One will routinely receive, store, use, and ship hazardous materials as defined by the U.S. Department of Transportation (DOT). In addition to the packaging and shipping requirements contained in the DOT Hazardous Materials Regulations (HMR), 49 CFR 172, Subpart I, *Security Plans*, requires that persons that offer for transportation or transport certain hazardous materials develop a Security Plan. Shipments may qualify for this DOT requirement under the following categories:

> §172.800(b)(4) A shipment of a quantity of hazardous materials in a bulk package having a capacity equal to or greater than 13,248 L (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids;
>
> §172.800(b)(5) A shipment in other than a bulk packaging of 2,268 kg (5,000 pounds) gross weight or more of one class of hazardous material for which placarding of a vehicle, rail car, or freight container is required;
>
> §172.800(b)(7) A quantity of hazardous material that requires placarding under the provisions of subpart F.

DOT requires that Security Plans assess the possible transportation security risks and evaluate appropriate measures to address those risks. All hazardous materials shippers and transporters subject to these standards must take measures to provide personnel security by screening applicable job applicants, prevent unauthorized access to the hazardous materials or vehicles being prepared for shipment, and provide for en route security. Companies must also train appropriate personnel in the elements of the Security Plan.

Transport of licensed/hazardous material by Uranium One employees will generally be restricted to moving ion exchange resin from the JAB Satellite facility to the Antelope Central Plant or transferring contaminated equipment between company facilities. This transport will generally occur over short distances through remote areas. Therefore, the potential for a security threat during transport by Uranium One vehicle is minimal. The goal of the driver, cargo, and equipment security measures is to ensure the safety of the driver and the security and integrity of the cargo from the point of origin to the final destination by:

- Clearly communicating general point-to-point security procedures and guidelines to all drivers and non-driving personnel;

- Providing the means and methods of protecting the drivers, vehicles, and customer's cargo while on the road; and
- Establishing consistent security guidelines and procedures that shall be observed by all personnel.

For the security of all tractors and trailers, the following will be adhered to:

- If material is stored in the vehicle, access must be secured at all openings with locks and/or tamper indicators;
- Off site tractors will always be secured when left unattended with windows closed, doors locked, the engine shut off, and no keys or spare keys in or on the vehicle;
- The unit is to be kept visible by an employee at all times when left unattended outside a restricted area.

The security guidelines and procedures will apply to all transport assignments. All drivers and non-driving personnel will be expected to be knowledgeable of, and adhere to, these guidelines and procedures when performing any load-related activity.

5.7 RADIATION SAFETY CONTROLS AND MONITORING

Uranium One has a strong corporate commitment to and support for the implementation of the radiological control program at the Antelope and JAB Uranium Project facilities. This corporate commitment to maintaining personnel exposures as low as reasonably achievable (ALARA) will be incorporated into the radiation safety controls and monitoring programs described in the following sections.

5.7.1 Effluent Control Techniques

5.7.1.1 Gaseous and Airborne Particulate Effluents

5.7.1.1.1 Radon Gas

Under routine operations, the only radioactive effluent at the Antelope and JAB facility will be radon-222 gas from the production solutions.

The radon-222 is found in the pregnant lixiviant that will come from the wellfield into the Antelope and JAB IX facilities. The production flow will be directed to the process plants for separation of the uranium. The uranium will be separated by passing the recovery solution through pressurized downflow ion exchange units. The vents from the individual vessels will be connected to a manifold that will be exhausted outside the plant building through the plant stack.

Venting radon gas to the atmosphere outside of the plant building minimizes personnel exposure. Small amounts of radon-222 may be released in the plant building during solution spills, filter changes, ion exchange resin transfer operations and maintenance activities. The plant building will be equipped with exhaust fans to remove any radon that may be released in the building. No significant personnel exposure to radon gas is expected based on operating experience from similar facilities. Ventilation and effluent control equipment will be inspected for proper operation as recommended in USNRC Regulatory Guide 3.56[4]. Ventilation and effluent control equipment inspections will be conducted during radiation safety inspections as discussed in Section 5.3.1.

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

As discussed in Section 7.3, EMC has used MILDOS-Area to model the dose from facility operations resulting from releases of radon gas. The central plant will include pressurized downflow ion exchange columns, which do not routinely release radon gas except during resin transfer and column backwashing. In these systems, the majority of radon released to the production fluid stays in solution and is not released. The radon which is released is generated by occasional venting of process vessels and tanks, small unavoidable leaks in ion exchange equipment, and maintenance of equipment. For the purposes of determining the source term for MILDOS-Area, radon gas release was estimated as 10% of the radon-222 in the production fluid from the wellfields and an additional 10% in the ion exchange circuit in the central plant. Release of radon-222 at this concentration did not result in significant public dose. The maximum TEDE of 0.5 mrem/yr. was located at the east-southeast property boundary of the JAB site and is 0.5 percent of the public dose limit of 100 mrem. The closest resident to the Antelope and JAB process facilities is in Bairoil. The TEDE at the east property boundary of the Antelope site was 0.18 mrem/yr., which is 0.18 percent of the regulatory limit. The actual dose to a resident in Bairoil would be significantly less.

5.7.1.1.2 Airborne Particulates

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

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

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

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

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

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

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

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

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

5.7.1.2 Liquid Effluents

The liquid effluents from the Antelope and JAB Uranium Project facilities can be classified as follows:

- Liquid Process Waste

The operation of the ion exchange process generates production bleed, the primary source of liquid waste as previously discussed in Section 3.0. This bleed will be routed to the deep disposal well(s) for disposal. Other liquid waste streams from the central plant will include plant wash down water and bleed stream from the elution and precipitation circuits. However, these other liquid waste streams will make up a very small portion of the total liquid waste stream.

- Aquifer Restoration

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

1. Groundwater Transfer,
2. Groundwater Sweep,
3. Groundwater Treatment, and
4. Wellfield Circulation.

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

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

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

Uranium One proposes to handle liquid effluents from the Antelope and JAB Uranium Projects using deep well injection.

5.7.1.3 Spill Contingency Plans

The RSO will be charged with the responsibility to develop and implement appropriate procedures to handle potential spills of radioactive materials. Personnel representing the engineering and operations functions of the Antelope and JAB Uranium Project facilities will assist the RSO in this effort. Basic responsibilities will include:

- Assignment of resources and manpower.
- Responsibility for materials inventory.
- Responsibility for identifying potential spill sources.
- Establishment of spill reporting procedures and visual inspection programs.
- Review of past incidents of spills.
- Coordination of all departments in carrying out goals of containing potential spills.
- Establishment of employee emergency response training programs.
- Responsibility for program implementation and subsequent review and updating.
- Review of new construction and process changes relative to spill prevention and control.

Spills can take two forms within an in-situ uranium mining facility: 1) surface spills such as tank failures, piping ruptures, transportation accidents, etc., and 2) subsurface releases such as a well excursion, in which process chemicals migrate beyond the wellfield resulting in a subsurface release.

Engineering and administrative controls will be in place to prevent both surface and subsurface releases to the environment and to mitigate the effects should a release occur.

- Surface Releases

  Failure of process tanks - Potential failures of process tanks will be contained within the central plant and satellite buildings. The central and satellite plant buildings will drain to sumps that will allow transfer of the spilled solutions to appropriate tankage or the waste disposal system.

  Surface Releases - The most common form of surface releases from in-situ mining operations occurs from breaks, leaks, or separations within the piping system that transfers mining fluids between the central plant and the wellfield. These are generally small releases due to engineering controls that detect pressure changes in the piping systems and alert the Plant Operators through system alarms.

In general, piping within the wellfield will be constructed of PVC or high-density polyethylene (HDPE) pipe with butt welded joints or an equivalent. All pipelines will be pressure tested at operating pressures prior to operation. It is unlikely that a break would occur in a buried section of line because no additional stress is placed on the pipes. In addition, underground pipelines will be protected from vehicles driving over the lines, which could cause breaks. The only exposed pipes will be at the wellheads and in the headerhouses. Trunkline flows and wellhead pressures will be monitored for process control. Spill response will be specifically addressed in Emergency Procedures.

- Releases Associated With Transportation

Uranium One will prepare an emergency action plan for responding to a transportation accident involving a radioactive materials shipment. The plan will provide instructions for proper packaging, documentation, driver emergency and accident response procedures and cleanup and recovery actions.

- Sub-surface releases

Well Excursions - Mining fluids are normally maintained in the production aquifer within the immediate vicinity of the wellfield. The function of the monitor well ring will be to detect any mining solutions that may migrate away from the production area due to fluid pressure imbalance. This system has been proven to function satisfactorily over many years of operating experience with ISR mining. At Antelope and JAB mining areas, an undetected excursion will be highly unlikely. A ring of perimeter monitor wells located no further than 500 feet from the wellfield and screened in the ore-bearing aquifer will surround all wellfields. Additionally, shallow monitor wells will be placed in the first overlying and underlying aquifers for each wellfield segment. Sampling of these wells will be done on a biweekly basis. Past experience at other ISR mining facilities has shown that this monitoring system is effective in detecting lixiviant migration. The total effect of the close proximity of the monitor wells, the low flow rate from the well patterns, and over-production of leach fluids (production bleed) makes the likelihood of an undetected excursion extremely remote.

Migration of fluids to overlying and underlying aquifers has also been considered. Several controls will be in place to prevent this. Uranium One will plug all exploration holes to prevent commingling of the ore zone, overlying, and underlying aquifers and to isolate the mineralized zone. In addition, prior to placing a well in service, a well mechanical integrity test (MIT) will be performed. This requirement of the WDEQ UIC Program ensures that all wells be constructed properly and capable of maintaining pressure without leakage. Finally, monitor wells completed in the overlying and underlying aquifer will be sampled on a regular basis for the presence of recovery solution.

In addition to the spills described above, the accumulation of sediment or erosion of existing soils can lead to potential releases of pollutants. The likelihood of significant sediment or erosion problems is greatest during construction activities. If rain, producing runoff, occurs during construction a small amount of the fill may be carried away from the construction area. Significant precipitation during plant facility construction may also produce the same effect. Plant cover for erosion control will be established as soon as possible on exposed areas. Little additional suspendable material should be produced during mining operations and restoration activities. Site reclamation in the future with grading the plant site and replacing the topsoil will also expose unsecured soil for suspension in runoff waters. The sediment load as a result of precipitation during future construction or reclamation activities should not significantly affect the quality of any watercourses since the projected plant location is not crossed by any streams.

Runoff from precipitation events should be controlled to minimize any exposure to pollutants on the site. Runoff should not be a major issue given the engineering design of the facilities as well as engineering and administrative controls. Should there be high runoff concurrent with a pipeline failure, some contamination could be spread depending upon the relative saturation of the soils beneath the leaking area. In any event, only minimal releases of solutions would occur in the event of a pipeline failure and migration of pollutants due to runoff would be minimal.

5.7.2 EXTERNAL RADIATION EXPOSURE MONITORING PROGRAM

5.7.2.1 Gamma Surveys

External gamma radiation surveys will be performed routinely at the Antelope and JAB plant facilities. The required frequency will be quarterly in designated Radiation Areas and semiannually in all other areas of the plant. Surveys will be performed at worker occupied stations and areas of potential gamma sources such as tanks and filters. Uranium One will establish a Radiation Area if the survey indicates that gamma radiation levels exceed the action level of 5.0 mRem per hour for worker occupied stations. An investigation will be performed to determine the probable source and survey frequency for areas exceeding 5.0 mRem per hour is increased to quarterly. Records will be maintained of each investigation and the corrective action taken. If the results of a gamma survey identified areas where gamma radiation is in excess of levels that delineate a "radiation area", access to the area will be restricted and the area will be posted as required in 10 CFR §20.1902 (a).

External gamma surveys will be performed with survey equipment that meets the following minimum specifications:

1. Range - Lowest range not to exceed 100 microRoentgens per hour (μR/hr) full-scale with the highest range to read at least 5 milliRoentgens per hour (mR per hour) full scale;

2. Battery operated and portable;

Examples of satisfactory instrumentation that meets these requirements are the Ludlum Model 3 survey meter with a Ludlum 44-38 probe or equivalent. Gamma survey instruments will be calibrated at the manufacturer's suggested interval or at least annually and will be operated in accordance with the manufacturer's recommendations. Instrument checks will be performed each day that an instrument is used.

Gamma exposure rate surveys will be performed in accordance with standard operating procedures. Proposed survey locations for the Antelope Central Plant are shown on Figure 5-2 and proposed survey locations for the JAB Satellite Plant are shown on Figure 5-3. The proposed survey locations were selected based on experience with external exposure rates at operating ISR facilities. Areas where elevated gamma exposure rates are typically found include the ion exchange columns, filter housings that remove solid materials from the production and injection streams, and tank bottoms where solid material may collect. These solids historically contain elevated concentrations of radium-226, which results in elevated gamma exposure rates. In some cases, the gamma dose rates from these components may exceed 5 mrem per hour and may require posting as Radiation Areas. Radiation Areas are not usually encountered in wellfield areas of ISR facilities unless filtration equipment is installed in headerhouses, which is not proposed for the Antelope and JAB wellfields.

Gamma survey instruments will be checked each day of use in accordance with the manufacturer's instructions. Surveys will be performed in accordance with the guidance contained in USNRC Regulatory Guide 8.30[5].

Beta surveys of specific operations that involve direct handling of large quantities of aged yellowcake are recommended in USNRC Regulatory Guide 8.30, Section 1.4. Beta evaluations may be substituted for surveys using radiation survey instruments. The beta dose rate on the surface of yellowcake just after separation from ore is negligible. Over a period of several months, the beta dose from aged yellowcake increases due to the ingrowth of protactinium-234 and thorium-234. Uranium One plans to ship yellowcake on a schedule that minimizes the dose from aged yellowcake.

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

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

5.7.2.2 Personnel Dosimetry

10 CFR §20.1502 (a)(1) requires exposure monitoring for "Adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10 percent of the limits in §20.1201 (a)". Ten percent of the dose limit would correspond to a Deep Dose Equivalent (DDE) of 0.500 Rem.

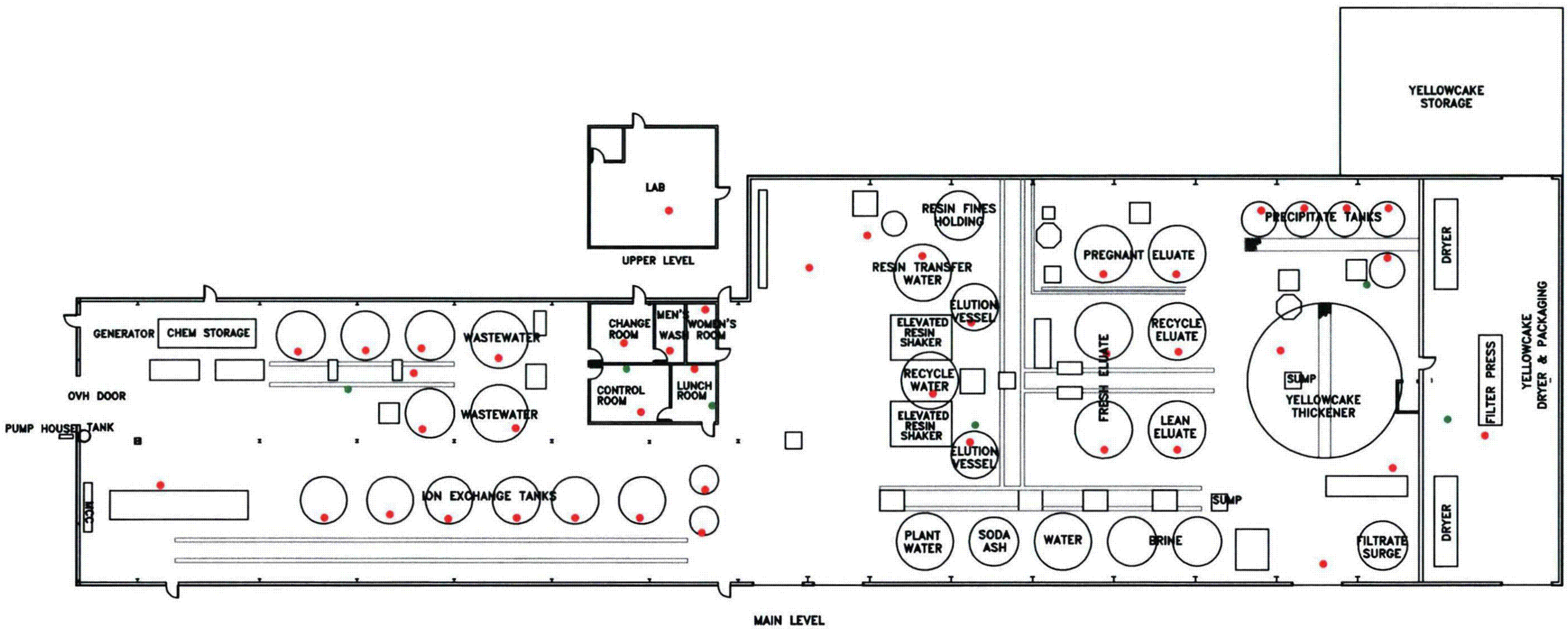
Uranium One will determine monitoring requirements in accordance with the guidance contained in USNRC Regulatory Guide 8.34[6]. Based on the experience of other ISR operations, Uranium One believes that it is not likely that any employee working at the Antelope Central Plant or the JAB Satellite Plant will exceed 10 percent of the regulatory limit (i.e., 500 mrem/yr).

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

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

Dosimeters will be provided by a vendor that is accredited by National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology as required in 10 CFR § 20.1501. The dosimeters will have a range of 1 mR to 1000 R. Dosimeters will be exchanged and read on a quarterly basis.

Results from personnel dosimetry will provide the individual Deep Dose Equivalent (DDE) for use in determining Total Effective Dose Equivalent (TEDE). The TEDE is defined in Regulatory Guide 8.30 as the sum of the DDE and the committed effective dose equivalent (CEDE) for internal exposures.



LEGEND

- RADON TESTING LOCATIONS
- GAMMA SURVEY LOCATIONS

FIGURE 5-2

URANIUM ONE
907 N. Poplar Suite 260 Casper, WY 82601 307-234-8235

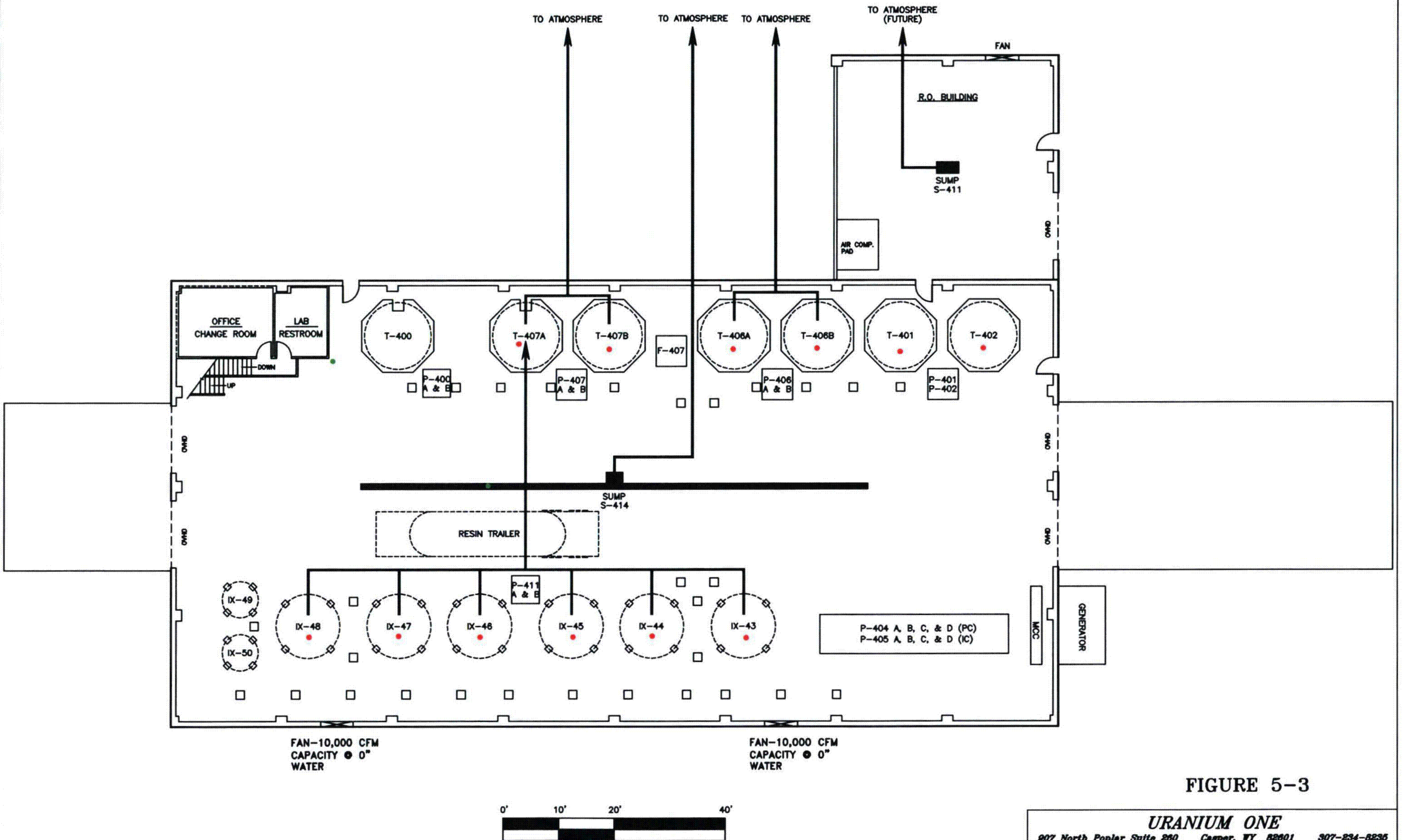
REVISIONS		
NO.	DATE	BY
1	06/08	JT

PROPOSED ANTELOPE CENTRAL PLANT

SURVEY & SAMPLE LOCATIONS

SWEETWATER COUNTY, WYOMING

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



LEGEND

- RADON TESTING LOCATIONS (green dot)
- GAMMA SURVEY LOCATIONS (red dot)

FIGURE 5-3

URANIUM ONE

907 North Poplar Suite 260 Casper, WY 82601 307-234-8235

REVISIONS		
NO.	DATE	BY

PROPOSED JAB SATELLITE PLANT

SURVEY & SAMPLE LOCATIONS

SWEETWATER COUNTY, WYOMING

5.7.3 IN-PLANT AIRBORNE RADIATION MONITORING PROGRAM

5.7.3.1 Airborne Uranium Particulate Monitoring

Airborne particulate levels at solution mines that employ vacuum dryers are very low since there are no emissions. The primary potential source of airborne uranium is during yellowcake packaging. This operation will be confined to the dryer room. The room will be closed and posted as an airborne radioactivity area during packaging. The proposed airborne uranium sampling locations for the Antelope Central Plant are shown on Figure 5.7-1. Samples will be obtained using area samplers on a monthly frequency.

Area samples will be taken in accordance with standard operating procedures. These procedures will implement the guidance contained in USNRC Regulatory Guide 8.25[7]. Samples will be taken with a glass fiber filter and a regulated air sampler such as an Eberline RAS-1 or equivalent. Sample volume will be adequate to achieve the lower limits of detection (LLD) for uranium in air. Samplers will be calibrated at the manufacturer's suggested interval or semiannually with a digital mass flowmeter or other primary calibration standard.

Breathing zone sampling will be performed to determine individual exposure to airborne uranium during certain operations. Sampling will be performed with a lapel sampler or equivalent. The air filters will be counted and compared to the Derived Air Concentration (DAC) using the same method used for area sampling. Air samplers will be calibrated at the manufacturer's recommended frequency or at least every six months using a primary calibration standard. Air sampler calibration will be performed in accordance with standard operating procedures.

Measurement of airborne uranium will be performed by gross alpha counting of the air filters using an alpha scaler such as a Ludlum Model 2000 or equivalent. The DAC for soluble (D classification) natural uranium of 5×10^{-10} µCi/ml from Appendix B to 10 CFR §§20.1001 - 20.2401 will be used. This is a conservative method because the gross alpha results include Uranium-238 and several of its daughters (notably Ra-226 and Th-230), which are also alpha emitters. An action level of 25% of the DAC for soluble natural uranium will be established at the Antelope Central Plant. If an airborne uranium sample exceeds the DAC, the RSO will investigate the cause.

The results of airborne uranium particulate monitoring will be used to determine the committed effective dose equivalent (CEDE) or internal exposure.

5.7.3.2 Radon Daughter Concentration Monitoring

Surveys for radon daughter concentrations will be conducted in the operating areas of the Antelope and JAB process plants on a monthly basis. Sampling locations will be determined in accordance with the guidance contained in USNRC Regulatory Guide 8.25. Proposed radon daughter sampling locations for the Antelope and JAB plants are shown on Figures 5-2 and 5-3.

Samples will be collected with a low volume air pump (e.g., lapel sampler) and then analyzed with an alpha scaler using the Modified Kusnetz method described in ANSI-N13.8-1973. Routine radon daughter monitoring will be performed in accordance with standard operating procedures. Samplers will be calibrated at the manufacturer's suggested interval or semiannually with a digital mass flowmeter or other primary calibration standard. Air sampler calibration will be performed in accordance with standard operating procedures.

Results of radon daughter sampling are expressed in Working Levels (WL) where one WL is defined as any combination of short-lived radon-222 daughters in one liter of air without regard to equilibrium that emit 1.3×10^5 MeV of alpha energy. The DAC limit from Appendix B to 10 CFR §§ 20.1001 - 20.2402 for radon-222 with daughters present is 0.33 WL. Uranium One will establish an action level of 25% of the DAC or 0.08 WL. Radon daughter results in areas with an average concentration in excess of the action level will result in an investigation of the cause and an increase in the sampling frequency to weekly until the radon daughter concentration levels do not exceed the action level for four consecutive weeks.

The results of radon daughter concentration monitoring will be used to determine the committed effective dose equivalent (CEDE) or internal exposure.

5.7.3.3 Respiratory Protection Program

Respiratory protective equipment will be supplied by Uranium One for activities where engineering controls may not be adequate to maintain acceptable levels of airborne radioactive materials or toxic materials. Use of respiratory equipment at Antelope and JAB Uranium Projects will be in accordance with a respiratory protection program designed to implement the guidance contained in USNRC Regulatory Guide 8.15[8] and USNRC Regulatory Guide 8.31. The respirator program will administered by the RSO as the Respiratory Protection Program Administrator (RPPA).

5.7.4 EXPOSURE DETERMINATION AND RECORDS CALCULATIONS

Employee exposure to radiation will be monitored and recorded in accordance with 10 CFR §20.1001 to §20.2401 and Regulatory Guides 8.30 and 8.34. Routine employee external exposures are determined and recorded for those employees likely to receive more than 10% of the allowable occupational dose limit (i.e., 0.5 rem). External exposures will be determined using personnel dosimetry as discussed in Section 5.7.2.2. Routine employee internal exposures will be determined and recorded for those employees likely to receive more than 10% of the Annual Limit of Intake (ALI) for internal exposure from radon daughters or uranium.

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

5.7.4.1 Natural Uranium Internal Exposure

Exposure calculations for airborne natural uranium will be performed using the intake method from USNRC Regulatory Guide 8.30, Section 2. The intake is calculated using the following equation:

$$I_u = b \sum_{i=1}^{n} \frac{X_i \times t_i}{PF}$$

where:

I_u	=	uranium intake, µg or µCi
t_i	=	time that the worker is exposed to concentrations X_i (hr)
X_i	=	average concentration of uranium in breathing zone, µg/m^3, µCi/m^3
b	=	breathing rate, 1.2 m^3/hr
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the week or quarter

The intake for uranium will be calculated and recorded. The intakes will be totaled and entered onto each employee's Occupational Exposure Record.

The data required to calculate internal exposure to airborne natural uranium will be determined as follows:

Time of Exposure Determination

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

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

Airborne Uranium Activity Determination

Airborne uranium activity will be determined from surveys performed as described in Section 5.7.3.1.

Exposures to airborne uranium will be compared to the DAC for the "D" solubility class for natural uranium from Appendix B of 10 CFR §§20.1001 - 20.2401 (i.e., 5×10^{-10} μCi/ml).

5.7.4.2 Radon Daughter Internal Exposure

Exposure calculations for airborne radon daughters will be performed using the intake method from USNRC Regulatory Guide 8.30, Section 2. The radon daughter intake will be calculated using the following equation:

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

where:

I_r	=	radon daughter intake, working-level months
t_i	=	time that the worker is exposed to concentrations W_i (hr)
W_i	=	average number of working levels in the air near the worker's breathing zone during the time (t_i)
170	=	number of hours in a working month
PF	=	the respirator protection factor, if applicable
n	=	the number of exposure periods during the year

The data required to calculate exposure to radon daughters will be determined as follows:
<u>Time of Exposure Determination</u>

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

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

Exposures during non-routine work (i.e., work requiring an RWP) will be based upon actual time.

Radon Daughter Concentration Determination

Radon-222 daughter concentrations will be determined from surveys performed as described in Section 5.7.3.2. The working-level months for radon daughter exposure will be calculated and recorded. The working-level months will be totaled and entered onto each employee's Occupational Exposure Record.

Exposures to radon daughters will be compared to the DAC for radon daughters from Appendix B of 10 CFR §§20.1001 - 20.2401 (i.e., 0.33 WL).

5.7.4.3 External Exposure

Occupational exposure to external gamma and beta radiation will be measured using personnel dosimeters such as Thermoluminescent Dosimeters (TLD) or Optically Stimulated Luminescence (OSL) dosimeters as discussed in Section 5.7.2.2. Consistent with 10 CFR §20.1502 and Regulatory Guide 8.34, occupational exposure to external radiation will be used to determine the TEDE for employees whose work locations or functions may be expected to exceed 10% of the occupational exposure limits. The RSO will use historical and current monitoring and survey data to ensure that external radiation exposures are less than 10% of the occupational dose limit for all unmonitored workers. The results of the external radiation monitoring program will be recorded and reviewed annually by the RSO to ensure that unmonitored employees have not exceeded 10% of the dose limit.

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5.7.4.4 Prenatal and Fetal Exposure

10 CFR §20.1208 requires that licensees ensure that the dose to an embryo/fetus during the entire pregnancy from occupational exposure of a declared pregnant woman does not exceed 0.5 Rem (500 mRem). Licensees are also required to make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman that would satisfy the 0.5 Rem limit. The dose to the embryo/fetus is calculated as the sum of (1) the deep-dose equivalent to the declared pregnant woman and (2) the dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

The dose equivalent to the embryo/fetus is determined by the monitoring of the declared pregnant woman. 10 CFR §20.1502(a)(2) requires monitoring the exposure of a declared pregnant woman when the external dose to the embryo/fetus is likely to exceed a dose from external sources in excess of 10% of the embryo/fetus dose limit (i.e., 0.05 Rem/yr). 10 CFR 20.1502(b)(2) also requires that the licensee monitor the occupational intakes of radioactive material for the declared pregnant woman if her intake is likely to exceed a committed effective dose equivalent in excess of 0.05 Rem/yr. Based on this 0.05 Rem threshold, the dose to the embryo/fetus must be determined if the intake is likely to exceed 1% of ALI during the entire period of gestation.

Prior to declaration of pregnancy, the woman may not have been subject to monitoring based on the conditions specified in 10 CFR §20.1502. In this case, Uranium One will estimate the exposure during the period monitoring was not provided, using any combination of surveys or other available data (e.g., air monitoring, area monitoring, and bioassay). Exposure calculations will be performed as recommended in USNRC Regulatory Guide 8.36[9].

- External Dose to the Embryo/Fetus

The deep-dose equivalent to the declared pregnant woman during the gestation period will be taken as the external dose for the embryo/fetus. The determination of external dose will consider all occupational exposures of the declared pregnant woman since the estimated date of conception and will be based on the methods discussed in Section 5.7.2.

- Internal Dose to the Embryo/Fetus

The internal dose to the embryo/fetus will consider the exposure to the embryo/fetus from radionuclides in the declared pregnant woman and in the embryo/fetus. The dose to the embryo/fetus will include the contribution from any radionuclides in the declared pregnant woman (body burden) from occupational intakes occurring prior to conception.

The intake for the declared pregnant woman will be determined as discussed in Sections 5.7.3.1 and 5.7.3.2.

5.7.4.5 Exposure Recording and Reporting

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

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

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

5.7.5 BIOASSAY PROGRAM

Uranium One will implement a urinalysis bioassay program at the Antelope and JAB Uranium Projects that meets the guidelines contained in USNRC Regulatory Guide 8.22[10]. The primary purpose of the program will be to detect uranium intake in employees who are regularly exposed to uranium and to confirm the results of the airborne uranium particulate monitoring program (discussed in Section 5.7.3.1) and the internal exposure determination (discussed in Section 5.7.4.1). The bioassay program will consist of the following elements:

1. Prior to assignment to the facility, all new employees will be required to submit a baseline urinalysis sample. Upon termination, an exit bioassay will be required from all employees.

2. During operations, urine samples will be collected from workers on a quarterly basis. Employees who have the potential for exposure to dried yellowcake will

submit bioassay samples on a monthly basis or more frequently as determined by the RSO. Samples will be analyzed for uranium content by a contract analytical laboratory. Blank and spiked samples will also be submitted to the laboratory with employee samples as part of the Quality Assurance program. The minimum measurement sensitivity for the analytical laboratory will be 5 µg/l.

3. Action levels for urinalysis will be established based upon Table 1 in USNRC Regulatory Guide 8.22.

Elements of the quality assurance requirements for the Bioassay Program will be based upon the guidelines contained in USNRC Regulatory Guide 8.22. These elements include the following:

1. Each batch of samples submitted to the analytical laboratory will be accompanied by two blind control samples. The control samples will be from persons that have not been occupationally exposed and are spiked to a uranium concentration of 10 to 20 µg/l and 40 to 60 µg/l. Alternatively, synthetic control samples may be used. The results of analysis for these samples are required to be within ± 30% of the spiked value

2. The analytical laboratory spikes 10 to 30% of all samples received with known concentrations of uranium and the recovery fraction is determined. Results will be reported to Uranium One.

5.7.6 CONTAMINATION CONTROL PROGRAM

Uranium One will perform surveys for surface contamination in operating and clean areas of the Antelope and JAB Process Plants in accordance with the guidelines contained in USNRC Regulatory Guide 8.30. Surveys for total alpha contamination in clean areas will be conducted weekly. In designated clean areas, such as lunchrooms, offices, change rooms, and respirator cabinets, the target level of contamination is nothing detectable above background. If the total alpha survey indicates contamination that exceeds 250 dpm/100 cm^2 (i.e., 25% of the removable limit) a smear survey will be performed to assess the level of removable alpha activity. If smear test results indicate removable contamination greater than 250 dpm/100 cm^2, the area will be promptly cleaned and resurveyed.

All personnel leaving the restricted area will be required to perform and document alpha contamination monitoring. In addition, personnel who could come in contact with potentially contaminated solutions outside a restricted area such as in the wellfields will be required to monitor themselves prior to leaving the area. All personnel will receive training in the performance of surveys for skin and personal contamination. All contamination on skin and clothing is considered removable, so the limit of 1,000 dpm/100 cm^2 will be applied to personnel monitoring. Personnel will also be allowed to conduct contamination monitoring of small, hand-carried items for use in wellfield and controlled areas as long as all surfaces can be reached with the instrument probe and the item does not originate in yellowcake areas. All other items are surveyed as described below.

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

The RSO, the radiation safety staff, or properly trained employees will perform surveys of all items removed from the restricted areas with the exception of small, hand-carried items described above. The release limits will be set as specified in *"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct or Source Materials"*, USNRC, May 1987.

Surveys will be performed with the following equipment:

1. Total surface activity will be measured with an appropriate alpha survey meter. A Ludlum Model 2241 scaler or a Ludlum Model 177 Ratemeter with a Model 43-65 or Model 43-5 alpha scintillation probe, or equivalent, will be used for the surveys.

2. Portable GM survey meter with a beta/gamma probe with an end window thickness of not more than 7 mg/cm^2, a Ludlum Model 3 survey meter with a Ludlum 44-38 probe or equivalent.

3. Swipes for removable contamination surveys as required.

Survey equipment will be calibrated annually or at the manufacturer's recommended frequency, whichever is more frequent. Surface contamination instruments will be checked daily when in use. Alpha survey meters for personnel surveys will be response checked before each use.

As recommended in USNRC Regulatory Guide 8.30, Uranium One will conduct quarterly unannounced spot checks of personnel to verify the effectiveness of the surveys for personnel contamination. The purpose of the spot check surveys is to ensure that employees are adequately surveying and decontaminating themselves prior to exiting the restricted areas.

Contamination control during maintenance or other nonroutine activities will be controlled through the use of an RWP unless standard operating procedures have been developed. In preparing an RWP, the RSO will assess the potential hazard to workers from loose and fixed contamination. In general, any work on pumps, piping, tankage, containers, or associated equipment will be evaluated for an RWP by the RSO. This would include any nonroutine maintenance or repairs in the drying and packaging facilities; sandblasting, welding, or grinding on any contaminated metal surfaces; and chipping or drilling concrete in plant buildings where contamination may be present. The RWP will contain requirements for specific contamination control techniques suited to the maintenance task. In most instances, some method of decontamination prior to performing maintenance work will be required. Methods typically employed at ISR facilities have included pressure washing surfaces or performing decontamination with a mild solution of muriatic acid to reduce contamination levels to a minimum. In some cases, work that may involve generation of dust that may contain radioactive materials will be performed under wet conditions.

5.7.7 AIRBORNE EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

Air Particulate

Potential air particulate releases from the satellite and central plant processes will be monitored at the same air monitoring locations that were used for baseline determination of air particulate concentrations as described in Section 2.9.6. Sampling locations are shown on Figure 5-4 and Figure 5-5. 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 within 10 km of the site, and one station at a control or background location. Monitoring will be performed using low volume air particulate samplers. Filters will be collected weekly to help prevent dust loading and will be composited on an approximate quarterly basis to provide respective estimates of average radionuclide concentrations as specified in

Regulatory Guide 4.14. Each quarterly batch of air filters from the four monitoring stations will be submitted to a contract laboratory for analysis of Ra-226, U-nat, Th-230, and Pb-210. Results of the operational air particulate monitoring program will be reported in the semi-annual effluent reports required by 10 CFR § 40.65.

Radon

The radon gas effluent released to the environment will be monitored at the same air monitoring locations (JB-4, AP-2, and AP-6) nearest to the air particulate stations that were used for baseline determination of radon concentrations as described in Section 2.9 and shown on Figures 5-4 and 5-5. Radon monitoring will also be conducted at the Bairoil site. 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, Uranium One will expose one duplicate radon Track Etch cup per monitoring period.

In addition to the environmental monitoring, the release of radon from process operations will be estimated using the source term method described in Section 7.3 and will be reported in the semi-annual effluent reports required by 10 CFR § 40.65.

Surface Soil

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

Subsurface Soil

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

Figure 5-4

Proposed Antelope Uranium Project Operational Environmental Monitoring Locations

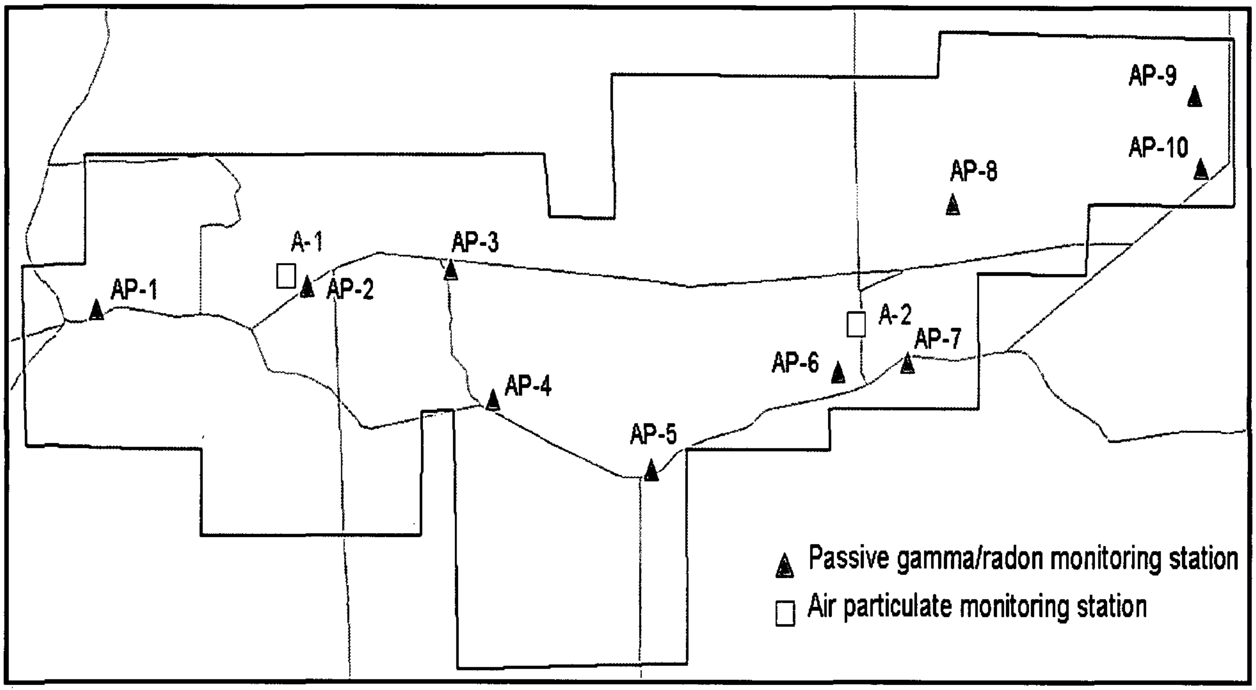
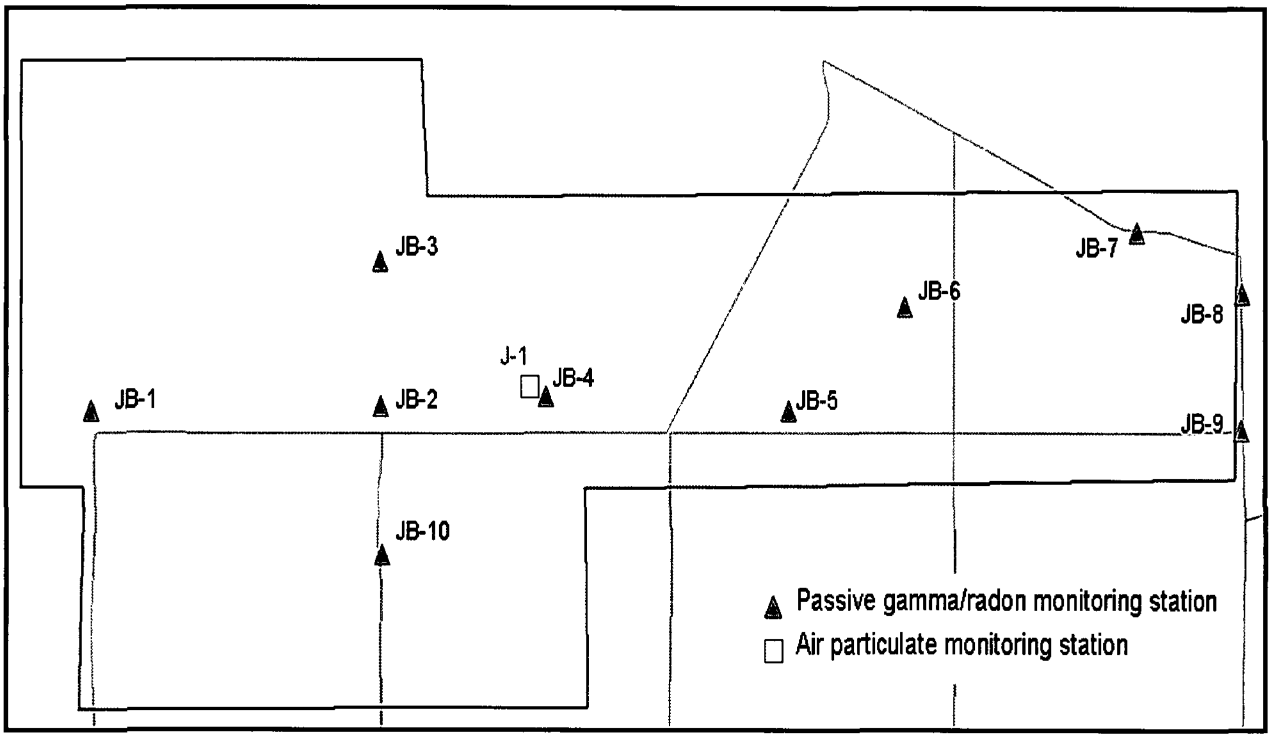


Figure 5-5

Proposed JAB Uranium Project Operational Environmental Monitoring Locations



Vegetation

Preoperational vegetation samples from the Antelope and JAB Uranium Project areas were collected in 2007 at the locations described in Section 2.9.

Uranium One does not propose to perform operational vegetation sampling at the environmental monitoring stations. In accordance with the provisions of USNRC Regulatory Guide 4.14[11], Footnote (o) to Table 2 requires that "*vegetation and forage sampling need be carried out only if dose calculations indicate that the ingestion pathway from grazing animals is a potentially significant exposure pathway...*" defined as a pathway which would expose an individual to a dose in excess of 5% of the applicable radiation protection standard. This pathway was evaluated by MILDOS-Area and is discussed further in Section 7.3.

Direct Radiation

Environmental gamma radiation levels will be monitored continuously at the same air monitoring locations (JB-4, AP-2, and AP-6) nearest to the air particulate stations that were used for baseline determination of radon concentrations as described in Section 2.9 and shown on Figures 5.4 and 5.5. Gamma radiation will be monitored through the use of environmental dosimeters obtained from a NVLAP certified vendor. Dosimeters will be exchanged on a quarterly basis.

Deep Disposal Well Monitoring

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

5.7.8 GROUNDWATER/SURFACE WATER MONITORING PROGRAM

5.7.8.1 Program Description

During operations at the Antelope and JAB Uranium Project, a detailed water sampling program will be conducted to identify any potential impacts to water resources of the area. Uranium One's operational water monitoring program will include the evaluation of groundwater on a regional basis, groundwater within the licensed area, and surface water on a regional and site specific basis.

5.7.8.2 Groundwater Monitoring

The groundwater monitoring program is designed to detect excursions of lixiviant outside of the wellfield under production and into the overlying and/or underlying water bearing strata.

- Private Well Monitoring

All private wells within one kilometer of the wellfield area boundary will be sampled on a quarterly basis with the landowner's consent. Groundwater samples will be analyzed for natural uranium and radium-226.

- Wellfield Baseline Sampling

Production zone wells (injection and production pattern area) will be sampled four times with a minimum of 2 weeks between samplings during baseline characterization. Wells will be selected based on a density of one well per three acres of mine unit. The first and second sample events will include analyses for all WDEQ LQD Guideline 8, Appendix 1, parts III and IV parameters as shown in Table 5.7-1. The third and fourth sampling events will be analyzed for a reduced list of parameters as defined by the results of the previous sample events. If certain elements are not detected during the first and second sampling events, then those elements will not be analyzed during the third and fourth sample events.

Data for each parameter are averaged. If the data collected for the entire mine unit indicate that waters of different underground water classes (WDEQ-WQD Rules and Regulations, Chapter VIII) exist together, the data are not averaged together, but treated as sub-zones. Data within specific sub-zones are averaged. Boundaries of sub-zones, where required, are delineated at half-way between the sets of sampled wells which define the sub-zones. The Restoration Target Values (RTV's) are determined from the baseline water quality data and are used to assess the effectiveness of ground water restoration activities. The average and range of baseline values determined for the wells completed in the Production Zone within the wellfield area constitute the RTV's.

- Well Sampling Methods

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

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

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

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

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

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

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

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

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

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

Casing Volume (Gals) = (Height of water in well in ft) x (Radius of the well^2 in inches) x (π) x (0.052)

Where: $\pi = 3.1416$
The height of the water in the well = the total depth (TD) of the well in feet minus the depth to water in feet.

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

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

- Identification of the well;

- Well depth;
- Static water level depth and measurement techniques;

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

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

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

Parameter	Volume Required (mls)	Preservative	Holding Time
Dissolved Metals	250	Filter (0.45 μm), then add HNO_3 to ph<2	6 months
Total Metals	250	HNO_3 to ph<2	6 months
Alkalinity	100	Cool, 4°C	14 days
Chloride	50	None Required	28 days
Conductance	100	Cool, 4°C	28 days
Fluoride	50	None Required	28 days
Ammonia as N	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate + Nitrite	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate	50	Cool, 4°C	48 hours
Nitrite	50	Cool, 4°C	48 hours
pH	25	None Required	Analyze immediately
TDS	500	Cool, 4°C	7 days
TSS	500	Cool, 4°C	7 days
Sulfate	100	Cool, 4°C	28 days
Lead-210	1000	HNO_3 to ph<2	6 months
Polonium-210	1000	HNO_3 to ph<2	6 months
Radium-226	1000	HNO_3 to ph<2	6 months
Uranium	1000	HNO_3 to ph<2	6 months

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

- Monitor Well Baseline Water Quality

Monitor well ring wells are installed within the Production Zone, outside the mineralized portion of the ore zone and production pattern area in a "ring" around the mine area. These wells are used to obtain baseline water quality data and characterize the area outside the production pattern area. Upper Control Limits (UCL's) are determined for these wells from the baseline water quality data used in operational excursion monitoring. As described in Section 3, 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 and underlying aquifer 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.

After completion, wells will be developed (by air flushing or pumping) until water quality in terms of pH and specific conductivity appears to be stable and consistent with the anticipated water quality of the area. After development, wells will be sampled to obtain baseline water quality. Wells will be purged before sample collection to ensure that representative water is obtained. All monitor wells including ore zone and overlying and underlying monitor wells will be sampled four times at least two weeks apart. The first sample will be analyzed for the parameters shown in Table 5-1. 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.

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Table 5-1
Baseline Water Quality Parameters
WDEQ LQD Guideline 8

Constituents (reported in mg/l unless noted)	*Analytical Method*
Ammonia Nitrogen as N	EPA 350.1
Nitrate + Nitrite as N	EPA 353.2
Bicarbonate	EPA 310.1/310.2
Boron	EPA 212.3/200.7
Carbonate	EPA 310.1/310.2
Fluoride	EPA 340.1/340.2/340.3
Sulfate	EPA 375.1/375.2
Total Dissolved Solids (TDS) @ 180°F	EPA 160.1/SM2540C
Dissolved Arsenic	EPA 206.3/200.9/200.8
Dissolved Cadmium	EPA 200.9/200.7/200.8
Dissolved Calcium	EPA 200.7/215.1/215.2
Dissolved Chloride	EPA 300.0
Dissolved Chromium	EPA 200.9/200.7/200.8
Total and Dissolved Iron	EPA 236.1/200.9/200.7/200.8
Dissolved Magnesium	EPA 200.7/242.1
Total Manganese	EPA 200.9/200.7/200.8/243.1/243.2
Dissolved Molybdenum	EPA 200.7/200.8
Dissolved Potassium	EPA 200.7/258.1
Dissolved Selenium	EPA 270.3/200.9/200.8
Dissolved Sodium	EPA 200.7/273.1
Dissolved Zinc	EPA 200.9/200.7/200.8
Radium-226 (pCi/l)	DOE RP450/EPA 903.1/SM 7500-R-AD
Radium-228 (pCi/l)	SM 7500-R-AD
Gross Alpha (pCi/l)	DOE RP710/CHEMTA-GP B1/EPA 900
Gross Beta (pCi/l)	DOE RP710/CHEMTA-GP B1/EPA 900
Uranium	DOE MM 800/EPA 200.8
Vanadium	EPA 286.1/286.2/200.7/200.8

- Wellfield Hydrologic Data Package

Following completion of the field data collection, the Wellfield Hydrologic Data Package is assembled and submitted to the WDEQ for review. In accordance with NRC Performance Based Licensing requirements, the Wellfield Hydrologic Data Package is reviewed by a Safety and Environmental Review Panel (SERP) to ensure that the results of the hydrologic testing and the planned mining activities are consistent with technical requirements and do not conflict with any requirement stated in NRC regulations or in the NRC license. A written SERP evaluation will evaluate safety and environmental concerns and demonstrate compliance with applicable NRC license requirements as previously discussed in Section 5.2.4. The written SERP evaluation will be maintained at the site.

The Wellfield Hydrologic Data Package contains the following:

1. A description of the proposed mine unit (location, extent, etc.).

2. A map(s) showing the proposed production patterns and locations of all monitor wells.

3. Geologic cross-sections and cross-section location maps.

4. Isopach maps of the Production Zone sand, overlying confining unit and underlying confining unit.

5. Discussion of how the hydrologic test was performed, including well completion reports.

6. Discussion of the results and conclusions of the hydrologic test including pump test raw data, drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps and when appropriate, directional transmissivity data and graphs.

7. Sufficient information to show that wells in the monitor well ring are in adequate communication with the production patterns.

8. Baseline water quality information including proposed UCLs for monitor wells and average production zone/restoration target values.

9. Any other information pertinent to the area tested will be included and discussed.

- Operational Upper Control Limits and Excursion Monitoring

After baseline water quality is established for the monitor wells for a particular production unit, upper control limits (UCLs) are set for chemical constituents which

would be indicative of a migration of lixiviant from the well field. The constituents chosen for indicators of lixiviant migration and for which UCLs will be set are chloride, conductivity, and total alkalinity. Chloride was chosen due to its low natural levels in the native groundwater and because chloride is introduced into the lixiviant from the ion exchange process (uranium is exchanged for chloride on the ion exchange resin). Chloride is also a very mobile constituent in the groundwater and will show up very quickly in the case of a lixiviant migration to a monitor well. Conductivity was chosen because it is an excellent general indicator of overall groundwater quality. Total alkalinity concentrations should be affected during an excursion as bicarbonate is the major constituent added to the lixiviant during mining. Water levels are obtained and recorded prior to each well sampling. However, water levels are not used as an excursion indicator. Upper control limits will be set at the baseline mean concentration plus five standard deviations for each excursion indicator. For chloride with a low baseline mean and little noted variation during baseline sampling, the UCL may be determined by adding 15 mg/l to the baseline mean if that value is greater than the baseline mean plus five standard deviations.

Operational monitoring consists of sampling the monitor wells at least twice monthly and at least 10 days apart and analyzing the samples for the excursion indicators chloride, conductivity, and total alkalinity. Uranium One 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, Uranium One will document the cause and the duration of any delays.

To assure that water within the well casing has been adequately displaced and/or formation water is sampled, wells will be purged before sample collection to ensure that representative water is obtained. Samples will be taken when field water quality parameters such as pH and specific conductivity appear to be stable and consistent with the anticipated water quality of the area. Low flow purging may also be used in certain instances to prevent pulling of mining fluids to the monitor well from excessive purging and ensure only formation water is sampled.

Water level and analytical monitoring data for the UCL parameters are reported to the WDEQ-LQD on a quarterly basis. This data is retained on site for review by the NRC.

- Excursion Verification and Corrective Action

During routine sampling, if two of the three UCL values are exceeded in a monitor well, the well is resampled within 24 hours of the determination that a sample has exceeded

two of the three UCL values and analyzed for the excursion indicators. The verification sample is split and analyzed in duplicate to assess analytical error. If results of the confirmatory sampling are not complete within 30 days of the initial sampling event, then the excursion will be considered confirmed for the purpose of meeting the reporting requirements described below. If the second sample does not exceed the UCLs, a third sample is taken within 48 hours. If neither the second or third sample results exceeded the UCLs, the first sample is considered in error.

If the second or third sample verifies an exceedance, the well in question is placed on excursion status. Upon verification of the excursion, the USNRC Project Manager and the WDEQ-LQD is notified by telephone or email within 24 hours and notified in writing within thirty (30) days. A written report describing the excursion event, corrective actions, and corrective action results will be submitted to the NRC within 60 days of the excursion confirmation.

If an excursion is verified, the following methods of corrective action will be instituted (not necessarily in the order given) dependent upon the circumstances:

- A preliminary investigation will be completed to determine the probable cause.
- Production and/or injection rates in the vicinity of the monitor well will be adjusted as necessary to increase the net bleed, thus forming a hydraulic gradient toward the production zone.
- Individual wells will be pumped to enhance recovery of mining solutions.
- Injection into the well field area adjacent to the monitor well may be suspended. Recovery operations continue, increasing the overall bleed rate and the recovery of wellfield solutions.

In addition to the above corrective actions, sampling frequency of the monitor well on excursion status will be increased to once every seven days.
If an excursion is not controlled within 30 days following confirmation of the excursion, the WDEQ requires that a sample must be collected from each of the affected monitoring wells and analyzed for the following parameters: ammonia; antimony; arsenic; barium; beryllium; bicarbonate; boron, cadmium, calcium, carbonate; chloride; chromium; conductivity; copper; fluoride; gross alpha; gross beta; iron; lead; magnesium; manganese; mercury; molybdenum; nitrate + nitrite; pH; potassium; selenium; sodium; sulfate; radium-226 and 228; thallium; TDS; uranium; vanadium; and zinc.

If the concentration of the UCL parameters detected in the monitor well(s) does not begin to decline within 60 days after the excursion is verified, injection into the production zone adjacent to the excursion will be suspended to further increase the net water withdrawals. Injection will be suspended until a declining trend in the concentration of the UCL parameters is established. Additional measures will be implemented if a declining trend does not occur in a reasonable time period. After a significant declining trend is established, normal operations will be resumed with the injection and/or production rates regulated such that net withdrawals from the area will continue. The declining trend will be maintained until the concentrations of excursion parameters in the monitor well(s) have returned to concentrations less than respective UCLs.

If an excursion is controlled, but the fluid which moved out of the production zone during the excursion has not been recovered within 60 days following confirmation of the excursion, the operator will submit to the WDEQ-LQD and the NRC within 90 days following confirmation of the excursion a plan and compliance schedule meeting the requirements of LQD Rules and Regulations, Chapter 13, Section 13(b).

A monthly report on the status of an excursion shall be submitted to the LQD administrator beginning the first month the excursion is confirmed and continuing until the excursion is over. The monthly report shall contain the requirements described in LQD Rules and Regulations, Chapter 12, Section 12(e). An excursion will be considered concluded when the concentrations of excursion indicators do not exceed the criteria defining an excursion, or if only one excursion indicator exceeds its respective UCL by less than 20%.

5.7.8.3 Surface Water Monitoring

Pre-operational surface water quality monitoring was performed as discussed in Sections 2.7 and 2.9. The proposed license area does not contain perennial streams and all surface water features are ephemeral and only contain natural runoff during heavy rainfall and snowmelt events. Upstream and downstream samples from all pre-operational surface water locations will be obtained quarterly when water is present. Due to the lack of surface water flow, pre-operational samples were only available at a few locations during spring snowmelt as described in Section 2.7. Therefore, additional sampling locations may be determined as development progresses. Surface water samples will be analyzed for Pb-210, Ra-226, Th-230, natural uranium, and Po-210. Surface water monitoring results will be submitted in the semi-annual environmental and effluent reports submitted to NRC and in the Annual Mine Permit Report to the WDEQ-LQD.

5.7.9 WILDLIFE MONITORING

Due to the dynamic nature of wildlife species, Uranium One voluntarily commissioned monitoring of known sage-grouse leks and raptor nest sites in spring 2008 for the Antelope and JAB Uranium Project. Those efforts will transition to annual monitoring once ISR operations are permitted, which will continue through the life of the project. Annual wildlife monitoring surveys should follow the same regimen as other ISR operations in the region to maximize comparisons among survey results and impact assessments. At a minimum, those surveys typically include the following, as modified for site-specific habitats (e.g., no trees, so no bald eagle winter roost surveys):

1. Early spring surveys for, and monitoring of, sage-grouse leks within one mile of the license/permit area, new and/or occupied raptor territories and/or nests, Pygmy Rabbit, Mountain Plover, and T&E species on and within the license/permit area;

2. Other surveys as required by regulating agencies.

Based on results from previous surveys, the WGFD recommended in late 1999 that big game monitoring be discontinued on all existing surface mine sites in Wyoming. Similarly, results from a three-year big game monitoring program conducted at the Smith Ranch and Highland Uranium Projects during their respective permitting processes documented that those operations were having no significant negative impact on pronghorn or mule deer. Because the entire Antelope and JAB Survey Area is covered by WGFD big game surveys, the BLM did not require such efforts for these baseline wildlife surveys, and no long-term monitoring requirements are anticipated as necessary.

5.7.10 QUALITY ASSURANCE PROGRAM

A quality assurance program will be implemented at the Antelope and JAB Uranium Projects for all relevant operational monitoring and analytical procedures. The objective of the program will be to identify any deficiencies in the sampling techniques and measurement processes so that corrective action can be taken and to obtain a level of confidence in the results of the monitoring programs. The QA program will provide assurance to the regulatory agencies and the public that the monitoring results are valid. The Uranium One Quality Assurance Plan for Wyoming ISR Operations is provided in Addendum 5-A.

The QA program addresses 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.

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5.8 REFERENCES

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

[2] USNRC Regulatory Guide 8.29, *Instructions Concerning Risks From Occupational Radiation Exposure* (Revision 1, February 1996).

[3] USNRC Regulatory Guide 8.13, *Instruction Concerning Prenatal Radiation Exposure* (Revision 3, June 1999).

[4] USNRC Regulatory Guide 3.56, *General Guidance For Designing, Testing, Operating, and Maintaining Emission Control Devices at Uranium Mills* (May 1986).

[5] USNRC Regulatory Guide 8.30, *Health Physics Surveys in Uranium Recovery Facilities* (Revision 1, May 2002).

[6] USNRC Regulatory Guide 8.34, *Monitoring Criteria and Methods To Calculate Occupational Radiation Doses* (July 1992).

[7] USNRC Regulatory Guide 8.25, *Air Sampling in the Workplace* (Revision 1, June 1992).

[8] USNRC Regulatory Guide 8.15, *Acceptable Programs For Respiratory Protection* (Revision 1, October 1999).

[9] USNRC Regulatory Guide 8.36, *Radiation Exposure to the Embryo/Fetus* (July 1992).

[10] USNRC Regulatory Guide 8.22, *Bioassay at Uranium Mills* (Revision 1, August 1988).

[11] USNRC Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills* (Revision 1, April 1980).

ADDENDUM 5-A

WYOMING ISR OPERATIONS QUALITY ASSURANCE PLAN

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Wyoming In Situ Recovery Projects Quality Assurance Plan

Prepared by
Uranium One Americas
Casper, Wyoming

Policy and Signature Page

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

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

Prepared By: Date:

______________________________ ______________

Approved By: Date:

______________________________ ______________

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:

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

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

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

Senior Environmental Specialist – The Senior Environmental Specialist has responsibility for the day-to-day supervision of the environmental monitoring programs for Uranium One Americas. The Senior Environmental Specialist reports to the Manager of Environmental and Regulatory Affairs, Wyoming.

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

5 QUALITY OBJECTIVES

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

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

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

5.1 Field Quality Objectives

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

5.2 Laboratory Quality Objectives

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

5.2.1 Precision

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

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

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

5.2.2 Bias

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

5.2.3 Accuracy

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

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

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

5.2.4 Representativeness

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

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

5.2.5 Comparability

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

5.2.6 Sensitivity

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

6 PERSONNEL AND TRAINING

6.1 Personnel Requirements

6.1.1 Training

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

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

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

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

6.1.2 Certifications

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

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

7 DATA GENERATION AND ACQUISITION

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

7.1 Sampling Process Design

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

Monitoring procedures for the Wyoming ISR sites have been established. These monitoring programs are designed to ensure that monitoring data would satisfy applicable regulations and would ensure that there were no unacceptable risks to human health or the environment. The site-specific environmental monitoring plan defines the sample locations and sampling frequency and determines the types of analyses that will be conducted on the samples collected from these locations. The plans are reviewed every 5 years, and changes to sampling strategies may be proposed on the basis of analytical results, site conditions, or regulatory requirements.

7.2 Sampling Methods

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

7.2.1 Sample Collection Procedures

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

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

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

7.2.2 Field Measurements and Sampling Methods

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

7.3 Preparation and Decontamination Requirements for Sampling Equipment

7.3.1 Requirements for Sample Containers, Preservation, and Holding Times

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

7.3.2 Container Requirements

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

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

7.3.3 Preservation and Holding Times

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

7.3.4 Decontamination Procedures and Materials

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

7.4 Sample Handling and Custody Requirements

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

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

7.4.1 Identification, Handling, Packaging, and Storage

7.4.1.1 Sample Identification

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

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

7.4.1.2 Sample Handling and Storage

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

7.4.1.3 Sample Custody

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

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

7.4.1.4 Sample Packaging and Shipping

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

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

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

7.4.2 Laboratory Requirements

7.4.2.1 Laboratory Sample Receipt

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

7.4.2.2 Discrepancies Identified During Sample Receipt

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

Chain of Sample Custody form, and contacting the Senior Environmental Specialist to resolve any questions.

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

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

7.4.2.3 Sample Disposition

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

7.4.3 Analytical Methods

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

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

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

7.4.3.1 Subcontracted Laboratory Requirements

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

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

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

7.4.4 Quality Assurance/Quality Control

7.4.4.1 Field QA/QC

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

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

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

7.4.4.2 Laboratory QA/QC

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

- Ensure that procedures and any revisions are documented

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

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

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

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

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

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

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

7.4.5.1 Field Equipment and Instruments

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

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

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

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

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

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

7.4.5.2 Laboratory Equipment and Instruments

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

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

7.4.6 Instrument/Equipment Calibration and Frequency

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

7.4.7 Inspection/Acceptance of Supplies and Consumables

7.4.7.1 Sample Containers

Sample containers for water, soil, sediment, and other media will be provided by the subcontracted laboratory and will be new or pre-cleaned. As appropriate, supplier-provided certificates of cleanliness will be retained with field documentation.

Containers will be visually inspected for integrity and cleanliness before being used. Suspect containers will not be used and will be discarded in a controlled manner to prevent inadvertent future use. If sufficient quantities of containers are suspect, the laboratory will immediately be notified of the condition and requested to provide a sufficient quantity of replacement containers. Suspect containers will be collected, segregated, and tagged for return to the analytical laboratory. The Senior Environmental Specialist will describe the situation in the field book as a field variance.

7.4.7.2 Supplies and Consumables

The Senior Environmental Specialist is responsible for ensuring that supplies, materials, and consumable items used during field activities are properly inspected for integrity, cleanliness, and compliance with specified tolerances and that they are appropriate to the activity. Items with a specified shelf life or expiration date will be labeled. Expired materials will not be used and will be properly disposed of or returned to the laboratory for disposal, as appropriate. Supplies, materials, and equipment will be inventoried at the conclusion of the sampling event in preparation for the next scheduled event.

7.4.8 Data Acquisition Requirements through Non-Direct Measurements

Data acquired through non-direct measurements may include data from historical databases, literature references, background information from historical facility files, climatic data, and regional geology or hydrology descriptions. Generally, these data are ancillary to the project.

Data from historical databases or historical facility files should be evaluated within the context in which they are presented and a determination made as to how accurate the data of interest may be. The exact nature of the evaluation likely will have to be made on a case-by-case basis. Information obtained from literature references should be from peer-reviewed journals or books whenever possible. Information such as climatic data and regional geology or hydrology descriptions should be obtained from documents produced by state or federal agencies whenever possible.

7.4.9 Data Management

Project data are generated mainly from routine sampling of monitor wells, routine operations system sampling, and occasional soil sampling events. The Senior Environmental Specialist is responsible for managing project data in compliance with Uranium One Americas requirements.

Field data books are assembled for most sampling events. These books contain information such as sample location identification (ID), date, QA sample ID, well purge method, sampling method, and field measurements. These are completed at the time of sample collection.

Data from samples submitted to an analytical laboratory are received as both hard copy and as electronic data. The hard copy analytical reports are archived in the project records along with the original field data forms and other relevant hard copy forms or documents containing project data. The hard copy forms are categorized in the project records according to the project filing procedures. Electronic data are also archived in the project records according to the project filing procedures.

7.5 Data Validation and Usability

Technical data, including field data and results of laboratory analyses, will be routinely verified and validated to ensure that the data are of sufficient quality and quantity to meet the project's intended data needs. Results of data validation efforts will be documented and summarized in the site-specific validation reports. The Senior Environmental Specialist is responsible for initiating the review, verification, validation, and screening associated with field and/or laboratory data.

7.5.1 Field Measurement Data

The objective of field data verification is to ensure that data are collected in a consistent manner and in accordance with procedures and schedules established in the Wyoming ISR environmental planning documents. Field data validation procedures include a review of raw data and supporting documentation generated from field investigations.

The data are reviewed for completeness, transcription errors, compliance with procedures, and accuracy of calculations.

The person doing the validation (in consultation with the Senior Environmental Specialist, if required) may correct problems that are found or noted in field documentation. Corrections to data forms will be made by lining through the incorrect entry, correcting the information, then initialing and dating the corrected information. The person validating the document, with the consent of the Senior Environmental Specialist, may also determine that incorrect data should not be entered into a database or that the data should have an additional qualifier.

7.5.2 Laboratory Data

The laboratory performing the analyses will document the analytical data in accordance with standard procedures inherent in the analytical methods and as approved by the Senior Environmental Specialist, if required.

Once the data package is received from the analytical laboratory, laboratory records and data package requirements will be checked to assess the completeness of the data package, and the data will be validated by personnel qualified and experienced in laboratory data validation.

The QC data provided by the laboratory (method blanks, matrix spikes, etc.) will be evaluated to see if they are within the acceptance range. If they are not, the data set affected by the QC samples will be evaluated to determine if corrective action is necessary.

7.5.2.1 Quality Control Samples

QC samples consisting of trip blanks, equipment rinsate blanks, field duplicate samples (replicated or co-located samples), laboratory spikes, laboratory blanks, laboratory duplicates, and laboratory control samples (including thermoluminescent dosimeters) are evaluated in the data validation process.

7.5.3 Qualification of Data and Corrective Actions

Qualification criteria are defined in the Uranium One Americas procedures. In addition to the process of qualifying the data, other corrective actions may be used. These may include reanalysis of the data by the laboratory or re-sampling of the affected locations. Other corrective actions to prevent contamination of future samples may also be proposed.

7.5.4 Determination of Anomalous Data

The final aspect of data validation involves the screening of both field and laboratory analytical data for potentially anomalous data points.

7.5.4.1 Data Screening

The initial step in determining potentially anomalous data points consists of screening all data from a sampling event for values that fall outside a designated historical data range. The historical data range used for comparison will be from previous sampling events.

7.5.4.2 Technical Review

The next step involves a review of the screened data by a qualified individual experienced in data review. Each data point will be evaluated to determine if the data point is acceptable or if follow-up action is required. This evaluation will consider factors such as number of historical data points, analyte concentration, magnitude of the deviation from the historical data range, number of historical non-detects, variability of the historical data, location of the sample point relative to other potential interfering activities, and correlation with other analytes.

7.5.4.3 Follow-up Actions

Follow-up actions can include one or more of the following:

- Requesting a laboratory check of calculations and dilutions
- Sample reanalysis
- Re-sampling
- Comparison to results from the next sampling event
- Data qualification

Based on the results of the follow-up action, the Senior Environmental Specialist will make a final determination of validity of the data point. The data point will be considered acceptable or it will be qualified, and a record of the action will be made. A summary of any anomalous data will be included in the site-specific data validation report.

7.5.4.4 Data Qualification

After the Senior Environmental Specialist has determined that a data point is anomalous, the data point will be qualified with an "R" flag (unusable) in the database. Qualification of data will be noted with a brief justification for the qualification.

7.6 Documentation and Records

The requirements for documentation and records management apply to the preparation, review, approval, issue, use, and revision of documents or forms that prescribe processes, specify requirements, or establish design. Records must be specified, prepared, reviewed, approved, and maintained as directed by Uranium One Americas policy.

Field and laboratory data will be sufficiently documented to provide a scientifically defensible record of the activities and analyses performed. Records of field variance reports, internal reviews, field and laboratory records of tests and analyses, field logs, Chain of Custody forms, and project reports will be used in interpreting and assessing the usability of the data. Standardized forms and computer files, codes, programs, and printouts will be designed to eliminate errors made during data entry and reduction. Calculation steps are described in the technical and analytical procedures and software lists. Routine data-transfer and data-entry verification checks are performed.

Laboratories must demonstrate continued proficiency through participation in performance evaluation programs required by the USNRC and WDEQ.

7.6.1 Records Management Plan

A site-specific records management plan shall be prepared to identify the records to be generated, file locations, and retention schedule for the Wyoming ISR site. The records management plan establishes the requirements for preparing, preserving, and storing records. Project personnel will work with the Senior Environmental Specialist, or his designee, to ensure that environmental monitoring records are correctly identified and maintained in accordance with the plan. Modifications to the plan shall be submitted to the Senior Environmental Specialist and are subject to his review and approval.

7.6.2 Document Control and Changes

Uranium One Americas policy and procedures will be followed to ensure that the preparation, issuance, and revisions to project documents and forms will be controlled so that current and correct information is available at the work location. These project documents (e.g., plans, procedures, drawings, and forms) and subsequent revisions will be reviewed for adequacy and approved before being issued for use. Written records and photo documentation will be handled in a manner that ensures association to the activity, the samples, and their locations. The Senior Environmental Specialist can authorize minor changes to project documents without requiring a formal review process.

At a minimum, personnel responsible for environmental monitoring activities at the Wyoming ISR site will have access to the applicable documents and will be knowledgeable of the contents before the associated work assignment.

Nonroutine sampling and field investigations will be documented in the file. The Senior Environmental Specialist will be briefed on and will approve all nonroutine field investigations before the work begins.

7.6.3 Corrections to Documents

When practical, correction of errors should be made by the individual who made the entry. The method used to make a correction is to draw a line through the error, enter the correct information, then initial and date the entry. The erroneous material must not be obscured.

When a document requires replacement due to illegibility or inaccuracies, the document will be voided, and a replacement document will be prepared. A notation will be made on the voided document that a replacement document was completed. The voided document will be retained with the field documentation.

7.6.4 Project Documents

Project documents are written materials that provide a background or history of the work, establish the basis for the work, give guidance to the work, and provide a summary of the work. They may be documents such as technical reports, technical and administrative plans, inspection or test documents, and design or as-built drawings. Documents prepared for the Wyoming ISR site that establishes instructions or procedures will be developed in accordance with the applicable requirements. Documents that are subject to revision will be managed and issued as controlled documents. These include, but are not limited to, the following documents:

- Quality Assurance Plans and Procedures
- Site-Specific Environmental Monitoring and Sampling Plans

7.6.5 Procedure Requirements

Uranium One Americas personnel will comply with the requirements of all approved written procedures or other instructions. Any deviation from approved field procedures must be authorized by the Senior Environmental Specialist. Field changes to project plans or deviation from procedures will be documented in the field book as a field variance and communicated to the Senior Environmental Specialist as soon as possible.

The Senior Environmental Specialist will be notified of any changes to subcontract laboratory procedures. He will be informed of and review changes to laboratory procedures. Impacts will be identified to the Senior Environmental Specialist. As appropriate, procedure changes that affect laboratory data will be identified and documented during the data review, verification, and validation activities. As appropriate, the Senior Environmental Specialist will inform Uranium One Americas management of technical or other substantive changes to laboratory procedures that may affect reporting limits or analytical sensitivity.

7.6.6 Field Documentation

Field documentation requirements are specified in the sampling procedures. All entries in field documents will be made with indelible (waterproof) ink and will be legible, reproducible, accurate, complete, and traceable to the sample measurements and/or site location. These documents will be retained as project records. Field documents are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the field sampling activities. Field logbooks and forms (e.g., sample collection data sheets, field measurement data forms, Chain of Custody forms, and shipping forms) will be stored in a manner that protects them from loss or damage.

The Senior Environmental Specialist will adequately document and identify field measurements and each sample collected. Field records will be completed at the time the observation or measurement is made and when the sample is collected. Project documents and written procedures will be available at the work site. The Senior Environmental Specialist will ensure that specified requirements are followed so that an accurate record of sample collection and transfer activities is maintained.

As appropriate, sample disposition will be specified to the subcontract laboratory in the appropriate procurement documents.

7.6.6.1 Field Books and Forms

Any person conducting field sampling will maintain a field book to provide a daily record of field activities associated with monitoring and sampling events and to document relevant operations and measurements. If initials are used in place of signatures, a signature/initials log will be maintained to identify personnel who are authorized to record, review, and authenticate field data.

Field books for project activities will be prepared, managed, and maintained in accordance with project records requirements. Project field books will be prepared and issued by the Senior Environmental Specialist. Field book information may include documentation associated with routine or ad hoc field measurements and sampling, chain of custody, soil boring and well installation, sampling equipment, calibration records and standards, and general field notes, including repairs made to equipment and instruments.

7.6.6.2 Field Variance and Nonconformance Documentation

Changes from specified field protocols established in planning documents or standard operating procedures must be authorized by the Senior Environmental Specialist and fully documented by the person doing the sampling. Field variances will be reported in a timely manner to evaluate the impact the variance has on the data or system operations. Field variance reporting applies to deviations from (1) prescribed field sampling and measurement requirements; (2) specified shipping, handling, or storage requirements; and (3) decontamination procedures.

A variance must be documented whenever an activity is performed or sample is obtained where:

- The activity performed or sample collection technique does not fall within the methods or protocols specified.

- The monitoring or measurement instrument that was used was out of calibration or had failed an operational check.
- Insufficient documentation results in the inability to trace the activity, measurement, or sample to the prescribed or selected location
- There is a loss of or damage to records that cannot be duplicated.

The variance should be fully described, and corrective action, if applicable, should be taken immediately. Comments describing the variance will be used during data evaluation to assess the use of associated results and validity of the data. Field variances should be noted in the field data sheet, on a general log sheet, or in the activity logbook. As appropriate, field variances will be summarized in the report at the conclusion of the activity.

7.6.6.3 Chain of Sample Custody

The custody of individual samples will be documented by recording each sample's identification, number of containers, and matrix on a standardized Chain of Custody form. This form will be used to list all transfers of sample possession.

7.6.7 Laboratory Documentation

The format and content of laboratory reports depend on contract requirements, regulatory reporting formats, and whether explanatory text is required. At a minimum, the laboratory data report will include the following items:

- Analytical method used
- Date and time of analysis
- The Chain of Custody form
- Sample receiving documentation
- QC data results and report
- Sample data results by analysis, including method detection limits, reporting limits, and dilution factors
- Summary of results (e.g., case narrative)
- Certification by the laboratory that the analytical data meet applicable data quality requirements

Analytical data that do not meet specified criteria will be qualified and flagged to allow data evaluation before use. Any nonconformances or difficulties encountered during analyses will be documented with each data package.

7.6.8 Reports Received from Subcontractors

7.6.8.1 Laboratory or Other Data Reports

Reporting requirements and formats will be defined in procurement documents issued for subcontracted services. The Senior Environmental Specialist will be consulted regarding difficulties or nonconformance associated with subcontracted analytical services and will resolve disputes that could affect data quality.

7.6.8.2 Plans and Technical Reports

The criteria for technical reports received from subcontracted services may include a deliverable schedule for draft and final documents, required reviews, format, software type and version requirements, and contents of the document, including any supporting documents, data, and references.

7.7 Quality Improvement, Assessment, and Oversight

All personnel must continually seek to improve the quality of their work. This section addresses the activities for assessing the effectiveness of the implementation of the project and associated QA/QC requirements.

7.7.1 Quality Improvement

Management encourages innovation and continuous improvement in the work environment by fostering a "no fault" attitude to encourage the identification of problems and to create an atmosphere of openness to suggestions for improvement. All personnel are encouraged to identify and suggest improvements.

Personnel have the freedom and authority to stop work until effective corrective action has been taken. Work that is performed by subcontractors will be subject to oversight. The work may be suspended immediately for imminent threats to health, safety, environmental release, or significant adverse quality issues. Re-start of such work stoppages will be at the direction of the Senior Vice President, ISR Operations.

7.7.2 Assessment and Response Actions

Assessments of project activities will be planned and scheduled with the appropriate levels of management. The Director of Environmental and Regulatory Affairs is responsible for scheduling and administering the internal assessment plan. When the assessment is conducted, results will be evaluated to measure the effectiveness of the implemented quality system. Assessment activities may include management assessments and independent assessments.

Assessment activities will be documented. Reports resulting from management assessments will be issued to the responsible manager and distributed internally to project management. Assessment activities involving subcontracted services will be coordinated with the appropriate levels of project management and will be documented.

The Senior Environmental Specialist will promptly define corrective actions and correct deficiencies identified through assessments. Corrective actions will be independently verified by staff not organizationally reporting to the Senior Environmental Specialist. Verification will be documented and retained in the assessment file.

7.7.2.1 Management Assessments

Included in the management assessments are human resource issues, operations issues, resource allocation, financial performance, financial controls, and quality control. The Senior Vice President, ISR Operations is responsible for ensuring that project staff supports these activities as delegated, that they observe firsthand the work in progress, communicate with those performing the work, identify potential or current problems, and identify good practices.

The Senior Vice President, ISR Operations shall determine the scope, schedule, and responsibilities for site-specific management assessment. All levels of management are responsible for responding to assessment findings and completing agreed-upon corrective actions.

7.7.2.2 Independent Assessments

Independent assessments (e.g., audits and surveillances) will be planned, performed, and documented in accordance with written instructions, procedures, or checklists.

Personnel who lead independent assessments (audits or surveillances) must be qualified, have reporting independence, and have access to the areas of inquiry. The Senior Vice President, ISR Operations or designee will track, report on the status, and verify closure of independent assessments and external assessment findings.

The Senior Vice President, ISR Operations is responsible for responding to assessment findings and ensuring that agreed-upon corrective actions are completed in a timely manner.

7.7.3 Reviews

Reviews are an integral component to the success of project activities. Reviews are conducted during planning and throughout the project to ensure that project objectives will be met. Reviews conducted at the project level may consist of:

- Management reviews—to ensure the adequacy of planning and availability of resources
- Administrative and technical reviews—typically include reviews of project documents to ensure that project objectives are clearly described and sufficiently planned, scheduled, and managed in accordance with project management strategies.

- Procurement Reviews—typically Uranium One Americas policies and procedures that apply to purchasing goods and services. Subcontracted analytical laboratories are required to have a documented QA program. Laboratory capability may be evaluated through review of the QA program description or through pre-award survey or vendor audit activities. The results of the survey are documented and provided to the laboratory.
- Readiness Reviews—Readiness reviews are routinely conducted to ensure that appropriate planning has taken place to allow the work to proceed safely and effectively and to ensure that as many contingencies and prerequisites as possible have been reviewed and addressed for the work. The Senior Vice President, ISR Operations is responsible for determining the level of rigor and formality of project readiness reviews based on complexity, frequency, and risk of work. Readiness reviews are routinely planned and conducted before the start of major project activities, before the start of new or infrequent tasks, and prior to scheduled sampling events.
- Independent Peer Reviews—May be conducted to solicit input for the planned technical approach and data quality objectives of the project or task.
- Data Review—to ensure that the data collected and used for each activity of the project are of sufficient quality. The Senior Environmental Specialist will conduct data reviews as a quality measure to ensure the adequacy and completeness of field activities. In addition, data review, verification, and validation will be conducted after a sampling event. Analytical data will be reviewed and summarized in the laboratory report. The results will include an explanation of any laboratory problems and their possible effects on data quality.

7.7.4 Reports to Management

Management assessments, internal assessments, and external appraisal report findings are documented. The QA organization maintains the schedule and file for these reports that are typically issued to the responsible manager.

Quality improvement actions (e.g., planning, lessons learned, nonconformance reporting, tracking and follow-up, and reviews) will be documented and reported to management.

TABLE OF CONTENTS

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TABLE OF FIGURES

TABLE OF TABLES

6 GROUNDWATER QUALITY RESTORATION, SURFACE RECLAMATION, AND FACILITY DECOMMISSIONING

The objective of groundwater restoration, surface reclamation, and facility decommissioning is to return the affected environment (groundwater and land surface) to conditions such that they are suitable for uses for which they were suitable prior to mining. The methods to achieve this objective for both the affected groundwater and the land surface are described in the following sections.

6.1 PLANS AND SCHEDULES FOR GROUNDWATER QUALITY RESTORATION

6.1.1 Groundwater Restoration Criteria

The purpose of groundwater restoration following mining operations is to protect groundwater adjacent to the mining zone. Approval of an aquifer exemption by the WDEQ and the EPA is required before mining operations can begin. The aquifer exemption removes the mining zone from protection under the Safe Drinking Water Act (SDWA). Approval is based on existing water quality, the ability to commercially produce minerals, and the lack of use as an underground source of drinking water (USDW). Groundwater restoration prevents any mobilized constituents from affecting aquifers adjacent to the ore zone.

The primary goal of the groundwater restoration efforts will be to return the groundwater quality of the production zone, on a wellfield average, to the preoperational (baseline) water quality conditions using Best Practicable Technology. Recognizing that restoration activities are not likely to return groundwater to the exact water quality that existed prior to in situ operations (as discussed in Section 6.5.1), a secondary restoration standard of class of use will be applied. The secondary standard of class of use will be applied only after restoration using BPT no longer shows significant improvement in groundwater quality and continuing restoration activities would not provide a significant benefit. The pre-mining baseline water quality and class of use will be determined by the baseline water quality sampling program which is performed for each wellfield, as compared to the use categories defined by the WDEQ, Water Quality Division (WQD). Baseline, as defined for this project, shall be the mean of the pre-mining baseline data after outlier removals. Restoration shall be demonstrated in accordance with Chapter 11, Section 5(a)(ii) of the WDEQ, Land Quality Division Rules and Regulations, NUREG-1569 Section 6, and Criterion 5B(5)(b) of Appendix A to 10 CFR Part 40.

The evaluation of the effectiveness of restoration of the groundwater within the production zone shall be based on the average baseline quality over the production zone. Baseline water quality will be collected for each wellfield from the wells completed in the planned production zone (i.e., MP-Wells). The evaluation of restoration will be conducted on a parameter by parameter basis. Restoration Target Values (RTVs) are established for the list of baseline water quality parameters. The RTVs for the wellfields will be the average of the pre-mining values. Restoration success will be evaluated by comparing restoration results to the RTVs to determine if pre-mining class of use has been met. Table 6-1 entitled Baseline Water Quality Parameters lists the parameters included in the RTVs.

Baseline values will not be changed unless the operational monitoring program indicates that baseline water quality has changed significantly due to accelerated movement of groundwater, and that such change justifies redetermination of baseline water quality. Such a change would require resampling of monitor wells and review and approval by the WDEQ.

Table 6-1 Baseline Water Quality Parameters

Parameter (units)
Dissolved Aluminium (mg/l)
Ammonia Nitrogen as N (mg/l)
Dissolved Arsenic (mg/l)
Dissolved Barium (mg/l)
Boron (mg/l)
Dissolved Cadmium (mg/l)
Dissolved Chloride (mg/l)
Dissolved Chromium (mg/l)
Dissolved Copper (mg/l)

Table 6-1 Baseline Water Quality Parameters

Parameter (units)
Fluoride (mg/l)
Total and Dissolved Iron (mg/l)
Dissolved Mercury (mg/l)
Dissolved Magnesium (mg/l)
Total Manganese (mg/l)
Dissolved Molybdenum (mg/l)
Dissolved Nickel (mg/l)
Nitrate + Nitrite as N (mg/l)
Dissolved Lead (mg/l)
Radium-226 (pCi/L)
Radium-228 (pCi/L)
Dissolved Selenium (mg/l)
Dissolved Sodium (mg/l)
Sulfate (mg/l)
Uranium (mg/l)
Vanadium (mg/l)
Dissolved Zinc (mg/l)
Dissolved Calcium (mg/l)

Table 6-1 Baseline Water Quality Parameters

Parameter (units)
Bicarbonate (mg/l)
Carbonate (mg/l)
Dissolved Potassium (mg/l)
Total Dissolved Solids (TDS) @ 180°F (mg/l)

Source: WDEQ LQD Guideline 8, Hydrology, March 2005

6.1.2 Estimate of Post-Mining Groundwater Quality

Uranium One has estimated the post-mining water quality based on the experience of COGEMA Mining, Inc. in Production Units 1 through 9 at the Irigaray ISR project located in the Powder River Basin[1]. The Irigaray data was selected because of the similar operating chemistry as proposed at the Antelope and JAB Uranium Project. COGEMA employed ammonium bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine production units located in a 30 acre site.

The water quality of the Irigaray ore zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Table 6-2. The chemical alteration of the ore zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations.

Table 6-2 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Aluminum (mg/l)	<0.05 – 4.25	<1.037
Ammonia Nitrogen as N (mg/l)*	<0.05 – 1.88	23
Dissolved Arsenic (mg/l)	<0.001 – 0.105	<0.601
Dissolved Barium (mg/l)	<0.01 – 0.12	<1.067
Boron (mg/l)	<0.01 – 0.225	<0.442
Dissolved Cadmium (mg/l)	<0.002 – 0.013	<0.979
Dissolved Chloride (mg/l)*	5.3 – 15.1	277
Dissolved Chromium (mg/l)	<0.002 – 0.063	<1.018
Dissolved Copper (mg/l)	<0.002 – 0.04	<0.828
Fluoride (mg/l)	0.11 – 0.66	<1
Total and Dissolved Iron (mg/l)	0.02 – 11.8	<1.098
Dissolved Mercury (mg/l)	<0.0002 - <0.001	<0.971
Dissolved Magnesium (mg/l)	0.02 – 9.0	45.7
Total Manganese (mg/l)	<0.005 – 0.190	1.249
Dissolved Molybdenum (mg/l)	<0.02 - <0.1	<1.067
Dissolved Nickel (mg/l)	<0.01 - <0.2	<1.018
Nitrate + Nitrite as N (mg/l)	<0.2 – 1.0	<3
Dissolved Lead (mg/l)	<0.002 - <0.050	<1.018

Table 6-2 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Radium-226 (pCi/L)	0 – 247.7	200.5
Dissolved Selenium (mg/l)	<0.001 – 0.416	0.247
Dissolved Sodium (mg/l)	95 - 280	827
Sulfate (mg/l)	136 - 824	639
Uranium (mg/l)	<0.0003 – 18.8	7.411
Vanadium (mg/l)	<0.05 – 0.55	<1.067
Dissolved Zinc (mg/l)	<0.01 – 0.200	<0.065
Dissolved Calcium (mg/l)*	1.6 – 33.5	199.2
Bicarbonate (mg/l)*	5 - 144	1343
Carbonate (mg/l)	0 - 96	<2
Dissolved Potassium (mg/l)	0.4 – 17.5	9
Total Dissolved Solids (TDS) @ 180°F (mg/l)	308 - 1054	2451

* Parameters with RTV other than baseline

Uranium One expects similar baseline and post-mining water quality at the Antelope and JAB site. The success of groundwater restoration at the Irigaray site is discussed in Section 6.1.5.

6.1.3 Groundwater Restoration Method

The commercial groundwater restoration program consists of two stages, the restoration stage and the stability monitoring stage. The restoration stage may consist of any or all of the following three phases:

1) Groundwater transfer;

2) Groundwater sweep;
3) Groundwater treatment, including reductants.

These phases are designed to optimize restoration equipment used in treating groundwater and to minimize the volume of groundwater consumed during the restoration stage. Uranium One will monitor the quality of groundwater in selected wells as needed during restoration to determine the efficiency of the operations and to determine if additional or alternate techniques are necessary. Online production wells used in restoration will be sampled for uranium concentration and for conductivity to determine restoration progress on a pattern-by-pattern basis.

The sequence of the activities will be determined by Uranium One based on operating experience and waste water system capacity. Not all phases of the restoration stage will be used if deemed unnecessary by Uranium One.

A reductant may be added at any time during the restoration stage to lower the oxidation potential of the mining zone. Either a sulfide or sulfite compound may be added to the injection stream in concentrations sufficient to establish reducing conditions within the production zone. Uranium One may also employ bioremediation as a reduction process.

Reductants are beneficial because several of the metals, which are solubilized during the leaching process, are known to form stable insoluble compounds, primarily as sulfides. Dissolved metal compounds that are precipitated under reducing conditions include those of arsenic, molybdenum, selenium, uranium and vanadium.

6.1.3.1 Groundwater Transfer

During the groundwater transfer phase, water may be transferred between a wellfield commencing restoration and a wellfield commencing mining operations. Also, a groundwater transfer may occur within the same wellfield, if one area is in a more advanced state of restoration than another.

Baseline quality water from the wellfield commencing mining will be pumped and injected into the wellfield in restoration. The higher TDS water from the wellfield in restoration will be recovered and injected into the wellfield commencing mining. The direct transfer of water will act to lower the TDS in the wellfield being restored by displacing affected groundwater with baseline quality water.

The goal of the groundwater transfer phase is to blend the water in the two wellfields until they become similar in conductivity. The water recovered from the restoration wellfield may be passed through ion exchange (IX) columns and/or filtered during this phase if suspended solids are sufficient in concentration to present a problem with blocking the injection well screens.

For the groundwater transfer between wellfields to occur, a newly constructed wellfield must be ready to commence mining. Therefore this phase may be initiated at any time during the restoration process.

The advantage of using the groundwater transfer technique is that it reduces the amount of water that must ultimately be sent to the waste water disposal system during restoration activities.

6.1.3.2 Groundwater Sweep

Groundwater sweep may be used as a stand-alone process where groundwater is pumped from the wellfield without injection causing an influx of baseline quality water from the perimeter of the mining unit, which sweeps the affected portion of the aquifer. The cleaner baseline water has lower ion concentrations that act to strip off the cations that have attached to the clays during mining. The plume of affected water near the perimeter of the wellfield may also drawn inside the boundaries of the wellfield. Groundwater sweep may also be used in conjunction with the groundwater treatment phase of restoration. The water produced during groundwater sweep is disposed of in an approved manner.

The rate of groundwater sweep will be dependent upon the capacity of the waste water disposal system and the ability of the wellfield to sustain the rate of withdrawal. Many

hydrologic systems are not able to sustain the one hundred percent consumptive removal of groundwater for a prolonged basis. Uranium One may choose to reduce the amount of groundwater sweep, or omit the step entirely for groundwater treatment if it is determined that restoration progress would be limited during this step.

6.1.3.3 Groundwater Treatment

Either following or in conjunction with, or instead of the groundwater sweep phase, groundwater will be pumped from the mining zone to treatment equipment at the surface. Ion exchange (IX), reverse osmosis (RO) or Electro Dialysis Reversal (EDR) treatment equipment will be utilized during this phase of restoration.

Groundwater recovered from the restoration wellfield will first be passed through an IX system prior to RO/EDR treatment. Additionally, prior to or following IX treatment, the groundwater may be passed through a de-carbonation unit to remove residual carbon dioxide that remains in the groundwater after mining.

At any time during the process, a reductant (either biological or chemical), which will be used to create reducing conditions in the mining zone, may be metered into the restoration wellfield injection stream. The concentration of reductant injected into the formation is determined by how the mining zone groundwater reacts with the reductant. The goal of reductant addition is to decrease the concentrations of redox sensitive elements. The reductant added to the injection stream during this stage will scavenge any oxygen and reduce the oxidation-reduction potential (Eh) of the aquifer. During mining operations, certain trace elements are oxidized. By adding the reductant, the Eh of the aquifer is lowered thereby decreasing the solubility of these elements. Regardless of the reductant used, a comprehensive safety plan regarding reductant use will be implemented.

All or some portion of the restoration recovery water can be sent to the RO unit. The use of an RO unit 1) reduces the total dissolved solids (TDS) in the affected groundwater, 2) reduces the quantity of water that must be removed from the aquifer to meet restoration limits, 3) concentrates the dissolved contaminates in a smaller volume of brine to facilitate waste disposal, and 4) enhances the exchange of ions from the formation due to the large difference in ion concentration. The RO passes a high percentage of the water through the membranes, leaving 60 to 90 percent of the dissolved salts in the brine water or concentrate. The clean water, called permeate, will be re-injected or stored for use in the mining process. The permeate may also be de-carbonated prior to re-injection into the wellfield. The brine water that is rejected contains the majority of dissolved salts in the affected groundwater and is sent for disposal in the waste system. Make-up water, which may come from water produced from a wellfield that is in a more advanced state of restoration, water being exchanged with a new mining unit, water being pumped from a different aquifer, the over-production from an operating wellfield or a combination of these sources, may be added prior to the RO or wellfield injection stream to control the amount of "bleed" in the restoration area.

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

The number of pore volumes treated and re-injected during the groundwater treatment phase will depend on the efficiency of the RO in removing TDS and the success of the reductant in lowering the uranium and trace element concentrations. Estimates of the number of pore volumes required for each restoration phase are discussed in Section 6.6.

6.1.4 Restoration Schedule

The proposed Antelope and JAB mine schedule is shown in Figure 6-1 and 6-2 respectively, showing the estimated schedule for restoration. The restoration schedule is preliminary based on Uranium One's current knowledge of the area, and are based on the completion of mining activities for the proposed wellfields. As the Antelope and JAB Project is developed, the restoration schedule will be defined further.

Figure 6-1 Proposed Antelope Project Operations and Restoration Schedule

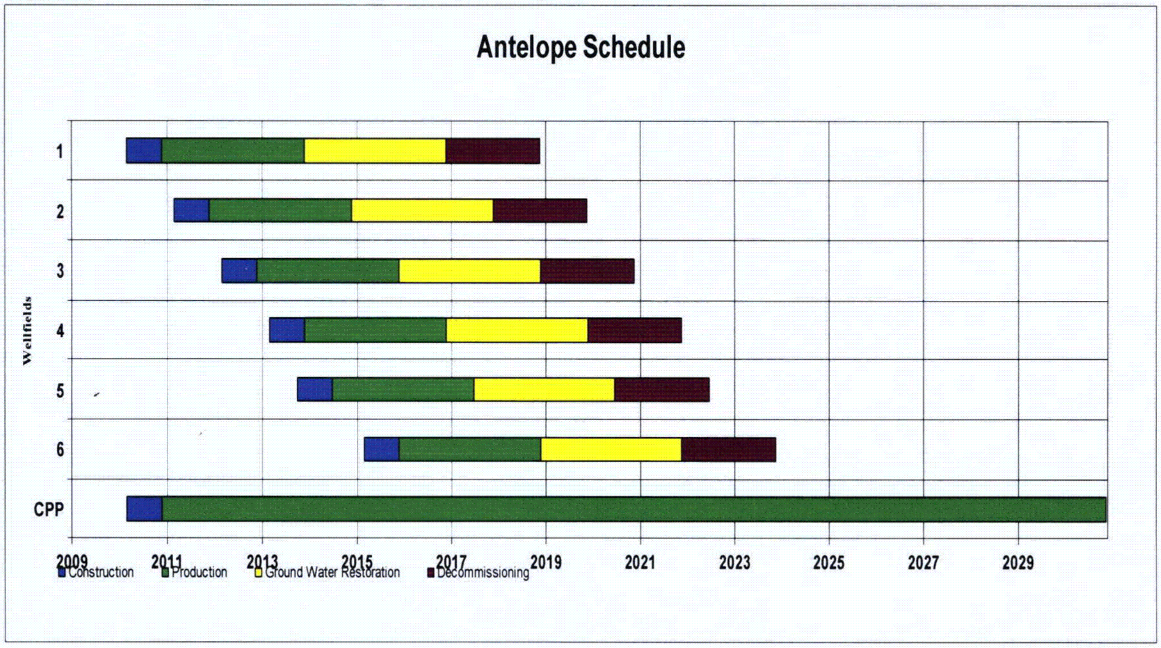
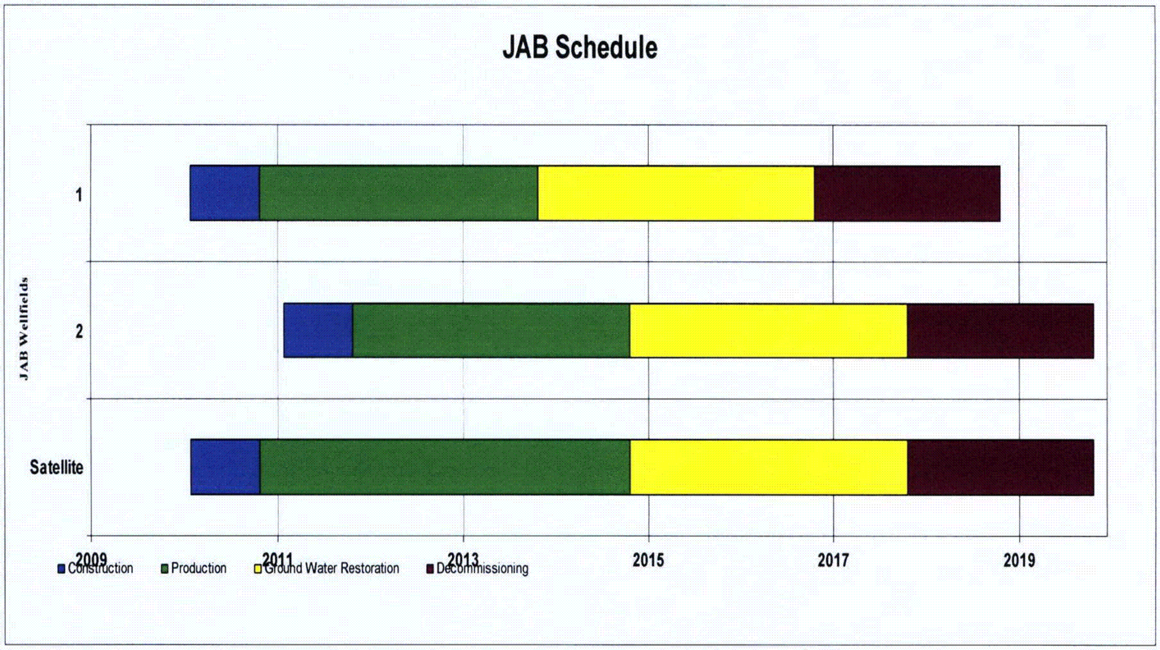


Figure 6-2 Proposed JAB Project Operations and Restoration Schedule



6.1.5 Effectiveness of Groundwater Restoration Techniques

The groundwater restoration methods described in this application have been successfully applied at other uranium ISR facilities in the Powder River Basin as well as in Nebraska and Texas. A number of uranium ISR mines in Wyoming, Nebraska, and Texas have successfully restored groundwater and obtained regulatory approval of restoration using these techniques. The following two ISR facilities with restoration history and regulatory approvals are located in the Powder River Basin in central Wyoming.

- Smith Ranch/Highland Uranium Project

Groundwater restoration activities at the Smith Ranch-Highland Uranium Project currently operated by Power Resources, Inc. (PRI) have been approved by the NRC and the WDEQ for the R&D operations and for the A-Wellfield during commercial operations. In 1987, the NRC confirmed successful restoration of the Q-sand project. Although one well exhibited uranium and nitrate levels above the target restoration values, the wellfield averages on a whole were below the targets.

In 2004, the NRC concurred with the WDEQ's determination that the A-wellfield at Highland had been restored in accordance with the applicable regulatory requirements[2]. Not all of the parameters were returned to baseline conditions, but the groundwater quality was consistent with the pre-mining class of use.

- Irigaray/Christensen Ranch Uranium Project

Groundwater restoration activities at the Irigaray/Christensen Ranch Uranium Project operated by COGEMA Mining, Inc. have been approved by the NRC and the WDEQ for Wellfields 1 through 9 following commercial operations and groundwater restoration. Post-mining water quality in the nine production units was described in Section 6.1.2. The WDEQ determined that twenty-seven of twenty-nine constituents were restored below the restoration target values. Only bicarbonate and manganese did not meet the baseline range. WDEQ determined that these two constituents met the criteria of pre-mining class of use. Based on this, the WDEQ determined that the groundwater, as a whole, had been returned to its pre-mining class of use and that the post restoration groundwater conditions did not significantly differ from the background water quality.

In 2006, the NRC concurred with the WDEQ's determination that wellfields 1 through 9 at Irigaray had been restored in accordance with the applicable regulatory requirements[3]. NRC determined that COGEMA used best practicable technology and agreed that the WDEQ class-of-use standards were met.

6.1.6 Environmental Effects of Groundwater Restoration

Based on the effectiveness of groundwater restoration at other ISR mines in the Powder River Basin, Uranium One expects that the proposed groundwater restoration techniques will successfully return the mining zones at the Antelope and JAB Project to the restoration target values. As discussed in Section 6.1.1, the purpose of restoring the groundwater to these restoration target values is to protect adjacent groundwater that is outside the production zone. If a constituent cannot technically or economically be restored to its restoration target value within the exploited production zone, WDEQ and NRC will require that Uranium One demonstrate that leaving the constituent at a higher concentration will not be a threat to public health and safety or the environment or produce an unacceptable impact to the use of adjacent groundwater resources. Uranium One believes that the application of proven best practicable technology for groundwater restoration and the regulatory requirements that are in place at the State and federal level will ensure that there is no adverse impact on the water quality of groundwater outside the production zone.

The proposed restoration methods consume groundwater. Groundwater recovered during groundwater sweep is generally directly disposed in the waste water system. Approximately 20 percent of the groundwater treatment flow through the RO system is disposed as RO brine. This consumption of groundwater is an unavoidable consequence of groundwater treatment. Impacts and water usage during operations and restoration are discussed in more detail in Section 7.2.5.1.

6.1.7 Groundwater Restoration Monitoring

6.1.7.1 Monitoring During Active Restoration

During restoration, lixiviant injection is discontinued and the quality of the groundwater is constantly being improved, thereby greatly diminishing the possibility and relative impact of an excursion. Therefore, the monitor ring wells (M-Wells), overlying aquifer wells (MO or MS-Wells), and underlying aquifer wells (MU or MD-Wells) are sampled once every 60 days and analyzed for the excursion parameters, chloride, total alkalinity and conductivity. Water levels are also obtained at these wells prior to sampling.

In the event that unforeseen conditions (such as snowstorms, flooding, equipment malfunction) occur, the WDEQ will be contacted if any of the wells cannot be monitored within 65 days of the last sampling event.

6.1.7.2 Restoration Stability Monitoring

A minimum six month groundwater stability monitoring period will be implemented to show that the restoration goal has been adequately maintained. The following restoration stability monitoring program will be performed during the stability period:

- The monitor ring wells will be sampled once every two months and analyzed for the UCL parameters, chloride, total alkalinity (or bicarbonate) and conductivity; and

- At the beginning, middle and end of the stability period, the MP-Wells will be sampled and analyzed for the parameters in Table 6-1.

In the event that unforeseen conditions (such as snowstorms, flooding, equipment malfunction) occur, the WDEQ will be contacted if any of the M-Wells or MP-Wells (if sampled under the same schedule as M-Wells) cannot be monitored within 65 days of the last sampling event.

6.1.8 Well Plugging and Abandonment

Wellfield plugging and surface reclamation will be initiated once the regulatory agencies concur that the groundwater has been adequately restored and that groundwater quality is stable. All production, injection and monitor wells and drillholes will be abandoned in accordance with WS-35-11-404 and Chapter VIII, Section 8 of the WDEQ-LQD Rules and Regulations to prevent adverse impacts to groundwater quality or quantity.

Wells will be plugged and abandoned in accordance with the following program.

- When practicable, all pumps and tubing will be removed from the well.
- All wells will be plugged from total depth to within three feet of the collar with a nonorganic well abandonment plugging fluid of neat cement or bentonite based grout mixed in the recommended proportion of 20 lbs per barrel of water, to yield an abandonment fluid with a 10 minute gel strength of at least 20 lbs/100 sq ft and a filtrate volume not to exceed 13.5 cc.
- The casing is cut off at least three feet below the ground surface. Abandonment fluid is topped off to the top of the cut-off casing. A steel plate is placed atop the sealing mixture showing the permit number, well identification, and date of plugging.

- A cement plug is placed at the top of the casing (if cement is not within three feet of the surface), and the area is backfilled, smoothed, and leveled to blend with the natural terrain.

As an alternative method of well plugging, a dual plug procedure may be used where a cement plug will be set using slurry of a weight of no less than 12 lbs/gallon into the bottom of the well. The plug will extend from the bottom of the well upwards across the first overlying aquitard. The remaining portion of the well will be plugged using a bentonite/water slurry with a mud weight of no less than 9.5 lbs/gallon. A 10-foot cement top plug will be set to seal the well at the surface.

6.1.9 Restoration Wastewater Disposal

Uranium One plans to install deep disposal wells (EPA UIC Class I or Class V non-hazardous wells) at the Antelope and JAB Project areas as the primary liquid waste disposal method. Uranium One believes that permanent deep disposal is preferable to evaporation in evaporation ponds. Disposal in a Class I or Class V well permanently isolates the waste water from the public and the environment. Alternatives assessed by Uranium One for waste water disposal are discussed in Section 8.

Based on the expected post mining concentrations of groundwater quality constituents discussed in Section 6.1.2 and the proposed groundwater restoration techniques discussed in Section 6.1.3, Uranium One projects that the restoration wastewater injection stream will exhibit the range of characteristics shown in Table 6-3.

Table 6-3 Projected Antelope and JAB Restoration Wastewater Injection Stream Water Quality

Parameter	Units	Min	Max
Calcium	mg/l	350	700
Magnesium	mg/l	50	150
Sodium	mg/l	400	950
Potassium	mg/l	40	90
Carbonate	mg/l	0	0.3
Bicarbonate	mg/l	200	1250
Sulfate	mg/l	900	2500
Chloride	mg/l	300	1000
Nitrate	mg/l	0.01	0.5
Fluoride	mg/l	0.01	2
Silica	mg/l	10	65
Total Dissolved Solids	mg/l	1000	6500
Conductivity	µmho/cm	1000	5500
Alkalinity	mg/l	165	1025
pH	Std. Units	6	12
Arsenic	mg/l	0.01	1
Cadmium	mg/l	0.0001	0.001
Iron	mg/l	0.5	15
Lead	mg/l	0.01	0.04
Manganese	mg/l	0.01	1.5
Mercury	mg/l	0.0001	0.001
Molybdenum	mg/l	0.1	1.5
Selenium	mg/l	0.01	0.5
Uranium	mg/l	0.05	15
Ammonia	mg/l	0.1	0.5

Table 6-3 Projected Antelope and JAB Restoration Wastewater Injection Stream Water Quality

Parameter	Units	Min	Max
Radium-226	pCi/l	500	5000

All compatible liquid wastes generated during groundwater restoration at the Antelope and JAB Project will be disposed in the planned deep wells. A feasibility study for both areas was initiated in the spring of 2007 and potential target sands have been identified. Data collection is continuing to further refine potential receivers and an application is under preparation for submittal to the WDEQ for a Class I (or Class V) UIC Permit for the Antelope and JAB Uranium Project. Uranium One plans to submit this application to the WDEQ in the third quarter of 2008.

6.2 PLANS AND SCHEDULES FOR RECLAIMING DISTURBED LANDS

6.2.1 Introduction

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

- Plug and abandon all wells as detailed in Section 6.1.8.
- Determination of appropriate cleanup criteria for structures (Section 6.3) and soils (Section 6.4).
- Perform radiological surveys and sampling of all facilities, process related equipment and materials on site to determine their degree of contamination and identify the potential for personnel exposure during decommissioning.

- Removal from the site of all contaminated equipment and materials to an approved licensed facility for disposal or reuse, or relocation to an operational portion of the mining operation as discussed in Section 6.3.
- Decontamination of items to be released for unrestricted use to levels consistent with the requirements of NRC.
- Survey excavated areas for contamination and remove contaminated materials to a licensed disposal facility.
- Perform final site soil radiation surveys.
- Backfill and recontour all disturbed areas and roads.
- Establish permanent revegetation on all disturbed areas.

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

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

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

6.2.2 New Drill Hole Site Preparation, Hole Abandonment and Site Reclamation

Prior to drilling a hole, topsoil will be removed from the mud pit location and stockpiled on native ground at a sufficient distance to avoid impacts by drilling activities. Subsoil excavated from the mud pit will be stockpiled on native ground separate from the stockpiled topsoil and near the mud pit.

Drill sites located on steep slopes will require excavation of a pad, and access route as well as the mud pit. Topsoil will be stripped from the pad, mud pit and access road and windrowed to the uphill side of the drill hole location. Subsoil excavated from the mud pit will be stockpiled next to the pit and downhill from the topsoil stockpile. The drill rig and water truck will then move onto the site and drill the hole.

After the hole has been drilled to total depth (TD) and prior to geophysical logging, abandonment fluid will be mixed to the specifications described below and circulated through the drill pipe to the bottom of the hole and back to the surface. The drill pipe will then be removed from the hole, the rig removed from location and the hole geophysically probed.

To minimize topsoil and vegetation disturbance, access routes to drill locations will be designated by marking with stakes or similar types of markers with survey ribbons attached. Vehicles will be required to stay within the designated access routes and on existing roads and two-tracks.

All drill holes will be abandoned in accordance with W.S. 35-11-404 and WDEQ-LQD Regulations Chapter VIII using Plug Gel or an equivalent abandonment material. The abandonment material will be mixed with water and circulated through the drill pipe filling the drill hole from bottom to top. The mixed abandonment fluid will have the following characteristics:

1. Ten minute gel strength of at least 20 lbs/100 sq. ft.; and

2. Filtrate volume not to exceed 13.5 cc.

Any open hole between the top of the abandonment mud column and the collar of the hole will be filled with bentonite chips, pellets or similar material. A concrete plug will be placed in the hole a minimum of two feet below the ground surface. The ground surface affected by the drilling will then be reclaimed. If the hole cannot be plugged immediately after probing, it will be securely covered until plugging is possible.

Following abandonment of the drill hole, the mud pit will be allowed to dry out for several days prior to backfilling. Other techniques, such as squeezing the mud from the

pit back into the drill hole or removing excess water from the pit for use at other drill sites, will be utilized to expedite mud pit reclamation. After backfilling the pits with subsoil, the pits will be allowed to settle before applying the topsoil and performing final grading. Steep slope sites and access routes will be reclaimed using a dozer or track hoe to minimize the surface disturbance.

Those drill sites that will become part of a production wellfield within one year of drilling the hole will not be seeded until wellfield construction is complete. Those sites that will not become part of a production wellfield within one year will be seeded after mud pit reclamation is complete. In either case, seeding will take place during the next available seeding window, spring or fall. All seeding will be completed using the approved permanent seed mixture described in Table 6-4 of Section 6.2..

Abandonment of delineation holes will be reported to the WDEQ with each Annual Report. A copy of the abandonment report will be sent to the WSEO pursuant to W.S. 35-11-404(d) and (e).

Drilling contractors will be instructed that chronic leaks of oil from their equipment onto the ground surface will not be allowed. Drip pans, absorbent pads or other means of preventing oil leaks onto the ground will be required. Uranium One will have spill control and containment materials on-site to control and contain any unanticipated spill events. Any spills of oil that may occur will be controlled and contained, and will be cleaned up as soon as practicable. Any contaminated soil resulting from spills of oil will be removed and properly disposed.

6.2.3 Surface Disturbance

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

Disturbances associated with the Antelope central processing plant, the JAB satellite plant, office and maintenance buildings, and field header buildings, will be for the life of those activities and topsoil will be stripped from the areas prior to construction. Disturbance associated with drilling and pipeline installation is limited, and is reclaimed and reseeded as soon as weather conditions permit. Vegetation will normally be reestablished over these areas within two years. Surface disturbance associated with development of access roads will occur at the Antelope and JAB sites and topsoil will be stripped from the road areas prior to construction and stockpiled as described in Section 3.

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

Wellfield decommissioning will consist of the following steps:

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

- Removal of buried wellfield piping.

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

- Removal of gravel surface on access roads, recontour and replace topsoil from stockpiles.

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

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

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

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

6.2.4 Topsoil Handling and Replacement

In accordance with WDEQ-LQD requirements, topsoil will be salvaged from building sites, permanent storage areas, main access roads, graveled wellfield access roads and chemical storage sites. Conventional rubber-tired, scraper-type earth moving equipment will typically be used to accomplish such topsoil salvage operations. The exact location of topsoil salvage operations will be determined by wellfield pattern emplacement and designated wellfield access roads within the wellfields, which will be determined during final wellfield construction activities.

As described in Section 2.6, topsoil thickness varies within the license area from non-existent to several feet in depth. However, typical topsoil stripping depths are expected to range from 3 to 12 inches.

Salvaged topsoil is stored in designated topsoil stockpiles. These stockpiles will be generally located on the leeward side of hills to minimize wind erosion. Stockpiles will not be located in drainage channels. The perimeter of large topsoil stockpiles may be bermed to control sediment runoff. Topsoil stockpiles will be seeded at the next available window of opportunity in the fall or spring seeding season with the permanent seed mix. In accordance with WDEQ-LQD requirements, all topsoil stockpiles will be identified with a highly visible sign with the designation "Topsoil."

During mud pit excavation associated with well construction, exploration drilling and delineation drilling activities, topsoil is separated from subsoil with a backhoe. Drill hole site topsoil management procedures was discussed in section 6.2.2.

6.2.5 Erosion Control Practices

Soil erosion mitigation will be implemented in accordance with WDEQ-LQD Rules and Regulations, Chapter 3, Environmental Protection Performance Standards. Typical erosion protection measures that may be implemented at the Antelope and JAB Project include the following:

- Temporary diversion of surface runoff from undisturbed areas around the disturbed areas and the use of water velocity dissipation structures;
- Retaining sediment within the disturbed areas through the use of best management practices such as silt fencing, retention ponds, or other effective means;
- Salvage and stockpiling of topsoil from the central plant and satellite facility areas and from secondary wellfield access roads in a manner to avoid wind and/or water erosion. This is accomplished by grading stockpiles to the appropriate slopes, avoiding excessive compaction, establishing a temporary vegetative cover, using appropriate fencing and signs, and installation of sedimentation catchments;
- Reestablishment of temporary or permanent native vegetation as soon as possible after disturbance; and
- Constructing roads to minimize erosion through practices such as surfacing with a gravel road base, constructing stream crossings at right angles with adequate embankment protection and culvert installation, and providing adequate road drainage with runoff control structures and revegetation.

Implementation of Best Management Practices (BMPs) will minimize the effects to soils associated with the construction and operation of the Antelope and JAB Project.

No drainages or bodies of water will be significantly modified or altered within the Antelope and JAB Project areas during project construction or operations. If significant changes or alterations were to occur, the impact to the second tributary to Simmons Draw wetlands would be minimal as the disturbance is short-term and the draw is ephemeral. The potential for erosion is present due to the construction of the wells near the drainage; however, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

The physical presence of the surface facilities including wellfields and associated structures, access roads, office buildings, pipelines, facilities and other structures associated with ISR mining and processing of uranium are not expected to significantly change peak surface water flows because of the relatively flat topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed Permit area. In areas where these structures may affect surface water drainage patterns, diversion ditches and culverts will be used to prevent excessive erosion and control runoff. In areas where runoff is concentrated, energy dissipaters are used to slow the flow of runoff to minimize erosion and sediment loading in the runoff.

Construction and industrial stormwater National Pollutant Discharge Elimination System (NPDES) permits will be obtained in accordance with WDEQ - WQD regulations. Best management practices will be implemented to reduce erosion impacts according to storm water management plans developed for those permits.

6.2.6 Final Contouring

Recontouring of land where surface disturbance has taken place will restore it to a surface configuration that will blend in with the natural terrain and will be consistent with the post mining land use. Since no major changes in the topography will result from the proposed mining operation, a final contour map is not required.

6.2.7 Revegetation Practices

Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. During mining operations the topsoil stockpiles, and as much as practical of the disturbed wellfield areas will be seeded to establish a vegetative cover to minimize wind and water erosion. After topsoiling prior to final reclamation, an area will normally be seeded with a permanent seed mix which will often contain a nurse crop (sterile wheat or oats) to establish a standing vegetative cover along with the permanent seed mix. This long term permanent seed mix typically consists of one or more of the native wheat grasses (i.e. Western Wheatgrass, Thickspike Wheatgrass). Listed below is the proposed permanent seed mix to be used at the Antelope and JAB site.

Table 6-4 Proposed Seed Mix for Use at the Antelope and JAB Project

SPECIES	LBS/ACRE	SEEDS/LB	SEEDS/FT SQ	% SEEDS
Bluebunch Wheatgrass	6.00	191,000.00	17.54	23.14
Slender Wheatgrass	4.00	110,000.00	10.10	13.33
Streambank Wheatgrass	6.00	97,000.00	4.45	5.88
Bottlebrush Squirreltail	4.00	926,000.00	21.26	28.04
Indian Ricegrass	4.00	181,000.00	8.31	10.96
American Vetch	4.00	154,000.00	14.14	18.66
Showy Evening Primrose	0.20		**75.80**	**100.00**
TOTAL POUNDS PLS/ACRE	28.20			

Larger disturbance areas will typically utilize drill seeding methods done with typical farming equipment. All seed will be drilled to the appropriate depths. Smaller disturbance areas may utilize broadcast seeding and raking methods. All seeding will be completed as soon as practical during the next available seasonal seeding window. At the minimum, all sites will be seeded within one month with a cover or nurse crop species if not in the optimal seasonal seeding window. An example of this situation would be if a construction of a site was completed on July 1. In this example, the site would be seeded within 30 days with a cover or nurse crop and then seeded with the permanent seed mix at a more optimal fall seeding date.

The success of permanent revegetation in meeting land use and reclamation success standards will be assessed prior to application for bond release by utilizing the "Extended Reference Area" method as detailed in WDEQ-LQD Guideline No. 2 - Vegetation (March 1986). This method compares, on a statistical basis, the reclaimed area with adjacent undisturbed areas of the same vegetation type.

The Extended Reference Area will be located adjacent to the reclaimed area being assessed for bond release and will be sized such that it is at least half as large as the area being assessed. In no case will the Extended Reference Area be less than 25 acres in size.

The WDEQ-LQD will be consulted prior to selection of Extended Reference Areas to ensure agreement that the undisturbed areas chosen adequately represent the reclaimed areas being assessed. The success of permanent revegetation and final bond release will be assessed by the WDEQ-LQD.

Reclaimed wellfield and process facility areas will remain fenced until successful reclamation is achieved to protect newly seeded areas from livestock grazing.

6.2.8 Road Removal and Reclamation

Those portions of roads constructed and utilized for access to the facilities and wellfields will be reclaimed unless landowners and lessees request that the roads be left for future access and accept the responsibility for their long term maintenance and ultimate reclamation.

Prior to reclamation, any contamination which resulted from the ISR operation would be cleaned to appropriate NRC standards and the contaminated material disposed at a licensed byproduct disposal facility. Following clean up, the roads will be ripped and/or disked to relieve compaction. Excess imported gravel will be removed. Culverts will be removed and pre-mine drainages reestablished. All roads and ditches to be reclaimed will be graded and recontoured to blend with the surrounding terrain.

Topsoil will salvaged and stockpiled during construction of all newly constructed primary and secondary access roads. Available topsoil will be replaced in a uniform manner prior to revegetation.

6.3 PROCEDURES FOR REMOVING AND DISPOSING OF STRUCTURES AND EQUIPMENT

6.3.1 Preliminary Radiological Surveys and Contamination Control

Prior to central process and satellite plant decommissioning, a preliminary radiological survey will be conducted to characterize the levels of contamination on structures and equipment and to identify any potential hazards. The survey will support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities. In general, the contamination control program used during mining operations (as discussed in Section 5.7) will be appropriate for use during decommissioning of structures.

Based on the results of the preliminary radiological surveys, gross decontamination techniques will be employed to remove loose contamination before decommissioning activities proceed. This gross decontamination will generally consist of washing all accessible surfaces with high-pressure water. In areas where contamination is not readily removed by high-pressure water, a decontamination solution (e.g., dilute acid) may be used.

6.3.2 Removal of Process Buildings and Equipment

The majority of the process equipment in the process building will be reusable, as well as the building itself. Alternatives for the disposition of the building and equipment are discussed in this section.

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., will be inventoried, listed and designated for one of the following removal alternatives:

- Removal to a new location for future use;
- Removal to another licensed facility for either use or permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other unrestricted use by others.

Uranium One believes that process buildings will be decontaminated, dismantled and released for use at another location. If decontamination efforts are unsuccessful, the material will be sent to a permanent licensed disposal facility. Cement foundation pads and footings will be broken up and trucked to a solid waste disposal site or to a licensed byproduct material disposal facility if contaminated.

6.3.2.1 Building Materials, Equipment and Piping to be Released for Unrestricted Use

Salvageable building materials, equipment, pipe and other materials to be released for unrestricted use will be surveyed for alpha contamination in accordance with NRC guidance. Release limits for alpha radiation are as follows:

- Removable alpha contamination of 1,000 dpm/100cm^2
- Average total alpha contamination of 5,000 dpm/100 cm^2 over an area no greater than one square meter
- Maximum total alpha contamination of 15,000 dpm/100 cm^2 over an area no greater than 100 cm^2.

Decontamination of surfaces will be guided by the ALARA principle to reduce surface contamination to levels as far below the limits as practical. Non-salvageable contaminated equipment, materials, and dismantled structural sections will be sent to an licensed byproduct material disposal facility. In most cases, the byproduct material will be shipped as Low Specific Activity (LSA-I) material, UN2912, pursuant to 49 CFR 173.427. Particular attention will be given to equipment and structures in which radiological materials could accumulate in inaccessible locations including piping, traps, junctions, and access points. Contamination of these materials will be determined by surveys at accessible locations. Items that cannot be adequately characterized or that are too large to be scanned will be considered contaminated in excess of the limits and will be disposed at a properly licensed facility.

6.3.2.2 Preparation for Disposal at a Licensed Facility

If facilities or equipment are to be moved to a facility licensed for disposal of 11e.(2) byproduct material, the following procedures may be used.

- Flush inside of tanks, pumps, pipes, etc., with water or acid to reduce excessive interior contamination as necessary for safe handling by workers during dismantling.

- The exterior surfaces of process equipment will be surveyed for contamination. If the surfaces are found to be excessively contaminated, the equipment may be washed down as necessary and decontaminated to permit safe handling by workers during dismantling.

- The equipment will be disassembled only to the degree necessary for transportation or as required by the licensed disposal facility. All openings, pipe fittings, vents, etc., will be plugged or covered prior to moving equipment from the plant building.

- Equipment in the building, such as large tanks, may be transported on flatbed trailers. Smaller items, such as links of pipe and ducting material, may be placed in lined roll off containers or covered dump trucks or drummed in barrels for delivery to the receiving facility.

- Contaminated buried process trunk lines and sump drain lines will be excavated and removed for transportation to a licensed disposal facility.

6.3.3 Waste Transportation and Disposal

Materials, equipment, and structures that cannot be decontaminated to meet the appropriate release criteria will be disposed at a disposal site licensed by the NRC or an Agreement State to receive 11e.(2) byproduct material. Uranium One is investigating alternatives for disposal at existing sites licensed to receive 11e.(2) byproduct material including Pathfinder Mines, Kennecott Uranium Company, Denison Mines, and Waste Control Specialists (Texas). An agreement for disposal of 11e.(2) byproduct material will be in place before operation of the Antelope and JAB project commences. A current disposal agreement will be maintained at a minimum of one licensed disposal facility throughout licensed operations.

Transportation of all contaminated waste materials and equipment from the site to the approved licensed disposal facility or other licensed sites will be handled in accordance with the Department of Transportation (DOT) Hazardous Materials Regulations (49 CFR Part 173) and the NRC transportation regulations (10 CFR 71).

6.4 METHODOLOGIES FOR CONDUCTING POST-RECLAMATION AND DECOMMISSIONING RADIOLOGICAL SURVEYS

6.4.1 Cleanup Criteria

Surface soils will be cleaned up in accordance with the requirements of 10 CFR Part 40, Appendix A, including a consideration of ALARA goals and the chemical toxicity of uranium. The proposed limits and ALARA goals for cleanup of soils are summarized in Table 6.4-2.

On April 12, 1999, the NRC issued a Final Rule (64 FR 17506) that requires the use of the existing soil radium standard to derive a dose criterion for the cleanup of byproduct material. The amendment to Criterion 6(6) of 10 CFR Part 40, Appendix A was effective on June 11, 1999. This "benchmark approach" requires that NRC licensees model the site-specific dose from the existing radium standard and then use that dose to determine the allowable quantity of other radionuclides that would result in a similar dose to the average member of the critical group. These determinations must then be submitted to NRC with the site reclamation plan or included in license applications. This section documents the modeling and assumptions made by Uranium One to derive a standard for natural uranium in soil for the proposed Antelope and JAB Project.

Concurrent with publication of the Final Rule, NRC published draft guidance (64 FR 17690) for performing the benchmark dose modeling required to implement the final rule. Final guidance was published as Appendix E to NUREG-1569[4]. This guidance discusses acceptable models and input parameters. This guidance, guidance from the RESRAD Users Manual[5], the Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil[6] and site-specific parameters were used in the modeling as discussed in the following sections.

6.4.1.1 Determination of Radium Benchmark Dose

RESRAD Version 6.3 computer code was used to model the Antelope-JAB Project site and calculate the annual dose from the current radium cleanup standard.

The following supporting documentation for determination of the radium benchmark dose is attached:

- The RESRAD Data Input Basis (Appendix C-1) provides a summary of the modeling values used as input parameters. A sensitivity analysis was performed for parameters that are important to the major component dose pathways and for which no site-specific data were available.

- Selected graphs produced with RESRAD that present the results of the sensitivity analysis performed on the input parameters are attached (Appendix C-2).
- A full printout of the final model results for the resident farmer scenario with the chosen input values is attached (Appendix C-3 and C-4).
- Graphs in Appendix C-5 provide the modeling results for the estimated doses during the 1,000 year time span for both radium-226 (Ra-226) and natural uranium (U-nat). A series of graphs depicts the summed dose for all pathways and the component pathways that contribute to the total dose.

The maximum dose from Ra-226 contaminated soil for the residential farmer scenario was 41.1 millirem per year (mrem/yr). This dose was based upon the 5 picocuries per gram (pCi/g) above background surface (0 to 6-inch) Ra-226 standard and occurred at time, t = 0 years. The most significant dose pathways (representing 90 percent of the maximum dose) were external exposure and plant ingestion (water independent). A sensitivity analysis was performed for important parameters used in these two pathways for which no site-specific information was available. The 41.1 mrem/yr dose from Ra-226 is the "Benchmark dose" at which the U-nat radiological end point soil standard will be based. Methods used to determine the U-nat soil concentration that would result in the radium "Benchmark dose" are describe in Section 3.0.

6.4.1.2 Determination of Natural Uranium Soil Standard

RESRAD was used to determine the concentration of U-nat in soil distinguishable from background that would result in a maximum dose of 41.1 mrem/yr. The method involved modeling the dose from a set concentration of U-nat in soil. This dose was then compared to the radium benchmark dose and scaled to arrive at the maximum allowable U-nat concentration in soil.

To facilitate calculations, a preset concentration of 100 pCi/g U-nat was used for modeling dose. The fractions used were 48.9 percent (or pCi/g) uranium-234, 48.9 percent (or pCi/g) uranium-238, and 2.2 percent (or pCi/g) uranium-235. The distribution coefficients used for each radionuclide were RESRAD default values. A sensitivity analysis was performed using a range of distribution coefficients to evaluate the potential effects of not using site-specific data. All other input parameters were the same as those used in the Ra-226 benchmark modeling. RESRAD output showing the input parameters is provided in Appendix C-3.

A U-nat concentration in soil of 100 pCi/g, resulted in a maximum dose of 8.1 mrem/yr. at time, t = 0 years. The printout of the RESRAD data summary is provided in Appendix C-4.

To determine the uranium soil standard, the following formula was used:

$$\text{Uranium Limit} = \left(\frac{100 \text{ pCi/g natural uranium}}{8.1 \text{ mrem/yr. natural uranium dose}} \right) \text{x } 41.1 \text{ mrem/yr radium benchmark dose}$$

$$\text{Uranium Limit} = 507 \text{ pCi/g natural uranium}$$

The U-nat limit is applied to soil cleanup with the Ra-226 limit using the unity rule. The unity rule approach will be used to determine if site soil cleanup standard are met. To determine whether an area exceeds the cleanup standards, the standards are applied according to the following formula:

$$\left(\frac{\text{Soil Uranium Concentration}}{\text{Soil Uranium Limit}} \right) + \left(\frac{\text{Soil Radium Concentration}}{\text{Soil Radium Limit}} \right) < 1$$

6.4.1.3 Uranium Chemical Toxicity Assessment

The chemical toxicity effects from uranium exposure were evaluated by assuming the same exposure scenario as that used for the radiation dose assessment. In the Benchmark Dose assessment for the resident farmer scenario, it was assumed that the diet consisted of 75 percent of the meat and milk, and 25 percent of fruits and vegetables are grown at the site. Intake of contaminated food through the aquatic pathway was considered improbable. Also, the model showed that the contamination would not affect groundwater quality. The model endpoint is dose based on U-nat activity concentrations in various compartments. This activity concentration can easily be converted to mass concentrations to evaluate the chemical toxicity of U-nat. Therefore the same model was used in assessing the chemical toxicity. In addition, the intake from eating meat and drinking milk was shown to be negligible compared to the plant pathway and, therefore, is not shown here.

The method and parameters for estimating the human intake of uranium from ingestion are taken from NUREG/CR-5512 Vol. 1 (NRC, 1992). The uptake of uranium in food is a product of the uranium concentration in soil and the soil-to-plant conversion factor. The annual intake in humans is then calculated by multiplying the annual consumption by the uranium concentration in the food. The soil-plant conversion factor is based on a dry weight, so the annual consumption is multiplied by the dry-weight to wet-weight ratio to convert it to a dry-weight basis. Parameters for these calculations are given in Section 6.5.9 of NUREG/CR-5512 Vol. 1.

Table 6-5 provides the parameters used in these calculations and annual human intakes for leafy vegetables, other vegetables, and fruit. Annual intakes of 14 and 97 kilograms per year (kg/year) were assumed for leafy vegetables and other vegetables and fruit, respectively. It was assumed that the concentration of U-nat in the garden or orchard soil was 507 pCi/g. This corresponds to the uranium Benchmark Concentration for surface soils determined for the Antelope-JAB project site. Multiplying the specific activity of U-nat, 677 pCi per milligram, by 507 pCi/g results in a soil concentration of 748

milligrams per kilogram (mg/kg). The intake shown in the first column of Table 6-5 is equal to the product of the parameters given in the subsequent columns. Table 6-5 shows that the total uranium intake from all food sources from the site is 49.3 mg/yr.

Table 6-5 Annual Intake of Uranium from Ingestion

Human Intake (mg/yr)	Soil Concentration (mg/kg)	Soil to Plant Ratio (mg/kg plant to mg/kg soil)	Annual Consumption (kg)	Dry Weight Wet Weight Ratio	Food Source
8.9	748	1.7E-2	3.5	0.2	Leafy Vegetables
34	748	1.4E-2	13	0.25	Other Vegetables
6.4	748	4.0E-3	12	0.18	Fruit
49.3	**Total**				

A two-compartment model of uranium toxicity in the kidney from oral ingestion was used to predict the burden of uranium in the kidney following chronic uranium ingestion (ICRP, 1995). This model tracks the distribution of uranium in the blood, and consists of a kidney with two compartments, as well as several other compartments for uranium distribution, storage and elimination including the skeleton, liver, red blood cells (macrophages), and other soft tissues.

The total burden to the kidney is the sum of the two compartments. The mathematical representation for the kidney burden of uranium at steady state can be derived as follows:

$$Q_P = \frac{IR \times f_1}{\lambda_P \left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pk} - f_{pk1}\right)}$$

Where:

Q_P = uranium burden in the plasma, µg
IR = dietary consumption rate, mg uranium/d
f_1 = fractional transfer of uranium from GI tract to blood, unitless
f_{ps} = fractional transfer of uranium from plasma to skeleton, unitless
f_{pr} = fractional transfer of uranium from plasma to red blood cells, unitless
f_{pl} = fractional transfer of uranium from plasma to liver, unitless
f_{pt} = fractional transfer of uranium from plasma to soft tissue, unitless
f_{pk1} = fractional transfer of uranium from plasma to kidney, compartment 1, unitless;
λ_p = biological retention constant in the plasma, d^{-1}.

The burden in kidney compartment 1 is:

$$Q_{k1} = \lambda_P \times Q_P \times \frac{f_{pk1}}{\lambda_{k1}}$$

Where:

Q_{k1} = uranium burden in kidney compartment 1, mg;
λ_{k1} = biological retention constant of uranium in kidney compartment 1, d^{-1}.

Similarly, for compartment 2 in the kidney, the burden is:

$$Q_{k2} = \lambda_P \times Q_P \times \frac{f_{pk2}}{\lambda_{k2}}$$

Where:

Q_{k2} = uranium burden in kidney compartment 2, µg;
λ_{k2} = biological retention constant of uranium in kidney compartment 2, d^{-1};
f_{pk2} = fractional transfer of uranium from plasma to kidney compartment 2, unitless.

The total burden to the kidney is then the sum of the two compartments:

$$Q_{k1} + Q_{k2} = \frac{IR \times f_1}{\left(1 - f_{ps} - f_{pr} - f_{pl} - f_{pt} - f_{pk1}\right)} \times \left(\frac{f_{pk1}}{\lambda_{k1}} + \frac{f_{pk2}}{\lambda_{k2}}\right)$$

The parameter input values for the two-compartment kidney model include the daily intake of uranium estimated for residents at this site, and values recommended by the ICRP as listed below (ICRP, 1995).

IR = 0.14 mg/day
f_l = 0.02
f_{ps} = 0.105
f_{pr} = 0.007
f_{pl} = 0.0105
f_{pt} = 0.347
f_{pk1} = 0.00035
f_{pk2} = 0.084
λ_{k1} = ln(2)/5 yrs
λ_{k2} = ln(2)/7 days

From the last equation above, the calculated uranium in the kidneys is 0.0093 mg, or a uranium concentration of 0.03 µg/g. This is three percent of the 1.0 µg U/g value that has generally been understood as the threshold of the toxic effects of uranium to the kidney.

The US EPA evaluated the chemical toxicity data and found that mild proteinuria has been observed at drinking water levels between 20 and 100 µg/liter. Assuming a water intake of 2 liters/day, this corresponds to an intake of 0.04 to 0.2 mg/day. Using data obtained from toxicity experiments with animals and a conservative factor of 100, the EPA arrived at a 30 µg/liter limit for use as a National Primary Drinking Water Standard (Federal Register/Vol.65, No.236/ December 7, 2000). This is equivalent to an intake of 0.06 mg/day for the average individual. Since large diverse populations are potentially exposed to drinking water sources regulated using these standards, the EPA is very conservative in developing limits.

This analysis in Table 6-5 indicates that a soil limit of 507 pCi/g of U-nat would result in an intake of approximately 0.14 mg/day (49.3 mg/yr divided by 365 days). Using the most conservative daily limit corresponding to the National Primary Drinking Water standard, a soil concentration of 217 pCi/g corresponds to the EPA intake limit from drinking water with a uranium concentration of 0.06 mg/day. Therefore, exposure to soils containing 217 pCi/g of natural uranium should not result in chemical toxicity effects.

6.5 DECOMMISSIONING HEALTH PHYSICS AND RADIATION SAFETY

The health physics and radiation safety program for decommissioning will ensure that occupational radiation exposure levels will be kept as low as reasonably achievable during decommissioning. The Radiation Safety Officer, Radiation Safety Technician or designee will be on site during any decommissioning activities where a potential radiation exposure hazard exists. In general, the radiation safety program discussed in Section 5 will be used as the basis for development of the decommissioning health physics program. Health physics surveys conducted during decommissioning will be guided by applicable sections of Regulatory Guide 8.30[7] or other applicable standards at the time.

6.5.1 Records and Reporting Procedures

At the conclusion of site decommissioning and surface reclamation, a report containing all applicable documentation will be submitted to the NRC. Records of all contaminated materials transported to a licensed disposal site will be maintained for a period of five years or as otherwise required by applicable regulations at the time of decommissioning.

6.6 FINANCIAL ASSURANCE

Uranium One will maintain surety instruments to cover the costs of reclamation including the costs of groundwater restoration, the decommissioning, dismantling and disposal of all buildings and other facilities, and the reclamation and revegetation of affected areas. Additionally, in accordance with NRC and WDEQ requirements, an updated Annual Surety Estimate Revision will be submitted to the NRC and WDEQ each year to adjust the surety instrument amount to reflect existing operations and those planned for construction or operation in the following year. After review and approval of the Annual Surety Estimate Revision by the NRC and WDEQ, Uranium One will revise the surety instrument to reflect the revised amount.

Groundwater restoration costs are based on treatment of 1 pore volume for groundwater sweep and 7 pore volumes for reverse osmosis and reductant/bioremediation. Wellfield pore volumes are determined using the following equation:

Wellfield Pore Volume = (Affected Ore Zone Area) x (Average Completed Thickness) x (Flare Factor) x (Porosity)

Flare factor has been determined for PRI's Smith Ranch wellfields to be approximately 1.5 to 1.7. This flare factor was estimated using a three dimensional groundwater flow model (MODFLOW) in conjunction with an advective particle tracking technique (MODPATH). Horizontal and vertical flare factors of 1.5 and 1.3, respectively, have been approved by the US Nuclear Regulatory Commission for the Hydro Resources, Inc. Churchrock licensing action in New Mexico. COGEMA Mining, Inc., at the Irigaray/Christensen Ranch sites, uses an overall flare factor of 1.44. Accordingly, Uranium One is using a flare factor of 1.5 for the surety estimate attached in Appendix D.

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TABLE OF CONTENTS

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TABLE OF FIGURES

TABLE OF TABLES

7 ENVIRONMENTAL EFFECTS

This section discusses and describes the degree of unavoidable environmental impacts that are associated with construction and operations of the Antelope and JAB Projects. Environmental impacts can be direct, indirect, and/or cumulative in nature and can be temporary (short term) or permanent (long term).

7.1 ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND CONSTRUCTION

The site preparation and construction associated with the Antelope and JAB Projects will include the following activities:

- Construction of the Antelope Central Plant, office and maintenance facilities.
- Construction of the JAB Satellite Plant, and associated structures.
- Construction of deep injection well(s) and associated building(s).
- Grading and construction of access roads, as required.

Site preparation and construction activities will include topsoil salvaging, site clearing and leveling, building erection, and access road construction. The impacts from wellfield construction activities including the construction of injection, production, and monitor wells are discussed in section 7.2 since these are ongoing activities at an ISR facility. This section strictly discusses the short term impacts of initial site preparation and plant construction where they differ from the impacts of operations.

Environmental impacts of construction projected for the Antelope and JAB Projects are based on the studies of the existing environment conducted by Uranium One and discussed in Section 2. The total area impacted by initial construction of plant and supporting facilities activities is approximately 15 acres. All areas disturbed will be reclaimed during final decommissioning activities as described in Section 6. The planned schedule for construction, production, restoration, and decommissioning was presented in Section 3 and Section 6.

7.1.1 Air Quality Effects of Construction

Construction activities at the Antelope and JAB Projects will cause minimal short term effects on local air quality. Increased suspended particulates from vehicular traffic on unpaved roads, fugitive dust caused by wind erosion of areas cleared of vegetation, and diesel emissions from construction equipment would be the primary air quality impacts. The application of water to unpaved roads would reduce the amount of fugitive dust to levels equal to or less than the existing condition. Diesel emissions from construction equipment are expected to be short term only, ceasing once the operational phase begins.

7.1.2 Land Use Impacts of Construction

As discussed in Section 2.2, Grazingland and Wildlife habitat is the primary land use within the proposed License Area and the surrounding 2.0-mile review area. Oil and gas production facilities and infrastructure are also located on rangeland throughout the review area, however no oil and gas production facilities are located within the License boundaries. Based on a site reconnaissance conducted in May 2007 and a 2006 aerial photo, there are no occupied housing units in the License Area. Figure 2.2-1 depicts land use in the review area.

Construction of the Antelope Central Plant, JAB Satellite Plant, and associated structures will encompass approximately 15 acres. Wellfield areas and roads will likely encompass a maximum of 1,400 acres. As a result of site preparation and construction, use of the land as rangeland will be excluded from the area that is under development. Oil and gas production facilities will not be affected as none are located within close proximity. Considering the relatively small size of the area impacted by construction, the exclusion of grazing from this area over the course of the Antelope and JAB Projects will have an insignificant impact on local livestock production.

7.1.3 Surface Water Impacts of Construction

7.1.3.1 Surface Water Impacts from Sedimentation

Construction activities for the Central Plant and Satellite Plant have the potential to increase the sediment yield of the disturbed areas. The impacted area during construction of the Central Plant and Satellite Plant is relatively small in comparison to the overall area that will be impacted during wellfield construction. Therefore, surface water impacts from sedimentation are discussed in Section 7.2.7.2.

7.1.4 Population, Social, and Economic Impacts of Construction

7.1.5 See Section 7.5 for population, social, and economic impacts of construction and operations.Noise Impacts of Construction

There are no occupied housing units in the vicinity of the proposed Antelope and JAB Projects. Open Grazingland is the primary land use within and in the surrounding 2.0-mile area. As a result of the remote location of the Project and the low population density of the surrounding area, impact to noise or congestion within the Project area or in the surrounding 2.0-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Sweetwater or other neighboring counties.

7.2 ENVIRONMENTAL EFFECTS OF OPERATIONS

This section describes the environmental impacts of operation of the Antelope and JAB Projects. Operational activities will include the following:

- Ongoing wellfield construction activities including well drilling and construction, access road construction, installation of pipelines and utilities, and construction of headerhouses;
- Plant and wellfield production operations;
- Groundwater restoration activities as wellfields are removed from production; and
- Final site reclamation activities.

Potential environmental concerns from the operation of the Antelope and JAB Projects addressed in the following sections are air quality impacts, land use and water quality impacts, soil impacts, impacts to cultural resources, ecological impacts, and other uranium development.

7.2.1 Air Quality Impacts of Operations

Uranium One estimated fugitive dust emissions from operation of the Antelope and JAB Projects based on projected activity levels and emission factors supplied by the WDEQ.

Projected activities impacting dust emissions included ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Based on these activities, the projected total PM_{10} emissions for Antelope and JAB operations is 202.93 tons per year. This level of emissions is small relative to surface mines and other industrial operations that generate dust from vehicles and disturbed areas. The larger surface mines in the Powder River Basin show PM_{10} emissions inventories in the thousands of tons per year. Sections of unpaved county roads can also exceed an emission rate of 202.93 tons per year. Viewed another way, atmospheric dispersion modeling generally shows that fugitive PM_{10} emissions on this order result in insignificant impacts to ambient air beyond a distance of a several hundred yards from the sources. Significant impact for PM_{10} is defined as 1.0 μg/m3 or more. For reference purposes, the national ambient standard for annual average PM_{10} is 50 μg/m3.

It is important to note that no control factors were assumed for the emission calculations. Periodic watering or chemical treatment of the unpaved roads, if necessary, would reduce emission factors by half or more.

7.2.2 Land Use Impacts of Operations

As discussed in Section 2.2 and 7.1.2, Grazingland and Wildlife Habitat is the primary land use within the Antelope and JAB License Areas and within the surrounding 2.0-mile areas. Oil and gas production facilities and infrastructure are also located on rangeland throughout the review area. Operation of the Antelope and JAB Projects will potentially encompass approximately 1,400 acres. As with site preparation and construction, use of the land as rangeland will be excluded from this area during the life of the project. Oil and gas production facilities will not be affected. Considering the relatively small size of the area impacted by operations, the exclusion of grazing from this area over the course of the Antelope and JAB Projects will have an insignificant impact on local livestock production.

7.2.3 Geologic and Soil Impacts of Operations

7.2.3.1 Geologic Impacts of Operations

Geological impacts from operations are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the target sandstone will be on the order of 1 percent or less. Further, once mining and restoration operations are completed, groundwater levels will return to near original conditions under a natural gradient.

7.2.3.2 Soil Impacts of Operations

Based on the soil mapping unit descriptions, the hazard for wind and water erosion within the Antelope and JAB License Area varies from slight to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the sandy loam, loam, and gravelly texture of the surface horizons throughout the majority of the Antelope and JAB License Area, the soils are more susceptible to erosion from wind than water. See Tables 2.6-12 and 2.6-13 for a summary of wind and water erosion hazards within the Antelope and JAB License Area.

The Antelope and JAB License Area is underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. All topsoil will be stripped, stockpiled and maintained in accordance with WDEQ-LQD rules and regulations, the surface will be graded, and stormwater will be routed. These measures will help reduce the effect of construction on soil erosion.

The soils underlying the proposed wellfields are at a moderate to severe risk of erosion from both wind and water. Though no topsoil will be stripped and stockpiled long term from the wellfields, construction may result in an increase in the erosion hazard from both wind and water due to the removal of vegetation and the physical disturbance from heavy equipment. All areas are reseeded as soon as possible to keep the duration of bare soil to a minimum. Reseeding will help mitigate the increased erosion potential from the construction disturbance.

Soil erosion mitigation will be implemented in accordance with WDEQ-LQD Rules and Regulations, Chapter 3, Environmental Protection Performance Standards. Typical erosion protection measures that may be implemented at the Antelope and JAB Projects include the following:

- Temporary diversion of surface runoff from undisturbed areas around the disturbed areas and the use of water velocity dissipation structures;
- Retaining sediment within the disturbed areas through the use of best management practices such as silt fencing, retention ponds, or other effective means;

- Salvage and stockpiling of topsoil from the central plant facility area and from secondary wellfield access roads in a manner to avoid wind and/or water erosion. This is accomplished by grading stockpiles to the appropriate slopes, avoiding excessive compaction, establishing a temporary vegetative cover, using appropriate fencing and signs, and installation of sedimentation catchments;
- Reestablishment of temporary or permanent native vegetation as soon as possible after disturbance; and
- Constructing roads to minimize erosion through practices such as surfacing with a gravel road base, constructing stream crossings at right angles with adequate embankment protection and culvert installation, and providing adequate road drainage with runoff control structures and revegetation.

Implementation of Best Management Practices (BMPs) will minimize the effects to soils associated with the construction and operation of the Antelope and JAB Projects.

7.2.4 Archeological Resources Impacts of Operations

As discussed in Section 2.4, the Class III Inventory investigations on the Antelope Project found 10 sites and 81 isolates. Three of the sites are considered significant under Criteria D, and are therefore potentially eligible for listing on the National Registry of Historic Places (NRHP). The other sites are not considered significant because they are small in areal extent, lack features, and exhibit poor integrity. The three sites considered significant will be avoided for development and therefore no impacts to these sites are anticipated.

Class III Inventory investigations on the JAB Project found a total of 25 sites and 29 isolates. Of the 25 sites, one is currently listed on the NRHP. No development is currently planned near the location of this listed site. Therefore no impacts to this site from operations at JAB is expected.

7.2.5 Visual and Scenic Impacts of Operations

The visible surface structures proposed for the Antelope and JAB Projects include wellhead covers, wellhouses, electrical distribution lines, and the central plant facility. The project will use existing and new roads to access each wellhouse and the central plant.

Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately 3 feet high and 2 feet in diameter. Each wellhouse is a small metal building. The Antelope central plant building will be approximately 350 feet by 100 feet in size for the initial phase. The JAB satellite building will be approximately 100 feet in width by 180 feet in length. In addition, maintenance, warehouse, and office structures are planned. A disturbance area around each wellhouse is necessary to provide an adequate area for operations and maintenance vehicles to turn around. Electric distribution lines would connect wellhouses to existing electric distribution lines. The distribution poles are approximately 20 feet high and are wooden so that their natural color harmonizes with the landscape.

Temporary and short-term visual effects during the construction period in each wellfield would result from wellhouse construction, well drilling, and construction of access roads and electric distribution lines. Following completion of wellfield installation, temporarily disturbed areas will be reclaimed. Only long-term effects associated with operations and maintenance will remain following post-construction reclamation.

Long-term effects will result from the addition of structures to the landscape, such as the central plant and associated structures, wellhouses, wellhead covers, access roads, and electric distribution lines. Effects from long-term activities will occur over the life of the project.

As noted in Section 2.4, the total score of the scenic quality inventory for the Antelope and JAB License Areas is 4. According to NUREG-1569, if the visual resource evaluation rating is 19 or less, no further evaluation is required. Therefore, no further evaluation of changes to scenic resources from the proposed Antelope and JAB Projects is required.

Despite the low scenic quality rating for the proposed project site, Uranium One intends to implement measures to lessen the visual impact from the project. Mitigation measures are meant to minimize adverse contrasts of project facilities with the existing landscape. One method to minimize these contrasts is the selection of paint colors for structures that harmonize with the surrounding landscape. To the extent possible, topographic features may be used to screen wellheads, plant facilities, and roads. Roads may be aligned with the contours of the topography, although this measure may result in a greater area of disturbance. Construction debris will be removed from new construction areas as soon as possible.

7.2.6 Groundwater Impacts of Operations

The potential groundwater impacts of ISR mining are related to the consumption of groundwater and short-and long-term changes to groundwater quality. Perhaps the most significant environmental impact that can occur as a result of ISR mining is the degradation of water quality in the ore-bearing aquifer.

7.2.6.1 Groundwater Consumption

Based on the limited drawdown observed during pump test operations, potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99%) of groundwater used in the mining process will be treated and re-injected. Potential impacts on groundwater due to consumptive use outside the proposed License Area are expected to be negligible.

As shown in Figure 2.7-22 few water wells are present in the vicinity of the Antelope and JAB Projects, and there is little use of shallow ground water in the immediate vicinity of these project areas. The limited drawdown that likely will be induced from mining, groundwater restoration and plant operations will have little if any impact on local water users.

To assess the impacts from mining and restoration operations on local groundwater, the following monitoring will be performed:

- Measure background water levels in the private domestic or livestock water wells surrounding the project area before mining and every three months during operations; and,
- Measure background water levels in regional monitoring wells installed by Uranium One before mining and every three months during operations

It is likely that the wells surrounding the Antelope and JAB sites License Area may provide stock water for private or public (BLM) leases. If significant impacts to those wells are observed (e.g., water levels drop to a point that impairs the usefulness of the wells), the following mitigation measures would be considered:

- Lowering the pump level in the wells, if possible;
- Deepening the wells, if possible; or,
- Replacing the wells with new wells completed in deeper sands that are not impacted by ISR operations.

7.2.6.2 Impacts on Ore Zone Groundwater Quality

During ISR mining operations, water quality impacts are usually of greater concern than water consumption impacts because water consumption during mining is relatively small. Contamination of groundwater from the proposed lixiviant is caused by (1) the addition of sodium bicarbonate and oxygen to the groundwater, (2) the addition of chloride to the groundwater by the processing plant, and (3) the interaction of these chemicals with the mineral and chemical constituents of the aquifer being mined. The result is that during mining, the concentration of most of the naturally occurring dissolved constituents will be appreciably higher than their concentrations in the original groundwater.

Uranium One has estimated the post-mining water quality based on the experience of Cogema Mining, Inc. in Production Units 1 through 9 at the Irigaray ISR project located in the Powder River Basin[1]. The Irigaray data was selected because of the similar geologic conditions to the Antelope and JAB Projects. Cogema employed ammonium bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine production units located in a 30 acre site.

The water quality of the Irigaray ore zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Table 7-1. The chemical alteration of the ore zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations. Thirty-five of the thirty-six parameter concentrations in the post-mining means exceeded the baseline means. Twenty-two of these parameters did not meet Restoration Target Values (of the twenty-nine with established RTVs).

Table 7-1 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Aluminum (mg/l)	<0.05 – 4.25	<1.037
Ammonia Nitrogen as N (mg/l)*	<0.05 – 1.88	23
Dissolved Arsenic (mg/l)	<0.001 – 0.105	<0.601
Dissolved Barium (mg/l)	<0.01 – 0.12	<1.067
Boron (mg/l)	<0.01 – 0.225	<0.442
Dissolved Cadmium (mg/l)	<0.002 – 0.013	<0.979
Dissolved Chloride (mg/l)*	5.3 – 15.1	277
Dissolved Chromium (mg/l)	<0.002 – 0.063	<1.018
Dissolved Copper (mg/l)	<0.002 – 0.04	<0.828
Fluoride (mg/l)	0.11 – 0.66	<1
Total and Dissolved Iron (mg/l)	0.02 – 11.8	<1.098
Dissolved Mercury (mg/l)	<0.0002 - <0.001	<0.971
Dissolved Magnesium (mg/l)	0.02 – 9.0	45.7
Total Manganese (mg/l)	<0.005 – 0.190	1.249
Dissolved Molybdenum (mg/l)	<0.02 - <0.1	<1.067
Dissolved Nickel (mg/l)	<0.01 - <0.2	<1.018
Nitrate + Nitrite as N (mg/l)	<0.2 – 1.0	<3
Dissolved Lead (mg/l)	<0.002 - <0.050	<1.018
Radium-226 (pCi/L)	0 – 247.7	200.5
Dissolved Selenium (mg/l)	<0.001 – 0.416	0.247
Dissolved Sodium (mg/l)	95 - 280	827
Sulfate (mg/l)	136 - 824	639
Uranium (mg/l)	<0.0003 – 18.8	7.411
Vanadium (mg/l)	<0.05 – 0.55	<1.067
Dissolved Zinc (mg/l)	<0.01 – 0.200	<0.065
Dissolved Calcium (mg/l)*	1.6 – 33.5	199.2
Bicarbonate (mg/l)*	5 - 144	1343
Carbonate (mg/l)	0 - 96	<2
Dissolved Potassium (mg/l)	0.4 – 17.5	9
Total Dissolved Solids (TDS) @ 180°F (mg/l)	308 - 1054	2451

* Parameters with RTV other than baseline

In general, these post-mining concentrations are within the range of those projected by NRC for ISR operations at the Crownpoint Uranium Project[2]. Uranium One expects similar baseline and post-mining water quality at the Antelope and JAB sites site.

7.2.6.3 Potential Groundwater Quality Impacts from Accidents

7.2.6.3.1 Lixiviant Excursions

Water quality impacts in adjacent aquifers from ISR mining activities are related to the identification, control, and clean-up of excursions. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, or hydrofracturing of the ore zone or surrounding units. Past experience from other commercial scale in-situ recovery projects in the Powder River Basin has shown that when proper steps are taken in monitoring and operating a wellfield, excursions, if they do occur, can be controlled and recovered and that serious impacts on the groundwater are prevented.

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

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

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers.

The State of Wyoming and the NRC require restoration of affected groundwater in the mining zone following production activities. Uranium One will be required to return the groundwater in the mining zone to baseline water quality conditions as a primary goal or to class of use standards. The mining aquifer must be exempted by the WDEQ and the EPA from protection under the Safe Drinking Water Act (SDWA) before mining can occur. One of the criteria for exemption is that the water is not currently used as an underground source of drinking water (USDW) and will not be used as a USDW in the future. By restoring the exempted aquifer, Uranium One ensures that adjacent, non-exempted aquifers will not be affected in the future.

Successful groundwater restoration has been demonstrated using the same methods proposed by Uranium One as discussed in Section 6. Therefore, long term impacts on groundwater quality are expected to be minimal.

7.2.6.4 Potential Groundwater Impacts from Spills

Potential impacts to groundwater and surface water may occur during operations as a result of an uncontrolled release of process liquids due to a wellfield leak. Should an uncontrolled wellfield release occur, there would be a potential for contamination of the shallow aquifer as well as surrounding soil. With a slow leak that remains undiscovered or a catastrophic failure, a shallow excursion is one potential impact.

The potential environmental impacts from spills and mitigative measures are discussed in further detail in Section 7.4.

7.2.7 Surface Water Impacts of Operations

7.2.7.1 Surface Waters and Wetlands

The Antelope and JAB License Area had 0.268 acres of PUB wetland ponds present. All of the wetlands presented in this study are recommended to be non-jurisdictional because the wetlands are all isolated and the Great Divide Basin is a closed basin and does not have a significant nexus. As described in Section 2.8.5, no wetlands will be impacted due to the construction within the wellfield sites based on the planned wellfield locations.

No drainages or bodies of water will be significantly modified or altered within the Antelope and JAB Projects area during project construction or operations. If significant changes or alterations were to occur, the impact to the wetlands would be minimal as the disturbance is short-term and the draw is ephemeral. The potential for erosion is present due to the construction of the wells near the drainage; however, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

7.2.7.2 Surface Water Impacts from Sedimentation

Normal construction activities within the wellfields, process plant, and along the pipeline courses and roads have the potential to increase the sediment yield of the disturbed areas. However, the relative size of these disturbances is small when compared to the size of the overall areas and to the size of the watersheds, and also have a short term impact. Since well field decommissioning and reclamation activities will be on-going throughout the life of the project, the area to be reclaimed at the conclusion of operations will be reduced, although a slight increase in sediment yields and total runoff can still be expected. Since all natural flow within the project boundaries is ephemeral with no intermittent or perennial streams, potential impacts to surface water from construction and decommissioning activities are also limited to uncommon precipitation or runoff events.

The physical presence of the surface facilities including wellfields and associated structures, access roads, office buildings, pipelines, plant facilities and other structures associated with ISR mining and processing of uranium are not expected to significantly change peak surface water flows because of the relatively flat topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed License Area. In areas where these structures may affect surface water drainage patterns, diversion ditches and culverts will be used to prevent excessive erosion and control runoff. In areas where runoff is concentrated, energy dissipaters are used to slow the flow of runoff to minimize erosion and sediment loading in the runoff.

Construction and industrial stormwater National Pollutant Discharge Elimination System (NPDES) permits will be obtained in accordance with WDEQ - Water Quality Division regulations in areas where discharge to surface waters is possible. Best management practices will be implemented to reduce erosion impacts according to storm water management plans developed for those permits.

7.2.7.3 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as excessive rainwater or runoff in impacted soil areas or failure or an uncontrolled release of process liquids due to a wellfield leak. Section 7.4 discusses measures to prevent and control wellfield spills. Process buildings and chemical storage areas will be constructed with sumps or secondary containments, and a regular program of inspections and preventive maintenance will be implemented.

7.2.8 Ecological Impacts of Operations

7.2.8.1 Vegetation

Wellfield and production facilities will be constructed within the five vegetation communities in the Antelope Area and the three vegetation communities in the JAB Area. Direct impacts include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types.) Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; reduction in livestock forage; and changes in visual asthetics. An estimated 1,400 acres of the Antelope and JAB Area would be affected by the construction disturbance under current development plans.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species within the project area. Non-native species invasion and establishment has become and increasingly important result of previous and current disturbance in Wyoming. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with the surrounding undisturbed vegetation. Uranium One will conduct weed control as needed to limit the spread of undesirable and invasive, non-native species on disturbed areas.

No threatened or endangered vegetation species were observed within the Antelope and JAB Projects areas; therefore, no impacts are anticipated.

Mitigation of vegetation impact will consist of temporary and permanent surface revegetation of disturbed areas. Revegetation practices will be conducted in accordance with WDEQ-LQD regulations and the mine permit. Disturbed areas will be seeded to establish a vegetative cover to minimize wind and water erosion and the invasion of undesired plant species. A long term temporary seed mix may be used in wellfield and other areas where the vegetation will be disturbed again prior to final decommissioning and final revegetation. This long term seed mix typically consists of one or more of the native wheatgrasses (e.g., western wheatgrass, and thickspike wheatgrass). Permanent seeding is accomplished with a seed mix approved by the WDEQ-LQD. The permanent seed mix typically contains native wheatgrasses, fescues, and clovers. Wellfield areas may be fenced as necessary to prevent livestock access, which will enhance the establishment of temporary vegetation.

7.2.8.2 Wildlife and Fisheries

A detailed description of effects to wildlife, fisheries, and threatened and endangered species is contained in Section 2.8.7. As with other energy extraction industries, ISR operations can have direct and indirect impacts on local wildlife populations. These impacts are both short-term (until successful reclamation is achieved) and long-term (persisting beyond successful completion of reclamation). Indirect impacts typically affect more than a single individual and often persist longer than direct impacts.

Direct, project-related impacts of ISR operations may be experienced by all wildlife species to varying degrees. Individuals may be injured or killed due to collisions with heavy drilling and/or construction equipment and related traffic. Topsoil stripping required for construction of drill pads, access roads, plant facilities, and other infrastructure may also result in injury and mortality to some wildlife species, particularly small and young burrowing species such as rodents and herptiles that have limited mobility to escape the equipment. The likelihood for impacts resulting in injury or mortality is greatest during the initial construction phase of each aspect of the project, when traffic is heaviest and machinery is actively disturbing new areas. Disturbance would also be greatest during construction of facilities and supporting infrastructure, which would require more equipment and cover a larger area.

Because few vertebrate species of concern occupy the Antelope and JAB License/Permit Area, the potential for direct impacts to those individuals during drilling exploration activities would be low. Sage-grouse would be at the greatest risk for direct impacts, as that species is known to breed in the area. Suitable habitat exists in the license/permit area for other uses (nesting, brood-rearing, etc.) by grouse, as well. No raptor nests were present within one-half mile (the standard BLM disturbance buffer) of the license/permit area in 2007 or 2008, though birds could forage there. No pygmy rabbits were documented in the area, though potential habitat is present.

Noise, dust, and human and mechanical presence would all be considered indirect effects. These elements can cause wildlife to avoid the disturbance area within their territories and/or result in their displacement into adjoining habitats. The latter result can negatively impact both the animals leaving the affected area as well as the population of animals upon which newly displaced individuals encroach. Because they are the most common of the species of interest, sage-grouse would also be most likely to experience indirect affects related to exploratory drilling. No raptor nests are present in or within one-half mile of the entire Antelope and JAB License/Permit Area, so nesting raptors would not be displaced or otherwise impacted by exploratory drilling or operations and foraging raptors could potentially avoid the disturbance area. No crucial big game habitat is present in the license/permit area. Potential pygmy rabbit habitat is present, but no rabbits of this species have ever been documented in the survey area.

Overcrowding can result in increased competition for limited resources, which could result in starvation and/or dehydration. Increased stress associated with overcrowding can also lead to physical altercations, resulting in injuries or fatalities. Habitat alteration, fragmentation, and loss of cover and forage are expected to occur in varying degrees as a result of the proposed project. Wyoming big sage communities, the dominant habitat type in the survey area, can be difficult and time-consuming to reestablish. Consequently, pre-construction vegetation communities (i.e., shrub-steppe) may be different than post-construction communities (i.e., grass-dominated) for several years, or possibly decades, which could alter the composition and abundance of both plant and wildlife species in the area. Reclamation or regeneration of native shrubs species could be further hindered by year-long grazing pressure. Large ungulates (wild and domestic) are attracted to the more succulent and younger plants, and often concentrate in newly seeded locations during the critical early-growth stage.

The potential for impacts associated with drilling operations would be largely mitigated by the relatively small area of surface disturbance associated with exploration activities. Surface disturbance associated with each drill site consists of an area measuring approximately 15 feet by 25 feet, or 0.01 acre, with drill sites spaced at regular intervals within each claim. Consequently, the maximum potential disturbance associated with exploratory drilling in the Antelope and JAB License/Permit Area would likely be no more than 20 non-contiguous acres (less than 0.001 % of the total license/permit area acreage) along with some limited potential disturbance from drill site access. This type of disturbance will not result in large expanses of habitat being dramatically transformed from its original character as in other surface mining operations. Additionally, all drill sites will be reclaimed following either the completion of drilling or uranium recovery operations, depending on the location of, and results from, each drill site. Impacts would also be partially mitigated by the low proportion (10%) of the total license/permit area expected to be impacted by future construction of well fields, processing facilities, and associated infrastructure. Once those structures are completed, regular disturbance would be reduced to only that needed to operate and maintain the operations. Traffic will persist during production, but should occur at a reduced and predictable level. Limited habitat disturbance also results in fewer displaced animals from existing territories into other, potentially occupied, areas, which reduces competition and stress on animals in both locations.

Given the factors outlined above, and the limited use of the Antelope and JAB Survey Area by most vertebrate species of concern, impacts to those species from exploratory drilling and ISR operations are expected to be minimal. Nevertheless, regulatory guidelines and requirements designed to prevent or reduce impacts to wildlife would include one or more of the following, as directed by the various regulating and permitting agencies:

1. Fencing designed to permit big game passage to the extent possible;

2. Use of existing roads when possible, and location of newly constructed roads to access more than one drill site;

3. Enforced speed limits to minimize collisions with wildlife, especially during the breeding season;

4. Adherence to timing and spatial restrictions within specified distances, as determined by appropriate regulatory agencies, of active sage-grouse leks during the breeding season (March 1 – June 15);

5. If direct impacts to raptors or other migratory bird species of management concern could result from operations, then a Monitoring and Mitigation Plan for those species must be prepared and approved by the US Fish and Wildlife Service (USFWS), including one or more of the following provisions:

    i. Relocation of active and inactive raptor nests that would be impacted by drilling, construction, or operation activities in accordance with the approved raptor monitoring and mitigation plan;

ii. Creation of raptor nests and nesting habitat through enhancement efforts such as nest platforms to mitigate other nest sites impacted by ISR operations;

iii. Obtaining appropriate permits for all removal and mitigation activities;

iv. Establishing buffer zones protecting raptor nests where necessary and restricting mine-related disturbances from encroaching within buffers around active raptor nests from egg-laying until fledging to prevent nest abandonment, or injury to eggs or young;

v. Reestablishing the ground cover necessary to attract and sustain a suitable raptor prey base after drilling, construction, and future mining; and

vi. Required use of raptor-safe construction for overhead power lines according to current guidelines and recommendations by the Avian Power Line Interaction Commission (APLIC) and/or USFWS;

6. Restoration of sagebrush and other shrubs on reclaimed lands and grading of reclamation to create swales and depressions for sage-obligates and their young;

7. Restoration of pre-drilling and pre-mining native habitats for species that nest and forage in those vegetative communities;

8. Restoration of diverse landforms, direct topsoil replacement, and the construction of brush piles, snags, and/or rock piles to enhance habitat for wildlife;

9. Restoration of habitat provided by jurisdictional wetlands; and

10. Reclamation of creek channels and restoration of surface water flow quantity and quality after mining to approximate pre-mining conditions.

Another effective way to minimize impacts related to drilling in the Antelope and JAB License/Permit Area would be to use a systematic drilling pattern that affects only one area at a time, working from one side the license/permit area to another. Reclamation would be completed in the same manner, with activity occurring in just one area at a time after drilling is complete. Agency standards for reclamation would be followed. This systematic approach would allow more mobile wildlife species to relocate into adjoining, undisturbed habitat and then return following completion of drilling in a particular area.

These efforts, in conjunction with the mitigation measures outlined above, would decrease direct and indirect impacts for all wildlife species.

Given the seasonal use of the area by those vertebrate species of concern that were documented in the survey area, the impacts described above could be fully mitigated with the delay of all surface disturbing activity within established buffer zones during the recognized breeding and nesting season (February 1 through July 31, annually) for those species (seasonal restrictions and buffer zones apply to surface disturbance activities only, operations will be conducted year-round in occupied areas). Given the timing of the current application process, this timing is likely to occur for much of the proposed drilling project. The fact that most of the crews work only during daylight hours would further reduce impacts to year-round residents, particularly more nocturnal species such as some reptiles; that timing also reduces potential impacts to these less mobile species due to moving equipment and vehicles.

7.2.9 Noise Impacts of Operations

As noted in section 7.1.5, there are no occupied housing units in the vicinity of the proposed Project. Open rangeland is the primary land use within and in the surrounding 2.0-mile area. Other land uses include oil and gas production facilities, as well as pastureland located to the west of the Project area.

7.2.10 Cumulative Impacts of Other Uranium Development Projects

The Great Divide Basin has historically been developed for conventional mining operations. The Sweetwater Mill, owned by Kennecott Uranium Company is located approximately 12 miles south of the Antelope and JAB Projects. This mill serviced historic open pit operations such as the Big Eagle Pit (approximately 15 miles north of the Antelope and JAB Projects Areas) and the Sweetwater Pit (adjacent to the Sweetwater Mill). There are no conventional uranium mines currently in operation in the Great Divide Basin and the Sweetwater Mill is on standby status.

Uranium One is aware that several companies are actively investigating the potential for ISR mining in areas near the Antelope and JAB Projects. These projects are in various stages of development. One License and permit application has been submitted to the regulatory agencies at the time of this application by Ur-Energy for the Lost Creek ISR Project approximately 6 miles south of Antelope and JAB. Currently, a NRC License or State Mine Permit has not been granted for this project. As such, it is not possible for

Uranium One to accurately predict the cumulative environmental impacts should these uranium projects seek and ultimately gain regulatory approval and be developed. However, some increased traffic on main artery roads would be observed if all projects were to come to fruition.

7.3 RADIOLOGICAL EFFECTS

Uranium One is proposing to develop a uranium in-situ recovery facility with a production and restoration flow of approximately 3,000 and 1,000 gallons per minute (gpm), respectively at the Antelope Project and a satellite recovery facility with a production and restoration flow of approximately 3,000 and 500 gpm respectively. An assessment of the radiological effects of the Antelope-JAB facility (the Facility) must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The Facility will use fixed-bed pressurized down flow ion exchange columns to separate uranium from the pregnant production fluid and treat restoration solutions. The uranium contained in the regenerant from the production ion exchange columns will be precipitated and subsequently vacuum dried in a central plant at the Antelope site.

In addition to ion exchange treatment, the groundwater restoration process will use reverse osmosis to remove the dissolved solids. Liquid waste disposal will occur via direct deep well injection. No surge water ponds are planned at this time.

The Facility will also consist of a satellite facility at the JAB site where an ion exchange system similar to the one described above will operate. The resin from this satellite facility will be transferred to the main processing plant at the Antelope site for elution. An average of 2 resin transfers per day from this satellite facility is anticipated.

The drying and packaging operation will be conducted under vacuum; as such, the only expected routine emission at the Facility will be radon-222 gas. Radon-222, a decay product of radium-226, is dissolved in the lixiviant as it travels through the ore to a production well where it is brought to the surface. The concentration of radon-222 in the production solution and estimated releases are calculated using the methods found in US NRC Regulatory Guide 3.59, "Methods for Estimating Radioactive and Toxic Airborne Source Terms for Uranium Milling Operations" (March 1987). The details of and assumptions used in these calculations are found in Section 7.3.3.

MILDOS-Area is used to model radiological impacts on human and environmental receptors (e.g. air and soil) using site-specific radon-222 release estimates, meteorological and population data, and other parameters. The estimated radiological impacts resulting from routine site activities are compared to applicable public dose limits as well as naturally occurring background levels.

7.3.1 Exposure Pathways

Figure 7-1 presents exposure pathways from all potential sources at the Facility. The predominant pathways for planned and unplanned releases are identified. As mentioned above, atmospheric radon-222 is expected to be the predominant pathway for impacts on human and environmental media. Impacts of Radon-222 releases can be expected in all quadrants surrounding the Facility, the magnitude of which is driven predominantly by wind direction and atmospheric stability. As a noble gas, radon-222 itself has very little radiological impact on human health or the environment. Radon-222 has a relatively short half-life (3.8 days) and its decay products are short lived, alpha emitting, nongaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. Figure 7-1 shows that all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon-222 are evaluated by MILDOS-AREA.

7.3.2 Exposures from Water Pathways

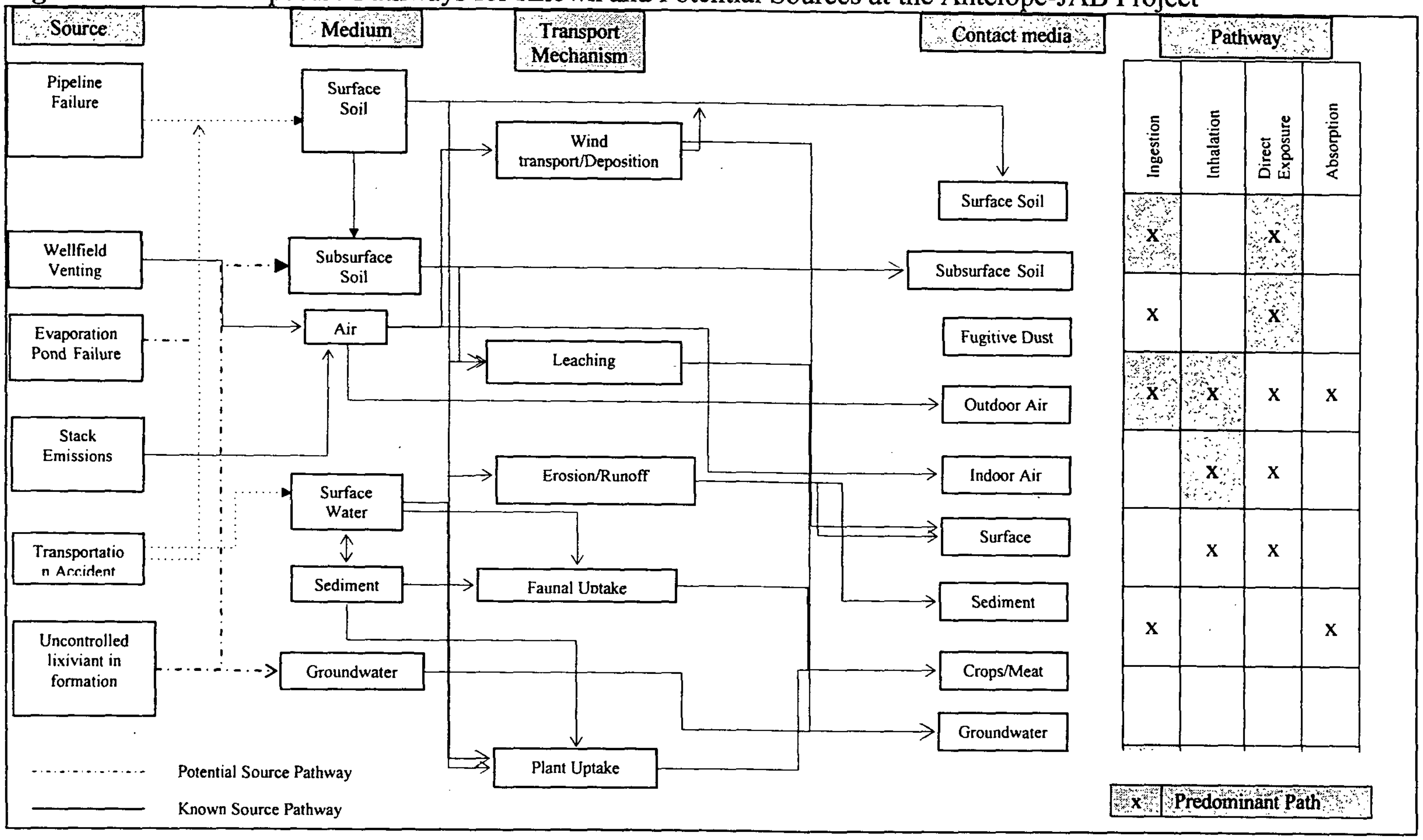
The mining solutions in the ore zone will be controlled and adequately monitored to ensure that migration does not occur. The overlying aquifer will also be monitored.

The primary method of waste disposal at the Facility will be by deep well injection. The deep well will be isolated geologically from underground sources of drinking water. The well will be constructed under a permit from the Wyoming Department of Environment Quality (WDEQ) and all requirements of the US EPA Underground Injection Control (UIC) program will be met.

The uranium ion exchange, precipitation, drying and packaging facilities will be located on curbed concrete pads to prevent any liquids from entering the environment. Solutions used to wash down equipment will drain to a sump and either pumped back into the processing circuit or disposal well. The pads will be of sufficient size to contain the contents of the largest tank in the event of a rupture.

No routine liquid environmental discharges, other than waste disposal via deep well injection, are planned and as such, no definable water-related pathways for routine operations exist.

Figure 7-1 Human Exposure Pathways for Known and Potential Sources at the Antelope-JAB Project



7.3.3 Exposures from Air Pathways

The only source of radionuclide emissions is radon-222 released into the atmosphere through a vent system in the main plant areas or from the wellfields. As shown in Figure 7-1, atmospheric releases of radon-222 can result in radiation exposure via three pathways; inhalation, ingestion, and external exposure. The Total Effective Dose Equivalent (TEDE) to a hypothetical person living at the property boundary was estimated using MILDOS-Area.

7.3.3.1 Source Term Estimates

The source terms used to estimate radon-222 releases from the Facility include three well fields in production, three restoration well fields, two new well fields, a main processing plant, and a satellite processing facility. The radon-222 releases from these source terms are calculated using methods described in Sections 7.3.3.1.1 through 7.3.3.1.4 below. For the Antelope area, wellfields 1 and 3 where chosen based on their proximity to site boundaries and predominant wind directions. Wellfield 1 in the JAB satellite area was also modeled. The parameters used to characterize and estimate releases are provided in Table 7-2.

Table 7-2 Parameters used to estimate and characterized source terms at the Antelope-JAB uranium in-situ recovery facility.

Parameter	Site	Value	Unit	Source
Average ore grade	Antelope JAB	0.074 0.074	%	Application
Ore radium-226 concentration	Antelope JAB	206 206	pCi g^{-1}	Reg. Guide 3.59
Mined area	Antelope JAB	9.7E+05 1.2E+06	m^2 y^{-1}	Application
Average lixiviant flow	Antelope JAB	1.14E+041. 14E+04	L m^{-1}	Application
Average restoration flow	Antelope JAB	1.89E+03 1.89E+03	L m^{-1}	Application
Operating days per year	Antelope JAB	365 365	days	Full-time operation assumed
Ore formation thickness	Antelope JAB	6.1 6.1	meters	Application
Ore formation porosity	Antelope JAB	0.25 0.25	NA	Application
Ore formation rock density	Antelope JAB	2.0 2.0	g cm^{-3}	Estimated
Average residence time for lixiviant	Antelope JAB	7 7	days	Application
Average residence time for restoration solutions	Antelope JAB	35 35	days	Application
Average mass of ore material in mud pit	Antelope JAB	5.2E+05 5.2E+05	g	Estimate based on planned activities
Number of mud pits generated per year	Antelope JAB	300 300	NA	Estimate based on planned activities
Storage time in mud pits	Antelope JAB	14 14	days	Estimate based on planned activities
Radon-222 emanating power	Antelope JAB	0.2 0.2	NA	Reg. Guide 3.59
Radon-222 release rates	Antelope JAB	0.1 0.1	y^{-1}	Estimate based on process
Resin porosity	Antelope JAB	0.4 0.4	NA	NUREG 1569
Ion exchange column volume	Antelope JAB	1.42E+041. 42E+04	L	Estimate based on planned activities
Number of resin transfers per day	Antelope JAB	0 2	NA	Estimate based on planned activities
Stack height	Antelope JAB	16 16	m	Application
Stack diameter	Antelope JAB	0.3 0.3	m	Application
Stack velocity	Antelope JAB	11 11	m s^{-1}	Application

7.3.3.1.1 Production Releases

Currently plans are to have up to three mine areas which potentially could be mined concurrently; one in the JAB satellite area and two in the Antelope area. The potential radon-222 releases from the production well fields were estimated using methods described in Regulatory Guide 3.59 as follows:

Radon released (equilibrium condition) to production fluid from leaching is calculated using Equation 1:

$$G = R\rho E \frac{(1-p)}{p} x10^{-6} \qquad \text{(Equation 1)}$$

Where:

G	=	radon released (Ci/m^3)
R	=	radium content of ore (pCi/g)
E	=	emanating power
ρ	=	rock density ($g\ cm^{-3}$)
p	=	formation porosity

The yearly radon released to the production fluid is calculated using Equation 2:

$$Y = 1.44GMD(1 - e^{-\lambda t}) \qquad \text{(Equation 2)}$$

Where:

Y	=	yearly radon released to production fluid ($Ci\ yr^{-1}$)
G	=	radon released at equilibrium ($Ci\ m^{-3}$)
M	=	lixiviant flow rate ($L\ min^{-1}$)
D	=	production days per year (d)
λ	=	radon-222 decay constant (d^{-1})
t	=	lixiviant residence time
1.44	=	unit conversion factor

Using Equations 1 and 2 and the parameters in Table 7-2, the yearly radon released to production fluid is 1068 $Ci\ yr^{-1}$. USNRC RG 3.59 assumes all the radon-222 that is released to the production fluid is ultimately released to the atmosphere, which in the case of ion exchange columns operating at atmospheric pressure in an open system is an appropriate, conservative assumption. In cases where pressurized down-flow ion exchange columns are used and wellfields are operated under pressure, the majority of radon released to the production fluid stays in solution and is not released. Fugitive radon is released from occasional well field venting for sampling events, small unavoidable leaks in well field and ion exchange equipment, and maintenance of well field and ion exchange equipment. For this reason, annual releases of 10% of the radon-222 from the production fluid are assumed to occur in the well fields. An additional 10% in the ion exchange circuit is assumed. Given these assumptions, the annual radon-222 released from production in the wellfield and the main plant facility is 107 and 96 Ci yr^{-1}, respectively. In the MILDOS-Area model simulations, the wellfield release of 107 Ci yr^{-1} was distributed equally among wellfields 1 and 3 at the Antelope site.

7.3.3.1.2 Restoration Releases

Radon-222 releases resulting from wellfield restoration activities were estimated in the same manner as the production activities above (i.e. using Equation 2) but modified for the lower restoration flow rate and the longer restoration fluid residence time, both of which are listed in Table 7-2. The assumption of a 10% release in the well field and treatment facility results in releases of 25 and 22 Ci yr^{-1}, respectively. for the JAB property The estimated releases from the well field and treatment facility at the Antelope site is 50 and 44 Ci yr^{-1} respectively. In the MILDOS-Area model simulations, the wellfield release of 25 Ci yr^{-1} was distributed equally among well fields 1 and 3 at the Antelope site.

7.3.3.1.3 New Well Field Releases

Radon-222 releases resulting from new wellfield development activities were estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* as follows:

$$Rn_{nw} = E\lambda[Ra]TmNx10^{-12} \qquad \text{(Equation 3)}$$

Where:

Rn_{nw}	=	Radon-222 release rate from new well field (Ci yr^{-1})
E	=	emanating power
[Ra]	=	concentration of radium-226 in ore (pCi g^{-1})
λ	=	decay constant of radon-222
T	=	storage time in mud pit (d)
m	=	average mass of ore material in the pit (g)
N	=	number of mud pits generated per year
10^{-12}	=	unit conversion factor (Ci pCi^{-1})

Using Equation 3 and the parameters in Table 7-2, the yearly radon released from new well field development in each location is 0.02 Ci yr^{-1}. In the MILDOS-Area model simulations, the new wellfield release was assumed to occur at wellfield 1 in the JAB area, and wellfield 1 in the Antelope area.

7.3.3.1.4 Resin Transfer Releases

The radon-222 release resulting from resin transfers from the JAB satellite facility was estimated using methods described in NUREG-1569, *Standard Review Plan for In Situ Leach Uranium Extraction License Applications* as follows:

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

Where:

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

The steady state radon-222 concentration in process water (C_{Rn}) was estimated from the following expression:

$$C_{Rn} = \frac{Y * 1.9E6}{M} \qquad \text{(Equation 5)}$$

Where:

C_{Rn} = Steady state radon-222 concentration in process water (pCi L^{-1})
Y = yearly radon released to production fluid (Ci yr^{-1})
M = lixiviant flow rate (L min^{-1})
1.9E6 = unit conversion factor (pCi Ci^{-1})(yr min^{1})

The water discharge rate from resin unloading (Fi) was estimated from the following expression:

$$F_i = N_i * V_i * P_i \qquad \text{(Equation 6)}$$

Where:

F_i = water discharge rate from resin unloading (L d^{-1})
N_i = Number of resin transfers per day
V_i = volume of resin in transfer (L)
P_i = porosity of resin

Using Equations 4 through 6 and the parameters in Table 7-2, the radon released from resin transfers from the JAB satellite facility is 0.74 Ci yr^{-1}. In the MILDOS-Area model simulations, the resin transfer release was assumed to occur only at the JAB plant site.

7.3.3.1.5 Radon-222 Release Summary

A summary of estimated radon-222 releases from the Facility is presented in Table 7-3. The source coordinates in Table 7-3 are relative to the Antelope main plant area.

Table 7-3 Estimated Radon-222 releases (Ci yr^{-1}) from Antelope-JAB Facility.

Location	X (km)	Y (km)	Production	Restoration	Drilling	Resin Transfer	Total
JAB Wellfield 1	-13.6	0.29	107	25	0.02	0	132.02
JAB Plant Stack	-13.6	0.0	96	22	0	0.74	118.7
Antelope Wellfield 1	-1.06	- 0.30	53.5	25	0.02	0	78.52
Antelope Wellfield 3	-2.25	1.41	53.5	25	0.02	0	78.52
Antelope Plant Stack	0	0	96	44	0	0	140.0
Total			406	141	0.06	0.74	547.76

7.3.3.2 Receptors

The receptors used in the MILDOS-AREA simulations are presented in Table 7-4 and represent the property boundary in 16 compass directions. The nearest resident to the site is in Bairoil, more that 20 kilometers east of the site.

Table 7-4 Antelope-JAB receptor names and locations

Location	X (km)	Y (km)	Distance (km)
1. Antelope Property Boundary- N	0.00	2.22	2.22
2. Antelope Property Boundary- NNE	0.91	2.21	2.39
3. Antelope Property Boundary- NE	1.74	1.74	2.46
4. Antelope Property Boundary- ENE	8.87	3.67	9.60
5. Antelope Property Boundary- E	6.15	0.00	6.15
6. Antelope Property Boundary- ESE	2.97	-1.23	3.21
7. Antelope Property Boundary- SE	1.80	-1.80	2.55
8. Antelope Property Boundary- SSE	0.12	-0.28	3.11
9. Antelope Property Boundary- S	0.00	-2.85	0.30
10. Antelope Property Boundary- SSW	-0.54	-1.30	1.41
11. Antelope Property Boundary- SW	-1.30	-1.30	1.84
12. Antelope Property Boundary- WSW	-2.21	-0.91	2.39
13. Antelope Property Boundary- W	-4.23	0.00	4.23
14. Antelope Property Boundary- WNW	-3.49	1.45	3.78
15. Antelope Property Boundary-NW	-2.29	2.29	3.24
16. Antelope Property Boundary- NNW	-0.96	2.32	2.51
17. JAB Property Boundary- N	-13.56	1.11	13.61
18. JAB Property Boundary- NNE	-13.11	1.10	13.16
19. JAB Property Boundary- NE	-12.45	1.11	12.50
20. JAB Property Boundary- ENE	-10.81	1.14	10.87
21. JAB Property Boundary- E	-10.19	0.00	10.19
22. JAB Property Boundary- ESE	-12.34	-0.51	12.35
23. JAB Property Boundary- SE	-13.20	-0.36	13.20
24. JAB Property Boundary- SSE	-13.36	-0.50	13.57
25. JAB Property Boundary- S	-13.56	-0.50	13.57
26. JAB Property Boundary- SSW	-14.27	-1.72	14.37
27. JAB Property Boundary- SW	-15.29	-1.73	15.39
28. JAB Property Boundary- WSW	-16.61	-1.26	16.66
29. JAB Property Boundary- W	-17.02	0.00	17.02
30. JAB Property Boundary- WNW	-17.04	1.44	17.10
31. JAB Property Boundary- NW	-15.47	1.91	15.59
32. JAB Property Boundary- NNW	-14.02	1.10	14.06

7.3.3.3 Miscellaneous Parameters

The metrological data used in the MILDOS-AREA model is from the Joint Frequency Distribution data presented in Section 2.3 of this application.

The population distribution used in the MILDOS-AREA model to estimate population doses is from the demographic information presented in Section 2.5 of this application.

7.3.3.4 Total Effective Dose Equivalent (TEDE) to Individual Receptors

In order to show compliance with the annual dose limit found in 10 CFR §20.1301, Uranium One has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the Antelope-JAB uranium in-situ recovery operation is less than 100 mrem per year. The results of the MILDOS-AREA simulation for each receptor in Table 7-4 are presented in Table 7-5.

An evaluation of the TEDE follows:

1) The maximum TEDE of 0.53 mrem/yr, located at the -south southeast Antelope property boundary, is 0.53 percent of the public dose limit of 100 mrem/yr.

2) The nearest resident to the site is the town of Bairoil, approximately 20 km to the East. The annual TEDE at the east property boundary of the Antelope site is 0.20mrem. The TEDE to the residents of Bairoil would be much less.

3) The maximum percent Effluent Concentration for radon-222 with daughters present is 0.02.

4) The effect of the Facility operation at any potential resident is less that 1 mrem/yr TEDE.

5) Since radon-222 is the only radionuclide emitted, public dose requirements in 40 CFR Part 190 and the 10 mrem/yr constraint rule in 10 CFR §20.1101 do not apply.

6) Even if 100% of the radon-222 contained in restoration and production fluids were released to the atmosphere (i.e., 100% released instead of 10%), the TEDE and radon-222 air concentrations at directional receptor locations surrounding the Facility would be less than the 100 mrem public dose limit and Radon-222 Effluent Concentration respectively.

Table 7-5 MILDOS-Area predicted Radon-222 concentrations and estimated TEDE at directional receptors surrounding the Antelope-JAB uranium processing facility.

Receptor	Distance (km)	Rn-222 Conc. (μCi ml^{-1})	% Effluent Conc.	TEDE (mrem yr^{-1})
1. Antelope Property Boundary- N	2.22	3.1E-12	0.01%	0.25
2. Antelope Property Boundary- NNE	2.39	2.9E-12	0.01%	0.23
3. Antelope Property Boundary- NE	2.46	3.4E-12	0.01%	0.27
4. Antelope Property Boundary- ENE	9.60	1.5E-12	0.01%	0.12
5. Antelope Property Boundary- E	6.15	2.4E-12	0.01%	0.0.20
6. Antelope Property Boundary- ESE	3.21	2.9E-12	0.01%	0.23
7. Antelope Property Boundary- SE	2.55	2.3E-12	0.01%	0.19
8. Antelope Property Boundary- SSE	3.11	6.9E-12	0.02%	0.53
9. Antelope Property Boundary- S	0.30	3.5E-12	0.01%	0.27
10. Antelope Property Boundary- SSW	1.41	4.6E-12	0.02%	0.35
11. Antelope Property Boundary- SW	1.84	4.3E-12	0.01%	0.33
12. Antelope Property Boundary- WSW	2.39	3.5E-12	0.01%	0.28
13. Antelope Property Boundary- W	4.23	2.6E-12	0.01%	0.21
14. Antelope Property Boundary- WNW	3.78	2.6E-12	0.01%	0.21
15. Antelope Property Boundary-NW	3.24	2.2E-12	0.01%	0.17
16. Antelope Property Boundary- NNW	2.51	3.1E-12	0.01%	0.25
17. JAB Property Boundary- N	13.61	2.3E-12	0.01%	0.18
18. JAB Property Boundary- NNE	13.16	3.7E-12	0.01%	0.29
19. JAB Property Boundary- NE	12.50	5.2E-12	0.02%	0.40
20. JAB Property Boundary- ENE	10.87	4.2E-12	0.01%	0.33
21. JAB Property Boundary- E	10.19	4.1E-12	0.01%	0.32
22. JAB Property Boundary- ESE	12.35	6.6E-12	0.02%	0.50
23. JAB Property Boundary- SE	13.20	5.7E-12	0.02%	0.43
24. JAB Property Boundary- SSE	13.57	3.2E-12	0.01%	0.25
25. JAB Property Boundary- S	13.57	3.3E-12	0.01%	0.25
26. JAB Property Boundary- SSW	14.37	2.5E-12	0.01%	0.19
27. JAB Property Boundary- SW	15.39	2.3E-12	0.01%	0.18
28. JAB Property Boundary- WSW	16.66	1.5E-12	0.01%	0.12
29. JAB Property Boundary- W	17.02	1.2E-12	0.0%	0.01
30. JAB Property Boundary- WNW	17.10	8.2E-13	0.00%	0.07
31. JAB Property Boundary- NW	15.59	9.0E-13	0.00%	0.07
32. JAB Property Boundary- NNW	14.06	1.7E-12	0.01%	0.13

7.3.3.5 Population Dose

The annual population dose commitment to the population in the region within 80 km of the Facility is also predicted by the MILDOS-AREA code. The results are listed in Table 7-6, where TEDE is expressed in units of person-rem/yr. For comparison, the dose to the population within 80 km of the Facility due to background radiation is included in the table. Background radiation doses are based on a North American population of 346 million and an average annual TEDE of 360 mrem.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming. The results of these calculations are included in Table 7-6 and also combined with dose to the region within 80 km of the Facility to arrive at the total radiological effects of one year of operation at the Facility.

The maximum radiological effect of the Facility operation would be to increase the TEDE of the continental population by 0.000036 percent.

Table 7-6 Total Effective Dose Equivalent to the population from one year's operation at Antelope-JAB Facility

Criteria	TEDE (person-rem/yr)
Dose received by population within 80 km of the Facility	0.01
Dose received by population beyond 80 km of the Facility	4.48
Total Continental Dose	4.48
Background North American Dose	1.2E+08
Fractional increase to background dose	3.7 E-08

7.3.3.6 Exposure to Flora and Fauna

To estimate potential radiological impacts to flora and fauna, the most important pathway for exposure should be identified. Since the only planned atmospheric emissions from the Facility is radon-222, the most important pathway for exposure to flora and fauna is deposition of radon-222 decay products on surface water, surface soils, and vegetation. MILDOS-Area estimates surface deposition rate as a function of distance from the source for the radon-222 decay products and calculates surface concentrations. Table 7-7 presents the highest surface concentrations of radon-222 decay products predicted by MILDOS-Area over a 100-year period. Soil concentrations were calculated based on a conservative assumption of 1.5 g cm^{-3} bulk soil density.

Table 7-7 Highest surface concentrations of Radon-222 decay products resulting from Antelope-JAB uranium ISR operations.

Radionuclide	Distance from site (km)	Direction	Surface Concentration (pCi/m^2)	Soil Concentration in upper 0.5 cm (pCi/g)
Polonium-218	1.5	E	6.3	8 E-04
Lead-214	1.5	E	6.3	8 E-04
Bismuth-214	1.5	E	6.3	8 E-04
Lead-210	45	E	15	2 E-03

Lead-210 represents the radionuclide with the highest concentration (2 E-3 pCi/g), which is at least an order of magnitude below most analytical laboratories detection limits. The increase in soil radioactivity is insignificant compared to site-specific background concentrations discussed in Section 2.9.

It is likely that soil re-suspension from background soils would be the predominant source of lead-210 concentration in vegetation surrounding the site since lead-210 concentrations in vegetation would be similar to that of soil.

From this evaluation, the impact of operations at the Antelope-JAB uranium ISR Facility would be minimal and indistinguishable from current conditions.

7.4 EFFECTS OF ACCIDENTS

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

NRC has previously evaluated the effects of accidents at conventional uranium milling facilities in NUREG–0706[3] and specifically at ISR uranium facilities in NUREG/CR-6733[4]. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The proposed Antelope and JAB facilities are consistent with the operating assumptions, site features, and designs examined in the NRC analyses in

NUREG/CR-6733. Uranium One will develop emergency management procedures to implement the recommendations contained in the NRC analyses. Training programs will be developed to ensure that Uranium One personnel are adequately trained to respond to all potential emergencies. These training programs were discussed in detail in Section 5.

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

7.4.1 Chemical Risk

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

7.4.1.1 Sulfuric Acid

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

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

7.4.1.2 Anhydrous Ammonia

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

To minimize the probability and consequence of an ammonia accident, the Uranium One system design and operating procedures will be consistent with American National Standards Institute (ANSI) recommendations[5]. These recommendations include 1) providing an excess flow valve located as close to the storage tank as possible that automatically closes if the flow rate exceeds a specific value; 2) the use of appropriate ANSI and American Society of Material Evaluation (ASME) standard codes for norrefrigerated pressure piping; and 3) provision of positive pressure, self-contained, full face respirators in the immediate vicinity of the ammonia piping and process operations. The ammonia piping will be placed so as to minimize the potential for impact from vehicles or other objects that might cause ruptures.

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

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

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

In addition to the listed regulatory programs, the Process Safety Management (PSM) of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119 applies to anhydrous ammonia for TQs in excess of 10,000 pounds. In the State of Wyoming, industrial safety at ISR mines is now regulated by Wyoming OSHA. Therefore, the PSM standard will apply to the ammonia system design and operating procedures.

7.4.1.3 Hydrogen Peroxide

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

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

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

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

As discussed in Section 3, the Antelope site design includes the use of hydrogen peroxide at a concentration of 50 percent contained in a hydrogen peroxide tank with a capacity of

6,000 gallons. With the design hydrogen peroxide concentration and capacity, Uranium One will not be subject to the aforementioned regulatory programs.

7.4.1.4 Oxygen

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. The oxygen will be delivered to Antelope and JAB sites by truck and stored on site under pressure in a cryogenic tank in liquid form. The oxygen will be allowed to evaporate and will be added to the barren lixiviant upstream of the injection manifold. The design and installation of underground and above-ground gaseous oxygen piping at the Antelope and JAB facilities including material specifications, velocity restrictions, location and specifications for valves, and design specifications for metering stations and filters will be in accordance with industry standards contained in CGA G-4.4[6]. Headerhouses will be equipped with an exhaust ventilation system.

Combustibles such as oil and grease will burn in oxygen if ignited. Uranium One will ensure that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1[7].

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

7.4.1.5 Carbon Dioxide

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

7.4.1.6 Sodium Carbonate and Sodium Chloride

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

Sodium carbonate and sodium chloride are also used for regeneration of ion exchange resin. Dry storage and handling systems will be designed to industry standards to control the discharge of dry material.

7.4.1.7 Sodium Sulfide

Sodium sulfide may be used as a reductant during groundwater restoration. Sodium sulfide is corrosive and will cause severe eye and skin burns. Routes of entry into the body include inhalation, ingestion, and contact with the skin. Under low pH conditions, sodium sulfide can react with water to liberate hydrogen sulfide gas. Sodium sulfide can be flammable and contact with heat, flame, or other sources of ignition will be avoided. Sodium sulfide will be stored separately from hydrogen peroxide and sulfuric acid.

7.4.2 Radiological Risk

7.4.2.1 Tank Failure

A spill of the materials contained in the process tanks at the Antelope and JAB Projects will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the central plant. The tanks at the Antelope site will contain injection and production solutions, ion exchange resin, pregnant eluant, yellowcake, and liquid waste. The tanks at the JAB site will contain injection and production solutions, ion exchange resin, and liquid waste. The plants will be designed to control and confine liquid spills from tanks should they occur. The central plant building structure and concrete curb will contain the liquid spills from the leakage or rupture of a process vessel and will direct any spilled solution to a floor sump. The floor sump system will direct any spilled solutions back into the plant process circuit or to the waste disposal system. Bermed areas, tank containments, and/or double-walled tanks will perform a similar function for any process chemical vessels located outside the central plant building.

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

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

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

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

7.4.2.2 Plant Pipe Failure

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

7.4.3 Groundwater Contamination Risk

7.4.3.1 Lixiviant Excursion

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

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

Uranium One will monitor for lateral movement of lixiviant using a horizontal excursion monitoring system. This system consists of a ring of monitor wells completed in the same aquifer and zone as the injection and production wells. Monitor wells will be installed as discussed in Section 5.7.8. Monitor wells will be sampled biweekly for approved excursion indicators.

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

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers. Uranium One will prevent vertical excursions through aquifer testing programs and rigorous well construction, abandonment, and testing requirements. Aquifer testing is conducted before mining wells are installed to detect any leaks in the confining layers. Aquifer test reports are submitted to the WDEQ for review and approval before well construction activities may proceed. Well construction and integrity testing will be conducted in accordance with WDEQ regulations and methods approved by NRC and

WDEQ. Construction and integrity testing methods were discussed in detail in Section 3.1. Well abandonment is conducted in accordance with methods approved and monitored by the WDEQ and discussed in detail in Section 6.2.

Uranium One will monitor for vertical excursions in the overlying aquifer using shallow monitor wells. These wells will be located within the wellfield boundary at a density of one well per four acres. Shallow monitor wells will be sampled biweekly for approved excursion indicators.

7.4.4 Wellfield Spill Risk

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the central plant, would result in a release of injection or production solution which would contaminate the ground in the area of the break. All piping from the central plant, to and within the wellfield will be buried for frost protection. Pipelines will be constructed of high density polyethylene (HDPE) with butt welded joints, or equivalent. All pipelines will be pressure tested at operating pressures prior to final burial and production flow and following maintenance activities that may affect the integrity of the system.

Each wellfield will have a number of headerhouses where injection and production wells will be continuously monitored for pressure and flow. Individual wells may have high and low flow alarm limits set. All monitored parameters and alarms will be observed in the control room via the computer system. In addition, each headerhouse will have a "wet building" alarm to detect the presence of any liquids in the building sump. High and low flow alarms have been proven effective in detection of significant piping failures (e.g., failed fusion weld).

Occasionally, small leaks at pipe joints and fittings in the headerhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. Uranium One will implement a program of continuous wellfield monitoring by roving wellfield operators and will require periodic inspections of each well that is in service. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. These leaks seldom result in soil contamination. Following repair of a leak, Uranium One will require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

7.4.5 Transportation Accident Risk

Transportation of hazardous materials to and from the Antelope and JAB Projects can be classified as follows:

- Shipments of uranium-laden resin from the JAB Satellite to the Antelope Central Plant for processing and return shipments of barren, eluted resin. Resin will be transported in tank trucks to the Antelope Central Plant facility for elution, precipitation, and drying.

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

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

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

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

7.4.5.1 Accidents Involving Ion Exchange Resin Shipments

A potential transportation risk associated with operation of the Antelope and JAB Projects is the transfer of the ion exchange resin to and from the plant. Loaded ion exchange resin would be transported from the JAB Satellite in a 4,000 gallon capacity tanker trailer. It is currently anticipated that up to two loads of uranium-laden resin may be transported for elution at the Antelope Central Plant and up to two loads of barren eluted resin may be returned on a daily basis. The transfer of resin will occur on a combination of private, county and State roads. For shipments of ion exchange resin to a central processing facility, NRC determined that the probability of an accident involving such a truck was 0.009 in any year[8].

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

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

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

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

- Properly licensed and trained drivers will transport the resin between the Antelope and JAB Projects.

Uranium One will develop an emergency response plan for yellowcake and other transportation accidents to or from the Antelope and JAB Projects. Uranium One personnel will receive training for responding to a transportation accident.

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium-laden resin where all of the tanker contents were spilled. Because the uranium is ionically-bonded to the resin and the resin is in a wet condition during shipment, the radiological and environmental impacts of such a spill are minimal. The radiological and environmental impact of a similar accident with barren, eluted resin would be less significant. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

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

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

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

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

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

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

7.4.5.2 Accidents Involving Yellowcake Shipments

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

As with resin shipments, yellowcake shipments will be made in accordance with DOT and USNRC regulations. Shipments will be handled as Low Specific Activity (LSA) material and will follow the same general shipping procedures as outlined for ion exchange resin shipments in Section 7.4.5.1.

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

7.4.5.3 Accidents Involving Shipments of Process Chemicals

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

7.4.5.4 Accidents Involving Radioactive Wastes

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

7.4.5.5 Pipeline Ruptures

Since no existing oil or gas pipelines exist within the current areas of development on the Antelope and JAB properties, the risk of pipeline ruptures due to ISR operations is negligible. Risk associated with ISR pipeline ruptures are described in Section 7.4.4.

7.4.6 Natural Disaster Risk

NUREG/CR-6733 considered the potential risks to an ISR facility from natural disasters. Specifically, the risk from an earthquake and a tornado strike were analyzed. NRC determined that the primary hazard from these natural events was from dispersal of yellowcake from a tornado strike and failure of chemical storage facilities, resulting in the possible reaction of process chemicals. NUREG/CR-6733 recommended that licensees follow industry best practices during design and construction of chemical facilities. Uranium One is committed to following these standards.

The Antelope and JAB Projects are located in Sweetwater County Wyoming, in which 19 tornadoes touch downs were recorded in a period from 1950 through 2003[9]. All of these tornadoes were classified as F0 (with wind speeds of 40-72 miles per hour and described as a gale tornado) or F1 tornadoes (described as moderate with wind speeds of 73-112 miles per hour). Based on maximum wind speed probability, the middle third of the state can expect a tornado between 100,000 and 1,000,000 years,

NUREG-0706 estimated the probability of occurrence of a tornado in the area in which the project is located is about 3.2×10^{-4} per year. The area was categorized as Region 3 in relative tornado intensity. For this category, the wind speed of the design tornado was 240 mph (F4 tornado), of which 190 mph is rotational and 50 mph is translational. The Antelope and JAB sites structures are not designed to withstand a tornado of this intensity.

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

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

7.5 ECONOMIC AND SOCIAL EFFECTS OF CONSTRUCTION AND OPERATION

The construction and operating work force for the Antelope and JAB Projects is anticipated to come from the surrounding region, primarily Sweetwater and Carbon Counties in south-central Wyoming. At least 50 percent of the work force would likely be located in Rawlins, which provides labor for a number of large-scale energy related projects in the region. The proposed project is located in Sweetwater County, which would experience effects to housing, public and other community services, recreation, county and municipal finances, crime, and the local transportation network. The adjacent Carbon County would also experience effects to housing and community services, as some of the project workforce would likely reside in Carbon County communities.

It is anticipated that the overall effect of the proposed facility operations on the local and regional economy would be beneficial. Purchases of goods and services by the mine and mine employees would contribute directly to the economy. Local, state, and the federal governments would benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, would also be beneficial. These economic effects would further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economies provided by the proposed Antelope and JAB Projects would continue for the life of the facility, estimated to be 15 years for the well field operation and 25 years for the Central Plant operations.

7.5.1 Construction

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

An estimated 50 percent of the construction work force would be based in Sweetwater County, which contains the License Area. The workforce hired outside of the county would likely be based in Rawlins, located in the neighboring Carbon County, as Rawlins is a regional economic hub that provides a variety of construction services and labor for projects located throughout Wyoming.

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

7.5.2 Operations Workforce

An estimated 40 to 60 people would be required for the operation of the proposed Antelope and JAB Projects. It is not known how many of the required operations workforce would be hired from outside of Sweetwater and Carbon Counties. In the event that the entire operations workforce and their families relocated to the counties, the population increase would be a maximum of 151, based on the 2005 average household size of 2.52 in Wyoming. This increase would account for 0.1 percent of the population of Sweetwater and Carbon Counties, and is smaller than the projected annual growth rate; therefore, there would be little to no effect to the vacancy rates of any type of housing in the Rawlins area or Sweetwater County.

7.5.3 Effects to Housing

The License Area lies within commuting distance of Rawlins and other communities along the I-80 corridor in Sweetwater and Carbon Counties, so that workers from these counties would likely commute from their homes. There would be no impact to temporary housing located within commuting distance (an estimated 1 to 2 hours) of the License Area.

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

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

It is anticipated that few of the construction work force during construction of any phase of the Antelope and JAB Projects would purchase or rent housing of any type; therefore, there would be no effects on the costs of any type of housing in the counties. Because rental housing usually require a long-term lease (generally a minimum of 6 months), only operations employees would likely enter into this type of lease agreement.

At least 50 percent of the operations workforce is expected to come from Sweetwater and Carbon counties. Those not located within commuting distance of the Antelope and JAB Projects would likely rent or purchase housing. In the unlikely event that the entire operations workforce are non-local and relocated to these counties, a maximum of 180 housing units would be required to accommodate relocating workers. Under this extreme scenario, the available housing units in Sweetwater and Carbon counties would not meet the demand for housing. On the other hand, the population increase would be a maximum 454 (180 workers times 2.52) based on the 2005 average household size of 2.52 in Wyoming. This increase would account for about one percent of the population of Sweetwater County as of 2006, and is within the county's annual projected population increase of 494 people per year between 2003 and 2010.

Household projections estimate a threefold increase in households from 2000 to 2030 as 291 percent in Sweetwater County, and 39 percent in Carbon County. The existing housing stock would not accommodate the projected households. Local communities in general are aware of the pressing need for the new residential development.

7.5.4 Effects to Services

It is likely that both the construction and operating work force would be from the Sweetwater and Carbon Counties, or other nearby counties in central Wyoming, and would not require permanent or temporary housing. In the event that up to 50 percent of the construction and operating workforce are non-local workers, it is anticipated that there would be a less than one percent increase in the population of Sweetwater and Carbon counties from the permanent relocation of the workers and their families. Most non-local workers would use temporary housing. Man camps or other housing would not be constructed for the project workforce, so no new water, sewer, electrical lines, or other infrastructure would be required. There would be no additional demands of increases in service levels for local infrastructure, such as police, fire, water, or utilities. In addition, there would be little measurable increase in non-basic employment, as these jobs are generated from ongoing employment of the existing base of construction workers, and would be maintained through the continued employment of local construction workers. Therefore, construction and operation of the Antelope and JAB Projects would not significantly affect the various public and non-public facilities and services described above from the in-migration of workers for non-basic employment opportunities.

7.5.5 Effects to Traffic

The most heavily used public road segments would be Bairoil Road west of the town of Bairoil, State Highway 73 between Lamont and Bairoil, and State Highway 287 between I-80 through Rawlins north to State Highway 73 at Lamont. Most construction traffic, the construction workforce, and the operations workforce would access the License Area via these road segments. The highest levels of project-related traffic would be from the operations workforce, and assuming there would be an average of one employee per vehicle, per one-way vehicle trip, there could be an increase of 5.4 percent in daily traffic along the highway. This 5.4 percent (10.8 percent for two trips per day) percent increase is well below the 25 percent threshold generally used for predicting significant effects to a transportation system.

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

7.6 ENVIRONMENTAL JUSTICE

The U.S Census 2000 Decennial Population program provides race and poverty characteristics for Census Tracts and Block Groups, which are subdivisions of Census Tracts. The License Area and the surrounding 2.0-mile buffer are contained within Census Tract 9716 in Sweetwater County, and in Block Group 1, Census Tract 3 in Fremont County. There is no population within the License Area or the surrounding 2.0-mile buffer.

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

As summarized in Table 7-8, the combined population within the Census Tracts that encompass the License Area buffer was 3,926. Minority populations accounted for a small proportion of the total population, with percentages of minorities generally similar to or smaller than those of the state as a whole, with the exception of the Hispanic population and the portion of the population that are racially characterized as two or more races. The proportion of the Hispanic population to the total population was slightly larger in Census Tract 9716 than in the state. Those people who are two or more races were also a slightly higher proportion of the total population in both census tracts than in the state.

No concentrations of minority populations were identified as residing near the License Area, as residents nearest are rural populations. There would be no disproportionate impact to minority population from the construction and implementation of the Antelope and JAB Projects.

The populations within the Tracts exhibit lower rates of people living below the poverty level than the state. Both Tracts contain rural populations; therefore, there is no concentration of people living below the poverty level in these Tracts. No disproportionate adverse environmental impacts would occur in populations living below the poverty level within the Census Tracts from proposed Project activities.

Table 7-8 Race and Poverty Level Characteristics of the Population in the Antelope and JAB License Area Census Tracts

	State of Wyoming	Percent of Total State Population	Census Tract 9716, Sweetwater County	Percent of Census Tract 9716	Block Group 1, Census Tract 3, Fremont County	Percent of Census Tract 3	Total
Total	493,782	100.0%	1,702	100.0%	2,224	100.0%	3,926
Urban:	322,073	65.2%	0	0.0%	0	0.0%	0
Inside urbanized areas	125,706	25.5%	0	0.0%	0	0.0%	0
Inside urban clusters	196,367	39.8%	0	0.0%	0	0.0%	0
Rural	171,709	34.8%	1,702	100.0%	2,224	100.0%	3,926
White alone	454,095	92.0%	1,588	93.3%	2,091	94.0%	3,679
Black or African American alone	3,126	0.6%	2	0.1%	0	0.0%	2
American Indian and Alaska Native alone	11,363	2.3%	16	0.9%	52	2.3%	68
Asian alone	2,972	0.6%	5	0.3%	17	0.8%	22
Native Hawaiian and Other Pacific Islander alone	232	0.0%	1	0.1%	0	0.0%	1
Some other race alone	12,595	2.6%	44	2.6%	11	0.5%	55
Two or more races	9,399	1.9%	46	2.7%	53	2.4%	99
People who are Hispanic or Latino	31,384	6.4%	127	7.5%	67	3.0%	194
Median household income in 1999	37,892	-	49,544	-	38,095	-	-
Per capita income in 1999	19,134	-	19,350	-	20,133	-	-
Population with income in 1999 below poverty level:	54,777	-	150	-	136	-	**286**
Percent below poverty level	11.1%	-	8.8%	-	6.1%	-	**0**

Source: U.S. Bureau of Census 2000

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TABLE OF CONTENTS

TABLE OF TABLES

8 ALTERNATIVES TO PROPOSED ACTION

8.1 NO-ACTION ALTERNATIVE

Under the provisions of the National Environmental Policy Act (NEPA), one alternative that must be considered in each environmental review is the no-action alternative. In this case, the no-action alternative would mean that the NRC would not approve the Antelope and JAB application and would not issue a Source Materials License. ISR uranium mining would not occur in the Antelope and JAB area and the associated environmental impacts would not occur.

8.1.1 Impacts of the No-Action Alternative

The no-action alternative would result in significant financial impacts to Uranium One and to Sweetwater County, Wyoming and the surrounding area. Uranium One has invested significant resources to develop the Antelope and JAB Uranium Project that would be irretrievably lost under the no action alternative. In addition, the no action alternative would adversely affect the economic growth of Sweetwater County. As discussed in further detail in Section 9, the Antelope and JAB Uranium Project is expected to provide a significant economic impact to the local economy.

A decision to not issue a NRC Source Materials License or WDEQ-LQD Mine Permit to Uranium One would leave a large resource unavailable for energy production supplies. Uranium One is continuing to develop estimates of the reserves at Antelope and JAB, the current estimated resource is 13.5 million pounds U_3O_8.

In 2006, total domestic U.S. uranium production was approximately 4.7 million pounds U_3O_8[1]. During the same year, domestic U.S. uranium consumption was approximately 67 million pounds U_3O_8[2]. The Antelope and JAB project represents an important new source of domestic uranium supplies that are essential to provide a continuing source of fuel to power generation facilities.

In addition to leaving a large deposit of valuable mineral resources untapped, a denial of this license/permit application would result in adverse economic affects on the individuals that have surface leases with Uranium One and own the mineral rights in the Antelope and JAB Project Area.

8.2 PROPOSED ACTION

The proposed Antelope and JAB Uranium Project contains a combined License/Permit area of approximately 14,574 acres. Of this potential area, the surface area to be affected by mining operations will be less than 1,400 acres for the central plant and facilities including the wellfields. The Antelope and JAB Uranium Project is located in Sweetwater County, Wyoming within in south central Wyoming in Township 26 North, Range 94 West, in all or portions of Sections 8, 9, 10, 13, 14, 15, 16, 17, 20, 21, 22, 23 and 24; Township 26 North, Range 93 West, in all or portions of Sections 11, 12, 13, 14, 15, 22, 23 and 24 and Township 26 North, Range 92 West, in all or portions of Sections 1, 2, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 28, 29 and 30. The proposed action will consist of construction, operation, and ultimately decommissioning of wellfields, ion exchange facilities, wastewater disposal well(s), and a processing and drying facility.

Commercial production of the reserves at the Antelope and JAB Project and subsequent groundwater restoration activities are projected to extend over the next fifteen years. The minimum projected life of the central plant is projected to be at least 25 years since Uranium One plans to use the facility to process ion exchange resin from other potential satellite facilities operated by Uranium One or others. Aquifer restoration and reclamation at Antelope and JAB will be accomplished concurrent with operations to the extent feasible plus an additional two years at the end of the project for final decommissioning of the central plant facilities and surface reclamation in these areas. More detailed schedules were provided in Section 1.

The in-situ process consists of an oxidation step and a dissolution step. The oxidants utilized in the facility are hydrogen peroxide and/or gaseous oxygen. A sodium bicarbonate lixiviant is used for the dissolution step. The uranium-bearing solution is recovered from the wellfield and piped to the central plant for extraction. The central plant process utilizes the following steps:

- Loading of uranium complexes onto an ion exchange resin;
- Reconstitution of the solution before reinjection by the addition of sodium bicarbonate and oxygen;
- Elution, precipitation, drying, and packaging of yellowcake in the central plant; and

- Restoration of groundwater following mining activities.

The operation of the Antelope and JAB Projects will result in a number of effluent streams. Airborne effluents are limited to the release of radon-222 gas during the uranium recovery process. Liquid wastes are handled through deep well injection.

Groundwater restoration activities consist of three steps:

- Groundwater transfer;
- Groundwater sweep; and
- Groundwater treatment;

Groundwater restoration will take place concurrently with development and production activities. The goal of the groundwater restoration is to return the water quality of the affected zone to a chemical quality consistent with baseline conditions or, as a secondary goal, to the class of use standards specified by the WDEQ.

Following groundwater restoration activities, all injection and recovery wells will be reclaimed using appropriate plugging and abandonment procedures. In addition, a sequential land reclamation and revegetation program will be implemented on the site. This reclamation will be performed on all disturbed areas, including the plant, wellfields, ponds and roads.

Uranium One will maintain financial responsibility for groundwater restoration, plant decommissioning and surface reclamation. Financial surety is discussed in Section 6.

The environmental impacts of the requested action will be minimal as discussed in Section 7. The only radiological air impacts will be from the release of radon gas during production. The release of radon will be minimized by the use of pressurized downflow ion exchange columns. In addition, radon gas quickly dissipates in the atmosphere and results in a minimal additional exposure to the public as discussed in Section 7. All drying and packaging performed at the Antelope and JAB Central Plant will use a vacuum drying system, so there are no additional radioactive air particulate releases.

In situ recovery mining of uranium alters the geochemistry and the water quality in the mining zone. Other operating ISR facilities have proven that impacts to groundwater can be controlled through stringent well construction techniques, wellfield operating methodologies that minimize excursions, and the use of best practicable technologies to restore the groundwater after mining activities are complete. The success of the groundwater protection practices proposed by Uranium One was discussed in Section 6.

The impacts discussed in Section 7 include short-term and long-term impacts. However, it should be noted that in situ recovery mining technique allows the entire mine site to be decommissioned and returned to unrestricted use within a relatively short time so there are no long-term impacts.

8.3 REASONABLE ALTERNATIVES

8.3.1 Process Alternatives

8.3.1.1 Lixiviant Chemistry

Uranium One proposes to use a sodium bicarbonate lixiviant that is an alkaline solution. Where the groundwater contains carbonate, an alkaline lixiviant will mobilize fewer hazardous elements from the ore body and will require less chemical addition than an acidic lixiviant. Also, test results at other projects indicate only limited success with acidic lixiviants, while the sodium bicarbonate has proven highly successful at commercial mining operations in Wyoming to date. Alternate leach solutions include ammonium carbonate solutions and acidic leach solutions. These solutions have been used in solution mining programs in other locations. However, operators have experienced difficulty in restoring and stabilizing the aquifer. Therefore these solutions were excluded from consideration.

8.3.1.2 Groundwater Restoration

The success of the groundwater restoration techniques proposed by Uranium One has been shown at other ISR mining operations in Wyoming. Groundwater sweep, permeate/reductant injection and groundwater treatment have successful restored the groundwater to pre-mining quality. No feasible alternative to the groundwater restoration method is currently available. The NRC and the WDEQ consider the method currently employed as the Best Practicable Technology (BPT) available.

8.3.1.3 Waste Management

Liquid wastes generated from production and restoration activities are generally managed at ISR facilities by solar evaporation ponds, deep well injection, and/or land application. The use of deep waste disposal well(s) is considered by Uranium One to be the best alternative to dispose of these types of wastes. The Antelope and JAB deep well(s) will isolate liquid wastes generated by the project from any underground source of drinking water (USDW). These wells must be authorized by the State of Wyoming under an Underground Injection Control (UIC) Permit. Uranium One has considered and rejected using solar evaporation ponds and land application as a disposal method at Antelope and JAB due to required treatment, monitoring and reclamation costs, and the potential environmental impacts from a surface discharge.

All solid wastes will be properly managed. Non-contaminated solid waste will be disposed in an off site solid waste landfill permitted by the county in which it is located. Contaminated wastes will be shipped to a NRC-approved facility for disposal.

8.4 ALTERNATIVES CONSIDERED BUT ELIMINATED

As a part of the alternatives analysis conducted by Uranium One, several mining alternatives were considered. Due to the significant environmental impacts and cost associated with these alternative mining methods in relation to the Antelope and JAB ore body, they were eliminated from further consideration.

8.4.1 Mining Alternatives

Underground and open pit mining represent the two currently available alternatives to solution mining for the uranium deposits in the project area. In the Wyoming southern Powder River Basin, Gas Hills, and Shirley Basin areas, uranium ore has been mined with open pits in the past. This activity occurred from 1950s to the early 1980's. Ore was also mined with underground mining in several of those areas. The JAB project was originally investigated by Union Carbide in the late 1970's as an open pit mine. Exploration activities also occurred on the Antelope Project area around that time period. Neither of these methods is economically viable for producing the Antelope and JAB reserves at this time.

From an environmental perspective, open pit mining or underground mining and the associated milling process involve higher risks to employees, the public, and the environment. Radiological exposure to the personnel in these processes is increased not only from the mining process but also from milling and the resultant mill tailings. The milling process generates a significant amount of waste relative to the amount of ore processed. Extensive mill tailings ponds are needed for the disposal of these wastes. The environmental impacts associated with open pit and underground mining are generally recognized as being considerably greater than those associated with in-situ recovery mining.

In a comparison of the overall impacts of ISR mining of uranium compared with conventional mining, an NRC evaluation[3] concluded that environmental and socioeconomic advantages of in situ recovery include the following:

1. Significantly less surface area is disturbed than in surface mining, and the degree of disruption is much less.

2. No mill tailings are produced and the volume of solid wastes is reduced significantly. The gross quantity of solid wastes produced by ISR methods is generally less than 1% of that produced by conventional milling methods (more than 948 kg (2090 lb) of tailings usually result from processing each metric ton (2200 lb) of ore).

3. Because no ore and overburden stockpiles or tailings pile(s) are created and the crushing and grinding ore-processing operations are not needed, the air exposure problems caused by windblown dusts from these sources are eliminated.

4. The tailings produced by conventional mills contain essentially all of the uranium daughter products including radium-226 that are originally present in the ore. By comparison, less than 5% of the radium in an ore body is brought to the surface when ISR methods are used. Consequently, operating personnel are not exposed to the radionuclides present in and emanating from the ore and tailings and the potential for radiation exposure is significantly less than that associated with conventional mining and milling.

5. By removing the solid wastes from the site to a licensed waste disposal site and otherwise restricting them from contaminating the surface and subsurface environment, the entire mine site can be returned to unrestricted use within a relatively short time.

6. Solution mining results in significantly less water consumption than conventional mining and milling.

7. The socioeconomic advantages of ISR include:

    - The ability to mine a lower grade ore,
    - A lower capital investment,
    - Less risk to the miner,
    - Shorter lead time before production begins, and
    - Lower manpower requirements.

8.5 CUMULATIVE EFFECTS

8.5.1 Future Development

Uranium One has other potential resource areas identified in the Great Divide Basin that may be developed as satellite facilities to the Antelope Central Plant. Development of these facilities is dependent upon further site investigations by Uranium One and the future of the uranium market. If conditions warrant, Uranium One may submit license amendment requests and WDEQ-LQD Mine Permit Applications for development of these additional resources. Uranium One currently projects that development of these areas would be primarily intended to maintain production allowed under the proposed license as reserves in the Antelope and JAB site deplete.

8.6 COMPARISON OF THE PREDICTED ENVIRONMENTAL IMPACTS

Table 8-1 provides a summary of the environmental impacts for the no-action alternative (Section 8.1), the preferred alternative (Section 8.2), and the process alternatives (Section 8.3). The predicted impacts for the mining alternatives discussed in Section 8.4 are not included for comparison because these alternatives were rejected due to significant environmental and economic impacts. Environmental impacts were discussed in greater detail in Section 7.

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Table 8-1: Comparison of Predicted Environmental Impacts

Impacts of Operation	No-Action Alternative	Preferred Alternative	Process Alternatives	
			Alternate Lixiviant Chemistry	Alternate Waste Management
Land Surface Impacts	None	Minimal temporary impacts in wellfield areas; Significant surface and subsurface disturbance confined to a portion of the Central Plant site.	Same as Preferred Alternative.	Same as Preferred Alternative. Potential additional impacts from land application of treated waste water.
Land Use Impacts	None	Loss of agricultural production (livestock grazing) in the impacted area for duration of project.	Same as Preferred Alternative.	Same as Preferred Alternative plus additional land use impact from installation of evaporation ponds and/or land application areas.
Transportation Impacts	None	Minimal impact on current traffic levels.	Same as Preferred Alternative.	Same as Preferred Alternative.
Geology and Soil Impacts	None	No geologic impacts. Minimal temporary soil impacts in disturbance areas from wind and water erosion.	Same as Preferred Alternative.	Same as Preferred Alternative. Potential additional impacts to soils from land application of treated waste water.
Surface Water Impacts	None	None	None	None

Table 8-1: Comparison of Predicted Environmental Impacts

Impacts of Operation	No-Action Alternative	Preferred Alternative	Process Alternatives	
			Alternate Lixiviant Chemistry	Alternate Waste Management
Groundwater Impacts	None	Consumption of mining zone groundwater for control of mining solutions and restoration. Temporary degradation of groundwater quality during mining.	Same as Preferred Alternative. Increased difficulty with groundwater restoration and stabilization.	Same as Preferred Alternative.
Ecological Impacts	None	No substantive impairment of ecological stability or diminishing of biological diversity.	Same as Preferred Alternative.	Same as Preferred Alternative.
Air Quality Impacts	None	Additional total dust emissions of 202.93 tons per year due to vehicle traffic on gravel roads for the combined projects.	Same as Preferred Alternative.	Same as Preferred Alternative.
Noise Impacts	None	Barely perceptible increase over background noise levels in the area.	Same as Preferred Alternative.	Same as Preferred Alternative.
Historic and Cultural Impacts	None	None	None	None

Table 8-1: Comparison of Predicted Environmental Impacts

Impacts of Operation	No-Action Alternative	Preferred Alternative	Process Alternatives	
			Alternate Lixiviant Chemistry	Alternate Waste Management
Visual/Scenic Impacts	None	Moderate impact; noticeable minor industrial component.	Same as Preferred Alternative.	Same as Preferred Alternative plus additional visual and scenic impacts installation of evaporation ponds and/or land application areas.
Socioeconomic Impacts	Loss of positive economic impact of $60.1M and 1,044 temporary and permanent jobs to the State of Wyoming, Sweetwater County and the surrounding area	Annual direct economic impact of $60.1M and 1,044 temporary and permanent jobs to local area	Same as Preferred Alternative.	Same as Preferred Alternative.
Nonradiological Health Impacts	None	None	None	None
Radiological Health Impacts	None	Estimated maximum dose from radon gas released at Antelope and JAB at the project boundary is 0.53 mrem/yr or 0.53% of the public dose limit.	Same as Preferred Alternative.	Same as Preferred Alternative.
Waste Management Impacts	None	Generation of additional liquid and solid waste for proper disposal.	Same as Preferred Alternative. Mobilization of additional hazardous elements in lixiviant requiring disposal.	Generation of additional 11e.(2) byproduct material from decommissioning evaporation ponds.

Table 8-1: Comparison of Predicted Environmental Impacts

Impacts of Operation	No-Action Alternative	Preferred Alternative	Process Alternatives	
			Alternate Lixiviant Chemistry	Alternate Waste Management
Mineral Resource Recovery Impacts	Loss of a valuable domestic energy resource. Uranium One estimated reserves are under development but the current estimated recoverable resource is potentially 13.5 million pounds with a current long-term market value of $1.2 billion (based on $90/lb current long-term price).	Recovery and use of a domestic energy resource.	Same as Preferred Alternative.	Same as Preferred Alternative.

8.7 REFERENCES

[1] Energy Information Administration, *Summary Production Statistics of the U.S. Uranium Industry*, www.eia.doe.gov/cneaf/nuclear/dupr/usummary.html accessed August 14, 2007.

[2] Energy Information Administration, *2006 Uranium Market Annual Report*, www.eia.doe.gov/cneaf/nuclear/umar/umar.html, accessed August 14, 2007.

[3] U.S. Nuclear Regulatory Commission, *Draft Environmental Statement Related to the Operation of the Teton Project*, NUREG-0925, June 1982. Para. 2.3.5.

TABLE OF CONTENTS

TABLE OF TABLES

9 BENEFIT-COST ANALYSIS

9.1 BENEFIT-COST ANALYSIS GENERAL BACKGROUND

Benefit-cost analysis (BCA) has established that the proposed development of a new uranium in-situ recovery facility at the Antelope and JAB Projects (Project) is potentially a cost-effective effort to undertake and will provide a net economic benefit to the State of Wyoming.

This analysis has been tailored to meet the requirements established by the Nuclear Regulatory Commission (NRC) NUREG 1569, and includes a description of the economic benefits from the construction and operation of the proposed Project and a discussion of the temporary and long-term external costs. Where possible, benefit and cost estimates are monetized; however, reliable monetary estimates for some potential impacts are not readily available so the narrative examines several factors in non-monetary or qualitative terms.

The following analyses use IMPLAN (IMpact Analysis for PLANning), a standard industry software package that models the economic impacts of capital intensive projects, to calculate the potential economic impacts to the county. It was originally developed by the United States Department of Agriculture (USDA) Forest Service in cooperation with the Federal Emergency Management Agency (FEMA) and the United States Department of the Interior (USDI) Bureau of Land Management (BLM) for land and resource management planning (IMPLAN 2004). Currently, it is being managed by the Minnesota IMPLAN Group, Inc. (MIG).

9.2 ALTERNATIVES AND ASSUMPTIONS

BCA is a widely-used analytical tool for helping decision makers determine whether the cost of a project today will result in sufficient benefits to justify expenditure on a capital intensive project (Brown 2003; Zerbe and Bellas 2006). To provide value and to assist in the decision process, the BCA needs to be clear about the alternatives being considered and the underlying assumptions including quantities of goods, labor costs, market conditions and discount rates used to compute net present value. The following discussion briefly identifies alternatives and key assumptions used throughout the analysis.

9.2.1 Development Alternatives

This BCA evaluates the benefits and costs of building the Project and all the costs and benefits resulting from its ongoing operation in Sweetwater County, Wyoming. The BCA tradeoff under consideration involves comparing a future with the proposed Project to a future that represents a continuance of the no action.

9.2.1.1 No Action Alternative

Under the no action alternative, there would be no change in the current land cover or land and water uses at the site; therefore, there would be no change in the existing underlying socioeconomic and demographic trends.

9.2.1.2 Proposed Antelope and JAB Project Alternative

The proposed alternative involves the construction and operation of a uranium in-situ recovery (ISR) facility. ISR involves leaving the ore where it is in the ground and using liquids which are pumped through it to recover the minerals out of the ore. Consequently, the proposed alternative involves limited surface disturbance at the Project site and no tailings or waste rock would be generated.

9.2.2 Key Assumptions and Limitations

Key assumptions about the costs and benefits associated with the proposed Project involve: (1) The Operating Life of the Project; (2) the Discount Rate used; (3) the Scope of the Impact; and (4) Non-monetary Impacts. Each of these is described in more detail below.

9.2.2.1 Operating Life of Project

The Project will be a single unit of analysis including the well fields, Central Processing Plant, Satellite Facility and outlying related structures. For this analysis, the total effective life of the Project is assumed to be 31 years. Within this time frame, there are three distinct project phases with a distinct suite of costs and benefits:

- 1 year of site development and facility construction

- 8 years of Satellite operation (concurrent with Central Processing Plant operation)
- 15 years of well fields and Central Processing Plant operation
- 15 years of the Central Processing Plant continuing operation after decommissioning the well fields.

9.2.2.2 Discount Rate

Computing the net present value (NPV) of the proposed Project requires that future benefits and costs be discounted. This discounting reflects the time value of money—economic benefits and costs are worth more if they are expected sooner. Following guidelines established by circular A-94 from the United States Office of Management and Budget (OMB), net present value estimates of benefits and costs are reported using a real discount rate of 7 percent (OMB 1992). Circular A-94 was revised in 1992 based on extensive review and public comment and currently reflects the best available guidance on standardized measures of costs and benefits. This rate approximates the marginal pretax rate of return on an average investment in the private sector in recent years.

9.2.2.3 Scope of Impact

A critical step in any BCA is establishing a viable scope of impact and thus establishing who will be affected by the Project (Zerbe and Bellas 2006). As a practical matter the proposed Project would be limited to the potential impact it may have on Sweetwater County in the State of Wyoming.

9.2.2.4 Non-monetary Impacts and Benefit-Cost Ratio

Conventional BCA uses monetary values to compare goods and services derived from a project or program. The values of goods and services represent their relative importance so that if the total value of the benefits is greater than the total value of the costs, the Project is desirable. The standard result is a quantified benefit-cost ratio (BCR), equal to a project's total net benefits divided by its total cost. BCR's above one have positive net economic impacts. While many inputs in the Project BCR are goods and services (skilled labor, construction material) that are regularly traded in markets at well known and predictable prices, others (changes to land or water, aesthetic impacts) are not directly traded and are more difficult to value. Where reliable monetary values are not available a qualitative approach based on the best available information is required.

9.3 ECONOMIC BENEFITS OF PROJECT CONSTRUCTION AND OPERATION

This section considers the potential economic impacts resulting from construction and operation-related activities over the life of the Project. Economic benefits are those that have the potential to affect the local economy, including the number of jobs created and state and local tax revenues generated from project related business activities.

These analyses use IMPLAN to calculate the potential economic impacts to Sweetwater County. IMPLAN allows the user to build an input-output model tailored to model the potential impact of a proposed project on a specific community or region. The system is flexible and contains a database of over 500 industrial sectors gathered from counties throughout the United States. By identifying the location and industrial sector of the project (i.e., construction and mining), the analyst can therefore estimate the total potential economic impact of a given project. The model requires labor and capital expenditures data as inputs in order to evaluate the potential economic impacts of the project. The output is the potential direct and indirect employment impacts and generated tax revenue.

This analysis focuses on Sweetwater County, Wyoming and two economic sectors most closely associated with the distinct phases of the proposed Project: new construction (IMPLAN code 41) and support activities for mining (IMPLAN code 29). Unfortunately, IMPLAN does not currently have a uranium mining sector for Sweetwater County, so all tax revenue estimates drawn from IMPLAN should be treated as lower-bound estimates given that ad valorem and severance taxes will likely differ for different mining sectors.

9.3.1 IMPLAN Input Data

This analysis assumes that the Project begins in 2009. Construction activities take place for one year employing a total estimated number of 75 construction workers of which 35 (about 50 percent) would likely be from Sweetwater County. Construction capital expenditures are estimated at $50 million for the duration of the construction period (Table 9-1).

Following one year of facility construction, the well fields, Central Plant and Satellite Facility would be fully-operational, employing 80 full-time workers per year for the first 15 years (this is considered the maximum potential number, it is anticipated that there will be less than 80 full time workers). After completion of mining and restoration activities, 60 full-time workers per year for the next 15 years will be required for continuing plant operations (this is considered the maximum potential number, it is anticipated that there will be less than 60 full time workers), accepting loaded ion exchange resin from other satellite facilities for processing. Approximately 50 percent of the workers (40 workers during the first 15 years and 30 workers during the last 15 years) would be located in Sweetwater County. The Project has the potential to incur up to $12 million in non-payroll-related operating costs annually for the first 15 years. Thereafter, the analysis assumes that non-payroll related operating costs will be reduced to 15 percent or $1.8 million per year.

Table 9-1 Input Data for the Antelope and JAB Projects

Activities	IMPLAN Code	Per Year		
		2009	2010 - 2024	2025 - 2039
Construction Expenditures				
Non-payroll[1]	41	$50 M	NA	NA
Payroll[2]	41	35 workers	NA	NA
Operations Expenditures				
Non-payroll	29	NA	$12 M	$1.8 M
Payroll	29	NA	40 workers	30 workers

1 Does not include land purchase cost
2 Limited to Sweetwater County

9.3.2 Employment Benefits

Using the above assumptions, Table 9-2 summarizes the potential employment-related effects generated by the Project. IMPLAN defines employment as total wage and salary of employees, including self-employed jobs that are related to the proposed Project. It also includes both full-time and part-time workers and is measured in annual average jobs.

Table 9-2 also shows the potential direct, indirect and induced effects on county-wide employment. The direct employment effects refer to the employment directly generated by the Project. For the initial construction phase in 2009, the model estimates a total of 552 workers directly hired by the Project in Sweetwater County per year including the 35 payroll workers engaged directly in construction activities and the $50 million of non-wage capital expenditures incurred by the Project in 2009.

Potential indirect effects pertain to the inter-industry effects from the direct effects and could include increased labor demand, goods and services required to support the Project (such as restaurant and hotel staff). In addition, new workers living within Sweetwater County would spend their income locally which induces additional income and employment. Construction workers living in the county for the construction period would purchase local goods and services which help generate additional employment. The sum of potential direct, indirect and induced effects represents the total potential employment impacts of the Project.

The results indicate that the Project is expected to create 794 additional jobs per year for the first year of intensive construction, 180 additional jobs per year in the next 15 years during full operation, and 70 additional jobs per year in the last 15 years of operation. It is important to note that the total potential economic impacts from the Project could extend to the surrounding areas of Freemont, Carbon and Natrona counties. As a result, the total potential employment impacts predicted by this analysis are conservative.

Table 9-2 Employment Effects of the Antelope and JAB Project in Sweetwater County

Years	Employment per Year			
	Direct	Indirect	Induced	Total
2009	552	111	132	794
2010 - 2024	101	41	38	180
2025 - 2039	39	16	15	70

9.3.3 State and Local Tax Revenue Benefits

In addition to aggregate employment effects, IMPLAN provides an estimate of expected state and local tax revenue impacts over the life of the Project associated with mining activities. In order to remain consistent with the scope of impact, federal taxes are not included in this analysis. The results standardized to 2007 dollar equivalents using the OMB recommended real discount rate of 7 percent are presented in Table 9-3.

Potential state and local tax implications associated with the proposed Project are presented in Table 9-3. While IMPLAN includes employee and employer social insurance taxes as well as personal tax items like income tax, property tax and motor vehicle license tax, these tax revenues are not reported here because they are paid by county workers and their families and thus represent a transfer of wealth rather than a net economic gain. Conversely, corporate dividend taxes and indirect business taxes associated with the proposed Project consist of tax items such as property tax and sales tax. These revenues stem directly from the construction and operation of the Project and are paid by the operator of the proposed Project, therefore can be counted as net economic gains when compared to the no action alternative.

As table 9-3 shows, the construction and operation of the Project is expected to generate a net present value of approximately $11.5 million in total enterprise and business tax revenues over the life of the Project. This estimate should be treated as a lower-bound estimate because the ad valorem and severance taxes associated with uranium mining in Sweetwater County are currently not available in IMPLAN.

Table 9-3 State and Local Tax Revenue IMPLAN Projections

	Net Present Value ($ Millions) *		
Activities	**Enterprise (Corporate) Tax**	**Indirect Business Tax**	**Total Taxes**
Construction	0.2	1.3	1.9
Operations	1.5	7.0	9.6
Total	1.7	8.4	**11.5**

*2007 DOLLAR EQUIVALENTS

Additionally, severance taxes associated with uranium mining in Sweetwater County are levied by the State of Wyoming, Mineral Tax Division of the Department of Revenue. The current uranium severance tax is 4% of taxable market value coming from mining operations (Wyoming Department of Revenue—Mineral Tax Division 2007). Current and historical resource estimates for the proposed combined projects are 13.5 million lbs. This does not include reserve estimates as these projections are not yet complete. Assuming that the identified 13.5 million lbs were sold at current long term market prices of approximately $90 per pound, the severance tax would yield approximately $48,600,000 in net economic benefits over the life of the operation.

In sum, the results show that $60.1 million net quantifiable economic benefits can be linked to the proposed project. It is noted that this figure represents a lower bound estimate as it excludes potential reserve resources and potential benefits derived from *ad valorem* taxes, taxes on royalties and lease payments to local landowners stemming from the operation of the proposed project.

9.4 EXTERNAL COSTS OF PROJECT CONSTRUCTION AND OPERATION

In this section of the analysis, external costs of the proposed Project are identified and compared to the no action alternative. Both short-term and long-term external costs that may affect the interest of people other than the owners and operators of the proposed Project are also identified and described.

9.4.1 Short Term External Costs

9.4.1.1 Housing Shortages

The area within a 50-mile radius of the project site includes portions of four counties in central and northeastern Wyoming, namely Sweetwater County, Fremont County, Carbon County and Natrona County. The proposed Antelope and JAB projects are located in Sweetwater County. Approximately 50 percent of the total construction and operations work force for the proposed Project would likely come from Sweetwater County. The remaining workforce would likely be based in Rawlins, located in neighboring Carbon County, as Rawlins provides work force for a number of large-scale construction and energy-related projects in the region.

The IMPLAN model results show that in 2009, the Project is expected to generate 794 new jobs due to construction-related activities. In 2010, 180 new jobs are generated for operations-related activities, which are expected to continue until 2024. In 2025, 70 jobs per year would be needed for central plant operations until 2039.

The nearest substantial housing stock is located in Rawlins. Nearby communities such as Bairoil and Jeffrey City, located in Sweetwater and Fremont Counties respectively also offer potential though relatively small numbers of available housing. Since the Project lies within commuting distance of Rawlins and other communities along the I-80 corridor in Sweetwater and Carbon counties, workers from these counties would likely commute from their homes, hence causing no significant impacts on the housing situation in these communities.

In the event that non-local workers are hired for the short-term construction phase of the Project, it is anticipated that few of the construction work force would purchase or rent housing of any type since rental housing usually require long-term lease contracts. In this situation, the present available stock of motel/hotel rooms would accommodate the temporary workers.

At least 50% of the operations workforce is expected to come from Sweetwater and Carbon counties. Those not located within commuting distance of the proposed Project would likely rent or purchase housing. In the unlikely event that the entire operations workforce are non-local and relocated to these counties, a maximum of 180 housing units would be required to accommodate relocating workers. Under this extreme scenario, the available housing units in Sweetwater and Carbon counties would not meet the demand for housing. On the other hand, the population increase would be a maximum 454 (180 workers times 2.52) based on the 2005 average household size of 2.52 in Wyoming. This increase would account for about one percent of the population of Sweetwater County as of 2006, and is within the county's annual projected population increase of 494 people per year between 2003 and 2010.

9.4.1.2 Impacts on Schools and Other Public Services

The Project Area is located within Sweetwater County School District 1, which serves all of Sweetwater County within 50 miles of the License/Permit Areas. However, the schools closest to the License/Permit Areas that would likely serve the project labor force are located in Carbon County School District #1. The nearest Sweetwater County community that provides education services to residents in the vicinity of the Project Area is the Bairoil Elementary School, which had a 2005 fall enrollment of 10 students. The school is located in Sweetwater County, but is administered through Carbon County School District #1. Rawlins is the closest city to the Project Area that provides a full range of education facilities, including three elementary school (total 2005 fall enrollment of 685) one middle school (2005 fall enrollment of 349), and one high school (2005 fall enrollment of 431) (Carbon County School District #1 2007).

Historic enrollment data indicates a fairly steady decline in school enrollment in the Carbon County School District # 1 from 1996 through 2004. Therefore, families moving into the Sweetwater County School District as a result of the proposed Project are not expected to significantly stress the current school system because it is presently under-capacity

Likewise, there is no significant change anticipated in the demand for local public services such as fire, police, water and utilities. As mentioned, at least 50% of the proposed Project's workforce would likely be local workers. The maximum population increase, primarily coming from operations worker would be 454, based on the 2005 average household size of 2.52 in Wyoming. This maximum possible increase would account for less than one percent of the combined populations of Sweetwater and Carbon Counties in 2006, thereby posing little or no change on the demand for local public services. Therefore impacts to community services such as roads, housing, schools and energy costs would be minor or non-existent and temporary.

9.4.1.3 Impacts on Noise and Congestion

There are no occupied housing units in the vicinity of the proposed Project. Open rangeland is the primary land use within and in the surrounding 2.0-mile area. Livestock grazing is the primary use of the rangeland in the Project Areas. Other uses include oil and gas production and minor dispersed recreation. As a result of the remote location of the Project and the low population density of the surrounding area, impact to noise or congestion within the Project area or in the surrounding 2.0-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Sweetwater or other neighboring counties.

9.4.2 Long Term External Costs

9.4.2.1 Impairment of Recreational and Aesthetic Values

While opportunities for developed and dispersed recreation exist throughout the four-county region surrounding the Project, there are currently no developed recreational sites, facilities or special recreational management areas within the Project area or in the surrounding 2.0-mile area. Most developed recreation opportunities within the surrounding 50-mile radius are specialized recreation management areas on public lands or community facilities in townships or urban areas for tourist services and facilities.

The Continental Divide National Scenic Trail runs two miles outside of the northeast boundary of the Project Area. No specific data on recreational use of the Project Areas are available; however, use is likely low because of the relatively small local population, long drives from major population centers, and lack of well-known natural attractions. Hunting is the most important recreational activity in the Project Areas. Hunting occurs primarily during the fall hunting seasons, specifically during September and October.

The general physical remoteness of the proposed Project and the anticipated low volume of recreational interest indicate that there are no significant long-term impairments to recreational values from developing the Project.

9.4.2.2 Land Disturbance

The Project area has been used historically for grazing, prospecting and oil and gas development; therefore, it is unlikely that any undisturbed land area currently exists within the proposed Project area. A significant, pre-existing human footprint on the landscape is evident in existing grazing activities and facilities (stock tanks, fences), oil production facilities and infrastructures that support these activities. Grazing and oil/gas production occur concurrently in any given parcel within the Project Areas. Oil and gas field infrastructure within the Project area and the surrounding 2.0-mile review area includes access roads, overhead electric distribution lines, and cleared rights-of-way for underground utilities, which are generally found along access roads. There would be negligible changes in land cover or land use from existing conditions outside of the 2.0-mile review area.

As the proposed Project would use in-situ recovery instead of conventional surface mining techniques, there would be limited land surface disturbance associated with the well field development and operation of the site. Land surface disturbance associated with well field development would also be short term as interim stabilization with native vegetation species is implemented as soon as construction activities are complete and maintained through the life of the well field. No tailings or waste rock would be generated. The processing plants and new private access roads would be confined to clearly delineated areas within and between the Project areas. While there would be some land use changes from the existing condition within the Project area, potential impacts will be minimal.

9.4.2.3 Habitat Disturbance

Currently, there is no federally or state designated wildlife habitat identified within the proposed Project area. As the Project area has been historically used extensively for livestock grazing and oil and gas development, there are no anticipated long-term losses to wildlife or wildlife habitat relative to the existing conditions resulting from the construction and operation of the proposed Project.

9.4.3 Groundwater Impacts

It is unlikely that any future irrigation development would occur within the proposed Project area due to limited water supplies, topography, soils, and climate. Irrigation within the 2.0-mile review area is anticipated to be consistent with the past. Based on population projections, future water use within the 2.0-mile review area would likely be a continuation of present use; therefore, it is anticipated that there would be no significant changes from the existing conditions for public water supply in the area.

Minimal effects to the existing aquifer as a result of drawdown are anticipated. Following standard mining practice, any contaminated water drawn from the aquifer on site would either be treated before re-injection or disposed through deep injection. Upon decommissioning, wells would be sealed and remaining groundwater would be restored. The primary goal of the groundwater restoration program would be to return groundwater affected by mining operations to baseline values on a mine unit average. The secondary goal would be to return the groundwater to a quality consistent with pre-mining use. Prior to mining in each mining unit, baseline groundwater quality would be determined. This data would be established for each mine unit at the minimum density of one production or injection well per four acres. Upon completion of restoration, a groundwater stabilization monitoring program would begin in which the restoration wells and any monitor wells on excursion status during mining operations would be sampled and analyzed for the restoration parameters.

Given the historically limited irrigation, the lack of domestic groundwater use, and the groundwater restoration program associated with the proposed Project, there would be no permanent commitment of water resources required and any potential long-term changes from the no action groundwater conditions would be limited to those identified and addressed in the groundwater restoration program.

9.4.4 Radiological Impacts

As the proposed Project would be using in-situ recovery techniques, most of the identified radioactivity in the ore body would remain permanently underground. Following standard ISR procedures, routine operational monitoring of air, dust and surface contamination would be undertaken by Uranium One as discussed in Section 5. Prior to process plant decommissioning, a preliminary radiological survey would be conducted to identify any potential radiological hazards. The survey will also support the development of procedures for dealing with such hazards prior to commencement of decommissioning activities.

Decommissioning of process facilities would be scheduled only after agency approval. This would be accomplished in accordance with an approved decommissioning plan and the most current applicable USNRC rules and regulations, permit and license stipulations and amendments in effect at the time of the decommissioning activity.

All process or potentially contaminated equipment and materials at the process facility including tanks, filters, pumps, piping, etc., would be designated for one of the following removal alternatives:

- Removal to a new location within the Project area for further use or storage;
- Removal to another licensed facility for either use or permanent disposal; or
- Decontamination to meet unrestricted use criteria for release, sale or other non-restricted use by the landowners and others.

It is likely that process buildings would be dismantled and moved to another location or to a permanent licensed disposal facility. Cement foundation pads and footings would be broken up and trucked to a disposal site or to a licensed facility if contaminated. The landowners may request that a building or other structures be left on site for future use. In that case, the building would be decontaminated to meet unrestricted use criteria. At the present time, burial of contaminants on site is not anticipated.

Under the proposed operating and decommissioning conditions, the potential long-term external radiological impacts at the Project are anticipated to be negligible compared to the existing background no action conditions.

9.5 BENEFIT-COST SUMMARY

A primary economic benefit of the Project is the creation of 1,044 new job opportunities within the county, including the direct, indirect and induced employment effects over the construction and operating life of the Project (Table 9-4). Additionally, the Project may generate up to $11.5 million in total state and local business tax revenues and $48.6 million in severance tax revenues over the life of the Project, which is a significant economic gain compared to the no action alternative.

Table 9-4 further shows that the short-terms effects on housing, schools and public facilities and the increased potential for noise and congestion in the county involve little or no change compared to the current conditions. Based on the historical land uses, physical remoteness and proposed reclamation practices, no potential quantifiable long-term impairments appear to significantly offset the benefits of the proposed Project.

The proposed Project is likely to place negligible short-term or long-term cost burdens on the county, while providing increased revenue and employment opportunities; therefore, the development and operation of the proposed Project would provide a net economic benefit to Sweetwater County when compared to the no action alternative.

Table 9-4 Summary of Benefits and Costs for the Antelope and JAB Project

Benefits	Costs
• **Tax revenue** $60.1 million • **Temporary and permanent jobs** 1,044 jobs	• **Housing impacts** Little or no change • **Schools and Public Facilities** Negligible • **Noise and Congestion** None • **Impairment of recreational and Aesthetic values** Negligible • **Land Disturbance** Minor • **Groundwater impacts** Controlled through mitigation • **Radiological Impacts** Controlled through mitigation

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TABLE OF CONTENTS

TABLE OF TABLES

10.0 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

Various permits and approvals from numerous Federal and State agencies will be required for the Antelope and JAB Project to operate. Section 10.1 identifies the issuing agencies, a description of the type of permit(s), license or approvals needed, and the current status of securing these approvals.

10.1 APPLICABLE REGULATORY REQUIREMENTS, PERMITS, AND REQUIRED CONSULTATIONS

As stated above, Table 10-1 lists the necessary environmental approvals from Federal and State Agencies required for the Antelope and JAB Project. The NRC Licensing process for a source materials license represents the longest lead-time approval; therefore, the majority of the remaining approvals are in-progress or will be initiated with in the next year. All necessary approvals must be secured prior to commencement of commercial production at the site.

Table 10-1: Environmental Approvals for the Antelope and JAB Uranium Project

Issuing Agency	Description	Status
Wyoming Department of Environmental Quality 122 West 25th St Herschler Building Cheyenne, Wyoming 82001	Underground Injection Control Class III Permit (WDEQ Title 35-11)	Class III UIC Permit application under preparation; expected submittal to WDEQ in the third quarter 2008
	Aquifer Exemption (WDEQ Title 35-11)	Aquifer exemption application under preparation; expected submittal to WDEQ in forth quarter 2008
	Underground Injection Control Permit (Deep Disposal Well) (WDEQ Title 35-11)	Class I UIC Permit application under preparation; expected submittal to WDEQ in first quarter 2009
	Industrial Stormwater NPDES Permit (WDEQ Title 35-11)	An Industrial Stormwater NPDES will be required for the Central Plant Area. Expected submittal first quarter 2009
	Construction Stormwater NPDES Permit (WDEQ Title 35-11)	Construction Stormwater NPDES authorizations are applied for and issued annually under a general permit based on projected construction activities. The Notice of Intent will be filed at least 30 days before construction activities begin in accordance with WDEQ requirements.

Table 10-1: Environmental Approvals for the Antelope and JAB Uranium Project

Issuing Agency	Description	Status
	Mineral Exploration Permit (WDEQ Title 35-11)	Approved Mineral Exploration Permit 353DN is currently in place for the Antelope and JAB areas.
	Underground Injection Control Class V (WDEQ Title 35-11)	The Class V UIC permit will be applied for following installation of an approved site septic system during facility construction.
U.S. Nuclear Regulatory Commission Washington, DC 20555	Source Materials License (10 CFR 40)	Application Submitted herein
U.S. Environmental Protection Agency 1200 Pennsylvania Ave, NW, Washington, DC 20460	Aquifer Exemption (40 CFR 144, 146)	Aquifer exemption application forwarded to EPA following WDEQ action
U.S. Department of Interior, Bureau of Land Management P.O. Box 589 Lander, WY 82520	BLM Right of Way (Roads) (43 CFR 3809 and BLM Manual 9113)	Right of Way Permit for road construction, including required design specifications is anticipated to be submitted to the BLM by July of 2009.
U.S. Department of Interior, Bureau of Land Management P.O. Box 589 Lander, WY 82520	Notice of Intent to Explore (43 CFR 3809)	Notice of Intent to Explore is currently in effect for the Antelope and JAB areas.

10.2 ENVIRONMENTAL CONSULTATION

During the course of the preparation of this license application, consultations were conducted with several agencies:

Ecological Resources

Preparation of the ecological resources discussion (Sections 2.0) required consultations with the following individuals and agencies:

Wetlands

Mike Burgan
Project Manager
United States Army Corps of Engineers
2232 Dell Range Blvd, Suite 210
Cheyenne, WY 82009-4942

Mark Moxley
Environmental Supervisor
Wyoming Department of Environmental Quality-Land Quality Division
510 Meadowview Drive
Lander, WY 82520

Melissa Bautz
Senior Environmental Analyst
Wyoming Department of Environmental Quality-Land Quality Division
510 Meadowview Drive
Lander, WY 82520

Soils

Tom Gustafson
Resource Soil Scientist
Natural Resource Conservation District
508 N Broadway
Riverton, WY 82501

Wildlife

BLM

- Sue Oberlie, Wildlife Biologist, Lander Field Office, 1335 Main/P.O. Box 589 Lander, WY 82520-0589 307-332-8400
- Rhen Etzelmiller, Wildlife Biologist, Rawlins Field Office, 1300 North Third/P.O. Box 2407 Rawlins, WY 82301-2407 307-328-4200

USFWS

- Patricia Deibert, Fish and Wildlife Biologist, USFWS, Ecological Services Office, Cheyenne, WY 5353 Yellowstone Road, Ste. 308A, Cheyenne, WY 82009

WGFD

- Greg Hyatt, Biologist, Lander Office 260 Buena Vista, Lander, WY 82520 307-332-2688
- Stan Harter, Biologist, Lander Office, 260 Buena Vista, Lander, WY 82520 307-332-2688
- Tom Christensen, Biologist, Cheyenne, WY 5400 Bishop Blvd, Cheyenne, WY 82006 303-777-4600

- Nyssa Whitford, GIS Coordinator, Cheyenne, WY 5400 Bishop Blvd, Cheyenne, WY 82006 303-777-4600