2.9 Background Radiological Characteristics

2.9.1 Introduction

This section presents the characterization methods used and the results of the pre-operational radiological baseline monitoring program conducted at the Ross ISR Project site between August 2009 and January 2011. Results presented are the measurements of natural radionuclides potentially occurring in important biota, soil, and air as well as surface and ground waters that could be affected by the proposed operations. The program, as described herein, presents information on which radionuclides were analyzed, the sampling locations, sample type, sampling frequency, location and density of monitoring stations, applicable detection limits and the analytical results.

The pre-operational radiological baseline program was conducted in accordance with the recommendations of:

- NRC Regulatory Guide 4.14, Revision 1, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC 1980)
- NRC Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, For In Situ Uranium Solution Mining", Section 2.9 (Radiological Background Characteristics) (NRC 1982)
- NRC Regulatory Guide 3.8, "Preparation of Environmental Reports for Uranium Mills" (NRC 1982)
- NUREG-1569, "Standard Review Plan For In Situ Leach Uranium Extraction License Applications" (NRC 2003b)

Field sample collection and/or measurement techniques were conducted using guidance (as recommended in 2.9.2 of NUREG-1569) from NUREG/CR–5849, "Manual for Conducting Radiological Surveys in Support of License Termination" (NRC 1992) or NUREG–1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" as applicable. For sampling and analysis of water, guidance from the EPA "Manual for Chemical Analysis of Water and Wastes" EPA-625-/6-74-003a, 1974 was also used. These field methods were incorporated into the Standard Operating Procedures (SOPs) that were used and are cross-referenced to the applicable program elements in Table 2.9-1. These SOPs are contained in Addendum 2.9-A.

Additional aspects of the radioanalytical program include the following:

- ♦ References to uranium analysis mean “total uranium”, assumed to be in the natural isotopic mixture of U-238, U-235 and U-234.
- ♦ Radionuclide parameters analyzed for water were defined by NUREG-1569, Table 2.7.3-1 along with NRC Regulatory Guide 4.14, Table 1.
- ♦ The radiological baseline program included the characterization of naturally occurring radionuclides in the following media:
  - ◊ Groundwater including the regional baseline monitoring wells and existing water supply wells,
  - ◊ Surface water, including runoff grab samples and reservoir samples,
  - ◊ Sediment Samples,
  - ◊ Radionuclide particulates in air,
  - ◊ Radon in air,
  - ◊ Surface soil (0-5 cm and 0-15 cm) and subsurface soil (0-100 cm),
  - ◊ Direct radiation measurements via field scanning,
  - ◊ Direct radiation measurements via thermoluminescent dosimeters (TLD),
  - ◊ Local vegetation potentially important to the human food chain, including hay crops and private garden vegetables,
  - ◊ Local animal tissue sampling of beef potentially important to the human food chain,
  - ◊ Local animal tissue sampling of wild game, and
  - ◊ Local animal tissue sampling of fish potentially important to the human food chain.

It should be is noted that the baseline monitoring program did not include radon flux. Radon flux sampling is of use for conventional mills where tailings impoundments are required and must meet radon flux standards as required in 10 CFR 40 Appendix A. As the ISR method does not involve generation of conventional tailings impoundments, radon flux measurements are not applicable to ISR facilities.

The components of the radiological baseline study are described in the following sub-sections. The guidance provided by NRC Regulatory Guide 4.14 is summarized for each program component. However, it must be recognized that this regulatory guide was written some years ago relative to the design and layout of conventional uranium mills. Accordingly, some modifications were made in the design and execution of this pre-operational radiological baseline program to accommodate the uranium ISR design, site layout and technology. These deviations are explained in the text and justification is provided to assure that the intent of Regulatory Guide 4.14 has been preserved. Many of these deviations are supported by guidance presented in NUREG-1569, "Standard Review Plan for In Situ Leach Uranium Extraction License Applications". Modifications and deviations from Regulatory Guide 4.14 that are presented in NUREG-1569 have been considered valid and compliant with current NRC standards for modern ISRs such as the Ross ISR Project.

The NRC was briefed on the baseline monitoring program in October 2009 and February 2010, as discussed in Section 1.9. A summary of meetings with the NRC and the public is provided in Table 1.9-1.

2.9.2 Program Elements – Radiological Baseline Characterization Program

For each program element the following format is used in each subsection:

- Summary and overview, including justifications for any deviations from NRC Regulatory Guide 4.14
- Number and location of samples
- Sampling methods and frequency
- Radionuclide analysis including analytical methods and minimum detection limits (MDLs)
- Data presentation
- Conclusions

2.9.2.1 Groundwater – Regional Baseline Monitoring Wells and Existing Water Supply Wells

Summary and Overview

Between 2009 and 2010 Strata established a monitoring network consisting of six well clusters as well as four CPP area piezometers. Quarterly samples from the six well clusters were taken from four depth intervals, surficial aquifer (SA), shallow monitoring zone (SM), ore zone aquifer (OZ), and deep monitoring zone (DM), throughout 2010. Sampling of the piezometers commenced in the second quarter of 2010 and continued quarterly throughout the year. In addition, Strata initiated quarterly sampling of existing water supply wells within and surrounding the proposed project area in the 3rd quarter of 2009. Section 2.7.3 provides more details on groundwater sampling locations and aquifers monitored.

Number and Location of Samples

Since ISR facilities do not have "conventional mill tailings", monitoring locations were selected based on anticipated hydrologic flow patterns relative to the mining zone and adjacent aquifers that require protection. Strata utilized the regional monitoring well network to characterize the up-gradient and down-gradient flow from the proposed locations of the CPP, disposal ponds, and wellfields within each aquifer.

The anticipated groundwater flow direction for confined or semi-confined systems in the proposed project area was anticipated to be to the west and north given structural implications of the Black Hills Uplift. However, abstractions in the form of stresses to the aquifers have altered the natural groundwater flow direction with a dominant pumping center located near the 21-19 well cluster. Withdrawals from the OZ and DM aquifer systems are apparent in the potentiometric surfaces presented in section 2.7.3. Based on these surfaces a summary of the upgradient and downgradient monitoring points is provided in Table 2.9.-2. The overlying aquifer (SM) and surficial aquifer (SA) largely represent ambient conditions; wells installed in these aquifers are also summarized in Table 2.9-2. Locations of the regional baseline monitoring wells and CPP area piezometers are depicted in Figure 2.7-14.

In addition to the regional baseline wells, Strata also sampled a total of 29 existing water supply wells comprising two industrial wells, 12 domestic wells and 15 livestock wells. A summary of the sampled water supply wells is presented in Table 2.7-44, while Figure 2.7-33 presents the location of each sampled water supply well. Fifteen of the sampled wells are located within a 2 km radius of the proposed area, including three wells within the proposed project area and the wells at the nearest residences. Wells outside of the 2 km boundary were included in the baseline monitoring program since water is supplied for domestic and livestock consumption.

Sample Methods and Frequency

All groundwater sampling was completed in accordance with procedures outlined in SOP 9, provided in Addendum 2.9-A. The regional baseline monitoring wells were sampled quarterly, with samples collected in January, May, July and October of 2010. Sampling of the existing water supply wells commenced in the 3rd quarter of 2009 and continued through 2010. The samples were collected "as available," as some privately owned wells were unavailable for sampling due to winterization or temporarily non-functioning.

Radionuclide Analysis

The radiological analytes and analytical methods used for groundwater samples are summarized in Table 2.9-3. Regulatory Guide 4.14 suggests quarterly analysis of all baseline and groundwater well samples for dissolved U-nat, Ra-226, Th-230, Pb-210, and Po-210. Wells used for potable water, livestock and crop irrigation were sampled for suspended U-nat, Ra-226, Th-230, Pb-210, and Po-210. While NUREG-1569, Table 2.7.3-1 provides "Typical Baseline Water Quality Indicators to be Determined During Pre-operational Data Collection" and states that "the list of constituents in Table 2.7.3-1 is accepted by the NRC for *in situ* leach facilities." This table recommends sampling for uranium and Ra-226 as trace and minor elements and gross alpha and gross beta as radiological parameters. For the first three quarters of sampling in 2010, Regulatory Guide 4.14 analysis parameters were followed with the addition of gross alpha and gross beta measurements. Because there were no results for Pb-210, Po-210 and Th-230 in the first three quarters of data that were inconsistent with other results or atypical for a mineralized area, the analysis parameters were reduced in the 4th quarter to reflect the NRC accepted ground water quality indicators provided in NUREG-1569 to expedite analysis time.

Additionally some wells were sampled prior to the 2010 baseline sampling program. Because these wells were tested prior to the program start, there are some parameters that are listed as not measured. The program was altered by the start of the 1st quarter of 2010 to be consistent for all samples.

Data Presentation

The radiological baseline groundwater monitoring results for the regional baseline monitoring wells are presented in Figures 2.9-1 through 2.9-8, while

Figures 2.9-9 through 2.9-16 provide the results for the water supply wells. The figures show the concentration of analytes measured by quarter. Additionally, each figure shows the applicable water effluent Maximum Permissible Concentration (MPC) as listed in 10 CFR 20, Appendix B, Table 2, Column 2 as a line across the top. Currently, there are no water effluent MPCs for Gross Alpha, Gross Beta, or Rn-222 and therefore the lines across these charts do not indicate a MPC value. Only results that are considered statistically significant (above the MDL for the laboratory method) are shown in the graphs. All of the radiological groundwater monitoring results are provided in Addendum 2.9-C.

Conclusions

Overall the groundwater wells exhibited considerable radionuclide variability, which is expected in a mineralized regime. Where individual wells were sampled multiple times, results were generally consistent. No consistent effect of seasonality could be observed without more rigorous statistical analysis.

It is of particular interest to compare the radionuclide concentrations from the water supply wells to EPA drinking water criteria for those radiological parameters for which numerical criteria have been promulgated (Radionuclides Rule 66 FR 76708 December 7, 2000 Vol. 65, No. 236). Relative to U-nat series radionuclides, EPA's MCLs are as follows:

Uranium = 30 μg/L
Combined Ra-226 and 228 = 5pCi/L
Gross alpha = 15 pCi/L

Numerous sample results exceed at least one of the three criteria at least once, and in some cases more than one criterion was exceeded consistently. Overall, the results indicate that 13 wells exceeded the gross alpha MCL at least once, seven wells exceeded the uranium MCL and two wells exceeded the Ra-226 and 228 MCL. Section 2.7.3 provides a discussion of the groundwater quality compared to WDEQ and EPA standards, while a detailed comparison of monitored groundwater quality to EPA and WDEQ standards is provided in Addendum 2.7-K.

It should be noted that EPA drinking water standards apply to public water supplies, not private water wells. Additionally, the EPA's uranium standard is based on the level of protection required to protect against nephrotoxicitiy (damage to the kidney) with a conservative margin of error. To date, there have been no studies that have shown a radiological carcinogenic (cancer causing) hazard from ingestion of uranium in drinking water or any known cases of permanent kidney damage in humans from drinking water with high levels of U-nat. The average resident of the United States receives a radiological dose of 310 mrem/yr (NCRP 1992), as a result of naturally occurring and manmade radiation exposures. Drinking 2 L/day of water at the maximum EPA drinking water standard (30 μg/L) would contribute approximately 4 mrem/yr.

2.9.2.2 Surface Water

Summary and Overview

The surface water monitoring network was established by Strata to satisfy Regulatory Guide 4.14 requirements. Regulatory Guide 4.14 requires that surface water samples be obtained from the following types of locations.

- Large, permanent water impoundments on or offsite that could be impacted by direct surface drainage from contaminated areas.
- Surface water passing through site or offsite surface waters (e.g., "streams") that could be impacted by surface drainage.

Strata's monitoring network consisted of stations situated along ephemeral surface water channels passing through the proposed project area as well as reservoirs located within the proposed project area. The surface water monitoring network is discussed in detail in Section 2.7.1 and depicted on Figure 2.7-7.

Number and Location of Samples

As discussed in Section 2.7.1, Strata installed surface water monitoring stations at two sites on the Little Missouri River and one site on Deadman Creek in June 2010. Each surface water station was equipped with a continuous flow monitor and passive sampler. The samplers provided the capability to automatically collect a sample in the event of significant runoff, although no events occurred. Prior to installation of the stations Strata collected two grab samples from each site (March and April 2010). In addition to the surface water monitoring stations, Strata also monitored 11 reservoirs located within the proposed project area. A summary of the reservoir sampling is presented in Table 2.7-13.

Sample Methods and Frequency

Surface water monitoring followed the sampling methods described in SOP 8, provided in Addendum 2.7-A. Regulatory Guide 4.14 requires that bodies of water flowing through the site be sampled monthly. However, this was not possible due to the ephemeral nature of streams in the proposed project area. An attempt to monitor the streams as frequently as possible was made with the implementation of active samplers. However, the frequency of sample collection and analysis was dictated by stream flow, no samples were collected after May 2010 when flow rates at all sites were less than 0.5 cfs. Other surface water bodies were sampled quarterly, when conditions allowed. Samples from the Oshoto Reservoir were available for all quarters; however, several smaller reservoirs were frozen during the winter quarter (January through March 2010).

Radionuclide Analysis

Table 2.9-4 present the analytes, analytical methods and MDLs for surface water samples.

Data Presentation

Results of the baseline surface water monitoring are presented in Figures 2.9-17 through 2.9-23 for each constituent. All graphs show the results in comparison to the MPCs of effluents in water released to unrestricted areas listed in 10 CFR.20, Appendix B, Table 2, with the exception of gross alpha and gross beta. These MPCs were used only as a frame of reference since they are not applicable to background conditions. Only results that are considered statistically significant (above the MDL for the laboratory method) are depicted in the graphs. All of the radiological surface water monitoring results are provided in Addendum 2.9-C.

Conclusions

The surface water monitoring results indicate variability for some analytes (gross alpha, Ra 226 and uranium in particular) between locations although no effect of seasonality was apparent. These results are typical for natural background in mineralized areas. Overall, the concentrations for all samples were less than the MPCs for release of effluents in water to unrestricted areas as defined in 10 CFR 20, Appendix B, Table 2.

2.9.2.3 Sediment Sampling

Summary and Overview

Sediment samples were collected in August of 2010 at the Oshoto Reservoir and the three surface water monitoring stations. Regulatory Guide 4.14 recommends that sediment samples be obtained from the following types of locations.

- ♦ Large, permanent water impoundments on or offsite that could be impacted by direct surface drainage from contaminated areas.
- ♦ Surface water passing through site or offsite surface waters (e.g., "streams") that could be impacted by surface drainage

Number and Location of Samples

One sediment sample was collected from each surface water monitoring station as well as Oshoto Reservoir. NRC Regulatory Guide 4.14 for sediment recommends sampling in flowing bodies of water and suggests two samples representing spring and late summer. Since the streams within the proposed project area are ephemeral the samples were collected during late summer and just after spring runoff.

Sample Methods and Frequency

The sediment samples were collected from the thalweg portion of the stream channels at each surface water monitoring station. Due to the ephemeral nature of the streams in the project area, samples were not collected along a traverse and composited as recommended in NRC Regulatory Guide 4.14.

Radionuclide Analysis

All sediment samples were analyzed for uranium, Ra-226, Th-230, and Pb-210 per NRC Regulatory Guide 4.14. Table 2.9-5 summarizes the analytes, analytical methods and MDLs for sediment samples.

Data Presentation

The results of the sediment sampling are presented in Table 2.9-6.

Conclusions

The baseline sediment sampling results indicated that one sample (SW-1-SED) reported erroneously high concentrations of Pb-210 and Th-230 compared to the other sediment samples. Since the gross alpha result of the sample was only slightly elevated relative to other results, the high concentrations are likely a result of an analytical error. Overall, the results of the sediment sampling were as expected with radionuclide concentrations near or below detection limits.

2.9.2.4 Radionuclide Particulates in Air

Summary and Overview

Regulatory Guide 4.14 recommends a total of five air particulate monitoring stations, which include:

- ♦ Three air monitoring stations at or near the site boundary in the downwind direction.
- ♦ One air monitoring station at the nearest residence within 10 km of the site representing "highest predicted concentration."
- ♦ One air monitoring station at a control location, upwind and remote from the site.

As part of the baseline monitoring, Strata installed six air sampling stations immediately adjacent to the proposed project area. The placement of these stations was based on data of prevailing winds from nearby weather stations and confirmed with site specific data. Assumptions on prevailing winds at the property were made from two main sets of data: a National Weather Service (NWS) station located in Gillette, WY and the 1977 Nubeth application. The NWS station, approximately 50 miles from the site, records prevailing winds from the northwest and southwest while Section 2.5.3 of the 1977 Nubeth application (SUA-1331) describes predominately westerly winds at the site. Based on this information the meteorological monitoring station was placed on the northwest boundary of the proposed project area such that it would be generally upwind, and on relatively high, unobstructed terrain. The upwind southwest station sampling station was defined as the background sampling location.

Number and Sample Locations

Strata commenced operation of five air particulate monitoring stations located on January 5, 2010. In November 2010, Strata added an additional monitoring station to provide further coverage. Throughout the baseline monitoring program the particulate monitoring stations were maintained by Inter-Mountain Laboratories of Sheridan, WY. The locations of the air monitoring stations in relation to the proposed project area are shown on Figure 2.9-24.

Placement of the stations was consistent with Regulatory Guide 4.14, Section 1.1.1, and (a) included site boundary locations representing “points of compliance” during operations relative to permissible releases of radioactive materials in air to unrestricted (public) areas; (b) in directions of prevailing/highest frequency wind with respect to project activities; and (c) at the location of nearby residence(s) that would represent the potentially “maximally exposed offsite individual” from project airborne releases under normal operations and/or accidental releases. The maximally exposed individual is defined using likely scenarios of regular workers and residents at the site in conjunction with MILDOS modeling. A detailed explanation of the modeling, including the identification of the maximally exposed person/resident can be found in Section 7.3.

Historical meteorological records indicated predominantly westerly winds in the vicinity of the proposed project area. Based on this information, the Strata office at Oshoto (approximately ¼ mile east of the proposed project area) was identified as the structure likely to experience the greatest impact from the proposed Ross ISR Project. Subsequent to installation of the air samplers, a preliminary MILDOS model was run utilizing meteorological data from the Gillette Airport. Unlike the Nubeth report, the Gillette wind data showed a strong southerly component. The model output indicated that the structure with the highest predicted impact from milling operations was the Wesley residence, located approximately ¼ mile north of the proposed project area. Additional on-site wind data collected through the first half of 2010 confirmed the predominant southerly wind direction. Based on these results Strata installed a sixth air particulate sampler near the Wesley residence. The final MILDOS-AREA results, presented in Section 7.3, confirm that the “maximally exposed offsite individual” would reside at the Wesley residence.

The Meteorological Station site, located northwest of the proposed project area, was initially considered to be upwind from the project. Under the assumption of predominantly westerly and northwesterly winds, an air sampler was co-located with the meteorological tower to measure background concentrations. With the emergence of on-site data that reveal the southerly winds as the dominant component (see wind rose Figure 2.9-25), the Southwest site appears most representative of background.

Sampling Methods and Frequency

Air particulate samples were collected using F&J Specialty Products Models DF-40L-BL-AC and LV-1D samplers. Filters were collected from each air-sampling unit on approximately a weekly basis during a three-month quarter. The collected set of filters (typically about 13, one per week) for each air sampling unit were composited and sent to a contract laboratory for analysis at the end of each calendar quarter.

The sampler units were operated at flow rates sufficient to ensure minimum detectable activities were achieved. A detailed description of the sampler unit, including operation, are described in SOP 3, provided in Addendum 2.9-A.

Radionuclide Analysis

Table 2.9-7 presents analytes, analytical methods and MDLs for air particulate (filter) samples to detect radionuclides in ambient air.

Data Presentation

Results for three quarters of the baseline radionuclide particulates in air sampling program are provided in Table 2.9-8. The results of the last quarter of data will be provided to the NRC as Addendum 2.9-D in February, 2011. The addendum will include a summary of the data, laboratory and field sheets, and final conclusions.

Conclusions

Results for the three quarters of data are consistent for all sites with no unusual anomalies or unexpected results. Overall, results indicate consistently high Pb-210 concentration in comparison to other radionuclides. These results are likely attributed to Pb-210 being a radon (gas) progeny making it more mobile in the atmosphere than the other particulate radionuclides which result from resuspension of soil particles. Conclusions on seasonal variations will be made when all four quarters of data are available.

2.9.2.5 Radon in Air

Summary and Overview

Regulatory Guide 4.14 recommends that radon in air measurements be co-located with the air particulate monitoring stations. Since ISR activities at the site will occur at the CPP and over the ore bodies, which are generally long, narrow and discontinuous, Strata located the radon detectors at the air monitoring stations and other locations commensurating with the TLD baseline monitoring program. These locations are consistent with the layout of modern ISRs and areas with potential radiological impacts.

Radon sampling was conducted with Landauer high sensitivity environmental radon Trak-Etch detectors. The first radon detectors were deployed to the site between January 12 and January 15, 2010.

Number and Location of Samples

A total of 17 radon sampling locations were used as part of the baseline monitoring program. As depicted on Figure 2.9-26, the radon detectors were located at each air particulate sampling station, the four residences nearest to the site, the potential locations for the CPP and evaporation ponds, the former Nubeth R&D site, and over two of the ore bodies identified for potential mining. These locations provided a baseline characterization of the areas with the greatest potential for radiological impact from the mining and milling process. Two of the stations (16 and 17) were established in mid-2010 with decommissioning occurring in the second and third quarters of 2012.

Sampling Methods and Frequency

Radon concentrations tend to be highly variable, both diurnally and seasonally, and require long-term continuous monitoring to be effectively characterized. The method employed for the Ross ISR Project used “alpha track” detectors (specifically, Radtrak detectors available from Landauer, Inc.) for the measurement of radon. The detector incorporates a radiosensitive element that records alpha emissions (that become visual tracks when subsequently processed) from the decay of radon and its short-lived decay products. The number of tracks over a pre-determined area is counted using a microscope or optical reader. The radon concentration (in pCi/L of air) is determined by the number of tracks per unit area in combination with the time of exposure.

Radon monitoring was completed in accordance with procedures described in SOP 1, provided in Addendum 2.9-A. The monitors were mounted approximately one meter off the ground from either steel posts driven in the ground for this purpose or on fence posts at locations where fencing was already present. Detectors were exchanged and returned for analysis to the vendor on a quarterly basis.

Radionuclide Analysis

Detectors were analyzed by Landauer, the supplier. The sensitivity of the RadTrak detector is typically in the range of 20 to 40 pCi/L/day. Assuming a quarterly (90 day) exposure period, the minimum detectable concentration is around 0.22 to 0.44 pCi/L radon in air.

Data Presentation

Results for three quarters of the baseline radon in air sampling program are provided in Table 2.9-9.

Conclusions

The results for all 17 locations and all quarters were consistent in that no unusual anomalies or unexpected results were reported. Results for all locations during all quarters were in the range of 0.1-2.0 pCi/L in air, which is a typical range for out of doors background in the Rocky Mountain States. In addition, the data indicated that there were no seasonal trends.

2.9.2.6 Soil Samples

Summary and Overview

The baseline soil sampling program was completed between June and August 2010. The soil sampling program involved surface and subsurface sampling. NRC Regulatory Guide 4.14 suggests that surface soil samples be collected to a depth of 5 centimeters at least once prior to construction, while the current reclamation standards (e.g., 10 CFR 40, Appendix A, Criterion 6) specify clean-up criteria based on surface soil samples to a depth of 15 cm. To satisfy the recommendations in Regulatory Guide 4.14 as well as the practical need for surface soil samples that characterize future clean-up standards, soil samples were taken over both the 0-5 cm and 0-15 cm intervals.

Regulatory Guide 4.14 also provides recommendations for subsurface soil sampling as part of the baseline monitoring program. The guidance recommends that subsurface samples be collected to a depth of one meter. To fulfill the recommendations, Strata collected three samples at each sampling site at 0-30, 30-60 and 60-100 cm depth intervals. In addition, NUREG-1569 suggests that a general description of the site soils and their properties be provided to support an evaluation of the environmental effects of construction and operation on erosion. Section 2.6.5 provides a discussion of the soils within the proposed project area, while specific soil details can be found in Addenda 3.3-A through 3.3-F of the ER.

Number and Location of Samples

For the proposed project area, soil sample locations were selected with bias toward areas of the site most likely to be impacted by the ISR process or otherwise of importance. Regulatory Guide 4.14 recommends locations for surface soil samples at 300 m intervals out to a distance of 1,500 m, in the eight cardinal directions from a point representing the geometric center of onsite processing activities and also at the air monitoring stations. Regulatory Guide 4.14 also recommends a total of five subsurface soil samples, collected at the center of the tailings pile and a distance out to 750 m in each cardinal direction.

The locations for soil sampling were adjusted from those recommended in Regulatory Guide 4.14, to properly characterize radiological baseline relative to the design, layout, and technology of modern ISR facilities. As described in Section 5.7 and 7.3, the Ross ISR Project will utilize vacuum dryers in the yellowcake circuit. Therefore, the only potential releases from uranium recovery activities would be liquids from leaks and spills and radon gas (i.e., see NRC NUREG-1910, Generic Environmental Impact Statement for In Situ Leach Uranium Milling Facilities, Section 4.2.11).

The soil sampling program used for baseline monitoring identified specific areas based on the proposed site layout. The sample sites included the three residences nearest the proposed project area, the Strata field office, the former R&D site, the air sampling stations, the potential location of the CPP, the potential locations of the disposal ponds, and locations along the major ore bodies where production and recovery wells will be located. Areas over the major ore bodies were of particular interest for the soil sampling program as the ISR process will involve many wells drilled into the ore bodies that will be connected by piping to the CPP. Pipe leaks could potentially occur along the ore bodies that could impact the soil. Additional soil sampling completed in conjunction with the field gamma survey study is discussed in Section 2.9.2.7.

Surface soil samples were collected from 39 locations within and surrounding the proposed project area, while 18 of the sites were also used for subsurface sample collection. Locations of soil samples are shown in Figure 2.9-27. All sample locations were recorded with coordinates provided by a GPS unit. In order to characterize soils along the ore bodies, axes were drawn through the middle of the major ore bodies and sample locations were chosen approximately every 300 m in an attempt to satisfy the intent of the original guidance in Regulatory Guide 4.14. In addition, subsurface soil samples were collected at one location within each of the areas of known mineralization, as depicted in Figure 2.9-27.

Sampling Methods and Frequency

Soil samples were collected in accordance with SOP 4, provided in Addendum 2.9-A. Surface soil samples were obtained at each location from the top 15 cm of surface soil or at the bedrock surface, whichever was shallower. In addition, selected surface soil sample locations were also sampled from the top 5 cm to fulfill the requirements of Regulatory Guide 4.14 for surface soil sampling. Subsurface soil samples were collected over the intervals of 0-30, 30-60 and 60-100 cm. Subsurface soil sample locations also included a surface soil sample from the 0-15 cm interval. All soil samples were collected once during the baseline monitoring program.

Radionuclide Analysis

Table 2.9-10 summarizes the analytes and analytical methods for surface soil and soil profile samples. All surface soil samples were analyzed for Ra-226 and gross alpha. In addition, soil samples from the five air monitoring stations as well as approximately 10 percent of the remaining surface soil samples were analyzed for U-nat, Th-230 and Pb-210. Regulatory Guide 4.14 requires one of the five (20%) required subsurface soil samples be analyzed for U-nat, Th-230 and Pb-210. To comply with the intent of this requirement, 24 percent of the soil profiles were analyzed for these additional radionuclides.

Data Presentation

The results of the radionuclide in surface and subsurface soil sampling program are presented on Table 2.9-11.

Conclusions

In general, results reported in Table 2.9-11 are consistent with expectations of typical surface and near surface soil radiological background of 1-2 pCi/g for total uranium, Ra-226 and gross alpha. Four surface soil results (0-15 cm depth) were in excess of the clean-up criteria for residual radioactivity as specified in 10 CFR 40, Appendix A, Criteria 6(6) {e.g., 5 pCi/g Ra-226 in first 15 cm; 15 pCi/g in 15 cm horizons below}. These results are not unusual given the potential for naturally occurring elevated levels of uranium and radium in mineralized areas (NCRP 1992).

2.9.2.7 Direct Radiation Measurements - Gamma Field Surveys

The following presents a summarized version of the full gamma survey report prepared by Tetra Tech, Inc. The report in its entirety is available in Addendum 2.9-B.

Summary and Overview

A baseline radiological investigation of the proposed project area was conducted by Tetra Tech from July 19 through 22, 2010. Activities included collection of baseline gamma exposure rates, correlation with measured dose rates and collection of soil samples for laboratory analysis of Ra-226 concentrations. The results were used to assess potential relationships between radiation levels and radium concentrations in soil.

Regulatory Guide 4.14 recommends a pre-operational gamma survey covering an area with up to 80 individual gamma exposure rate measurements (NRC 1980). This sampling design includes a higher density of measurements clustered near the mill location with more dispersed measurements in a radial pattern at greater distances from the mill. Since the guidance does not address differences or special considerations associated with ISR facilities, the recommendations were modified to account for technological advances capable of providing much higher density and more uniform gamma measurements across very large areas. The technologies used for the baseline radiological investigation were consistent with ISR License Application guidelines described in Regulatory Guide 3.46 (NRC 1982) and NUREG-1569 (NRC 2003b), as well as field survey considerations outlined in MARSSIM, the Multi-Agency Radiation Survey and Site Investigation Manual (NRC 2000).

The gamma radiation survey utilized sodium iodide (NaI) gamma radiation detectors and rate meters paired with GPS units. The systems were mounted on all-terrain vehicles. Since NaI systems exhibit energy-dependent response characteristics, the detectors over-estimate exposure rates from lower-energy radiation (predominant at ISR sites). Therefore, exposure rates were compared to Bicron® micro-rem radiation measurements at ten sites within the proposed project area. Soil samples were also collected during the baseline radiological investigation for correlation between gamma radiation and soil radionuclide concentrations. The samples collected were in addition to the soil sampling discussed in Section 2.9.2.6.

The NaI detectors were cross-calibrated in the field against an energy-independent micro-rem meter previously calibrated to a high-pressure ionization chamber. These data were used to statistically convert raw NaI scan data to estimates of true gamma exposure rates. This allowed a common (instrument independent) basis of comparison for evaluations with future gamma surveys (surveys that may use different gamma survey instruments, configurations, or measurement technologies).

<u>Number and Location of Samples</u>

A total of 80,833 valid gamma exposure data points were collected over the proposed project area. In addition, soil samples were collected at ten locations within the proposed project area as depicted in Figure 2.9-28. The sampling locations were selected based on the gamma radiation survey results and covered the measured exposure rate range. These sample locations were also used to compare Bicron® dose rates to measured gamma exposure rates.

Sampling Methods and Frequency

The gamma survey utilized Ludlum 44-10 2-inch sodium iodide (NaI) gamma radiation detectors coupled to Ludlum 2350-1 rate meters. Dose rate measurements were made using a Bicron® detector. Each soil sample was a composite of nine sub-samples collected to a depth of 15 cm. Configuration and use of these systems for this project were consistent with methods described in SOP 7, included in Addendum 2.9-A.

Radionuclide Analysis

Gamma survey exposure rate data with corresponding GPS coordinates were recorded as μR/hr, while dose rate measurements made with the Bicron® were recorded as mrem/hr. Soil samples were analyzed for Ra-226 by ALS Laboratory in Fort Collins, CO. A detailed discussion of the Tetra Tech's QA/QC methods are discussed in the report, provided in Addendum 2.9-B.

Data Presentation

Gamma radiation exposure rates measured at the proposed project area are depicted on Figure 2.9-29. Analytical results for the soil samples and corresponding gamma radiation exposure rates are presented in Table 2.9-12, while dose rate estimates for the proposed project are presented on Figure 2.9-30.

Conclusions

The gamma radiation exposure rates measured at the proposed project area ranged from 5.3 to 25.3 μR/hr, with a standard deviation of 1.54 μR/hr. The lowest gamma exposure rates (5 μR/hr to 6 μR/hr) were measured along D-Road (running north-south on the western property boundary), while some of the higher exposure rates were measured on CR 193 (14-16 μR/hr). The difference in exposure rates indicate that the road base material on CR 193 is likely different than material used on other roads in the area. Within the proposed project area the highest gamma exposure rates was observed in a small area in the southern section.

Analytical results for the soil samples indicated that all Ra-226 concentration were at or near typical natural background levels (<1 pCi/g), with the exception of one sample collected at site ROSS-CORR5. This site, located in the southern portion of the proposed project area, also corresponded with a higher gamma radiation exposure rate in comparison to other sites. In general, gamma exposure rates corresponding with the low concentrations of radium in soil are a result of Th-232 and K-40, rather than Ra-226 decay products. Tetra Tech's experience with similar sites indicate that correlations are not common until soil radium concentrations approach 3 to 5 pCi/g.

The results for the gamma exposure rate and dose rate correlation analysis indicated there was low radiation variability observed throughout the proposed project area. A linear regression of the data resulted in a strong coefficient of determination (R^2=0.93). The overall difference between measured exposure and dose rates is directly attributable to the over response of NaI detectors to the lower energy photon fields. The results of the regression analysis were used to calculate radiation dose rates throughout the proposed project area.

Overall, the results of the baseline radiological investigation in combination with the results of the long term average exposure rates (Section 2.9.2.8) will facilitate the future assessment of any contamination resulting from ISR activities.

2.9.2.8 Direct Radiation – Long Term Studies

Summary and Overview

The long term gamma radiation monitoring program was implemented in conjunction with the radon in air monitoring program on January 12, 2010. Long term gamma radiation was measured using Landauer environmental low level TLDs.

Regulatory Guide 4.14 recommends preoperational direct radiation measurements be obtained at 150 m intervals out to 1,500 m in eight cardinal directions from the center of the uranium milling area and also at air particulate stations to determine average exposure rate. Strata employed a much more extensive data set, consistent with the expanse and layout of modern ISRs, as described previously in this report (e.g., Section 2.9.2.5, Radon in Air; 2.9.2.6, Soil Samples).

Number and Location of Samples

TLDs were installed at the air particulate stations (Section 2.9.2.4) and at additional locations across the project site, consistent with the approach and rational previously described in Section 2.9.2.5 regarding the radon in air monitors. The locations were identical to those of the radon monitor locations shown in Figure 2.9-26 that were selected to be spatially representative and to obtain general coverage across the project site. The number and location of TLD dosimeters deployed and the rationale for these locations takes into account Regulatory Guide 4.14 requirements. Initially, there were a total of 15 TLD locations placed in the field. Two additional TLDs were placed in the field in May, 2010 on the northern boundary of the proposed project area. These locations were chosen to represent a potential CPP location, although this location was not chosen for the proposed CPP.

Sampling Methods and Frequency

TLDs were supplied by a vendor (Landauer, Inc.) and exchanged on a quarterly basis. After approximately a 90 day exposure period in the field, the dosimeters were replaced with "unexposed" units. The exposed units were returned to the vendor for analysis.

TLDs were mounted on posts approximately 3 feet off the ground. TLDs were emplaced and retrieved in accordance with SOP 2, provided in Addendum 2.9-A.

Radionuclide Analysis

Environmental TLDs have sensitive elements constructed of special aluminum oxide materials that when exposed to ionizing radiation (photons), store the absorbed energy in the material's crystal lattice. Upon stimulation by heating or by special light sources (depending on dosimeter type), the stored energy is released in the form of light photons which are converted into an electronic signal by a photo multiplier tube and recorded to provide a measure of light emissions. Light emission is proportional to the amount of energy (ionizing radiation) absorbed by the dosimeter materials, and the total dose received is calculated using algorithms based on controlled calibrations.

Data Presentation

Tables 2.9-13, 2.9-14, and 2.9-15 present the results for the first three quarters of monitoring. The results of the last quarter of monitoring will be provided to the NRC as Addendum 2.9-D in February, 2011. The addendum will include a summary of the data, laboratory and field sheets, and final conclusions.

Conclusions

Since only three quarters of data are reported at this time, no final conclusions in regards to the potential for seasonal or spatial variability can be made. However, preliminary results indicate typical regional background for cosmic and terrestrial exposure rates. Results for the three quarters range from 8 to 14 uR/hr, which is consistent with the direct gamma exposure rate field surveys results reported in Section 2.9.2.7.

2.9.2.9 Vegetation and Crop Sampling

Summary and Overview

Vegetation and crop sampling was completed with cooperation of landowners within and surrounding the proposed project area. The baseline vegetation and crop sampling program was conducted during the 2010 growing season (June through September).

Regulatory Guide 4.14 recommends vegetation sampling from grazing areas near the site with the highest predicted air particulate concentration during operation and sampling of all food products within 3 km of the proposed project area at the time of harvest.

Number and Location of Samples

Since grazing animals within and surrounding the proposed project area feed on a diet of grasses and shrubs, a field reconnaissance was completed to assess species' presence and abundance and to select general areas for plant sampling. The list of vegetation species observed during the 2010 field study is discussed in Section 2.8.

Eleven vegetation samples were collected to best represent the diets of grazing animals located on or near the proposed project area. The sample locations are shown in Figure 2.9-31. In general, sampling was concentrated in areas most likely to be impacted by the mining and milling process. Samples were collected not only downwind, but also at the proposed CPP and evaporation pond areas and along the major ore bodies. In general, the wellfields have the greatest potential for leaks resulting in impacts to the soil quality (with resultant uptake by vegetation) while offsite areas have the potential for radionuclide particulate deposition on vegetation via the air pathway (i.e., radon progeny). Table 2.9-16 lists the location numbers for the vegetation sampling and their sampling location rationale.

Based on MDL requirements by the laboratory to meet NRC standards, the minimum size of samples was 8 kg. Due to the considerable sample size it was not practical to take samples by species for each type of vegetation present in grazing areas without considerable species depletion. Therefore, composite samples of typical food products for grazing animals were made at each location. In addition, wetland species were sampled near the confluence of Oshoto Reservoir and the Little Missouri River.

Food crop sampling included hay crops and produce from personal gardens. Three samples of hay crops from local landowners were obtained at the time of harvest in late July to early August 2010. Produce from personal gardens was limited due to the large sample size required (8 kg) for the samples. One sample of beets, zucchini, and potatoes was received from the personal garden at the Strong Residence, a garden bordering the proposed project area.

Sample Methods and Frequency

Sample collection was carried out in accordance with SOP 6, provided in Addendum 2.9-A. Grazed vegetation samples were collected three times during the growing season, in accordance with Regulatory Guide 4.14. Samples were obtained in the months of July, August, and September of 2010. Samples for each type of vegetation were collected at least two weeks apart. Three samples of hay crops were collected during the harvest season and three samples of different vegetables (one sample each) were collected from a landowner's personal garden in the month of September. Only the edible portions of all crops and vegetation were used for analysis. Sample site locations were documented with a GPS field unit.

Radionuclide Analysis

Table 2.9-17 presents analytes and analytical methods for vegetation and food products. All vegetation and food product samples were analyzed for total uranium, Th-230, Ra-226, Pb-210 and Po-210, per Regulatory Guide 4.14.

Data Presentation

Grazing vegetation data analysis is presented in Tables 2.9-18 through 2.9-20, while wetland vegetation results are provided in Table 2.9-21. Table 2.9-22 summarizes the results of vegetation samples taken from hay crops and the vegetable garden.

Conclusions

Some variability was observed across the sampling campaigns and the overall data set which is not unusual due to species-specific uptake characteristics for certain elements/radionuclides. For example, Pb-210 values were consistently higher than other radionuclides as would be expected due to the typically greater bioconcentration in plants of this element. Nonetheless, the data set provides a comprehensive natural baseline of terrestrial radionuclides in the vegetation within the proposed project area environs.

2.9.2.10 Animal Tissue Sampling - Livestock

Summary and Overview

Several animal tissue samples were collected from locally raised beef cattle in cooperation with the local landowners in July 2010. NRC Regulatory Guide 4.14 recommends the sampling and analysis of the edible portions of livestock raised within 3 km of the site.

Number and Location of Samples

Cattle are raised on and near the proposed project area for human consumption. As many of the cattle only live on or near the proposed project area for a small portion of their lives, meat samples were collected from a cattle population that spends the largest portion of its life nearest the proposed project area prior to slaughter. The beef samples utilized for the baseline monitoring program were from cattle reared within 3 km of the proposed project area. Horses are the only other livestock raised on or near the proposed area. However, since horses are not raised for human consumption, they were not sampled.

Sample Methods and Frequency

Sample collection was performed in accordance with SOP 10, provided in Addendum 2.9-A. An edible tissue sample was taken from beef cattle samples at the time of slaughter in July.

Radionuclide Analysis

Radionuclide analysis coincided with requirements listed in Table 2.9-17.

Data Presentation

Radionuclide analysis results for beef samples are provided in Table 2.9-23.

Conclusions

The beef results were near or below detectable limits for analyzed radionuclides. The sample provides a baseline for radionuclides in edible meat samples near the proposed Ross ISR Project.

2.9.2.11 Animal Tissue Sampling- Large Game Wildlife

Summary and Overview

A sample of deer meat was collected with cooperation from a local landowner in October of 2010 and November of 2011.

Number and Location of Samples

Several species of wild game hunted for meat regularly cross the proposed project area. These species include, but are not limited to: whitetail deer, mule deer, pronghorn antelope, cottontail rabbits, sharptail grouse, sage grouse, and wild turkey. Surveys of the wildlife on the permit area were completed as part of the baseline monitoring program. A discussion of wildlife species observed is provided in Section 2.8.4.2. Based on the wildlife surveys and resident hunting habits, deer and antelope were identified as the only wildlife hunted for human consumption. One sample from a deer harvested within the greater ecological area was provided by a local landowner.

Sample Methods and Frequency

One deer sample was donated as a frozen meat sample following processing. The sample was collected during the 2010 hunting season. A deer sample was also collected following the 2011 hunting season.

Radionuclide Analysis

Radionuclide analysis coincided with the requirements listed in Table 2.9-17.

Data Presentation

Results of the radionuclide analysis of the deer tissue is provided in Table 2.9-24.

Conclusions

Analysis of the deer tissue sample indicated generally low radionuclide levels (as compared to the MDL for the methods). Overall, the results were consistent with concentrations measured in the beef sample, with the exception of Pb-210. Due to the migratory nature of deer it is difficult to attribute radionuclide concentration origins to any particular site.

2.9.2.12 Animal Tissue Sampling - Fish

Summary and Overview

Fish samples were collected in September, 2010. Regulatory Guide 4.14 recommends sampling of the edible portions of fish from all applicable bodies of water at least twice prior to construction.

Number and Location of Samples

Oshoto Reservoir is the only water impoundment within the proposed project area capable of supporting edible fish. All other water impoundments within the proposed project area are located in ephemeral drainages and therefore are unable to sustain edible fish populations.

A total of 99 fish were caught from Oshoto Reservoir to create a composite sample of edible tissue from the site. Landowner interviews indicated that residents do not typically consume fish from the reservoir and therefore fish from the reservoir is not a pathway to the human food chain. Nonetheless, to meet the intent of Regulatory Guide 4.14 requirements, the fish sampling and analysis program was conducted.

Sample Methods and Frequency

Because the fish are not considered a major part of the food chain and to comply with WGFD requirements to prevent potential detriment to the reservoir ecosystem, fish were only sampled once for this study. Table 2.9-25 summarizes the fish sampling program.

Radionuclide Analysis

Radionuclide analysis coincided with requirements listed in Table 2.9-17.

Data Presentation

Fish sample radionuclide analysis is provided in Table 2.9-26.

Conclusions

The fish samples showed a higher uptake of both Pb-210 and Ra-226 in comparison to other animals analyzed as part of the baseline monitoring program. Higher Pb-210 levels can be expected since lead has a tendency to bioaccumulate in ecosystems. Higher levels of Ra-226 are evidence of a slightly nutrient poor environment where uptake of radium is common in place of other chemically similar elements (such as calcium). Despite the higher levels of Ra-226 and Pb-210 as compared to other meat samples, ingestion of fish is unlikely to provide a significant pathway for radionuclides since it is not typical for local residents to consume fish from Oshoto Reservoir. The sample also provides a baseline for edible fish tissue within the Ross ISR Project Area.

Table 2.9-1. Summary of the Major Elements of the Radiological Baseline Characterization Program

Program Element	Radionuclides Analyzed	Sampling Frequency	Analysis Frequency	Number of Sampling Locations	Applicable Standard Operating Procedures (SOP – see Addendum 2.9-A)
Groundwater - Regional Monitoring Wells and CPP Area Piezometers	Total U, Ra-226, gross alpha, gross beta [Th-230,Pb-210 (semi-annual)]	Quarterly	Quarterly	28	9,11,12
Groundwater – Existing Water Supply Wells	Total U, Ra-226, gross alpha, gross beta [Th-230 and Pb-210 (semi-annual)]	Quarterly	Quarterly	29	9,11,12
Surface Water	Total U, suspended U, Ra-226, gross alpha, gross beta	Quarterly or when samples are obtained in passive storm samplers	Quarterly or when samples are obtained	26	8,11,12
Sediment Sampling	Total U, Ra-226, Pb-210, Th-230, gross alpha	Once	Once	4	5,11,12
Particulates in Air	Total U, Th-230, Ra-226,Pb-210	Continuous	Composites of weekly filters analyzed Quarterly	5	3, 12
Radon in Air	Rn 222	Continuous	Quarterly	15	1,12
Surface Soil	Total U, Th-230, Ra-226,Pb-210, gross alpha, gross beta	Once	Once	39	4,11,12
Soil Profiles	Total U, Th-230, Ra-226,Pb-210	Once	Once	17	4,11,12
Direct Radiation via Field Scans	uR/hr	Once	N/A	> 42,000	7,12,13
Direct Radiation TLDs	mrem/quarter (uR/hr)	Quarterly	4 times	15	2,12,13
Vegetation	Total U, Th-230, Ra-226,Pb-210,Po-210	3 times (once for crops at harvest)	3 times	15	6,11,12
Animal Tissue Sample- Cattle	Total U, Th-230, Ra-226,Pb-210,Po-210	Once	Once	3 edible meat samples	10,12
Animal Tissue Sampling- Wild Game	Total U, Th-230, Ra-226,Pb-210,Po-210	Once	Once	3 edible meat samples	10,12
Animal Tissue Sampling- Fish	Total U, Th-230, Ra-226,Pb-210,Po-210	Once	Once	1 composite sample	10,12

Table 2.9-2. Summary by Aquifer of Wells Upgradient and Downgradient of Proposed Processing Areas

Aquifer	Upgradient Wells	Downgradient Wells
Surficial Aquifer (SA)	21-19SA, 14-18SA, 12-18SA	34-7SA, SA43-18-1, SA43-18-2, SA43-18-3
Shallow Monitoring Aquifer (SM)	42-19SM, 34-18SM, 12-18SM	14-18SM, 21-19SM, 34-7SM
Ore Zone Aquifer(OZ)*	42-19OZ, 12-18OZ, 34-7OZ	14-18OZ, 21-19OZ, 34-18OZ
Deep Monitoring Aquifer (DM)*	34-7DM, 12-18DM, 42-19DM	14-18DM, 21-19DM, 34-18DM

*Indicates groundwater flow direction influenced by aquifer stresses

Table 2.9-3. Analytes and Analytical Methods for Groundwater Samples

Radionuclide[1]	Analytical Method	Lower Limit of Detection	Frequency
Uranium (total)	EPA 200.8	2E-10 µCi/mL	Semi-Annual
Ra-226	SM 7500-Ra B	2E-10 µCi/mL	Quarterly
Gross Alpha Gross Beta	SM7110B	N/A	Quarterly
Th-230	ACW10	2E-10 µCi/mL	Semi-Annual
Pb-210	OTW01	1E-9 µCi/mL	Semi-Annual
Po-210	OTW01	1E-9 µCi/mL	Semi-Annual
Rn-222	SM 7500-RN	2E-10 µCi/mL	Annual
Ra-228	Ra-05 or Ga-Tech	N/A	N/A

[1] NUREG-1569, Table 2.7.3-1 and Regulatory Guide 4.14

Table 2.9-4. Analytes and Analytical Methods for Surface Water Samples

Radionuclide[1]	Analytical Method	Lower Limit of Detection
Uranium (total)	EPA 200.8	2E-10 µCi/mL
Ra-226	SM 7500-Ra B	2E-10 µCi/mL
Gross Alpha Gross Beta	SM7110B	N/A

[1] NUREG-1569, Table 2.7.3-1

Table 2.9-5. Analytes and Analytical Methods for Sediment Samples

Radionuclide	Analytical Method	Reporting Level
Uranium (total)	E908.1	0.2 mg/kg – dry (1.35E-7 µCi/g)
Th-230	E907.0	0.2 pCi/g (2E-4 µCi/g)
Ra-226	E903.0	0.2 pCi/g (2E-4 µCi/g)
Pb-210	E905.0 Mod	0.2 pCi/g (2E-4 µCi/g)
Gross Alpha	E900.0	0.2 pCi/g (2E-4 µCi/g)

[1] Regulatory Guide 4.14, Table 1

Table 2.9-6. Sediment Sampling Analytical Results

Sample ID	Sample Date	Total Uranium (mg/kg)	Gross Alpha (pCi/g)	Pb-210 (pCi/g)	Ra-226 (pCi/g)	Th-230 (pCi/g)
SW-1-SED	8/25/10	2.11	2.8 ± 0.6	471 ± 6.1	1.5 ± 0.1	371 ± 58
	5/4/11	1.48	Not analyzed	1.6 ± 0.4	0.6 ± 0.1	<0.2
OSHOTO-RES-SED	8/25/10	1.32	<1	1.7 ± 0.5	1.0 ± 0.1	0.87 ± 0.21
	5/4/11	3.40	Not analyzed	1.8 ± 1.0	1.0 ± 0.1	0.5 ± 0.2
SW-2-SED	8/25/10	0.876	1.1 ± 0.4	<1	0.9 ± 0.1	0.39 ± 0.14
	5/4/11	1.33	Not analyzed	2.4 ± 0.4	1.0 ± 0.1	0.9 ± 0.2
SW-3-SED	8/25/10	2.24	1.6 ± 0.4	2.1 ± 1.0	0.8 ± 0.1	0.84 ± 0.21
	5/4/11	2.51	Not analyzed	3.2 ± 0.5	1.3 ± 0.1	0.8 ± 0.2
CSRES02	5/16/11	0.74	Not analyzed	<1.0	<0.5	0.3 ± 0.1
CSRES03	5/16/11	0.89	Not analyzed	<1.0	<0.5	0.5 ± 0.2

Table 2.9-7. Analytes and Analytical Methods for Air Particulate Filters

Radionuclide[1]	Analytical Method	Detection Limit
Uranium (total)	E908.1	0.2 mg/kg – dry (1.35E-7 µCi/g)
Th-230	E907.0	0.2 pCi/g (2E-4 µCi/g)
Ra-226	E903.0	0.2 pCi/g (2E-4 µCi/g)
Pb-210	E905.0 Mod	0.2 pCi/g (2E-4 µCi/g)

[1] Regulatory Guide 4.14, Table 1

Table 2.9-8. Air Particulate Sampling Results

Site	Analyte	Quarter 1		Quarter 2		Quarter 3		Quarter 4[1]	
		Sample Result (pCi/L)	DL[2] (pCi/L)	Sample Result (pCi/L)	DL[2] (pCi/L)	Sample Result (pCi/L)	DL[2] (pCi/L)	Sample Result (pCi/L)	DL[2] (pCi/L)
Met	Total Uranium	<3.12E-08	3.12E-08	<3.65E-08	3.65E-08	3.59E-07	3.59E-08		
	Th-230	<6.25E-08	6.25E-08	<7.29E-08	7.29E-08	<7.17E-08	7.17E-08		
	Ra-226	<6.25E-08	6.25E-08	<7.29E-08	7.29E-08	<7.17E-08	7.17E-08		
	Pb-210	3.87E-06	6.25E-08	1.64E-06	7.29E-08	4.77E-06	7.17E-08		
South	Total Uranium	<2.95E-08	2.95E-08	<3.35E-08	3.35E-08	<3.25E-08	3.25E-08		
	Th-230	<5.90E-08	5.90E-08	<6.70E-08	6.70E-08	9.74E-08	6.50E-08		
	Ra-226	<5.90E-08	5.90E-08	<6.70E-08	6.70E-08	<6.50E-08	6.50E-08		
	Pb-210	1.64E-06	5.90E-08	1.64E-06	6.70E-08	8.74E-06	6.50E-08		
Southwest	Total Uranium	1.17E-07	2.99E-08	1.17E-07	2.90E-08	<6.97E-08	3.48E-08		
	Th-230	<5.98E-08	5.98E-08	<5.81E-08	5.81E-08	<6.97E-08	6.97E-08		
	Ra-226	<5.98E-08	5.98E-08	<5.81E-08	5.81E-08	<6.97E-08	6.97E-08		
	Pb-210	1.17E-07	5.98E-08	1.51E-06	5.81E-08	9.44E-06	6.97E-08		
East	Total Uranium	<3.28E-08	3.28E-08	<3.41E-08	3.41E-08	<3.63E-08	3.63E-08		
	Th-230	<6.56E-08	6.56E-08	<6.83E-08	6.83E-08	<7.26E-08	7.26E-08		
	Ra-226	<6.56E-08	6.56E-08	<6.83E-08	6.83E-08	<7.26E-08	7.26E-08		
	Pb-210	1.64E-06	6.56E-08	1.64E-06	6.83E-08	1.11E-05	7.26E-08		
Office	Total Uranium	<1.16E-08	1.16E-08	4.04E-08	1.00E-08	6.59E-08	9.41E-09		
	Th-230	<2.31E-08	2.31E-08	<2.01E-08	2.01E-08	3.77E-08	1.88E-08		
	Ra-226	<2.31E-08	2.31E-08	<2.01E-08	2.01E-08	<1.88E-08	1.88E-08		
	Pb-210	3.84E-06	2.31E-08	1.52E-06	2.01E-08	1.14E-05	1.88E-08		

[1] Results to be provided in February 2011 in an updated Addendum 2.9-D
[2] DL - Laboratory specific detectable limit. Meets or exceeds NRC DL requirements (Total Uranium= 1.0E-07 pCi/L, Th-230=1.0E-07 pCi/L, Ra-226=1.0E-07 pCi/L, Pb-210=2.0E-06 pCi/L)

Table 2.9-9. Radon Air Sampling Program Results (all results pCi/L in air)

Sample Site	Quarter 1			Quarter 2			Quarter 3			Quarter 4		
	Start Date	**End Date**	**Avg Radon Con.**	**Start Date**	**End Date**	**Avg Radon Con.**	**Start Date**	**End Date**	**Avg Radon Con.**	**Start Date**	**End Date**	**Avg Radon Con.**
Office Site (1)	1/12/10	4/22/10	1.7 ±0.12	4/22/10	7/19/10	0.7 ±0.05	7/19/10	10/15/10	0.8 ±0.06	10/15/10	1/12/11	0.5 ±0.04
Met Station (2)	1/12/10	4/22/10	2.0 ±0.13	4/22/10	7/19/10	0.6 ±0.05	7/19/10	10/15/10	0.4 ±0.04	10/15/10	1/12/11	0.2 ±0.02
Southwest Site (3)	1/12/10	4/22/10	1.9 ±0.13	4/22/10	7/19/10	1.1 ±0.07	7/19/10	10/15/10	1.0 ±0.07	10/15/10	1/12/11	0.5 ±0.05
East Site (4)	1/12/10	4/22/10	1.7 ±0.12	4/22/10	7/19/10	0.7 ±0.05	7/19/10	10/15/10	0.6 ±0.05	10/15/10	1/14/11	0.6 ±0.05
South Site (5)	1/15/10	4/22/10	0.5 ±0.05	4/22/10	7/19/10	0.8 ±0.06	7/19/10	10/15/10	0.8 ±0.06	10/15/10	1/14/11	0.6 ±0.04
Wesley Site (6)	1/12/10	4/22/10	0.9 ±0.08	4/22/10	7/19/10	1.0 ±0.07	7/19/10	10/15/10	0.9 ±0.06	10/15/10	1/12/11	0.5 ±0.04
Wood Site (7)	1/12/10	4/22/10	1.1 ±0.09	4/22/10	7/19/10	0.9 ±0.06	7/19/10	10/15/10	1.3 ±0.08	10/15/10	1/12/11	0.5 ±0.04
Strong Site (8)	1/12/10	4/22/10	0.8 ±0.07	4/22/10	7/19/10	0.7 ±0.05	7/19/10	10/15/10	0.9 ±0.06	10/15/10	1/12/11	0.5 ±0.04
Site 9	1/15/10	4/22/10	0.3 ±0.04	4/22/10	7/19/10	0.9 ±0.06	7/19/10	10/15/10	0.8 ±0.06	10/15/10	1/14/11	0.9 ± 0.06
Site 10	1/15/10	4/22/10	0.4 ±0.04	4/22/10	7/19/10	0.8 ±0.06	7/19/10	10/15/10	1.2 ±0.07	10/15/10	1/14/11	0.7 ±0.05
Site 11	1/15/10	4/22/10	0.6 ±0.06	4/22/10	7/19/10	0.6 ±0.04	7/19/10	10/15/10	0.6 ±0.05	10/15/10	1/14/11	0.5 ±0.04
Site 12	1/15/10	4/22/10	0.5 ±0.05	4/22/10	7/19/10	0.8 ±0.06	7/19/10	10/15/10	0.7 ±0.05	10/15/10	1/14/11	0.4 ±0.03
Site 13	1/12/10	4/22/10	1.7 ±0.12	4/22/10	7/19/10	0.8 ±0.06	7/19/10	10/15/10	1.2 ±0.08	10/15/10	1/12/11	0.7 ±0.05
Site 14	1/12/10	4/22/10	0.8±0.07	4/22/10	7/19/10	0.6 ±0.04	7/19/10	10/15/10	0.8 ±0.06	10/15/10	1/12/11	0.6 ±0.04
Site 15	1/12/10	4/22/10	0.7 ±0.07	4/22/10	7/19/10	0.8 ±0.06	7/19/10	10/15/10	0.7 ±0.05	10/15/10	1/12/11	0.5 ±0.04
Site 16	N/A	N/A	N/A	5/20/10	7/19/10	1.4 ±0.10	7/19/10	10/15/10	0.8 ±0.06	10/15/10	1/12/11	0.6 ±0.05
Site 17	N/A	N/A	N/A	5/20/10	7/19/10	1.4 ±0.10	7/19/10	10/15/10	0.8 ±0.06	10/15/10	1/12/11	0.5 ±0.04

Table 2.9-9. Radon Air Sampling Program Results (all results pCi/L in air) (continued)

Sample Site	Quarter 5			Quarter 6			Quarter 7			Quarter 8		
	Start Date	End Date	Avg Radon Con.	Start Date	End Date	Avg Radon Con.	Start Date	End Date	Avg Radon Con.	Start Date	End Date	Avg Radon Con.
Office Site (1)	1/12/11	4/13/11	0.4 ±0.03	4/13/11	7/12/11	0.4 ±0.03	7/12/11	10/18/11	0.8 ±0.05	10/18/11	1/10/12	0.9 ±0.06
Met Station (2)	1/12/11	4/13/11	0.4 ±0.03	4/13/11	7/12/11	0.6 ±0.04	7/12/11	10/18/11	0.7 ±0.05	10/18/11	1/10/12	1.1 ±0.07
Southwest Site (3)	1/12/11	4/13/11	0.2 ±0.02	4/13/11	7/12/11	0.4 ±0.03	7/12/11	10/18/11	1.1 ±0.06	10/18/11	1/10/12	1.4 ±0.08
East Site (4)	1/14/11	4/13/11	0.2 ±0.02	4/13/11	7/12/11	0.4 ±0.03	7/12/11	10/18/11	0.9 ±0.06	10/18/11	1/10/12	1.1 ±0.07
South Site (5)	1/14/11	4/13/11	0.2 ±0.02	4/13/11	7/12/11	0.5 ±0.04	7/12/11	10/18/11	0.7 ±0.05	10/18/11	1/10/12	0.9 ±0.06
Wesley Site (6)	1/12/11	4/13/11	0.2 ±0.02	4/13/11	7/12/11	0.4 ±0.03	7/12/11	10/18/11	0.9 ±0.06	10/18/11	1/10/12	1.3 ±0.08
Wood Site (7)	1/12/11	4/13/11	0.3 ±0.03	4/13/11	7/12/11	0.7 ±0.05	7/12/11	10/18/11	1.0 ±0.06	10/18/11	1/10/12	1.0 ±0.06
Strong Site (8)	1/12/11	4/13/11	0.1	4/13/11	7/12/11	0.5 ±0.04	7/12/11	10/18/11	0.7 ±0.05	10/18/11	1/10/12	0.9 ±0.06
Site 9	1/14/11	4/13/11	0.4 ±0.03	4/13/11	7/12/11	0.5 ±0.04	7/12/11	10/18/11	1.0 ±0.06	10/18/11	1/10/12	1.0 ±0.06
Site 10	1/14/11	4/13/11	0.3 ±0.02	4/13/11	7/12/11	0.5 ±0.04	7/12/11	10/18/11	1.2 ±0.07	10/18/11	1/10/12	1.0 ±0.06
Site 11	1/14/11	4/13/11	0.4 ±0.03	4/13/11	7/12/11	0.5 ±0.04	7/12/11	10/18/11	0.8 ±0.05	10/18/11	1/10/12	0.9 ±0.06
Site 12	1/14/11	4/13/11	0.3 ±0.02	4/13/11	7/12/11	0.5 ±0.04	7/12/11	10/18/11	0.5 ±0.04	10/18/11	1/10/12	0.9 ±0.06
Site 13	1/12/11	4/13/11	0.2 ±0.02	4/13/11	7/12/11	0.4 ±0.03	7/12/11	10/18/11	0.9 ±0.06	10/18/11	1/10/12	1.0 ±0.06
Site 14	1/12/11	4/13/11	0.4 ±0.03	4/13/11	7/12/11	0.5 ±0.04	7/12/11	10/18/11	0.8 ±0.05	10/18/11	1/10/12	1.0 ±0.06
Site 15	1/12/11	4/13/11	0.3 ±0.03	4/13/11	7/12/11	0.2 ±0.02	7/12/11	10/18/11	0.8 ±0.05	10/18/11	1/10/12	1.1 ±0.07
Site 16	1/12/11	4/13/11	0.2 ±0.02	4/13/11	7/12/11	0.4 ±0.04	7/12/11	10/18/11	0.8 ±0.05	10/18/11	1/10/12	0.9 ±0.06
Site 17	1/12/11	4/13/11	0.5 ±0.04	4/13/11	7/12/11	0.3 ±0.03	7/12/11	10/18/11	1.0 ±0.06	10/18/11	1/10/12	0.8 ±0.05

Table 2.9-9. Radon Air Sampling Program Results (all results pCi/L in air) (continued)

Sample Site	Quarter 9			Quarter 10		
	Start Date	End Date	Avg Radon Con.	Start Date	End Date	Avg Radon Con.
Office Site (1)	1/10/12	3/30/12	0.5 ±0.04	---	---	Decommissioned 3/30/12
Met Station (2)	1/10/12	4/5/12	1.1 ±0.07	4/5/12	7/13/12	0.4 ±0.03
Southwest Site (3)	1/10/12	4/5/12	1.2 ±0.07	4/5/12	7/13/12	1 ±0.06
East Site (4)	1/10/12	4/5/12	0.2 ±0.02	4/5/12	7/13/12	0.7 ±0.05
South Site (5)	1/10/12	4/5/12	0.3 ±0.02	4/5/12	7/13/12	0.7 ±0.05
Wesley Site (6)	1/10/12	4/5/12	0.5 ±0.03	4/5/12	7/13/12	0.6 ±0.04
Wood Site (7)	1/10/12	4/5/12	0.7 ±0.04	4/5/12	7/13/12	0.8 ±0.05
Strong Site (8)	1/10/12	4/5/12	0.3 ±0.02	4/5/12	7/13/12	0.5 ±0.04
Site 9	1/10/12	4/5/12	0.2 ±0.02	4/5/12	---	NM[1]
Site 10	1/10/12	4/5/12	0.7 ±0.05	4/5/12	7/13/12	0.1[1]
Site 11	1/10/12	4/5/12	0.6 ±0.04	4/5/12	7/13/12	0.6 ±0.04[1]
Site 12	1/10/12	4/5/12	0.7 ±0.05	4/5/12	7/13/12	2.8 ±0.12[1]
Site 13	1/10/12	4/5/12	0.6 ±0.04	4/5/12	7/13/12	0.8 ±0.05
Site 14	1/10/12	4/5/12	0.7 ±0.05	4/5/12	7/13/12	0.5 ±0.04
Site 15	1/10/12	4/5/12	0.6 ±0.04	4/5/12	7/13/12	0.6 ±0.04
Site 16	1/10/12	4/5/12	0.8 ±0.05	4/5/12	7/13/12	0.6 ±0.04
Site 17	1/10/12	4/5/12	0.5 ±0.04	4/5/12	7/13/12	0.7 ±0.05

[1] Livestock damage, radon cup either missing or displaced

Table 2.9-10. Analytes and Analytical Methods for Surface and Subsurface Soil Samples

Radionuclide[1]	Analytical Method	Detection Limit
Uranium (total)	E908.1	0.2 mg/kg – dry (1.35E-7 µCi/g)
Th-230	E907.0	0.2 pCi/g (2E-4 µCi/g)
Ra-226	E903.0	0.2 pCi/g (2E-4 µCi/g)
Pb-210	E905.0 Mod	0.2 pCi/g (2E-4 µCi/g)
Gross Alpha	E900.0	0.2 pCi/g (2E-4 µCi/g)

[1] Regulatory Guide 4.14, Table 1

Table 2.9-11. Surface and Subsurface Soil Sample Results

Sample ID	Depth Interval	Date Sampled	Total Uranium (mg/kg)	Gross Alpha (pCi/g)	Pb-210 (pCi/g)	Ra-226 (pCi/g)	Th-230 (pCi/g)
RP-1	0-30	6-21-2010	0.93	2.0 ± 0.4	0.9 ± 0.4	1.6 ± 0.2	0.60 ± 0.13
RP-1	30-60	6-21-2010	1.12	1.9 ± 0.4	1.0 ± 0.4	1.1 ± 0.1	0.68 ± 0.14
RP-1	60-100	6-21-2010	1.76	<1	1.1 ± 0.6	1.5 ± 0.2	0.96 ± 0.18
RP-1	0-15	6-21-2010	1.05	<1	1.0 ± 0.4	1.0 ± 0.1	0.72 ± 0.17
RP-2	0-30	6-21-2010	Not analyzed	2.0 ± 0.4	Not analyzed	1.6 ± 0.2	Not analyzed
RP-2	30-60	6-21-2010	Not analyzed	1.5 ± 0.4	Not analyzed	1.1 ± 0.2	Not analyzed
RP-2	60-100	6-21-2010	Not analyzed	2.0 ± 0.5	Not analyzed	1.3 ± 0.2	Not analyzed
RP-2	0-15	6-21-2010	1.32	<1	1.4 ± 0.4	1.2 ± 0.2	0.97 ±0.19
RP-3	0-30	6-10-2010	Not analyzed	1.4 ± 0.4	Not analyzed	0.5 ± 0.1	Not analyzed
RP-3	30-60	6-10-2010	Not analyzed	<1	Not analyzed	0.6 ± 0.1	Not analyzed
RP-3	60-100	6-10-2010	Not analyzed	<1	Not analyzed	0.5 ± 0.1	Not analyzed
RP-3	0-15	6-10-2010	0.36	1.0 ± 0.4	0.6 ± 0.4	0.5 ± 0.1	0.234 ± 0.078
RP-4	0-30	6-10-2010	Not analyzed	<1	Not analyzed	0.4 ± 0.1	Not analyzed
RP-4	30-60	6-10-2010	Not analyzed	<1	Not analyzed	0.5 ± 0.1	Not analyzed
RP-4	60-100	6-10-2010	Not analyzed	1.4 ± 0.4	Not analyzed	<0.005	Not analyzed
RP-4	0-15	6-10-2010	0.24	<1	0.8 ± 0.4	0.3 ± 0.1	<0.2
RP-5	0-30	6-10-2010	Not analyzed	<1	Not analyzed	1.0 ± 0.1	Not analyzed
RP-5	30-60	6-10-2010	Not analyzed	3.6 ± 1.7	Not analyzed	1.0 ± 0.2	Not analyzed
RP-5	60-100	6-10-2010	Not analyzed	1.7 ± 0.4	Not analyzed	1.5 ± 0.2	Not analyzed
RP-5	0-15	6-10-2010	0.79	1.6 ± 0.4	1.1 ± 0.6	1.1 ± 0.2	0.59 ± 0.13
RP-6	0-30	6-10-2010	0.82	2.1 ± 0.5	0.6 ± 0.4	1.3 ± 0.2	0.55 ± 0.14
RP-6	30-60	6-10-2010	0.48	<1	<0.5	1.0 ± 0.2	0.39 ± 0.10
RP-6	60-100	6-10-2010	0.67	1.1 ± 0.4	0.9 ± 0.4	1.1 ± 0.2	0.52 ± 0.12
RP-6	0-15	6-10-2010	0.92	1.0 ± 0.4	1.4 ± 0.5	1.0 ± 0.2	0.53 ± 0.12
RP-7	0-15	8-9-2010	0.030	1.8 ± 0.4	1.1 ± 0.5	<0.5	0.47±0.11
RP-7	0-30	8-9-2010	0.030	1.5 ± 0.4	1.1 ± 0.5	<0.5	0.51±0.11
RP-7	30-60	8-9-2010	0.054	1.3 ± 0.4	0.8	<0.5	0.47±0.11
RP-7	60-100	8-9-2010	0.090	1.2 ± 0.4	0.7	<0.5	0.48±0.11
RP-8	0-30	6-10-2010	Not analyzed	<1	Not analyzed	0.7 ± 0.1	Not analyzed
RP-8	30-60	6-10-2010	Not analyzed	1.5 ± 0.4	Not analyzed	1.0 ± 0.2	Not analyzed
RP-8	60-100	6-10-2010	Not analyzed	1.4 ± 0.4	Not analyzed	1.2 ± 0.2	Not analyzed
RP-8	0-15	6-10-2010	0.51	1.0 ± 0.4	Not analyzed	0.6 ± 0.1	Not analyzed
RP-9	0-30	6-21-2010	1.18	1.7 ± 0.4	1.2 ± 0.5	1.4 ± 0.2	0.86 ± 0.17
RP-9	30-60	6-21-2010	1.76	1.9 ± 0.5	1.0 ± 0.4	1.6 ± 0.2	0.47 ± 0.12

Table 2.9-11. Surface and Subsurface Soil Sample Results (continued)

Sample ID	**Depth Interval**	**Date Sampled**	**Total Uranium (mg/kg)**	**Gross Alpha (pCi/g)**	**Pb-210 (pCi/g)**	**Ra-226 (pCi/g)**	**Th-230 (pCi/g)**
RP-9	60-100	6-21-2010	1.88	1.4 ± 0.4	0.7 ± 0.5	1.0 ± 0.1	0.96 ± 0.18
RP-9	0-15	6-21-2010	1.08	1.8 ± 0.4	Not analyzed	1.3 ± 0.2	Not analyzed
RP-9	0-5	6-21-2010	Not analyzed	1.1 ± 0.4	Not analyzed	1.2 ± 0.2	Not analyzed
RP-10	0-30	6-10-2010	Not analyzed	1.0 ± 0.4	Not analyzed	0.6 ± 0.1	Not analyzed
RP-10	30-60	6-10-2010	Not analyzed	1.1 ± 0.4	Not analyzed	1.9 ± 0.2	Not analyzed
RP-10	60-100	6-10-2010	Not analyzed	1.3 ± 0.4	Not analyzed	1.7 ± 0.2	Not analyzed
RP-10	0-15	6-10-2010	0.56	1.1 ± 0.4	Not analyzed	1.3 ± 0.2	Not analyzed
RP-10	0-5	6-10-2010	Not analyzed	1.1 ± 0.4	Not analyzed	1.2 ± 0.2	Not analyzed
RP-11	0-30	6-10-2010	Not analyzed	1.1 ± 0.4	Not analyzed	1.3 ± 0.2	Not analyzed
RP-11	30-60	6-10-2010	Not analyzed	1.7 ± 0.5	Not analyzed	1.0 ± 0.2	Not analyzed
RP-11	60-100	6-10-2010	Not analyzed	1.7 ± 0.4	Not analyzed	0.9 ± 0.2	Not analyzed
RP-11	0-15	6-10-2010	0.65	1.4 ± 0.4	Not analyzed	1.1 ± 0.2	Not analyzed
RP-11	0-5	6-10-2010	Not analyzed	1.1 ± 0.4	Not analyzed	1.2 ± 0.2	Not analyzed
RP-12	0-30	6-21-2010	Not analyzed	<1	Not analyzed	1.2 ± 0.2	Not analyzed
RP-12	30-60	6-21-2010	Not analyzed	1.4 ± 0.4	Not analyzed	1.1 ± 0.2	Not analyzed
RP-12	60-100	6-21-2010	Not analyzed	1.0 ± 0.4	Not analyzed	1.2 ± 0.2	Not analyzed
RP-12	0-15	6-21-2010	0.53	<1	Not analyzed	0.8 ± 0.1	Not analyzed
RP-12	0-5	6-21-2010	Not analyzed	1.7 ± 0.4	Not analyzed	1.1 ± 0.2	Not analyzed
RP-13	0-30	6-21-2010	Not analyzed	1.2 ± 0.4	Not analyzed	1.1 ± 0.2	Not analyzed
RP-13	30-60	6-21-2010	Not analyzed	<1	Not analyzed	7.1 ± 1.3	Not analyzed
RP-13	60-100	6-21-2010	Not analyzed	1.1 ± 0.4	Not analyzed	9.7 ± 1.5	Not analyzed
RP-13	0-15	6-21-2010	0.79	1.2 ± 0.4	Not analyzed	1.8 ± 0.2	Not analyzed
RP-13	0-5	6-21-2010	0.71	1.0 ± 0.4	2.0 ± 0.7	1.1 ± 0.2	<0.73
RP-14	0-30	6-21-2010	1.78	2.3 ± 0.5	1.3 ± 0.9	2.0 ± 0.2	1.29 ± 0.59
RP 14	30-60	6-21-2010	1.93	2.2 ± 0.5	0.9 ± 0.8	1.8 ± 0.2	<2.6
RP-14	60-100	6-21-2010	2.80	2.0 ± 0.5	1.6 ± 0.7	2.0 ± 0.2	<1.73
RP-14	0-15	6-21-2010	1.19	1.3 ± 0.4	Not analyzed	1.6 ± 0.2	Not analyzed
RP-14	0-5	6-21-2010	Not analyzed	1.9 ± 0.5	Not analyzed	1.4 ± 0.2	Not analyzed
RP-17	0-15	8-9-2010	0.016	3.5 ± 0.6	1.1 ± 0.5	<0.5	0.57±0.12
RP-17	0-30	8-9-2010	0.020	1.5 ± 0.4	1.2 ± 0.5	<0.5	0.54±0.12
RP-17	30-60	8-9-2010	0.078	2.0 ± 0.5	0.8	<0.5	0.47±0.13
RP-17	60-100	8-9-2010	0.100	1.1 ± 0.4	1.2 ± 0.6	<0.5	0.56±0.12
RP-18	0-15	8-9-2010	0.084	1.5 ± 0.4	1.7 ± 0.5	<0.5	0.59±0.12
RP-18	0-30	8-9-2010	0.040	1.9 ± 0.5	1.0	<0.5	0.54±0.12

Table 2.9-11. Surface and Subsurface Soil Sample Results (continued)

Sample ID	Depth Interval	Date Sampled	Total Uranium (mg/kg)	Gross Alpha (pCi/g)	Pb-210 (pCi/g)	Ra-226 (pCi/g)	Th-230 (pCi/g)
RP-18	30-60	8-9-2010	<0.04	1.6 ± 0.4	<0.2	<0.5	0.49±0.12
RP-18	60-100	8-9-2010	0.052	<1	2.0 ± 0.6	<0.5	0.44±0.11
RP-19	0-30	6-21-2010	Not analyzed	1.9 ± 0.5	Not analyzed	0.9 ± 0.1	Not analyzed
RP-19	30-60	6-21-2010	Not analyzed	1.4 ± 0.4	Not analyzed	1.0 ± 0.2	Not analyzed
RP-19	60-100	6-21-2010	Not analyzed	1.9 ± 0.5	Not analyzed	1.1 ± 0.2	Not analyzed
RP-19	0-15	6-21-2010	<0.01	<1	Not analyzed	1.0 ± 0.2	Not analyzed
RP-19	0-5	6-21-2010	Not analyzed	2.0 ± 0.5	Not analyzed	1.0 ± 0.2	Not analyzed
RP-20	0-30	6-21-2010	Not analyzed	2.6 ± 0.5	Not analyzed	1.7 ± 0.2	Not analyzed
RP-20	30-60	6-21-2010	Not analyzed	1.4 ± 0.4	Not analyzed	1.5 ± 0.2	Not analyzed
RP-20	60-100	6-21-2010	Not analyzed	1.4 ± 0.4	Not analyzed	1.5 ± 0.2	Not analyzed
RP-20	0-15	6-21-2010	<0.01	1.5 ± 0.4	Not analyzed	13.7 ± 1.7	Not analyzed
RS-1	0-15	6-10-2010	<0.01	1.3 ± 0.4	Not analyzed	8.2 ± 1.4	Not analyzed
RS-2	0-15	6-10-2010	1.38	1.3 ± 0.4	Not analyzed	2.1± 0.2	Not analyzed
RS-3	0-15	8-9-2010	<0.004	1.2 ± 0.4	1.1 ± 0.5	<0.5	0.60±0.13
RS-4	0-15	6-10-2010	0.70	1.2 ± 0.4	Not analyzed	0.8 ± 0.1	Not analyzed
RS-5	0-15	6-10-2010	0.74	<1	Not analyzed	1.0 ± 0.2	Not analyzed
RS-6	0-15	6-10-2010	0.44	<1	Not analyzed	0.9 ± 0.2	Not analyzed
RS-7	0-15	6-21-2010	0.57	1.1 ± 0.4	Not analyzed	0.7 ± 0.1	Not analyzed
RS-8	0-15	6-21-2010	1.22	1.1 ± 0.4	Not analyzed	1.8 ± 0.2	
RS-9	0-15	8-9-2010	0.036	<1	1.3 ± 0.5	<0.5	0.217±0.078
RS-10	0-15	8-9-2010	0.008	1.5 ± 0.4	1.2 ± 0.5	<0.5	0.401±0.099
RS-11	0-15	6-21-2010	0.72	1.2 ± 0.4	Not analyzed	1.2 ± 0.2	Not analyzed
RS-12	0-15	6-21-2010	1.20	1.5 ± 0.4	1.9 ± 0.5	2.0 ± 0.2	0.72 ± 0.17
RS-13	0-15	8-9-2010	0.024	1.3 ± 0.4	1.2 ± 0.4	<0.5	0.420±0.099
RS-14	0-15	6-21-2010	0.93	1.1 ± 0.4	1.5 ± 0.4	1.6 ± 0.2	0.59 ± 0.13
RS-15	0-15	6-10-2010	0.90	1.6 ± 0.4	Not analyzed	1.4 ± 0.0.2	Not analyzed
RS-15	0-5	6-10-2010	Not analyzed	1.2 ± 0.4	Not analyzed	1.7 ± 0.2	Not analyzed
RS-16	0-15	6-21-2010	1.02	1.4 ± 0.4	Not analyzed	1.5 ± 0.2	Not analyzed
RS-17	0-15	6-10-2010	0.83	1.1 ± 0.4	Not analyzed	1.0 ± 0.2	Not analyzed
RS-17	0-5	6-10-2010	Not analyzed	1.2 ± 0.4	Not analyzed	1.3 ± 0.2	Not analyzed
RS-18	0-15	6-10-2010	0.97	1.8 ± 0.4	Not analyzed	1.5 ± 0.2	Not analyzed
RS-18	0-5	6-10-2010	Not analyzed	1.5 ± 0.4	Not analyzed	14.4 ± 2.0	Not analyzed
RS-19	0-15	6-21-2010	0.65	1.1 ± 0.4	1.7 ± 0.6	14.1 ± 1.9	0.281 ± 0.084
RS-20	0-15	6-21-2010	<0.01	1.8 ± 0.5	Not analyzed	1.9 ± 0.2	Not analyzed
RS-21	0-15	6-21-2010	<0.01	1.3 ± 0.5	Not analyzed	1.5 ± 0.2	Not analyzed

Table 2.9-12. Soil Ra-226 Concentrations and Gamma Radiation Exposure Rates

Soil Correlation ID	Ra-226 Soil Concentration (pCi/g)	Ra-226 Standard Deviation (+/-)	Gamma Radiation Exposure Rate (μR/hr)
ROSS-CORR1	1.15	0.37	10.0
ROSS-CORR2	1.96	0.48	10.7
ROSS-CORR3	1.97	0.36	10.2
ROSS-CORR4	1.81	0.43	11.9
ROSS-CORR5	14.3	1.9	19.1
ROSS-CORR6	1.18	0.32	9.0
ROSS-CORR7	0.93	0.25	9.8
ROSS-CORR8	1.60	0.40	12.5
ROSS-CORR9	1.44	0.41	10.7
ROSS-CORR10	1.53	0.42	12.6

Table 2.9-13. First Quarter TLD Results

Location #	Detector Description	Exposure Dates (2010)	Total Days Exposed	Reported Dose (mrem)	Environmental Dose[1] (mrem)	Daily Dose Rate (mrem/day)	Dose Rate (µrem/hr)
Control	Deploy Control	1/12-4/22	91	29.4	24.5	0.269	11.2
1	Oshoto office	1/12-4/22	91	35.5	30.6	0.336	14.0
2	Met station	1/12-4/22	91	32.1	27.2	0.299	12.5
3	SW station	1/12-4/22	91	31.3	26.4	0.290	12.1
4	E station	1/12-4/22	91	29.6	24.7	0.271	11.3
5	S station	1/12-4/22	91	32.3	27.4	0.301	12.5
6	Wesley residence	1/12-4/22	91	35.0	30.1	0.331	13.8
7	Wood residence	1/12-4/22	91	33.6	28.7	0.315	13.1
8	Strong residence	1/12-4/22	91	33.8	28.9	0.318	13.2
9	E evaporation pond	1/15-4/22	88	32.7	27.8	0.316	13.2
10	E CPP	1/15-4/22	88	34.8	29.9	0.340	14.2
11	W evaporation pond	1/15-4/22	88	33.7	28.8	0.327	13.6
12	W CPP	1/15-4/22	88	34.4	29.5	0.335	14.0
13	Former R&D	1/12-4/22	91	34.2	29.3	0.322	13.4
14	N mineralized	1/12-4/22	91	34.9	30.0	0.330	13.7
15	S mineralized	1/12-4/22	91	32.8	27.9	0.307	12.8
AVERAGE				**33.1**	**28.2**	**0.313**	**13.0**

[1] Environmental Dose= Reported Dose - Transit Control
Transit Control (Detectors 1 – 15) = 4.9 mrem

Table 2.9-14. Second Quarter TLD Results

Location #	Detector Description	Exposure Dates (2010)	Total Days Exposed	Reported Dose (mrem)	Environmental Dose[1] (mrem)	Daily Dose Rate (mrem/day)	Dose Rate (µrem/hr)
Control	Deploy control (TLDs 1-15)	4/22-7/19	89	24.3	21.5	0.242	10.1
Control	Deploy control (TLDs 16-17)	5-20-7/19	61	17.2	14.4	0.236	9.8
1	Oshoto office	4/22-7/19	89	30	27.2	0.306	12.7
2	Met station	4/22-7/19	89	30.2	27.4	0.308	12.8
3	SW station	4/22-7/19	89	29.2	26.4	0.297	12.4
4	E station	4/22-7/19	89	32.7	29.9	0.336	14.0
5	S station	4/22-7/19	89	26.3	23.5	0.264	11.0
6	Wesley residence	4/22-7/19	89	32.1	29.3	0.329	13.7
7	Wood residence	4/22-7/19	89	30.4	27.6	0.310	12.9
8	Strong residence	4/22-7/19	89	29.6	26.8	0.301	12.5
9	E evaporation pond	4/22-7/19	89	23.2	20.4	0.229	9.6
10	E CPP	4/22-7/19	89	21.9	19.1	0.215	8.9
11	W evaporation pond	4/22-7/19	89	31.1	28.3	0.318	13.2
12	W CPP	4/22-7/19	89	32.4	29.6	0.333	13.9
13	Former R&D	4/22-7/19	89	28.4	25.6	0.288	12.0
14	N mineralized	4/22-7/19	89	31.2	28.4	0.319	13.3
15	S mineralized	4/22-7/19	89	31.1	28.3	0.318	13.2
16	N evaporation pond	5/20-7/19	61	23.2	18.6	0.305	12.7
17	N CPP	5/20-7/19	61	21.9	17.3	0.284	11.8
AVERAGE				**27.7**	**24.7**	**0.291**	**12.1**

[1] Environmental Dose= Reported Dose - Transit Control
Transit control (detectors 1 – 15) = 2.8 mrem
Transit control (detectors 16 -17) = 4.6 mrem

Table 2.9-15. Third Quarter TLD Results

Location #	Detector Description	Exposure Dates (2010)	Total Days Exposed	Reported Dose (mrem)	Environmental Dose[1] (mrem)	Daily Dose Rate (mrem/day)	Dose Rate (µrem/hr)
Control	Deploy control (TLDs 1-15)	7/19-10/15	88	30.5	21.3	0.242	10.1
Control	Deploy control (TLDs 16-17)	7/19-10/15	88	21.7	19.3	0.219	9.1
1	Oshoto office	7/19-10/15	88	35.7	26.5	0.301	12.5
2	Met station	7/19-10/15	88	38.7	29.5	0.335	14.0
3	SW station	7/19-10/15	88	36.2	27	0.307	12.8
4	E station	7/19-10/15	88	34.3	25.1	0.285	11.9
5	S station	7/19-10/15	88	31	21.8	0.248	10.3
6	Wesley residence	7/19-10/15	88	37.0	27.8	0.316	13.2
7	Wood residence	7/19-10/15	88	38.2	29	0.330	13.7
8	Strong residence	7/19-10/15	88	36.1	26.9	0.306	12.7
9	E evaporation pond	7/19-10/15	88	38.7	29.5	0.335	14.0
10	E CPP	7/19-10/15	88	36.2	27	0.307	12.8
11	W evaporation pond	7/19-10/15	88	27.2	24.8	0.282	11.7
12	W CPP	7/19-10/15	88	28.4	26.0	0.295	12.3
13	Former R&D	7/19-10/15	88	28.7	26.3	0.299	12.5
14	N mineralized	7/19-10/15	88	29	26.6	0.302	12.6
15	S mineralized	7/19-10/15	88	29.9	27.5	0.313	13.0
16	N evaporation pond	7/19-10/15	88	28.7	26.3	0.299	12.5
17	N CPP	7/19-10/15	88	30.1	27.7	0.315	13.1
AVERAGE				**32.4**	**26.1**	**0.297**	**12.4**

[1] Environmental Dose= Reported Dose - Transit Control
Transit control (detectors 1 – 10) = 9.2 mrem
Transit control (detectors 11 -17) = 2.4 mrem

Table 2.9-16. Grazing Vegetation Sample Location Number and Rationale

Sample Location #	Location Rationale
1	Downwind/former candidate CPP location
2	Downwind/former candidate CPP location
3	Downwind
4	Downwind/Ore body where wellfields will be located
5	Ore body where drilling will occur
6	Former R&D uranium recovery site
7	SE permit area coverage/close to a resident
8	Ore body where wellfields will be located/former candidate CPP location
9	Former candidate CPP location
10	CPP location
11	Evaporation pond site
12	West permit area coverage

Table 2.9-17. Analytes and Analytical Methods for Vegetation and Food Product Samples

Radionuclide[1]	**Analytical Method**	**Detection Limit (wet weight basis)**[2]
Uranium (total)	E908.1	0.2 pCi/kg (2E-4 μCi/kg)
Th-230	E907.0	0.2 pCi/kg (2E-4 μCi/kg)
Ra-226	E903.0	0.05 pCi/kg (5E-5 μCi/kg
Pb-210	E905.0 Mod	1 pCi/kg (1E-3 μCi/kg)
Po-210	RMO 3008	1 pCi/kg (1E-3 μCi/kg)

1 Regulatory Guide 4.14, Table 1

2 Recommended in Regulatory Guide 4.14 but typically not readily achievable due to sample mass requirements

Table 2.9-18. Results for First Grazing Vegetation Sample

Sample Location ID	Sample Date	Analyte				
		Pb-210 (pCi/kg)	**Po-210 (pCi/kg)**	**Ra-226 (pCi/kg)**	**Th-230 (pCi/kg)**	**U-nat (mg/kg)**
1	6-28-10	87.9± 7.8	1.72 ± 0.55	5.21±0.17	0.570±0.15	1.47
2	6-28-10	3.9 ± 0.5	0.9 ± 0.3	3.06±0.13	0.675±0.16	1.87
3	6-28-10	48.4 ± 6.3	1.34 ± 0.52	1.78±0.10	0.280±0.09	0.586
4	6-28-10	52.6 ± 6.7	0.766 ± 0.38	1.28±0.08	0.720±0.16	1.36
5	6-28-10	105 ± 8.2	0.438 ± 0.30	1.24±0.07	1.92±0.38	3.99
6	6-28-10	57.3 ± 7.5	0.587 ± 0.34	1.92±0.10	5.55±1.1	13.9
7	6-28-10	149 ± 15.2	1.99 ± 0.95	4.64±0.16	1.72±0.38	2.80
8	6-28-10	264 ± 19.1	0.225 ± 0.51	1.12±0.08	3.0±0.6	2.28
9	6-28-10	79.3 ± 14.4	1.66 ± 0.83	4.78±0.16	0.955±0.20	2.14
10	6-28-10	149 ± 16.3	1.56 ± 0.74	3.73±0.14	1.08±0.28	1.65
11	6-28-10	69.8 ± 11.2	1.15 ± 0.67	3.35±0.13	0.700±0.19	2.17

Table 2.9-19. Results for Second Grazing Vegetation Sample

Sample Location ID	Sample Date	Analyte				
		Pb-210 (pCi/L)	**Po-210 (pCi/L)**	**Ra-226 (pCi/kg)**	**Th-230 (pCi/kg)**	**U-nat (mg/kg)**
1	8-24-10	82.6 ± 8.9	9.46 ± 3.0	27.0 ± 0.59	2.38±0.77	4.47
2	8-24-10	68.0 ± 8.5	2.57 ± 1.4	7.97± 0.31	0.954±0.21	2.35
3	8-24-10	60.3 ± 8.0	3.94 ± 2.0	7.68 ± 0.28	0.657±0.17	1.25
4	8-24-10	85.3 ± 9.0	5.05 ± 2.1	7.64 ± 0.26	0.945±0.22	1.54
5	8-24-10	45.7 ± 7.4	4.52 ± 2.0	2.37± 0.16	1.84±0.34	6.66
6	8-24-10	32.6 ± 6.2	23.4 ± 7.2	1.84 ± 0.10	0.88±0.22	2.04
7	8-24-10	19.6 ± 5.3	7.86 ± 4.4	2.65 ± 0.13	1.39±0.30	2.46
8	8-24-10	58.3 ± 7.5	13.7 ± 5.7	8.62 ± 0.40	0.68±0.18	1.86
10	8-24-10	54.8 ± 7.2	16.0 ± 6.0	4.45 ± 0.29	0.39±0.15	1.11
11	8-24-10	105 ± 9.2	6.01 ± 3.9	3.04 ± 0.15	<0.2	1.42
12	8-24-10	41.5 ± 6.3	4.16 ± 4.0	1.38 ± 0.16	3.73±0.65	8.99

Table 2.9-20. Results for Third Grazing Vegetation Sample

Sample Location ID	**Sample Date**	**Analyte**				
		Pb-210 (pCi/kg)	**Po-210 (pCi/kg)**	**Ra-226 (pCi/kg)**	**Th-230 (pCi/kg)**	**U-nat (mg/kg)**
1	9-21-10	182 ± 10	16.0 ± 4.2	26.2 ± 1.8	22.0 ± 9.5	0.0103
2	9-21-10	155 ± 10	9.84 ± 3.2	33.6 ± 2.0	4.3 ± 1.1	0.0122
3	9-21-10	213 ± 11	7.01 ± 2.6	23.8 ± 1.6	2.8 ± 0.6	0.0060
4	9-21-10	167 ± 10	10.2 ± 3.4	73.9 ± 7.0	0.4 ± 0.6	0.0019
5	9-21-10	55.6 ± 6.9	5.90 ± 2.5	14.4 ± 1.4	8.3 ± 1.4	0.0158
6	9-21-10	172 ± 11	12.8 ± 3.6	13.3 ± 1.4	0.7 ± 1.0	0.0017
7	9-21-10	137 ± 9.6	9.67 ± 3.1	20.3 ± 1.7	3.1 ± 1.5	0.0061
8	9-21-10	38.5 ± 5.8	1.63 ± 1.5	9.1 ± 1.1	0.8 ± 0.8	0.0020
9	9-21-10	101 ± 8.4	1.60 ± 1.5	4.3 ± 0.7	0.3 ± 0.3	0.0018
10	9-21-10	76.3 ± 7.6	4.79 ± 2.3	642 ± 20.7	4.1 ± 2.2	0.0072
11	9-21-10	127 ± 9.1	9.87 ± 3.1	1530 ± 0.4	89.5 ± 16.4	0.0187
12	9-21-10	20.3 ± 5.0	5.92 ± 2.5	1.6 ± 0.9	1.1 ± 0.6	0.0039

Table 2.9-21. Wetland Vegetation Sample

Sample Location ID	Sample Date	Analyte				
		Pb-210 (pCi/kg)	Po-210 (pCi/kg)	Ra-226 (pCi/kg)	Th-230 (pCi/kg)	U-nat (mg/kg)
WL Veg J1	9-16-10	25.5 ± 5.4	4.12 ± 2.6	8.8 ± 0.4	<0.2	0.0005
WL Veg R6	9-16-10	43.1 ± 6.1	5.88 ± 2.8	11.4 ± 0.5	3.9 ± 1.5	0.0011
WL Veg A2	9-16-10	36.1 ± 6.0	3.75 ± 2.1	7.5 ± 0.5	1.2 ± 0.6	0.0019
WL Veg A2-2	9-16-10	9.07 ± 4.1	1.87 ± 1.7	0.3 ± 0.1	0.5 ± 0.5	0.0010

Table 2.9-22. Hay and Vegetable Samples

Sample Location ID	Sample Date	Analyte				
		Pb-210 (pCi/kg)	**Po-210 (pCi/kg)**	**Ra-226 (pCi/kg)**	**Th-230 (pCi/kg)**	**U-nat (mg/kg)**
Strong (vegetables)	9-16-10	2.95 ± 4.9	2.55 ± 1.8	<0.05	0.40 ± 0.90	0.0001
Berger (hay crop)	8-10-10	122 ± 13	7.61 ± 4.1	123 ± 1.1	0.83 ± 0.20	3.10
SC01	7-27-10	57.0 ± 7.5	11.3 ± 4.7	11.2 ± 0.35	0.96 ± 0.23	1.63

Table 2.9-23. Beef Sample Analysis

Sample Date	Analyte				
	Pb-210 (pCi/kg)	**Po-210 (pCi/kg)**	**Ra-226 (pCi/kg)**	**Th-230 (pCi/kg)**	**U-nat (mg/kg)**
8-13-10	3.12 ± 4.8	<1.0	0.288±0.05	<0.2	<0.001

Table 2.9-24. Wild Game Tissue Sample Analysis

Sample Date	Analyte				
	Pb-210 (pCi/kg)	**Po-210 (pCi/kg)**	**Ra-226 (pCi/kg)**	**Th-230 (pCi/kg)**	**U-nat (mg/kg)**
10-18-10	13.0 ± 7.5	3.68 ± 3.75	1.8 ± 1.5	7.6 ± 4.2	<0.001
11-20-11	17 ± 1	<1.0	0.5 ± 0.4	<0.2	0.025

Table 2.9-25. Summary of Fish Caught in Oshoto Reservoir

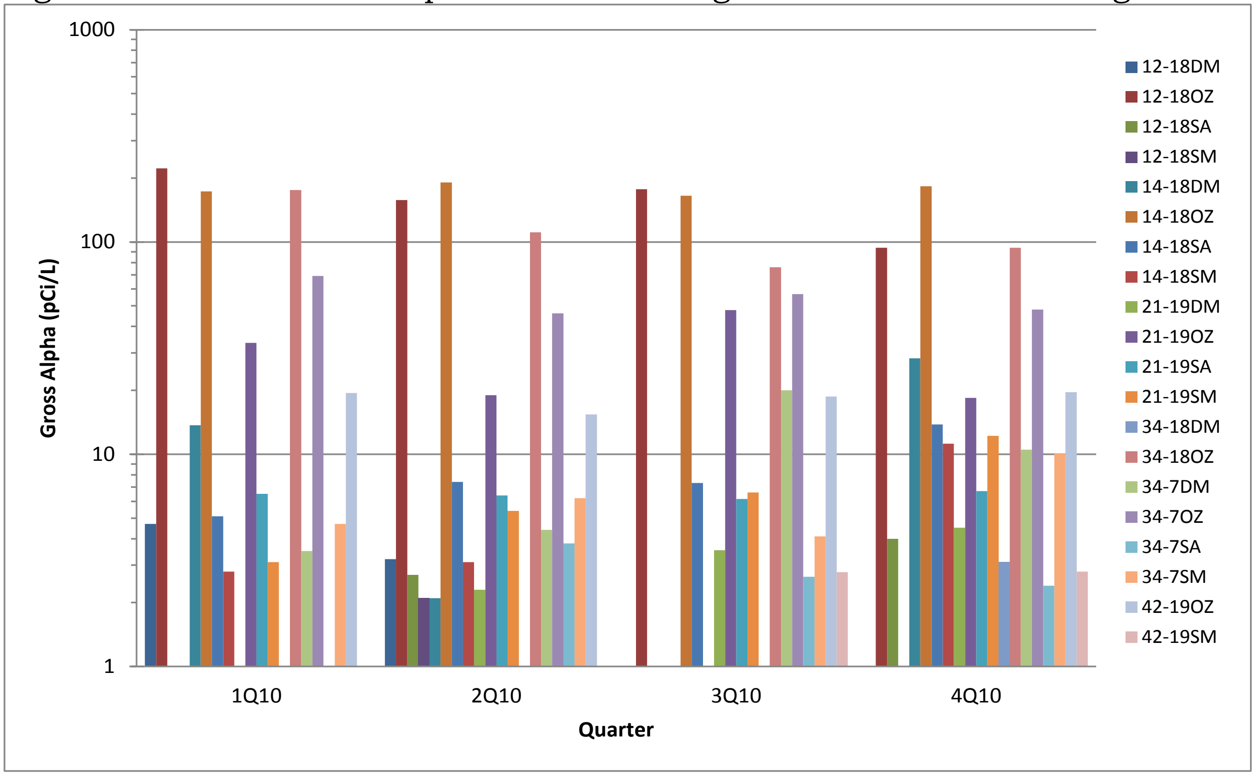
Species	Length (inches)	Weight (ounces)	Species	Length (inches)	Weight (ounces
Black bullhead	7.0	3.0	Black bullhead	6.7	2.5
Black bullhead*	7.0	3.0	Black bullhead	6.7	3.0
Black bullhead*	7.6	4.0	Black bullhead	7.0	3.5
Black bullhead	9.0	8.0	Black bullhead	7.1	4.0
Black bullhead	7.5	4.0	Black bullhead	7.1	3.0
Black bullhead	10.1	8.5	Black bullhead	7.2	3.5
Black bullhead	8.5	5.0	Black bullhead	7.2	3.5
Black bullhead	10.5	12.0	Black bullhead	7.7	4.5
Black bullhead	7.0	4.5	Black bullhead	7.7	4.0
Black bullhead	10.0	9.5	Black Bullhead	7.9	4.0
Black bullhead	10.1	9.0	Black bullhead	8.0	5.0
Black bullhead	8.0	5.0	Black bullhead	8.1	5.5
Black bullhead	10.3	10.0	Black bullhead	8.3	5.0
Black bullhead	8.5	5.5	Black bullhead	8.7	6.0
Black bullhead	10.0	11.5	Black bullhead	9.1	7.0
Black bullhead	9.5	8.0	Black bullhead	9.5	11.0
Black bullhead	8.0	4.0	Black bullhead	9.5	8.0
Black bullhead	9.1	8.5	Black bullhead	9.5	8.0
Black bullhead	9.6	8.5	Black bullhead	9.5	8.0
Black bullhead	10.0	10.5	Black bullhead	9.7	9.0
Black bullhead	9.0	6.5	Black bullhead	9.7	7.0
Black bullhead	9.5	8.5	Black bullhead	9.8	8.5
Black bullhead	7.2	4.0	Black bullhead	10.0	10.0
Black bullhead	7.5	4.5	Black bullhead	10.0	8.0
Black bullhead	8.2	4.0	Black bullhead	10.0	8.0
Black bullhead	9.5	8.0	Black bullhead	10.2	11.0
Black bullhead	9.0	7.5	Black bullhead	10.3	10.0
Black bullhead	7.5	4.0			
B. Bullhead TOTAL		**189.0**	55 (fish)		**170.5**
White sucker	15.0	**21.0**	1 (fish)		
Green Sunfish	4.5-7.0	**64.0**	43 (fish)		
Total Fish	**99 (fish)**				
Total Weight	**444.5 (oz) (27.8 lbs)**				

Note: Oshoto Reservoir fish collected and retained for analysis from net sampling and angling 23-24 Sept 2010. Fish were collected under Wyoming Game and Fish Department Chapter 33 permit and angling. Each angler had a valid Wyoming fishing license. Numerous additional fish were collected through sampling efforts and returned to the reservoir.

Table 2.9-26. Fish Sample Analysis

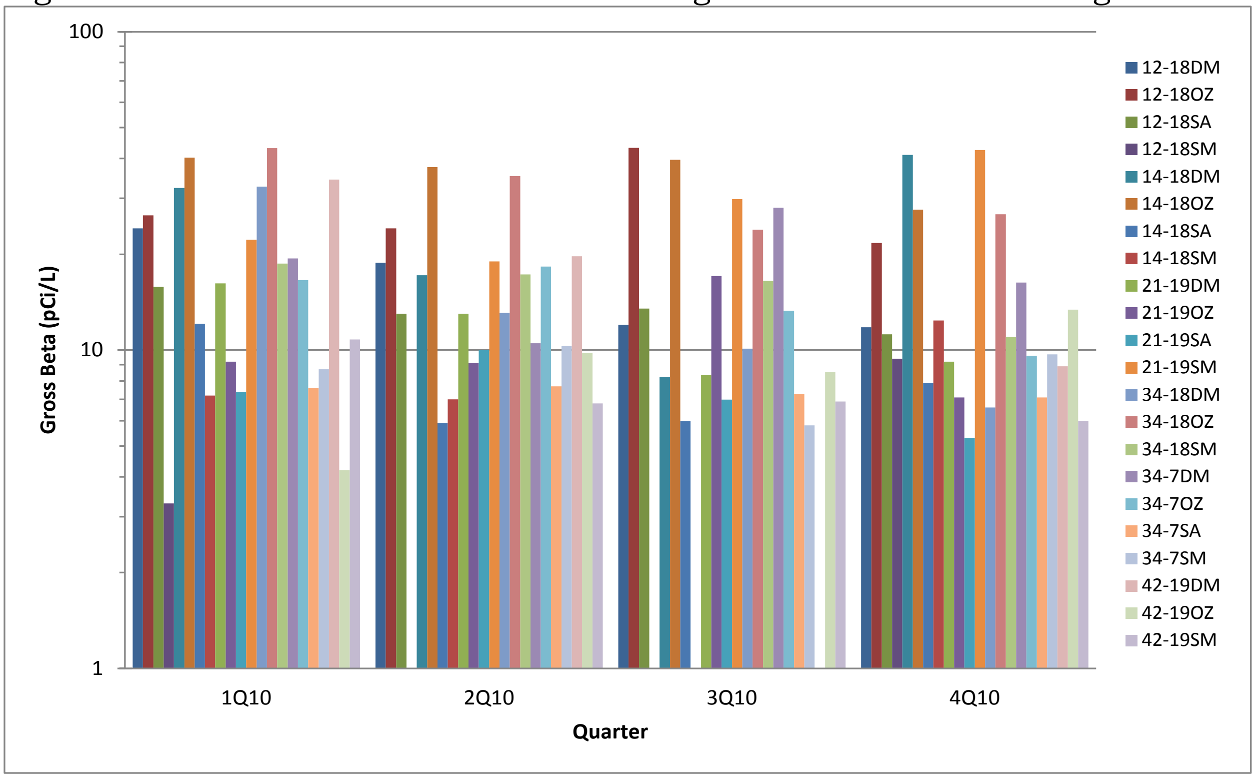
Sample Date	Analyte				
	Pb-210 (pCi/kg)	**Po-210 (pCi/kg)**	**Ra-226 (pCi/kg)**	**Th-230 (pCi/kg)**	**U-nat (mg/kg)**
9-24-10	60.4 ± 93.6	<1.0	175 ± 15	0.6 ± 0.6	0.0160

Figure 2.9-1. Gross Alpha Results for Regional Baseline Monitoring Wells



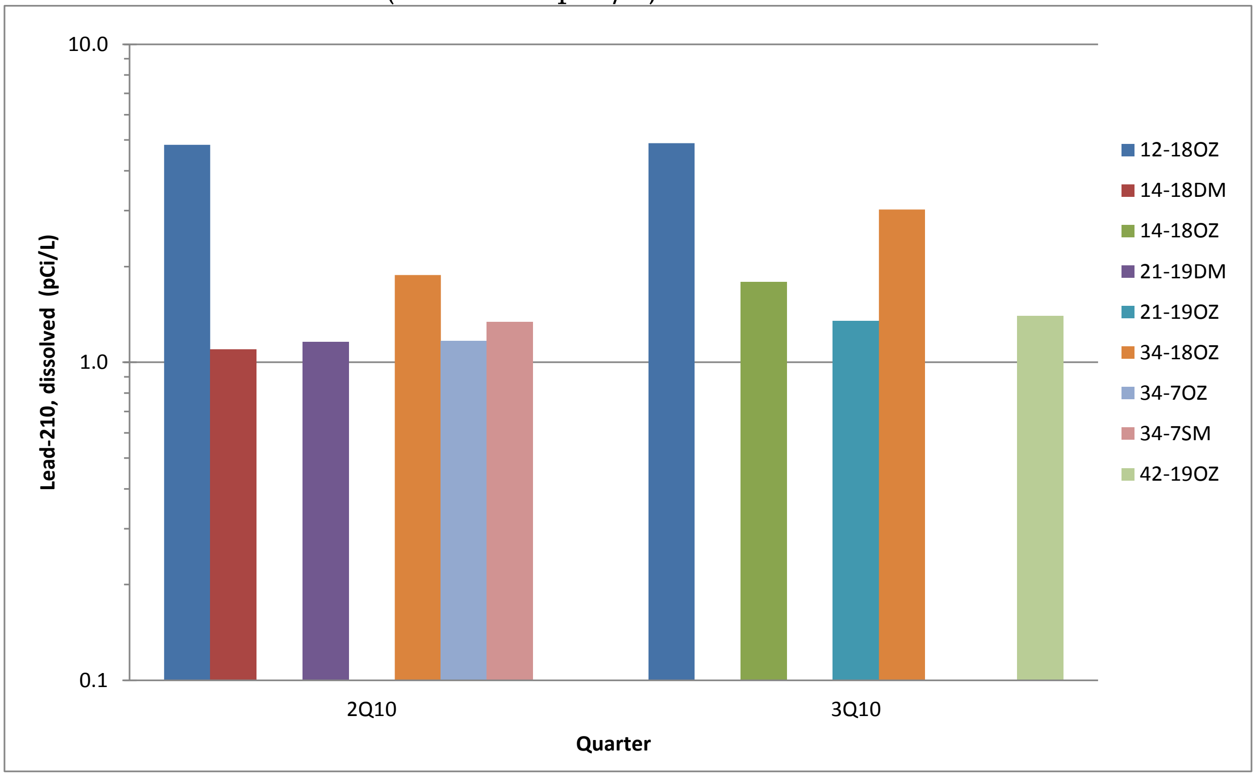
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-2. Gross Beta Results for Regional Baseline Monitoring Wells



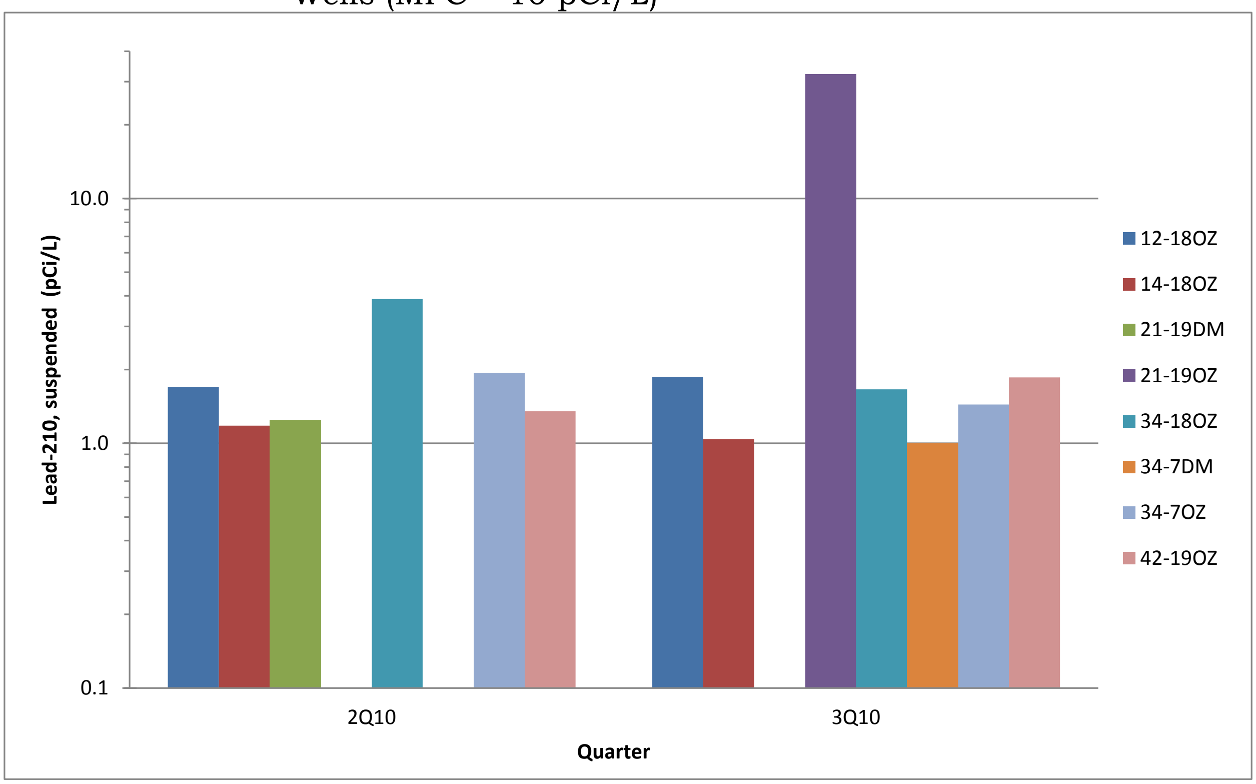
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-3a. Pb-210, Dissolved Results for Regional Baseline Monitoring Wells (MPC = 10 pCi/L)



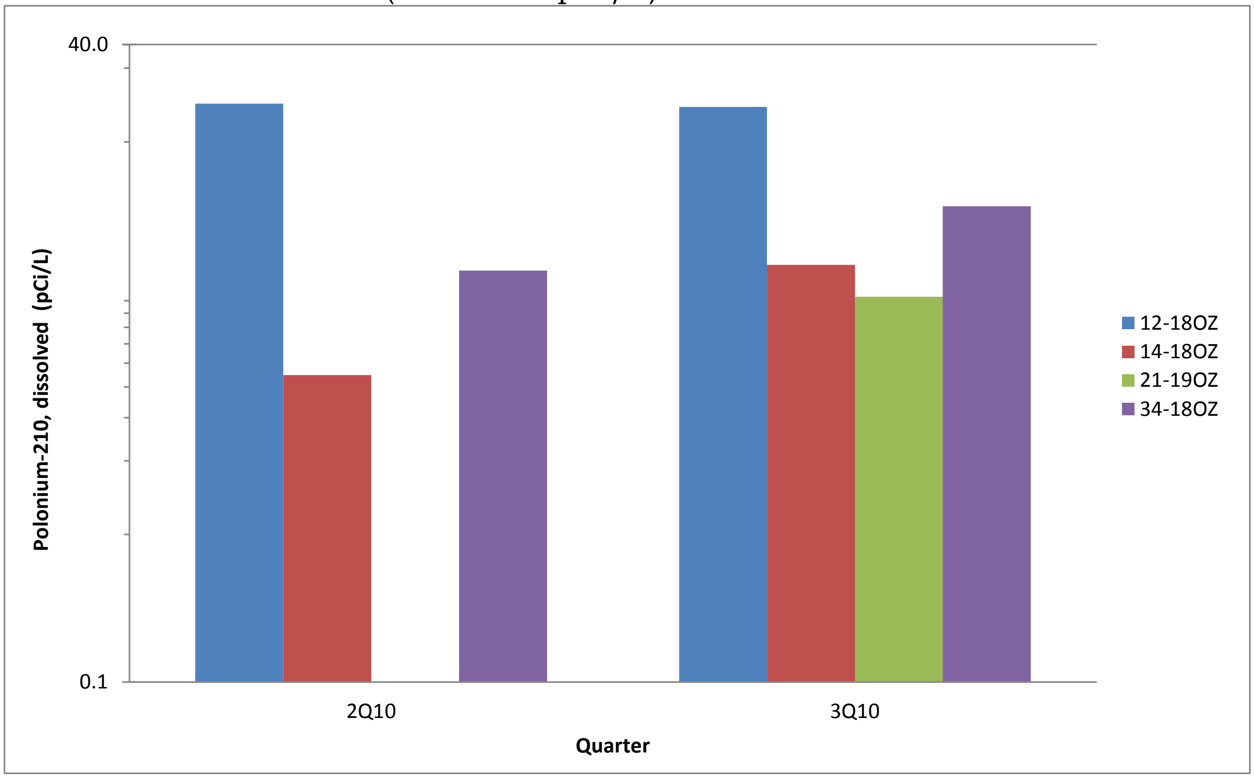
Note: Results for water samples reported as “non-detect” from the laboratory are not shown in graphs.

Figure 2.9-3b. Pb-210, Suspended Results for Regional Baseline Monitoring Wells (MPC = 10 pCi/L)



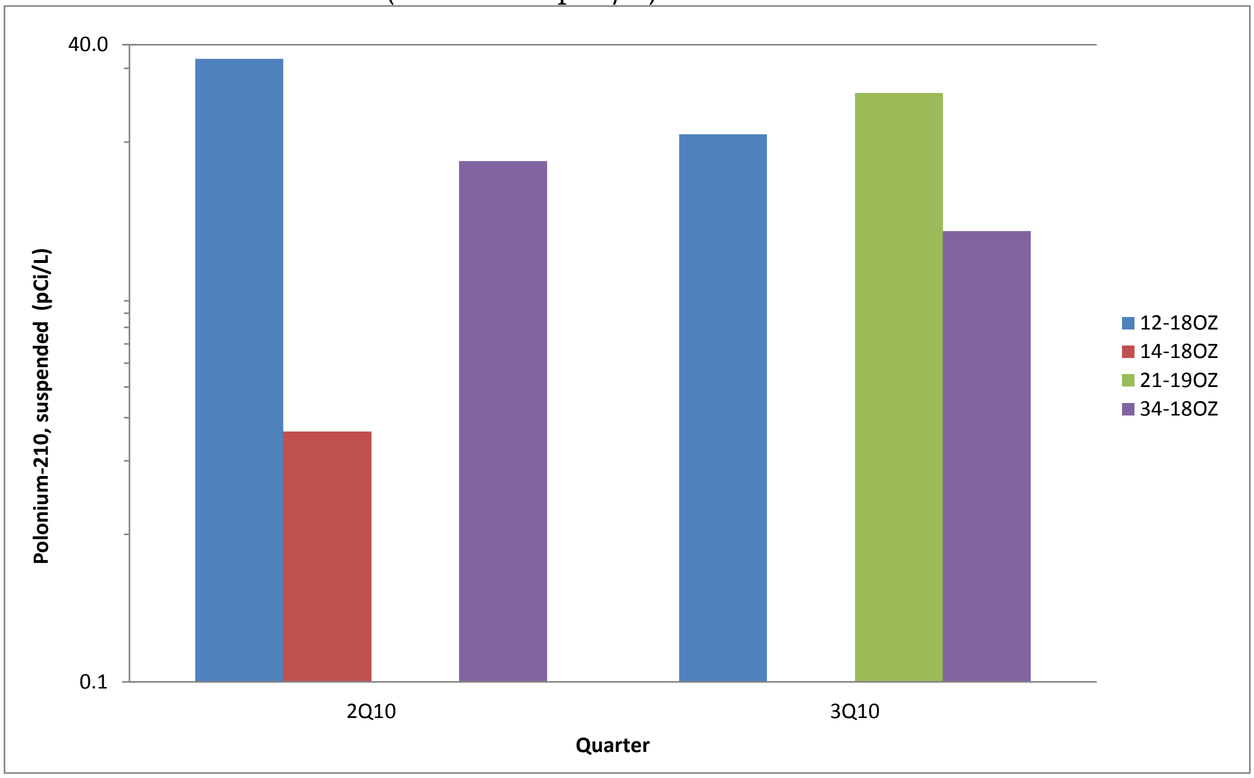
Note: Results for water samples reported as “non-detect” from the laboratory are not shown in graphs.

Figure 2.9-4a. Po-210, Dissolved Results for Regional Baseline Monitoring Wells (MPC = 40 pCi/L)



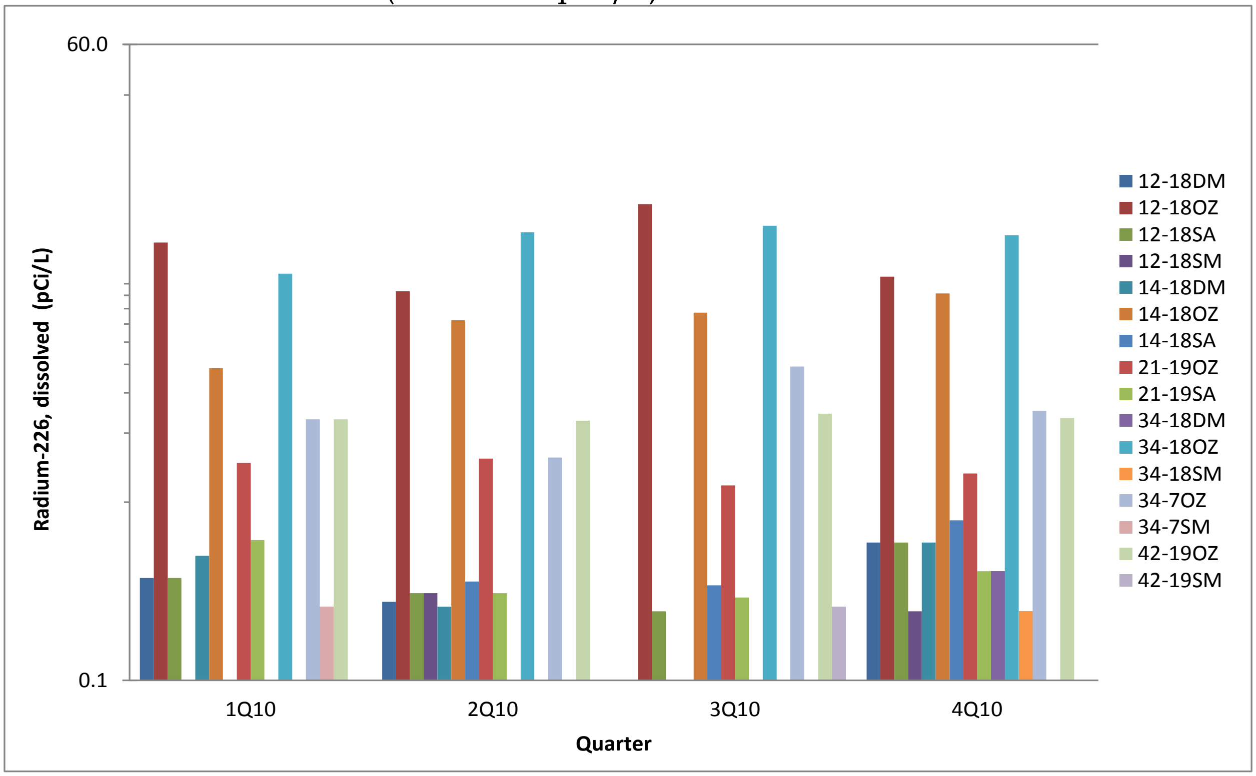
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-4b. Po-210, Suspended Results for Regional Baseline Monitoring Wells (MPC = 40 pCi/L)



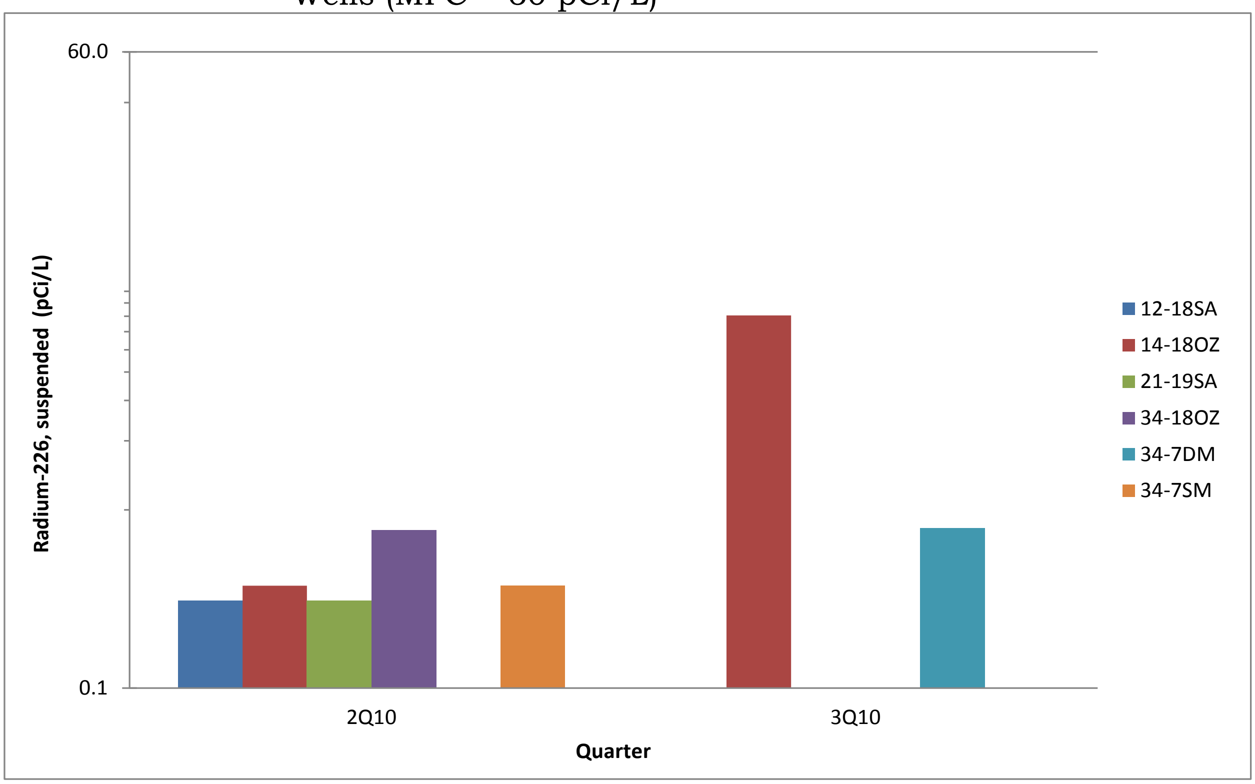
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-5a. Ra-226, Dissolved Results for Regional Baseline Monitoring Wells (MPC = 60 pCi/L)



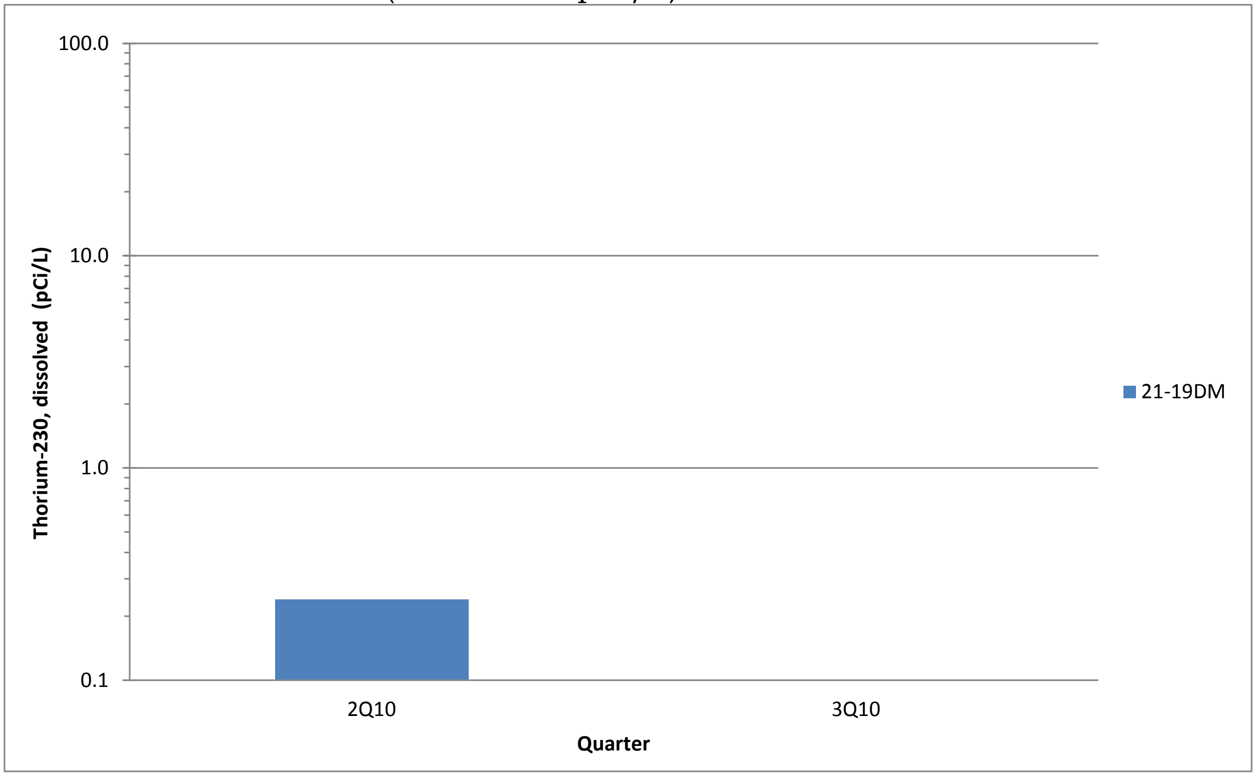
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-5b. Ra-226, Suspended Results for Regional Baseline Monitoring Wells (MPC = 60 pCi/L)



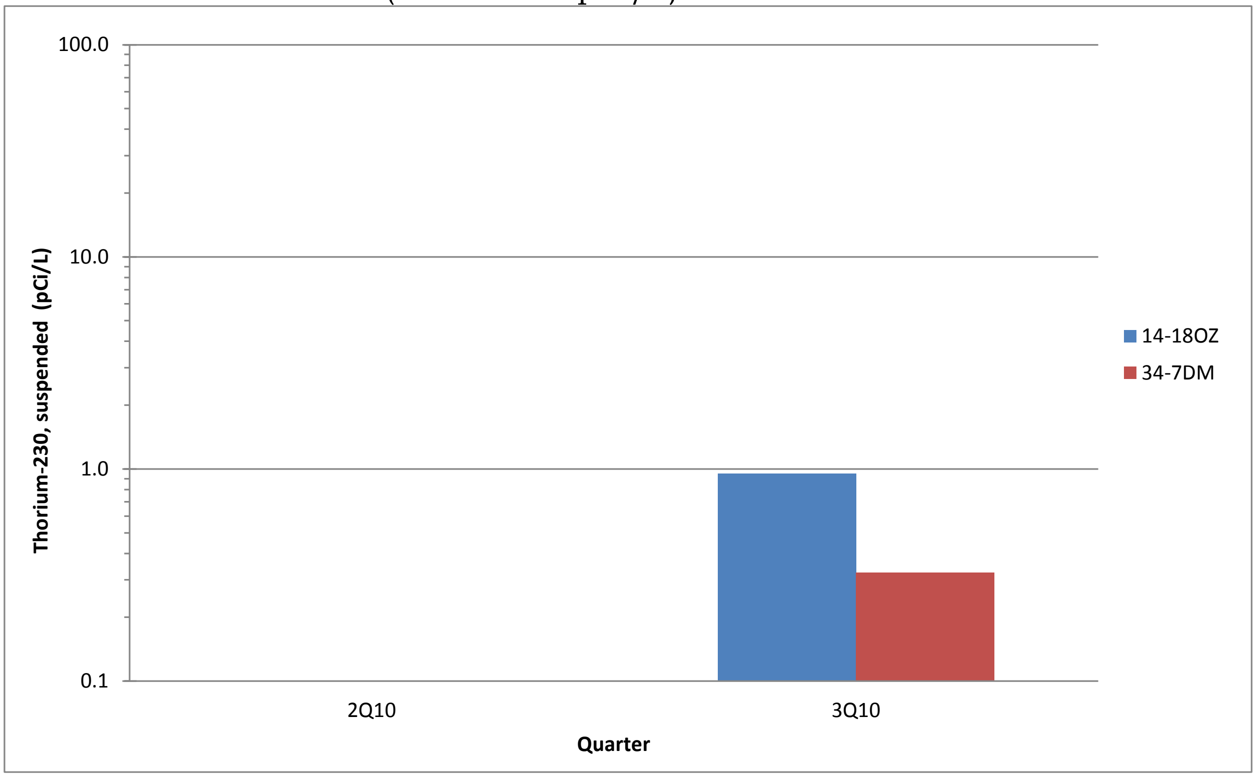
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-6a. Th-230, Dissolved Results for Regional Baseline Monitoring Wells (MPC = 100 pCi/L)



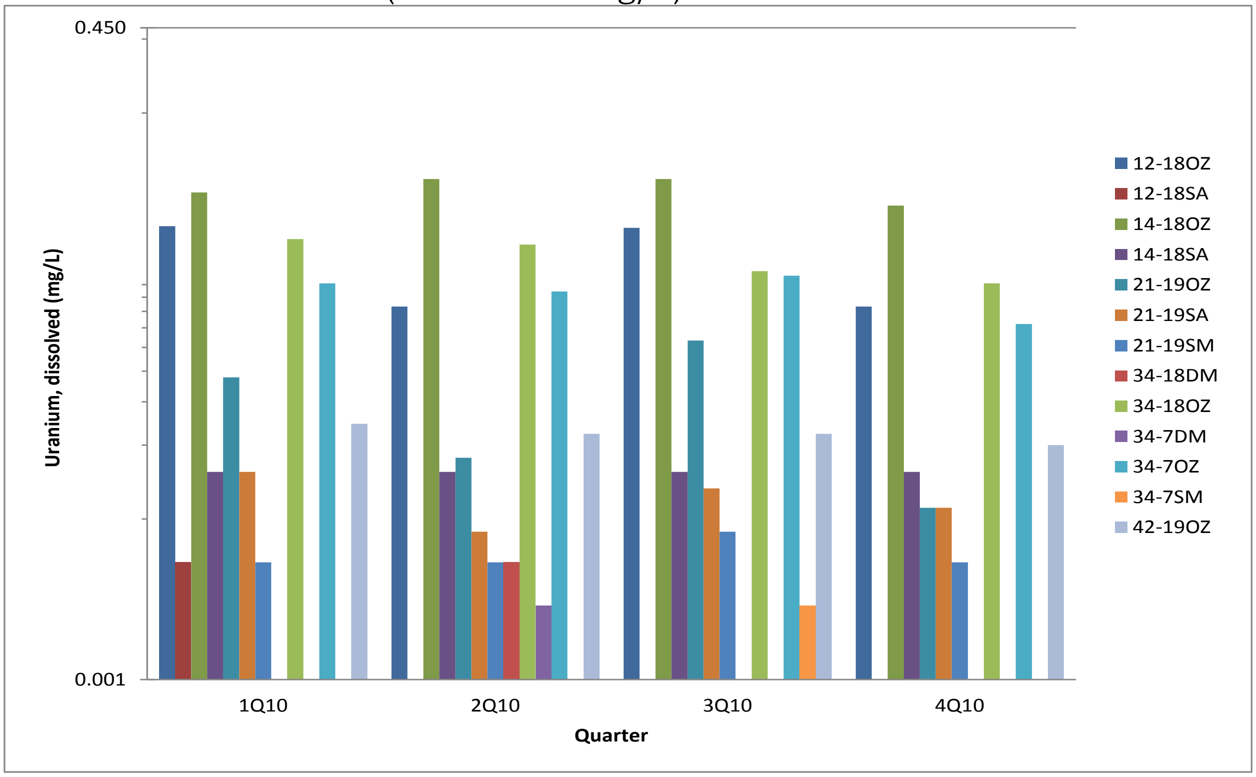
Note: Results for water samples reported as “non-detect” from the laboratory are not shown in graphs.

Figure 2.9-6b. Th-230, Suspended Results for Regional Baseline Monitoring Wells (MPC = 100 pCi/L)



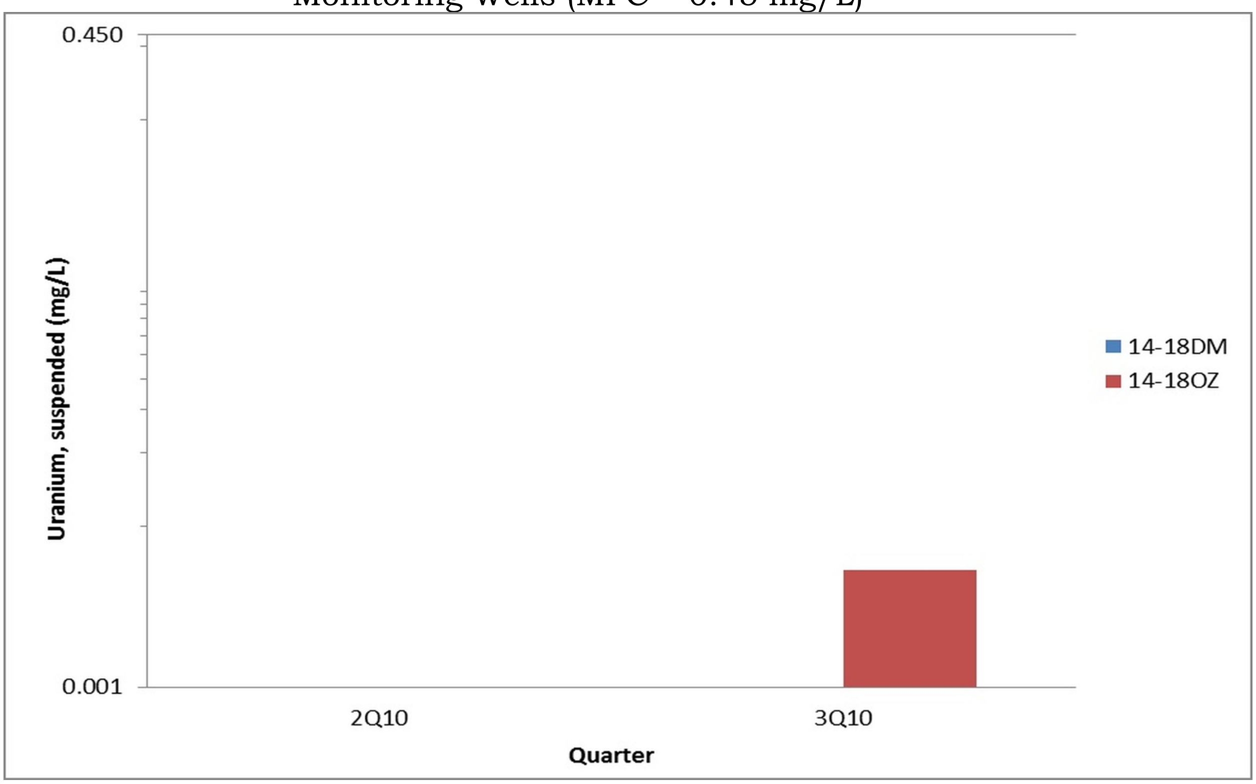
Note: Results for water samples reported as “non-detect” from the laboratory are not shown in graphs.

Figure 2.9-7a. Uranium, Dissolved Results for Regional Baseline Monitoring Wells (MPC = 0.45 mg/L)



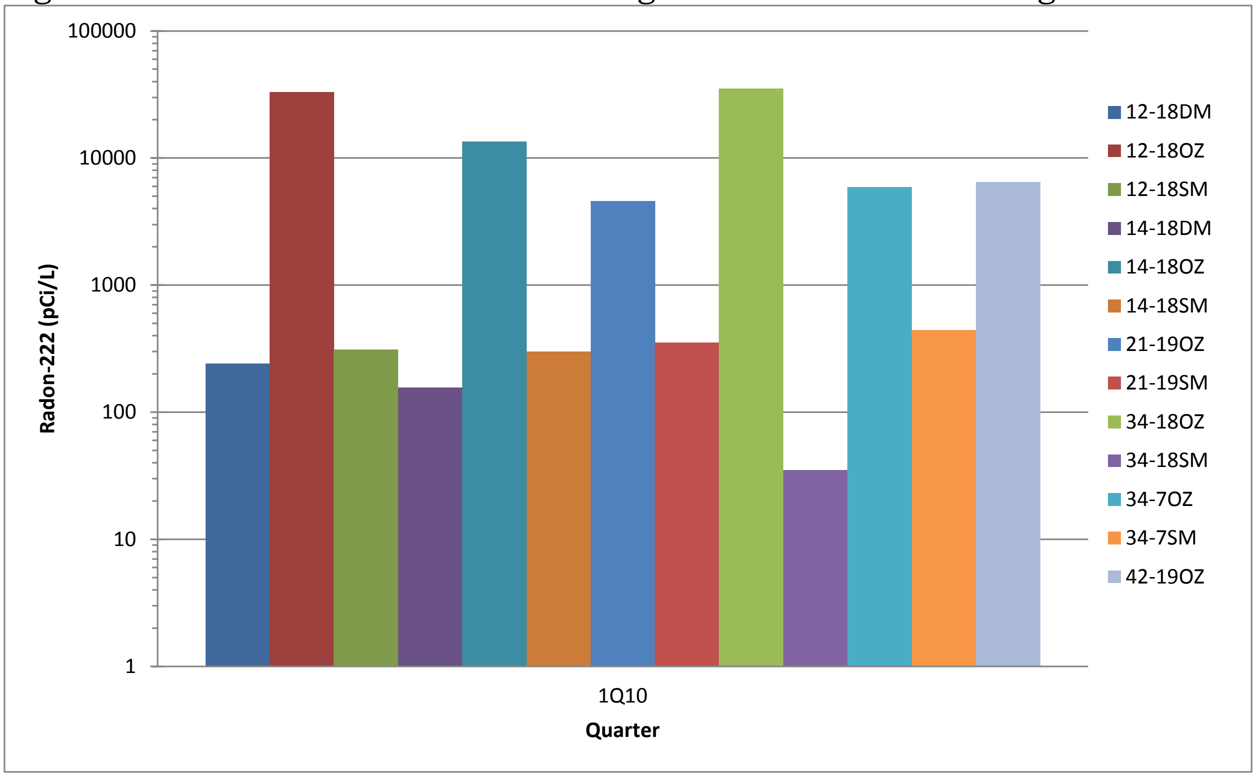
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs

Figure 2.9-7b. Uranium, Suspended Results for Regional Baseline Monitoring Wells (MPC = 0.45 mg/L)



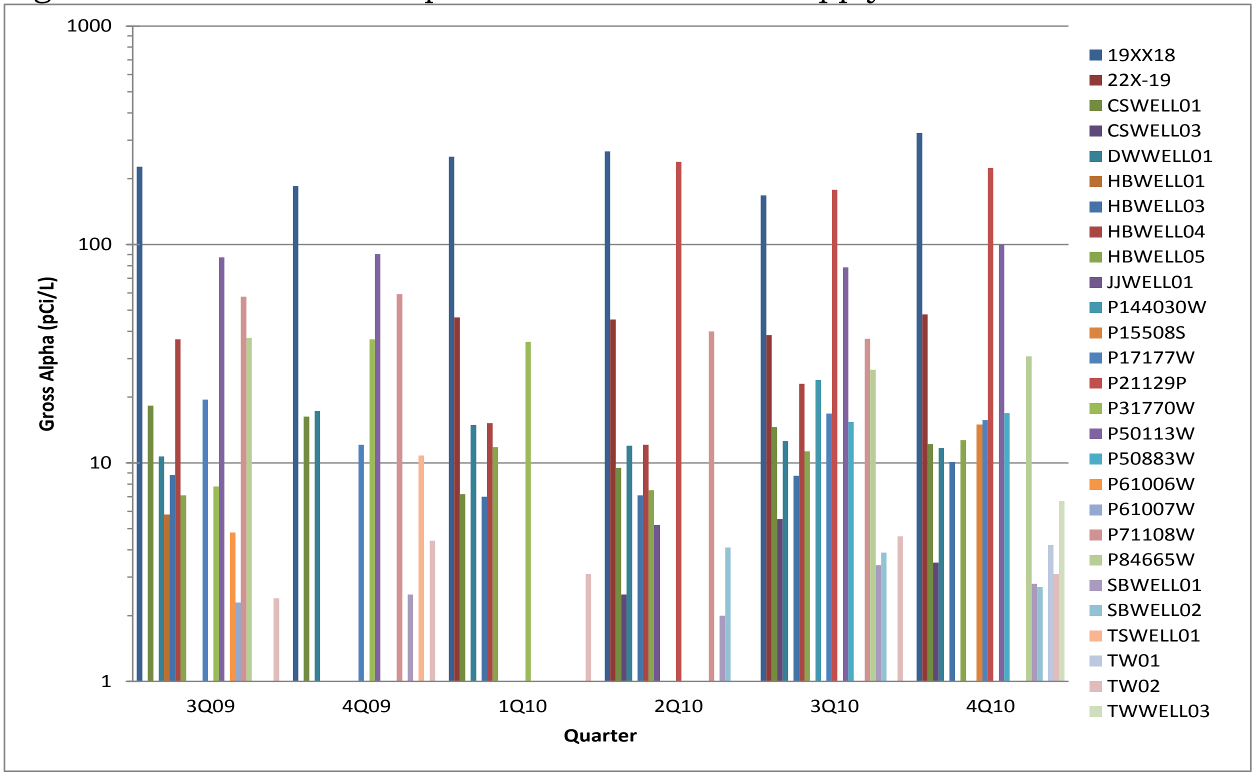
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs

Figure 2.9-8. Rn-222 Results for Regional Baseline Monitoring Wells



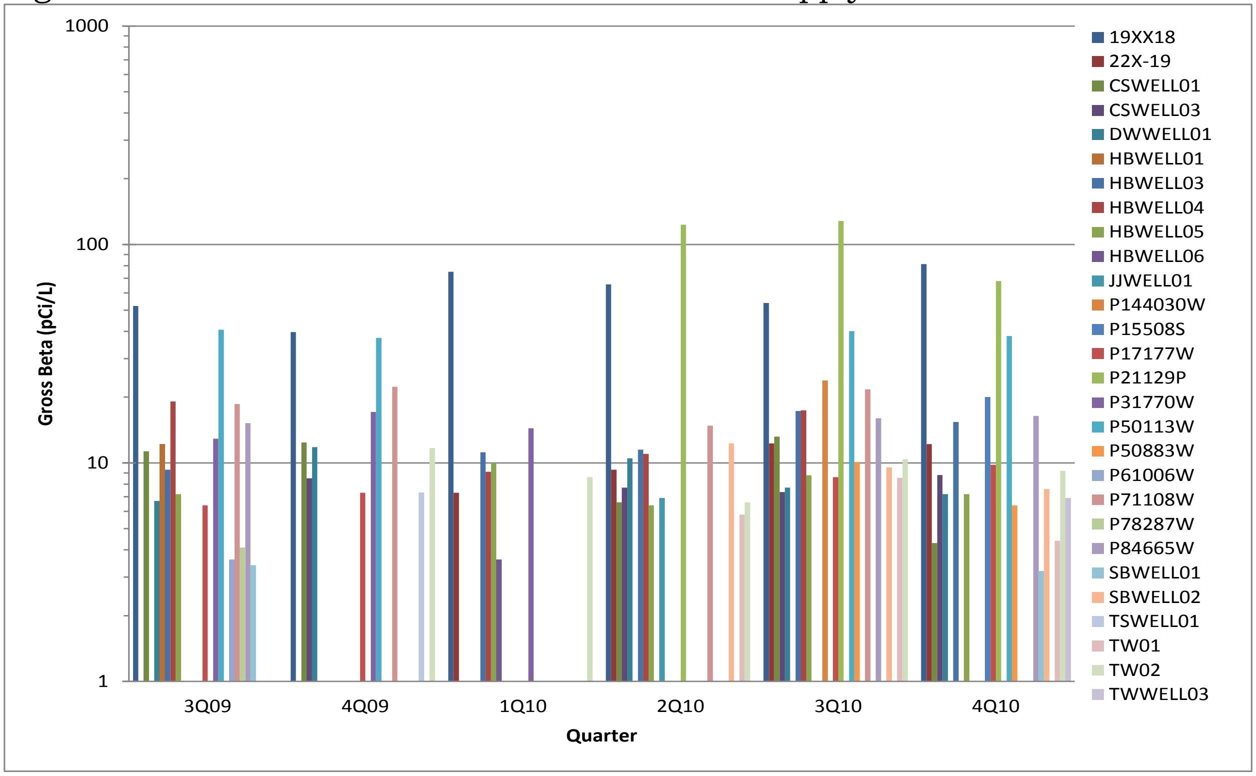
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs

Figure 2.9-9. Gross Alpha Results for Water Supply Wells



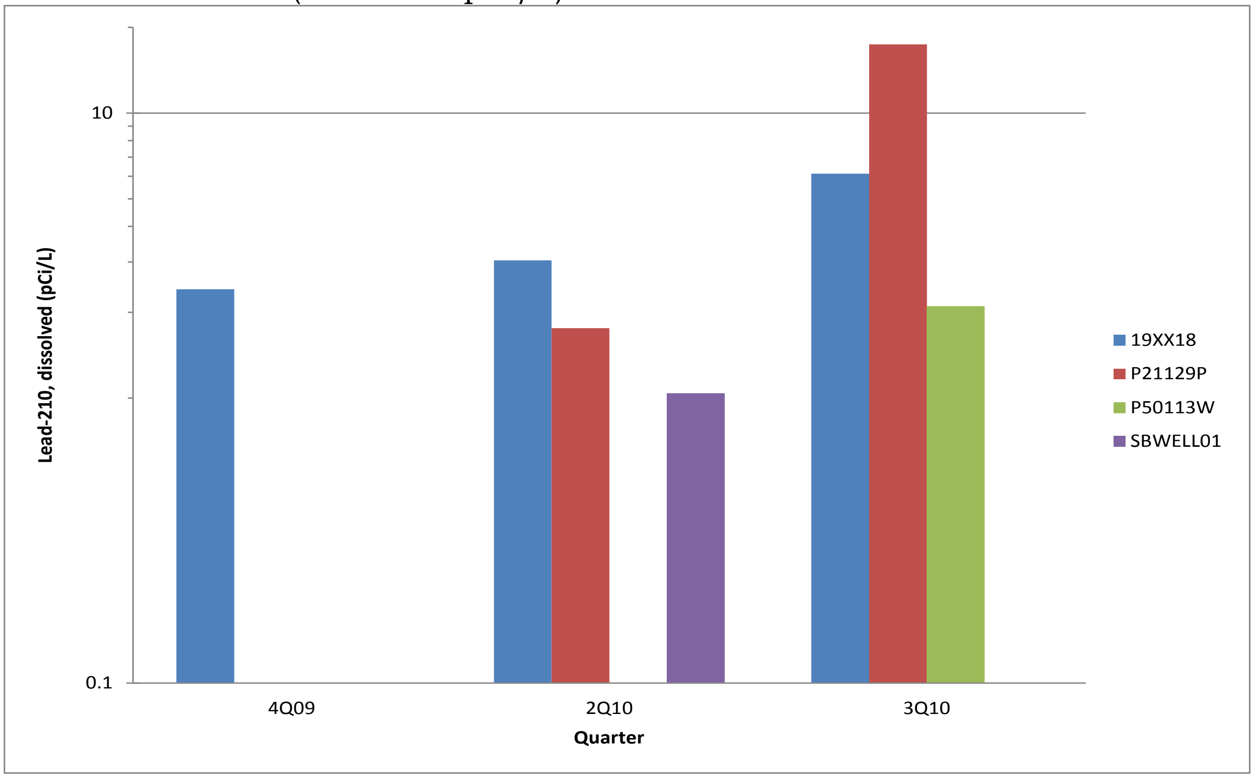
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-10. Gross Beta Results for Water Supply Wells



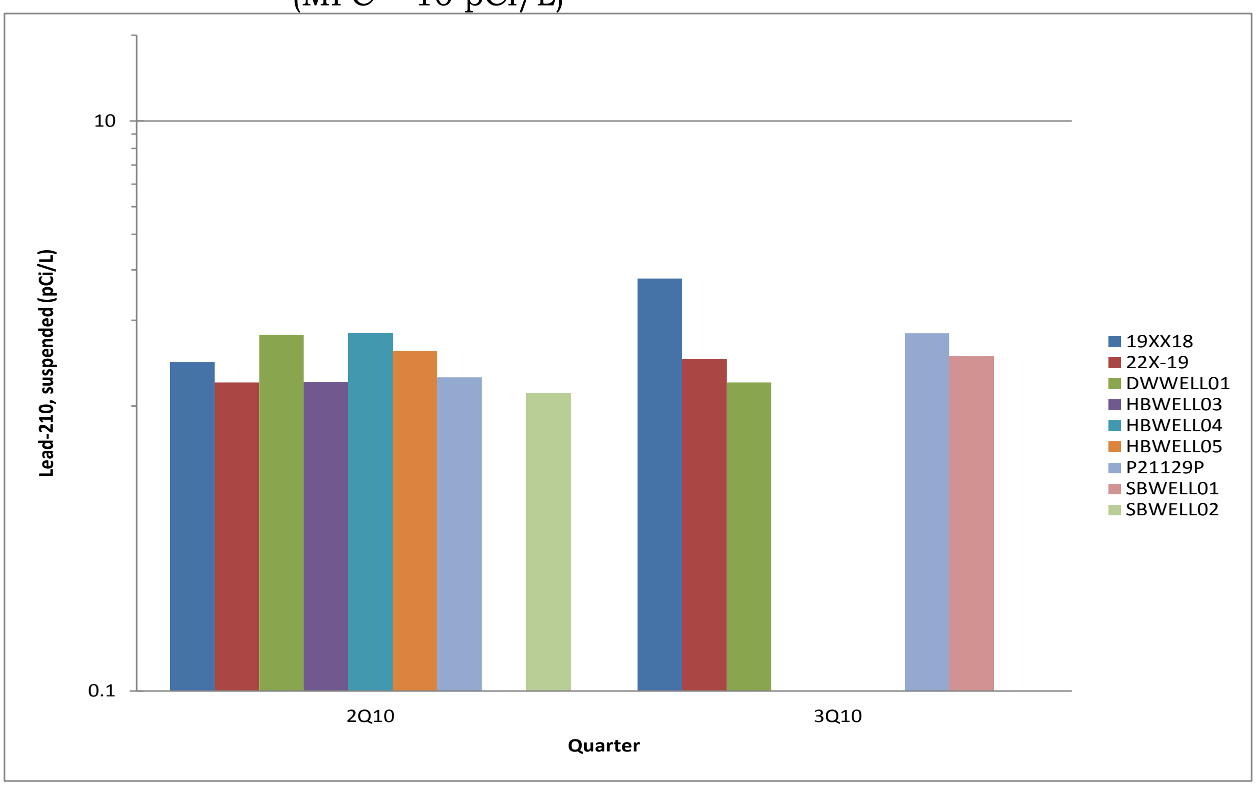
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-11a. Pb-210, Dissolved Results for Water Supply Wells (MPC = 10 pCi/L)



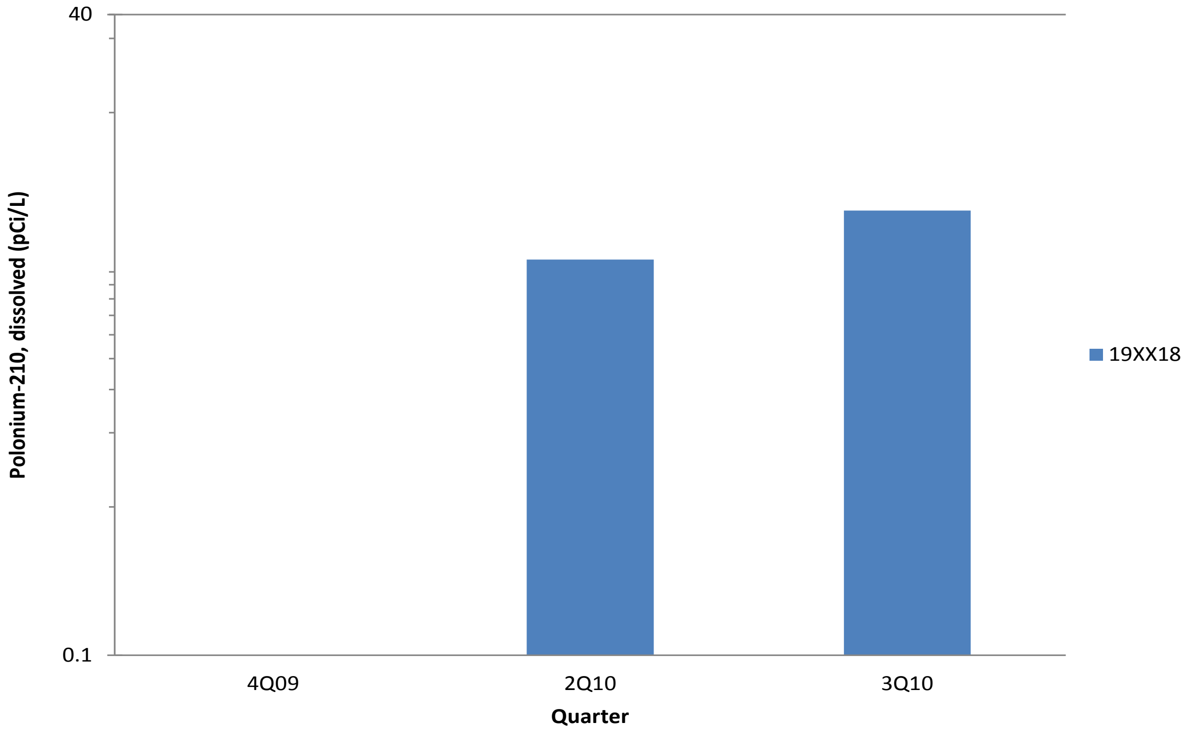
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-11b. Pb-210, Suspended Results for Water Supply Wells (MPC = 10 pCi/L)



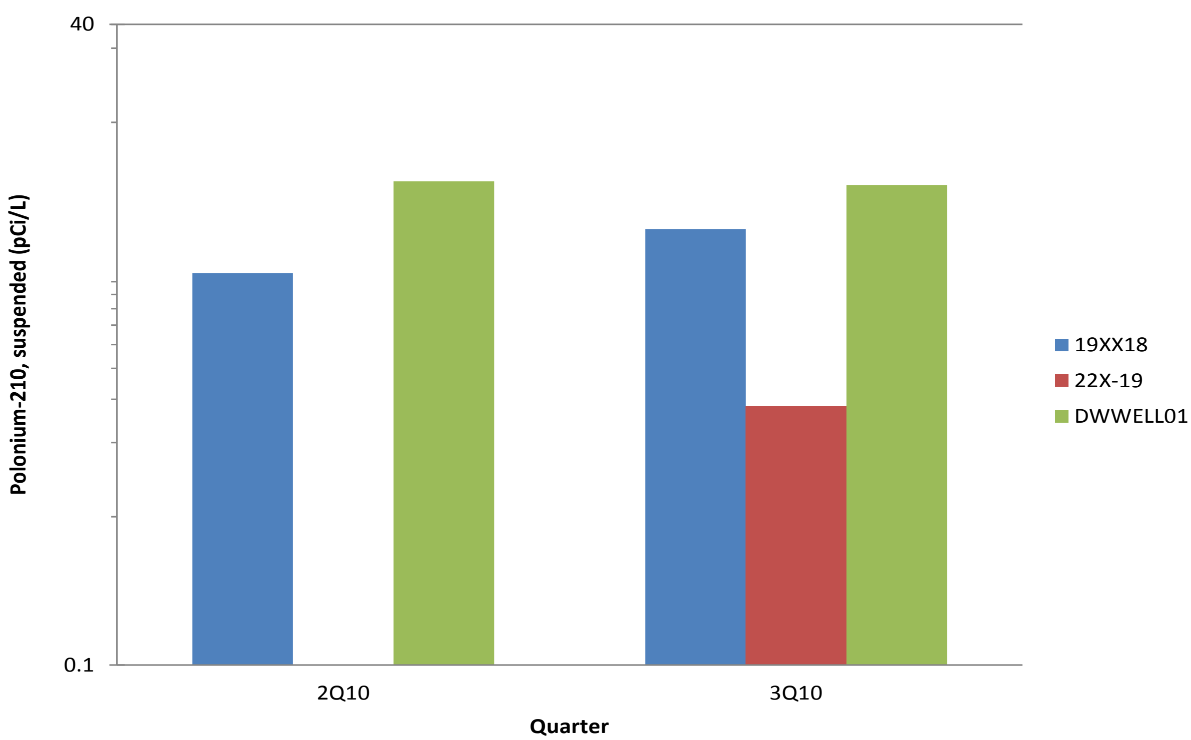
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-12a. Po-210, Dissolved Results for Water Supply Wells (MPC = 40 pCi/L)



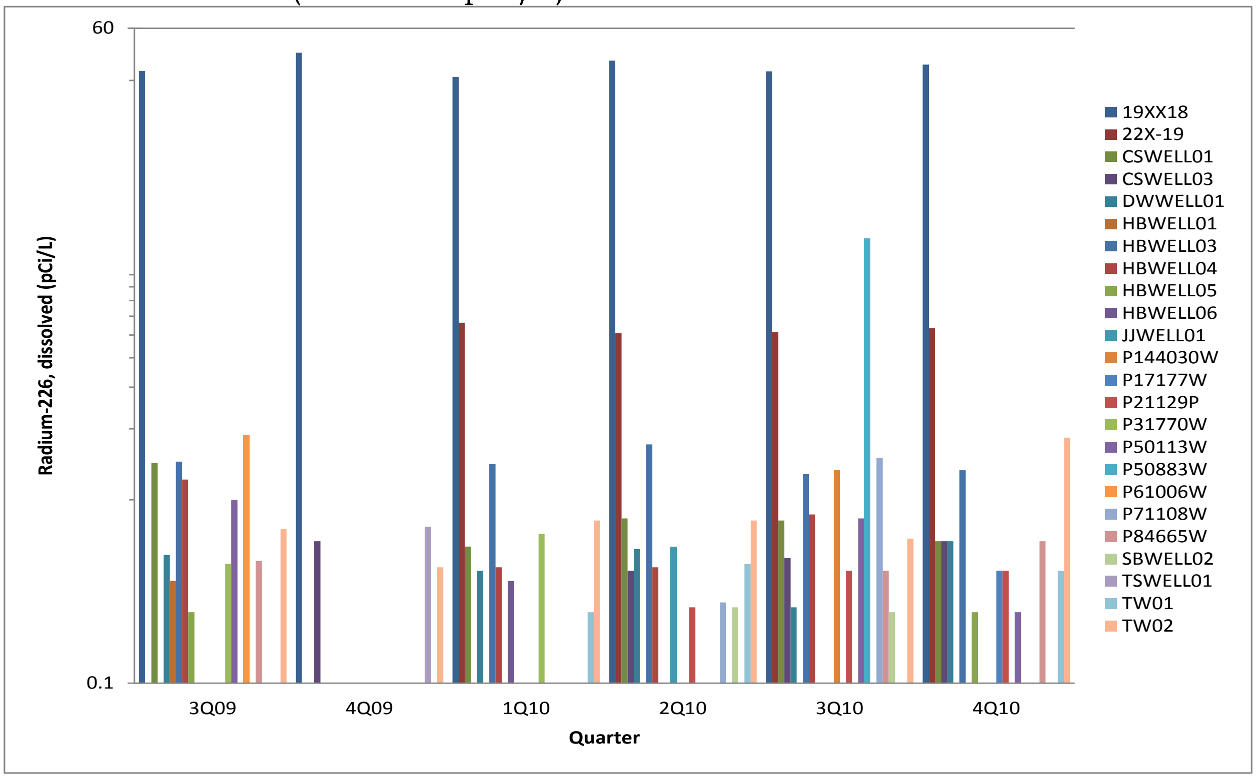
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-12b. Po-210, Suspended Results for Water Supply Wells (MPC = 40 pCi/L)



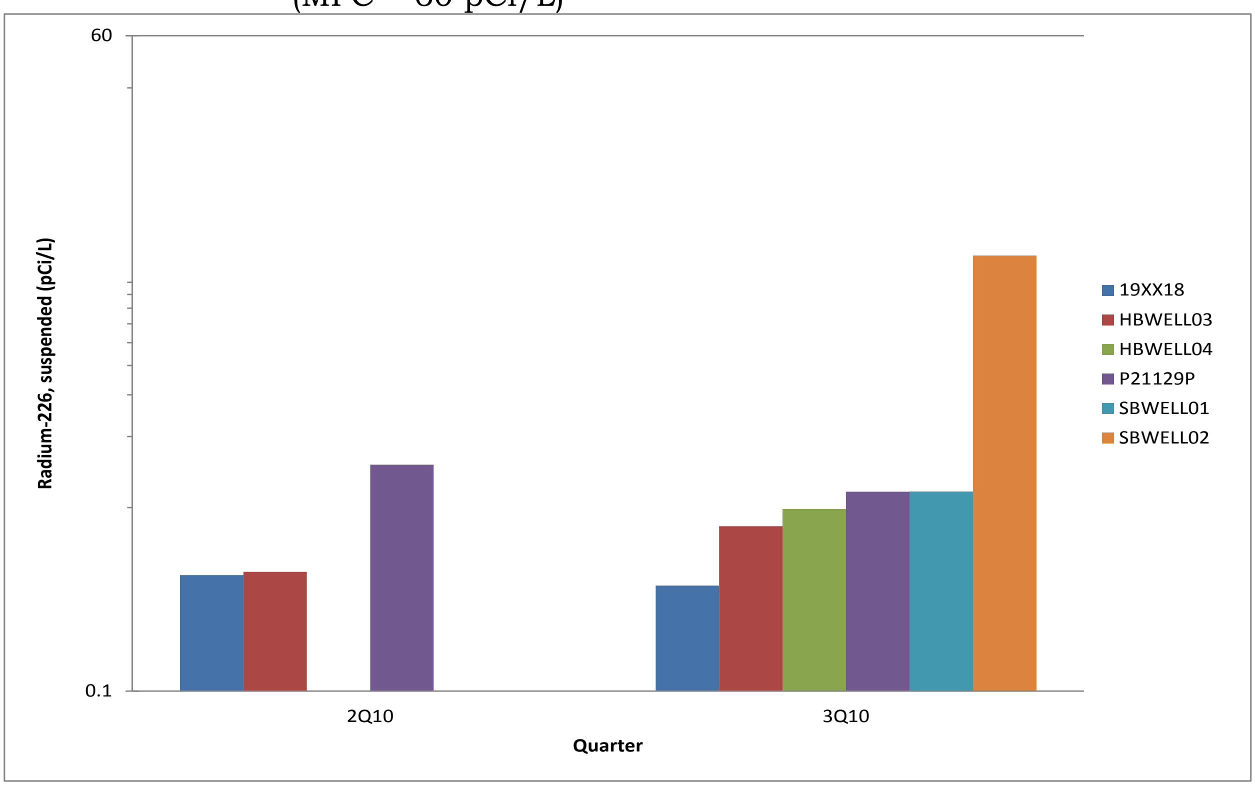
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-13a. Ra-226, Dissolved Results for Water Supply Wells (MPC = 60 pCi/L)



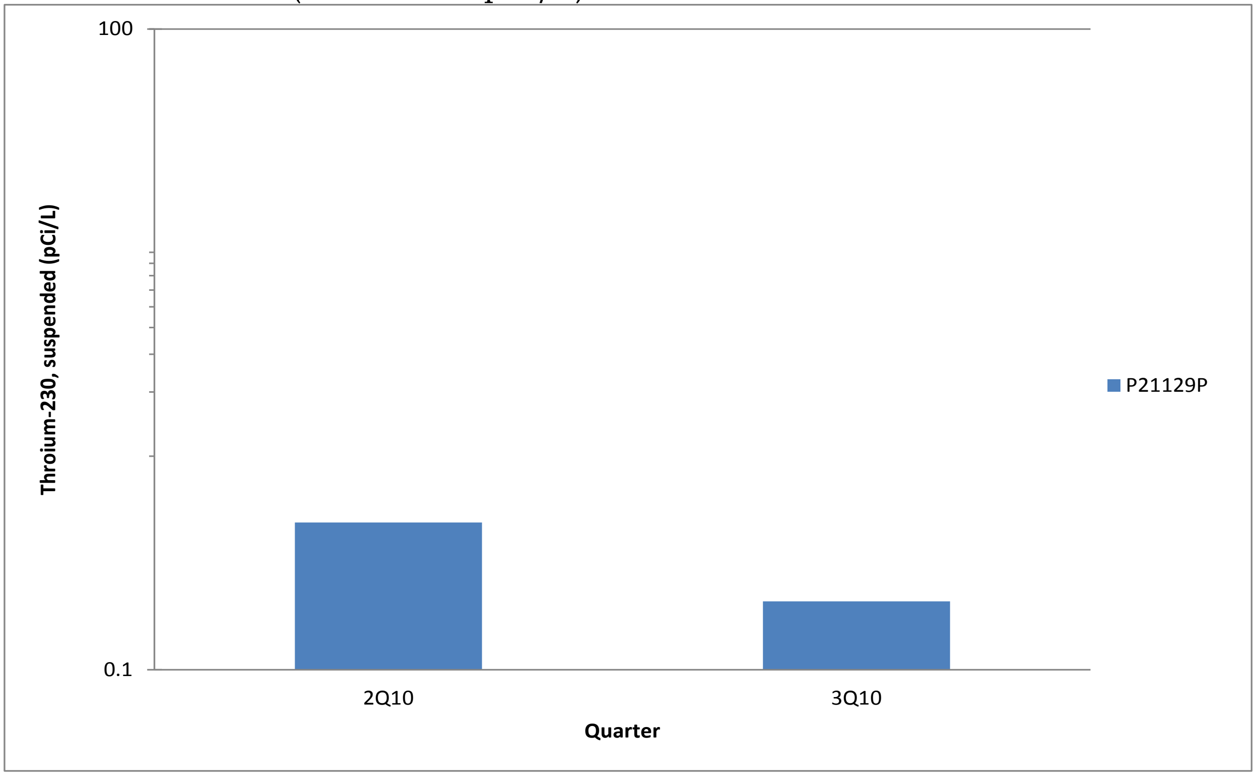
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-13b. Ra-226, Suspended Results for Water Supply Wells (MPC = 60 pCi/L)



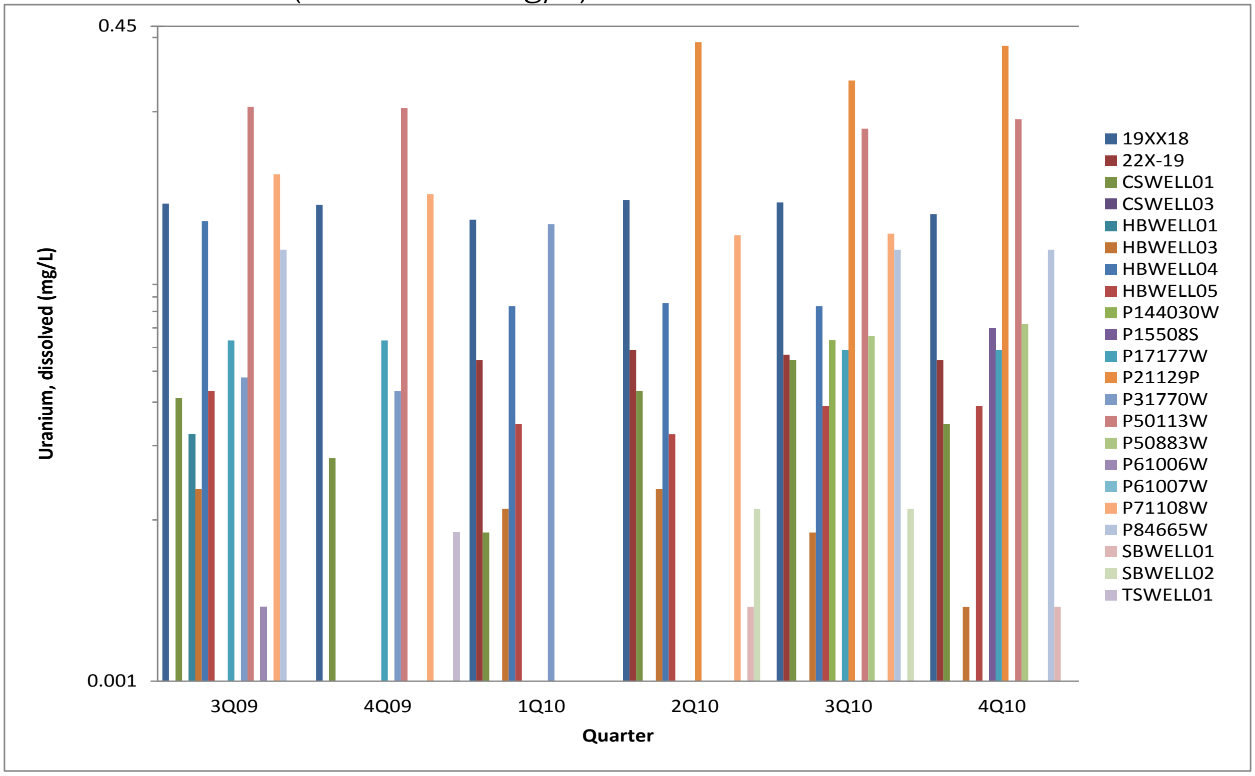
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-14. Th-230, Suspended Results for Water Supply Wells (MPC = 100 pCi/L)



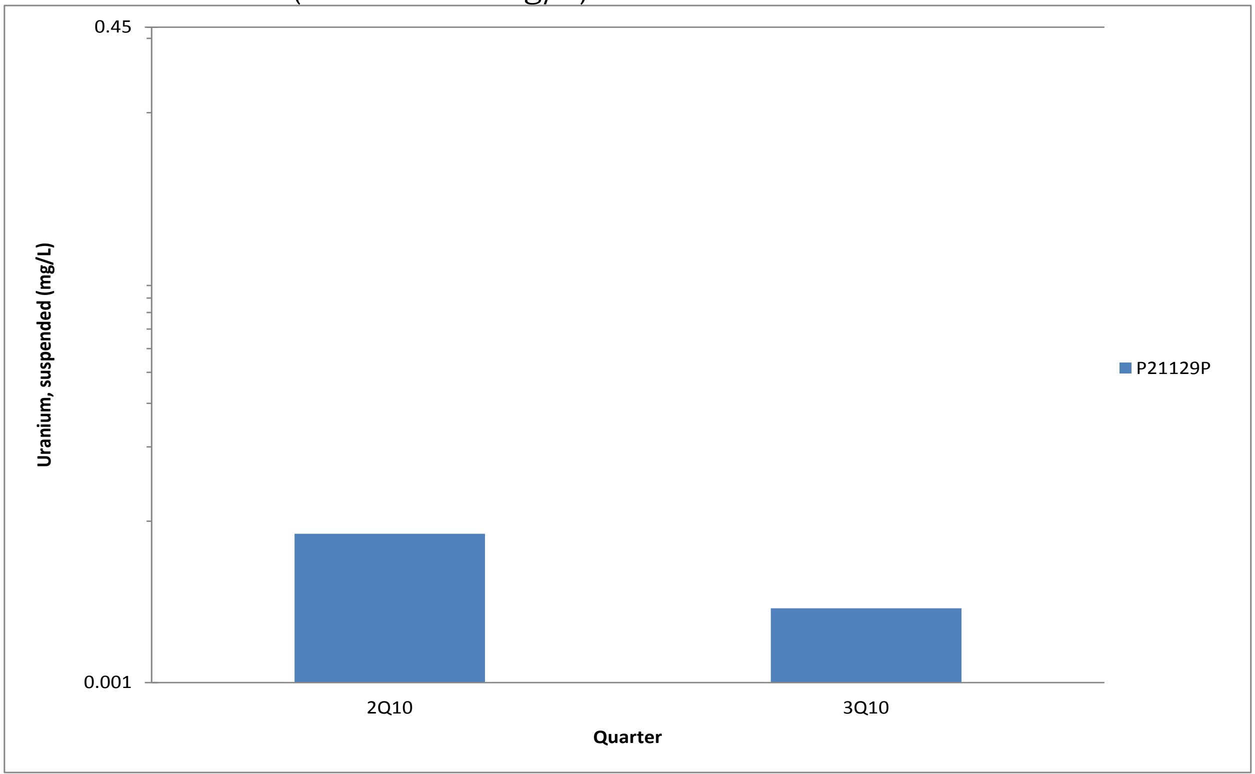
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-15a. Uranium, Dissolved Results for Water Supply Wells (MPC = 0.45 mg/L)



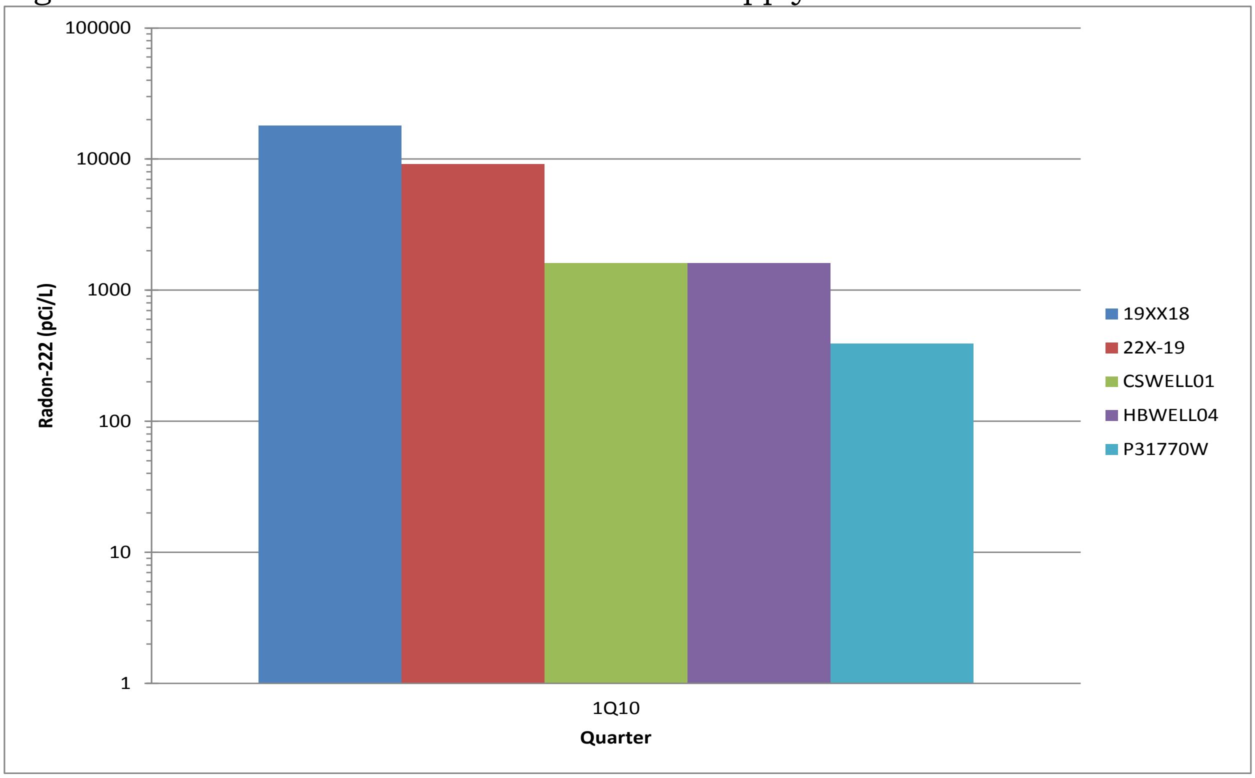
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-15b. Uranium, Suspended Results for Water Supply Wells (MPC = 0.45 mg/L)



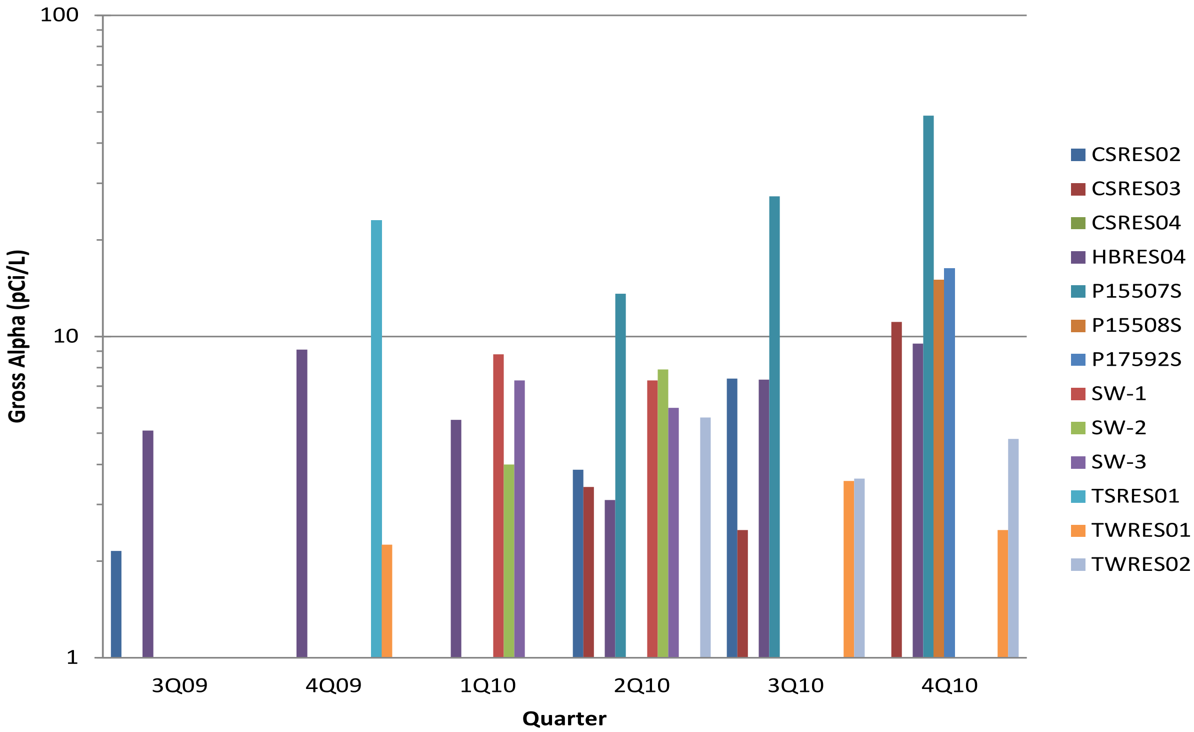
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-16. Rn-222 Results for Water Supply Wells



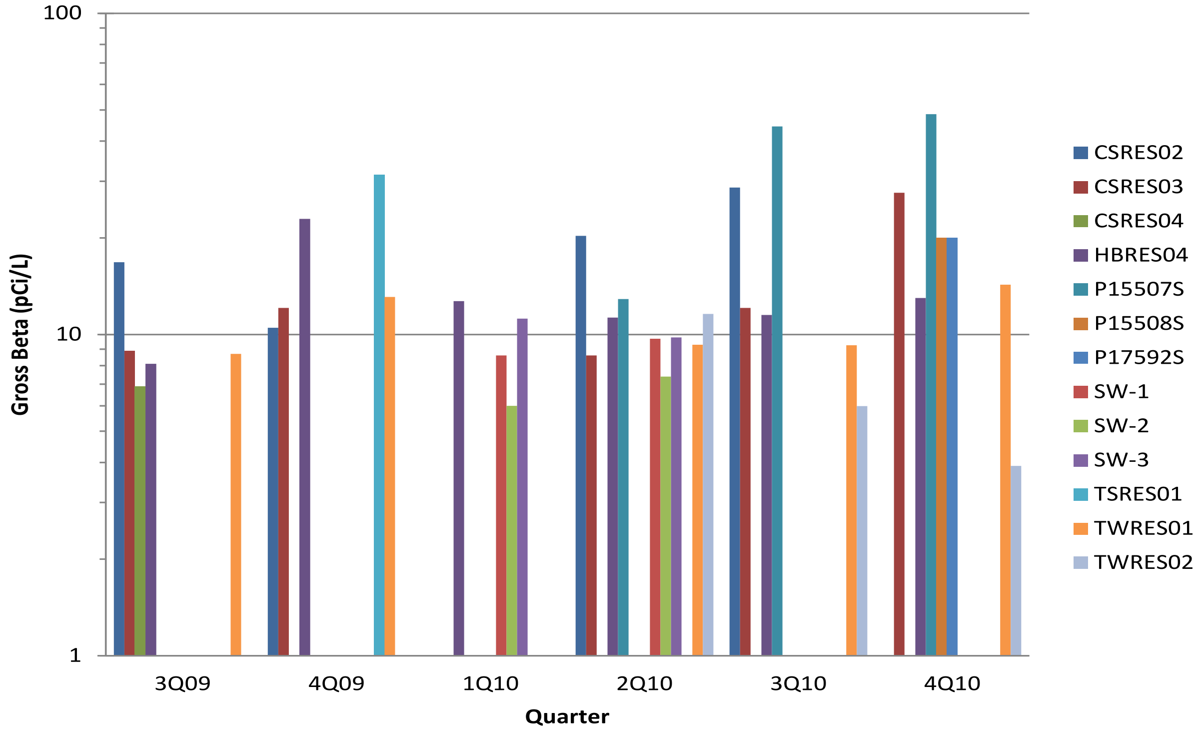
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-17. Gross Alpha Results for Surface Water Monitoring



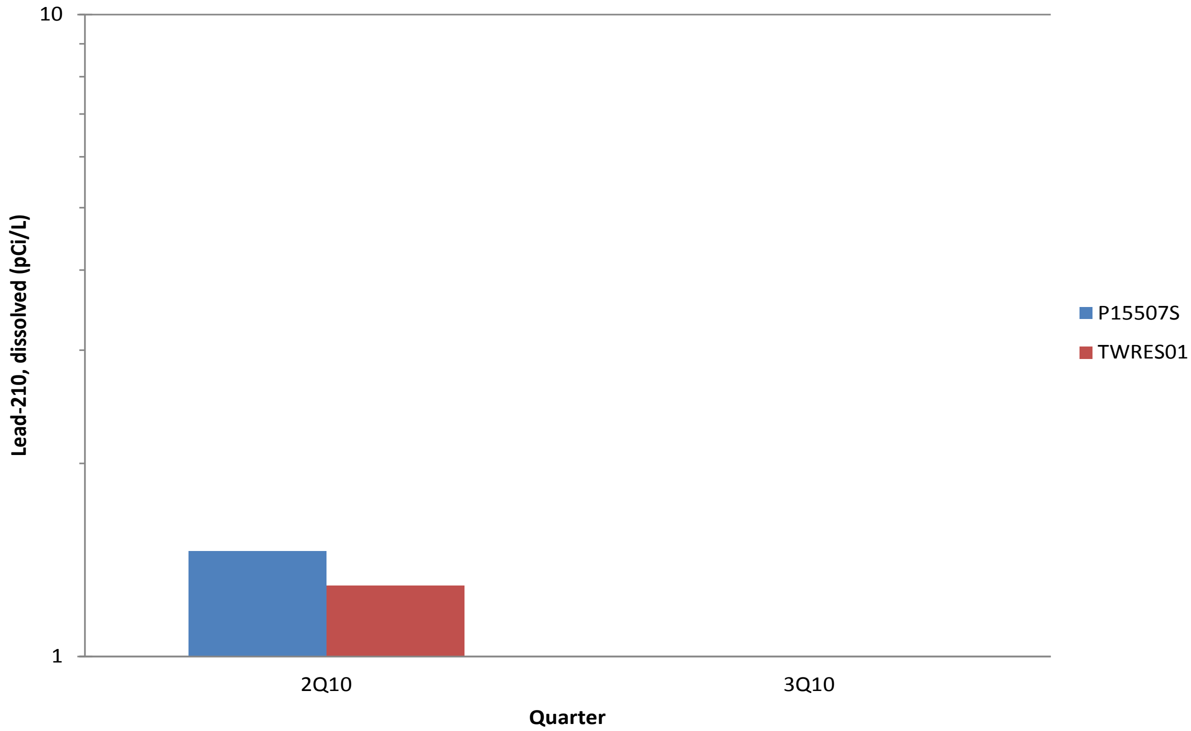
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-18. Gross Beta Results for Surface Water Monitoring



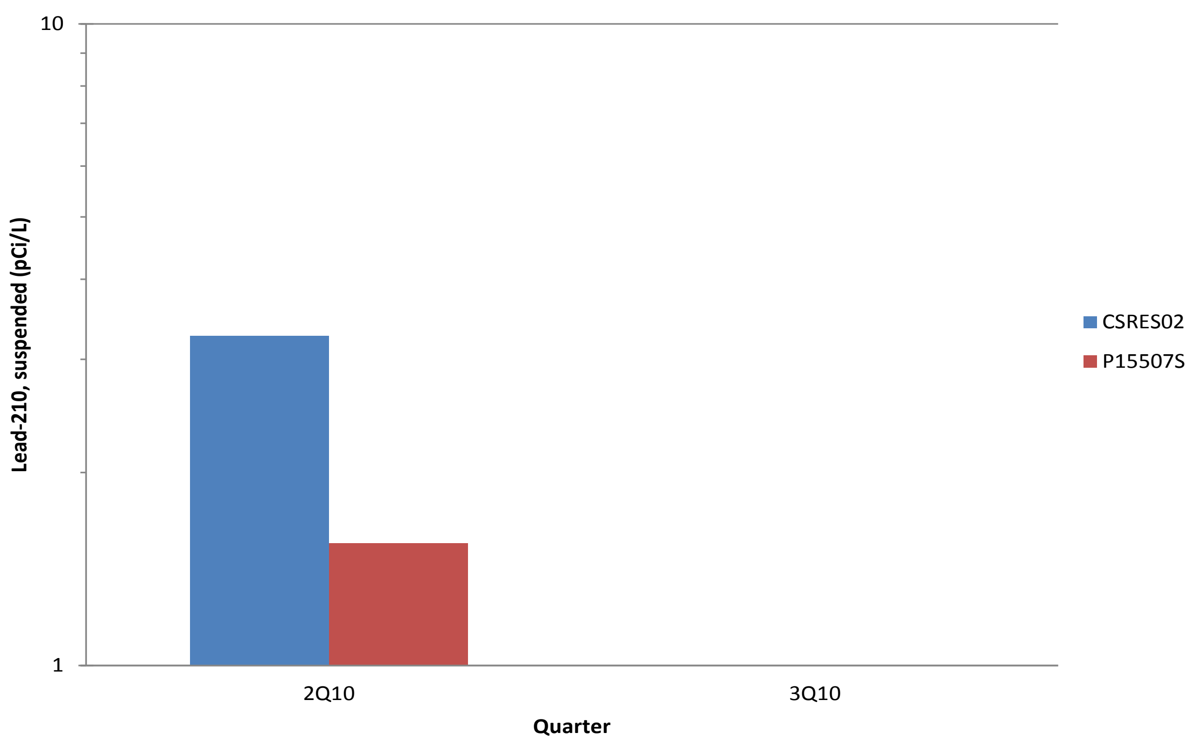
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-19a. Pb-210, Dissolved Results for Surface Water Monitoring (MPC = 10 pCi/L)



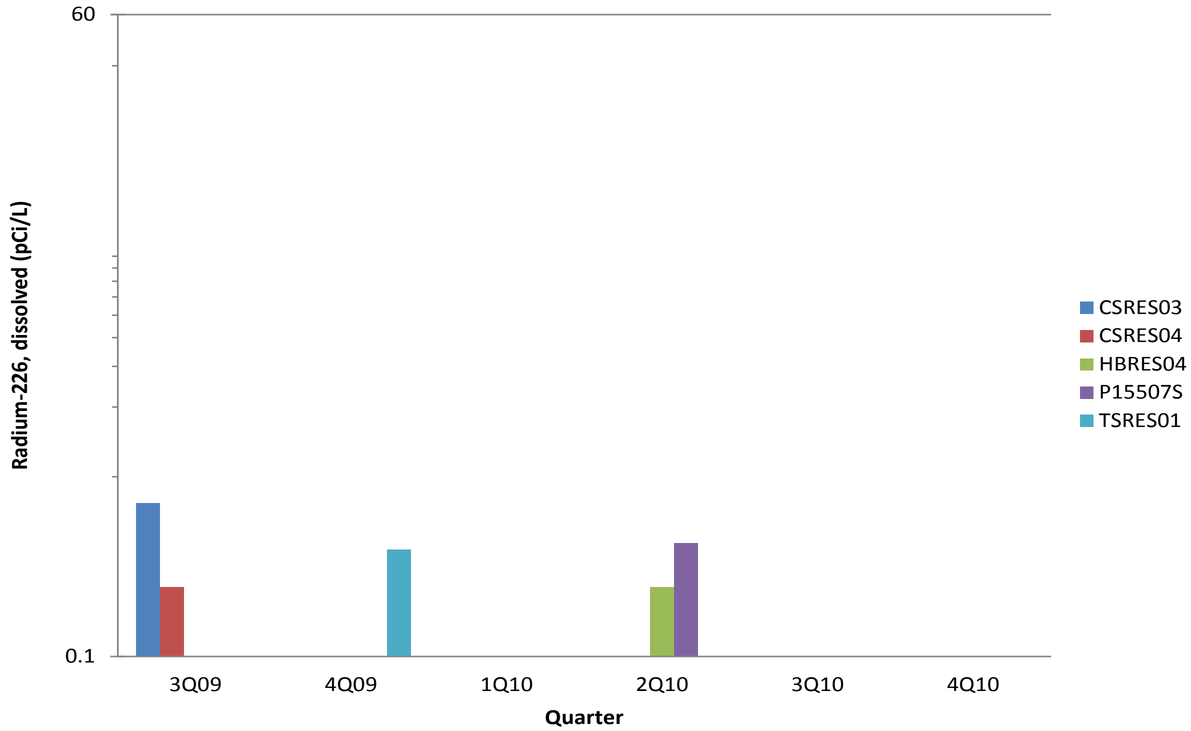
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-19b. Pb-210, Suspended Results for Surface Water Monitoring (MPC = 10 pCi/L)



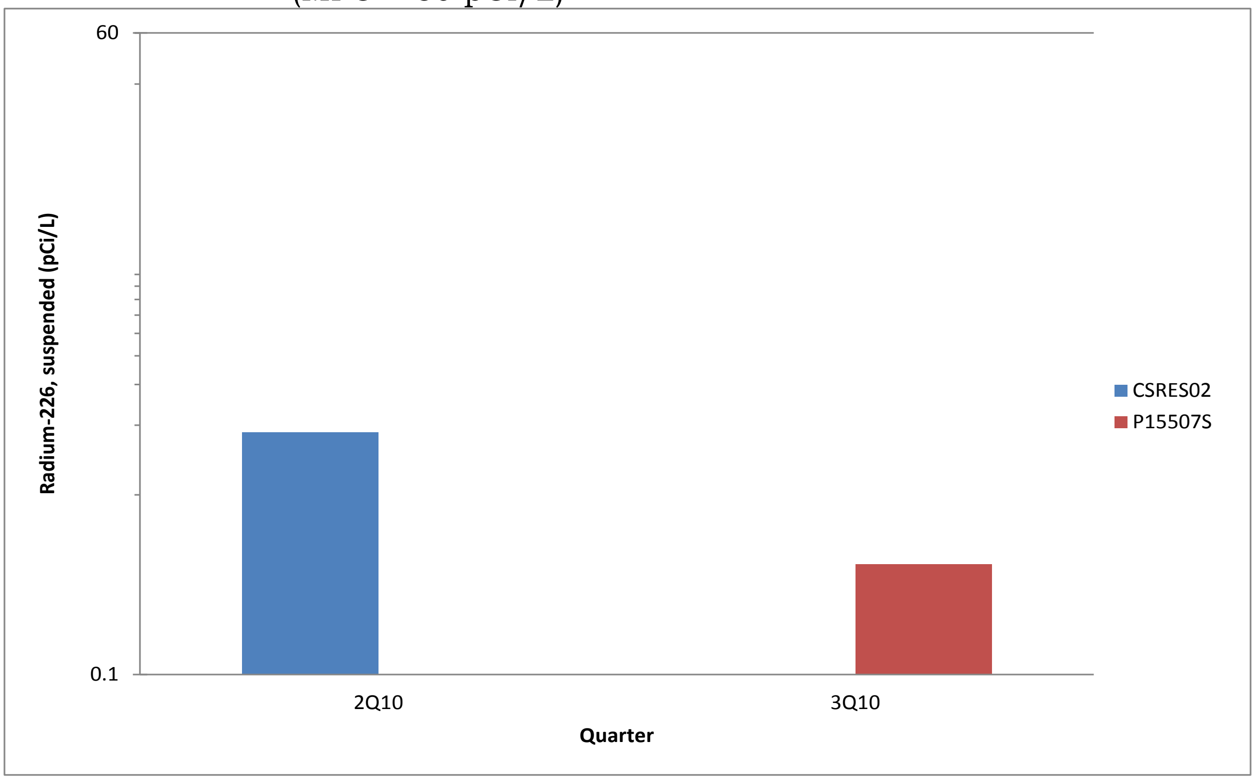
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-20a. Ra-226, Dissolved Results for Surface Water Monitoring (MPC = 60 pCi/L)



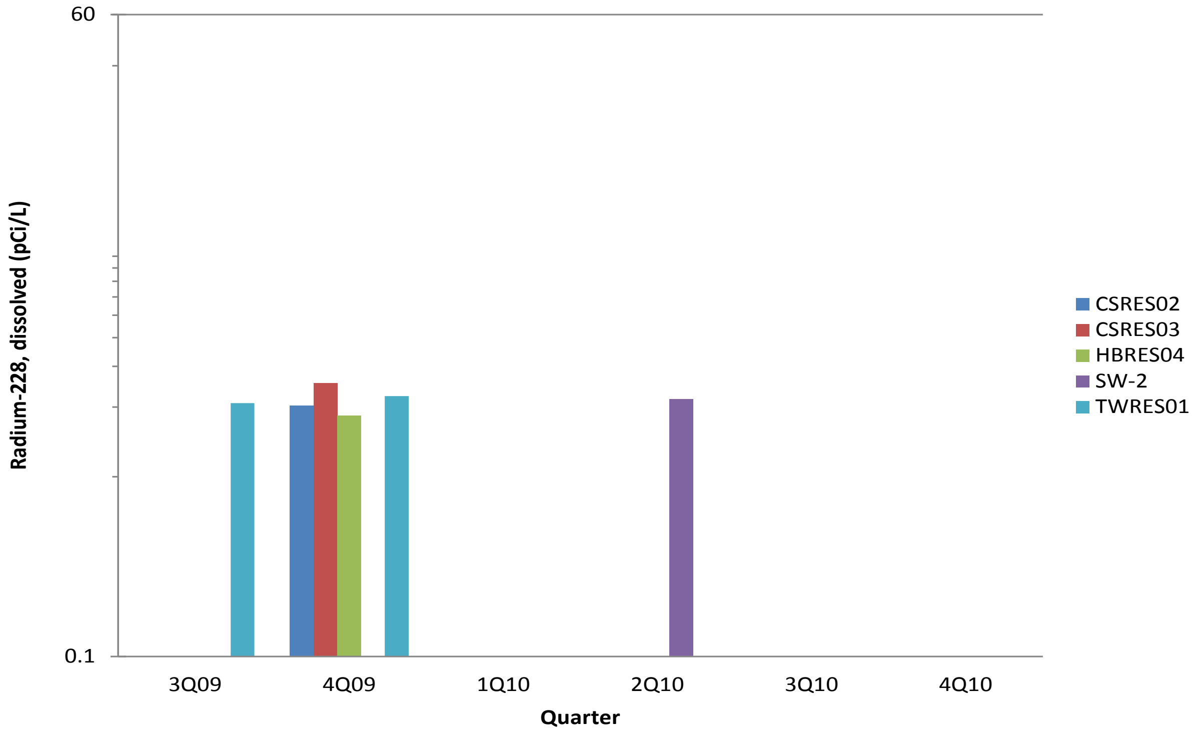
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-20b. Ra-226, Suspended Results for Surface Water Monitoring (MPC = 60 pCi/L)



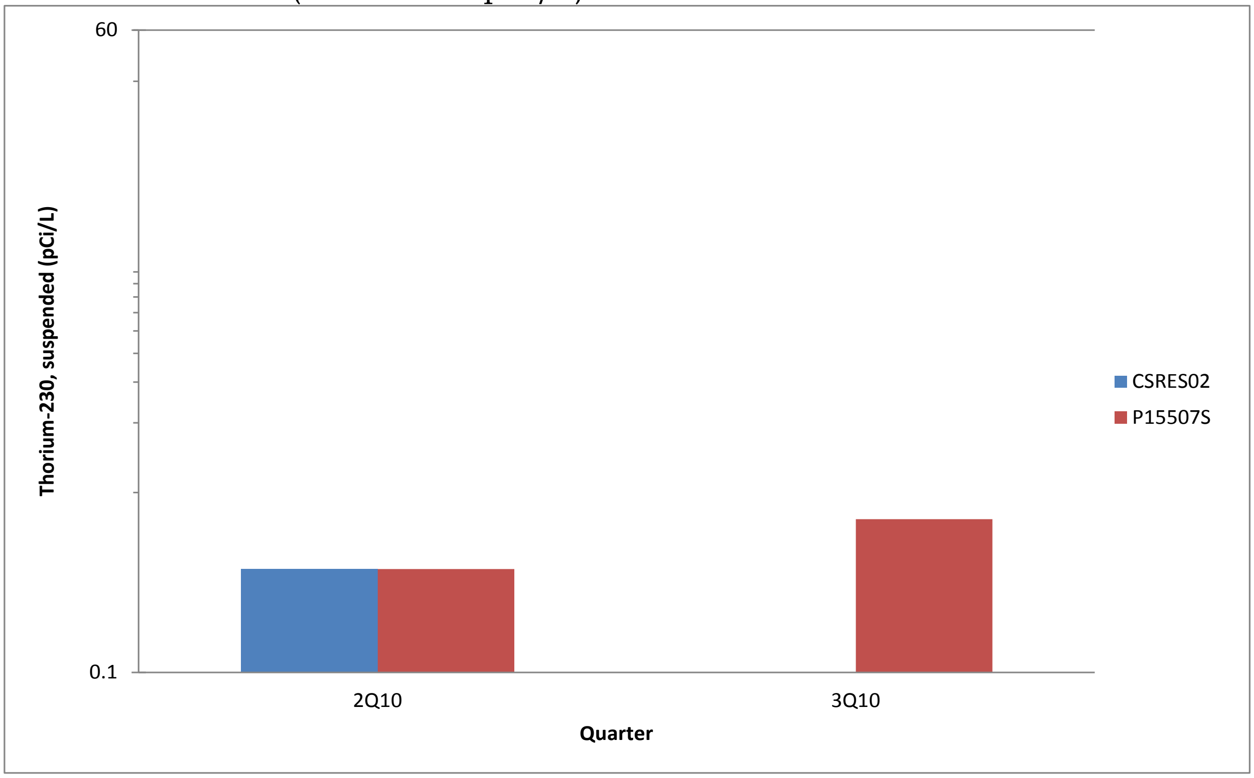
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-21. Ra-228, Dissolved Results for Surface Water Monitoring (MPC = 60 pCi/L)



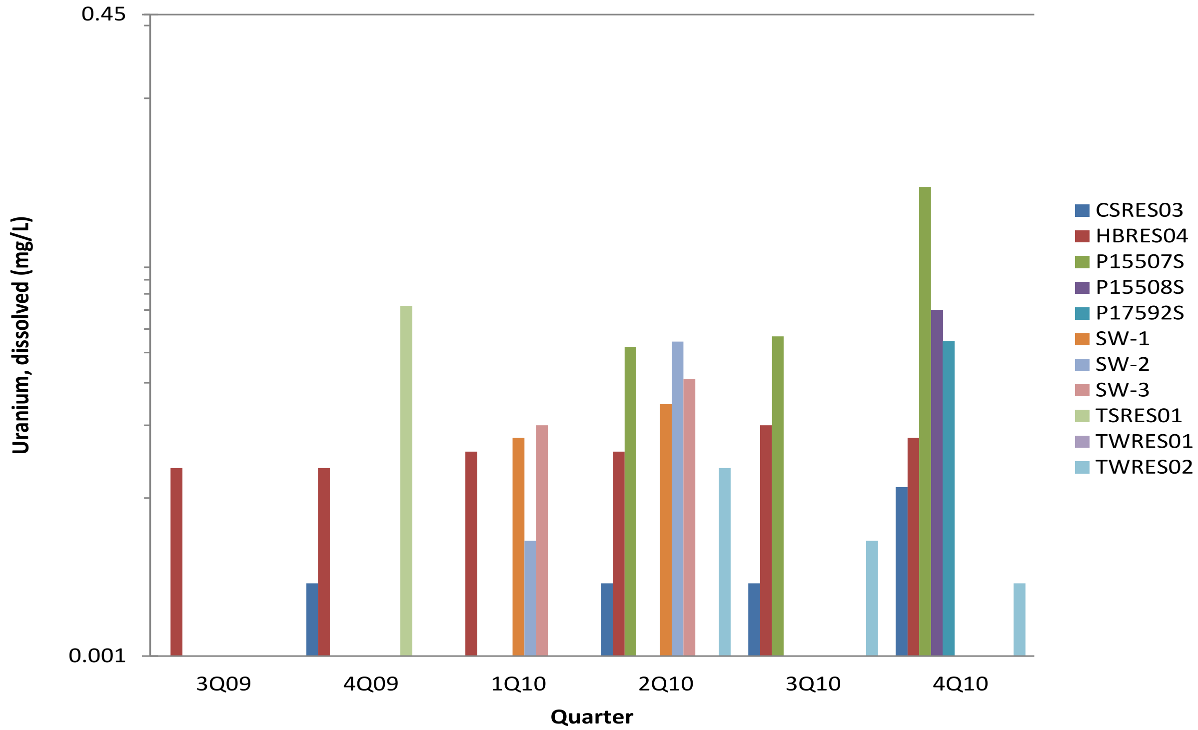
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-22. Th-230, Suspended Results for Surface Water Monitoring (MPC = 100 pCi/L)



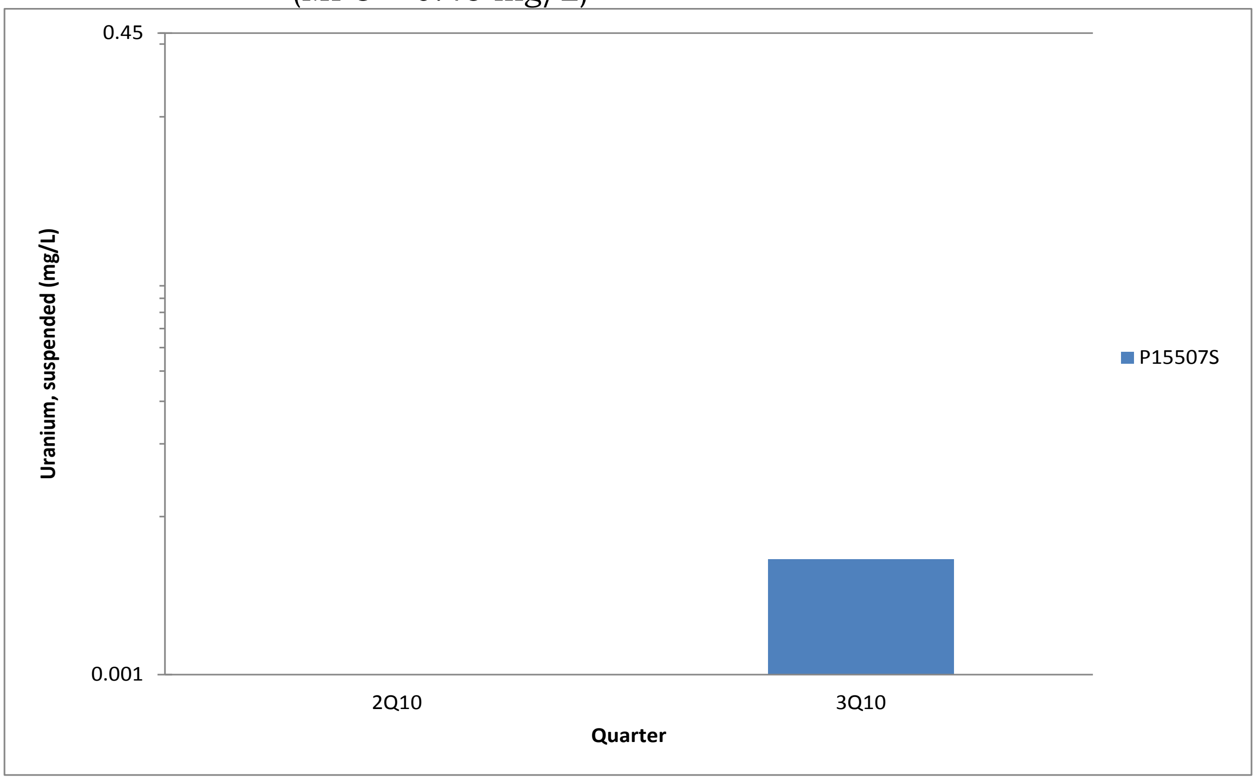
Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-23a. Uranium, Dissolved Results for Surface Water Monitoring (MPC = 0.45 mg/L)



Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

Figure 2.9-23b. Uranium, Suspended Results for Surface Water Monitoring (MPC = 0.45 mg/L)



Note: Results for water samples reported as "non-detect" from the laboratory are not shown in graphs.

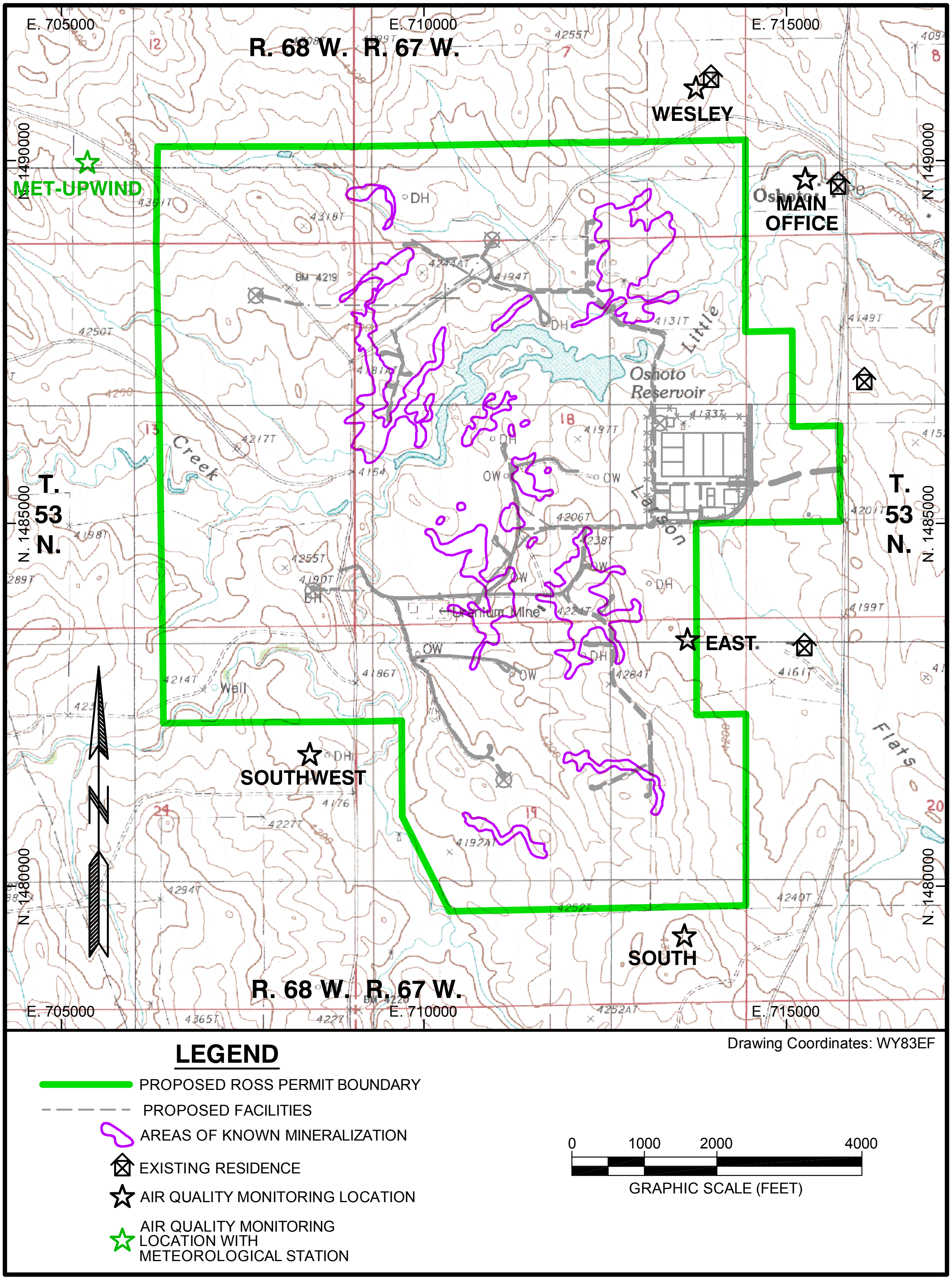
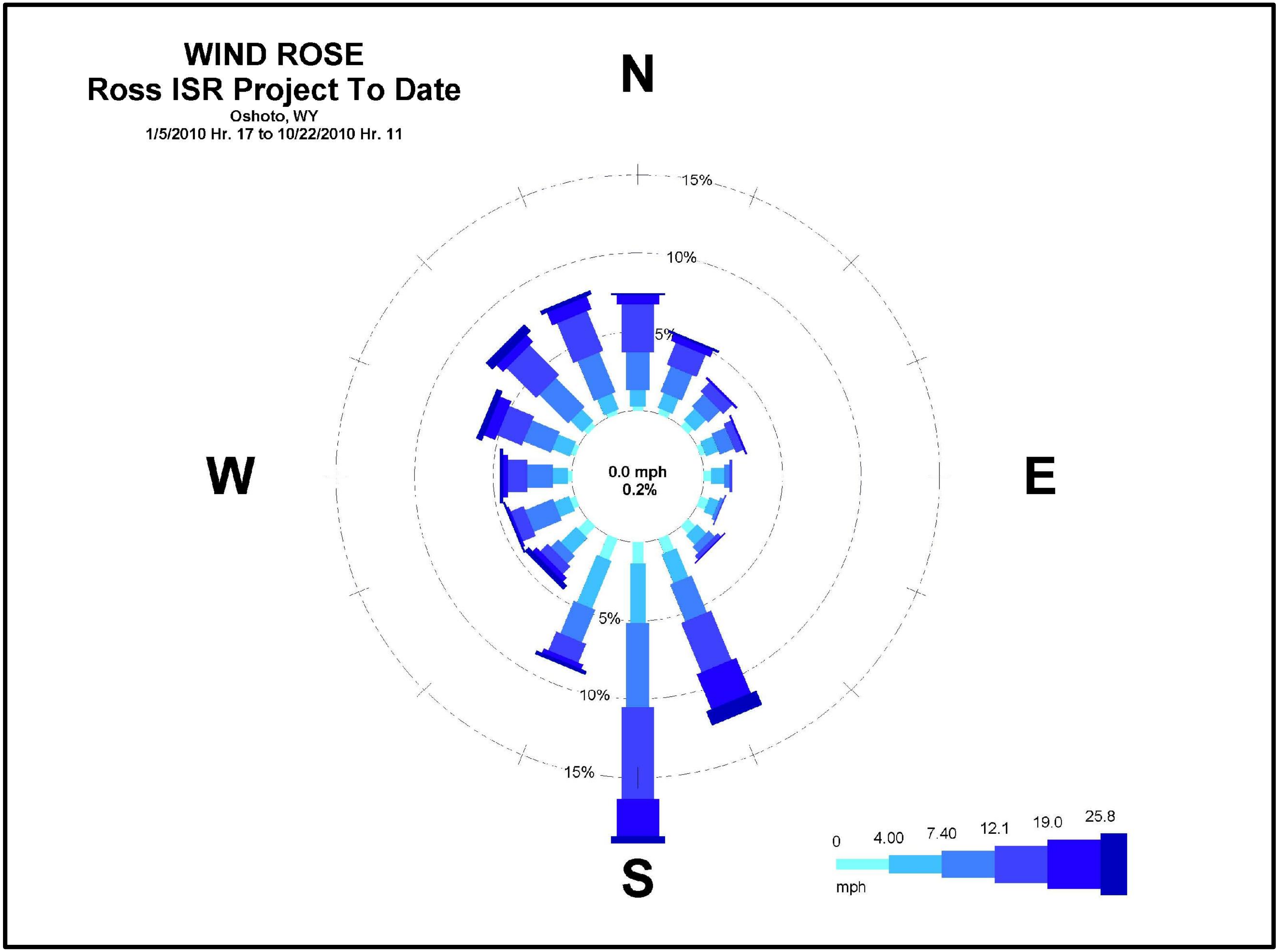


Figure 2.9-24. Air Particulate Sampling Locations

K:\Peninsula_Minerals\09142\DWGS_WY83E\ROSS_TR_RAD_AQ_MON_LOCS.dwg, TR_FIGURE_2.9-24, 12/23/2010 11:37:03 AM

Figure 2.9-25. Ross Wind Rose



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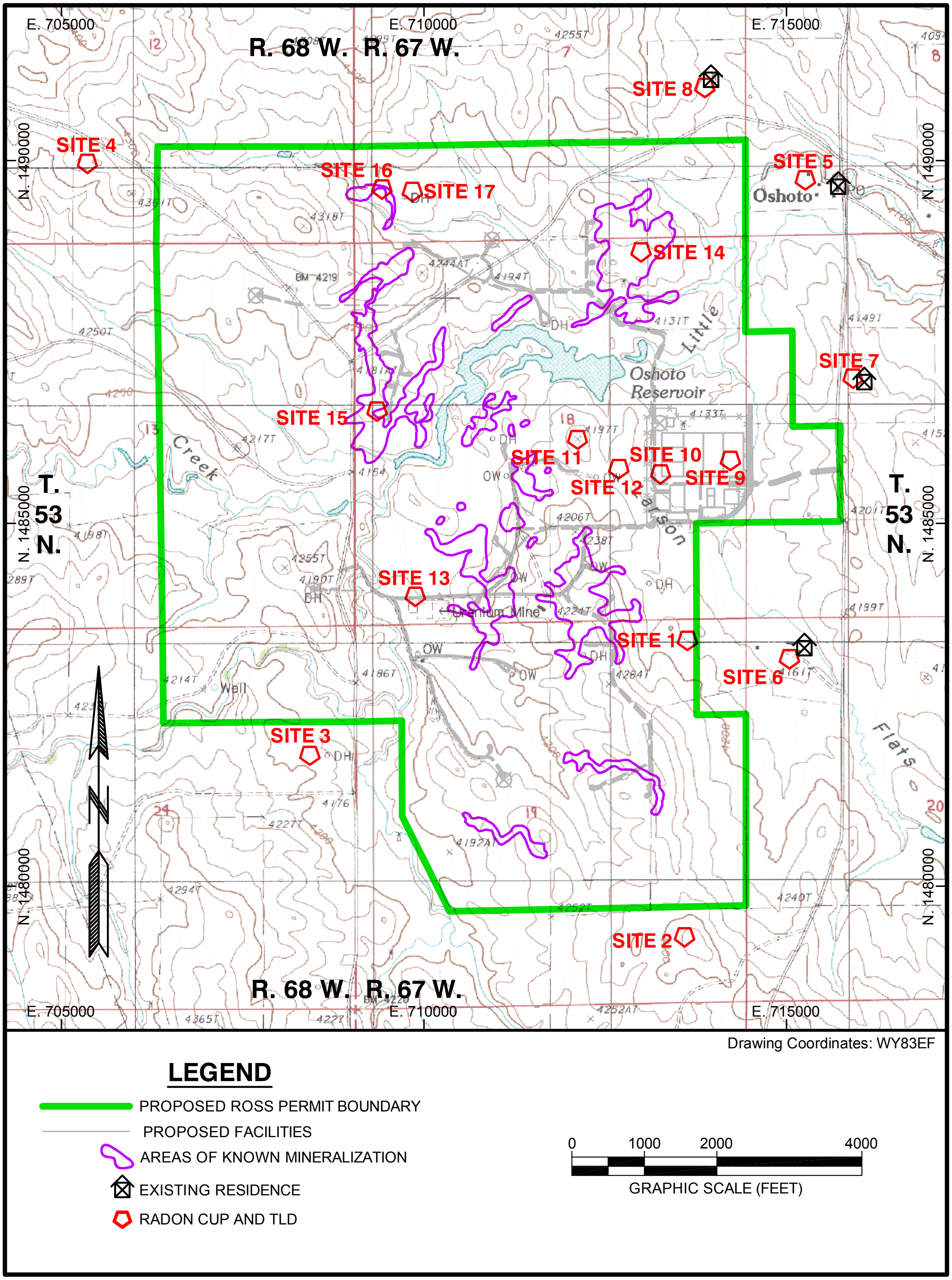


Figure 2.9-26. Radon Detectors and TLD Locations

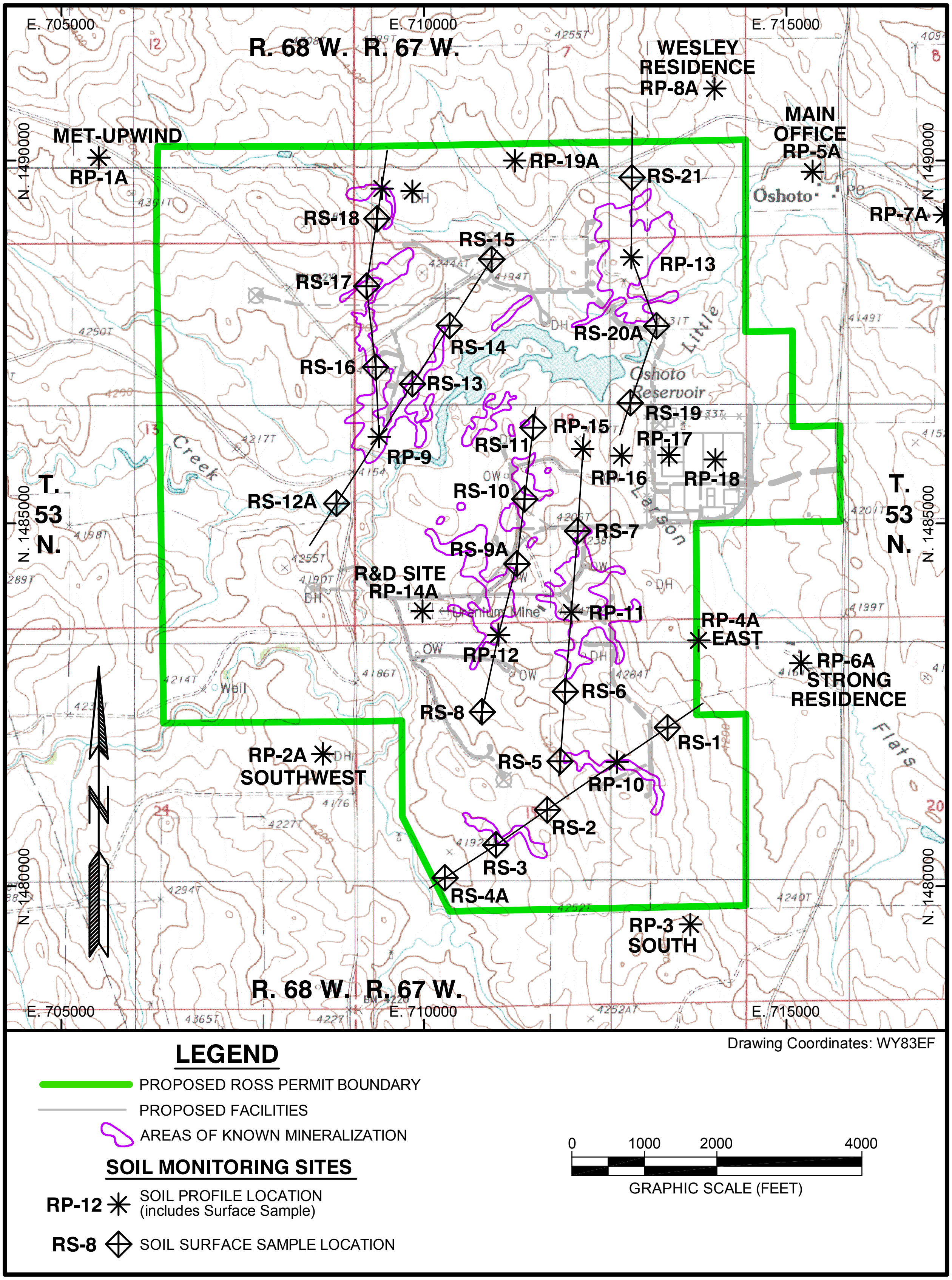


Figure 2.9-27. Soil Surface Sampling and Profile Locations

K:\Peninsula_Minerals\09142\DWGS_WY83E\ROSS_TR_RAD_SOIL_SAMP.dwg, TR_FIGURE_2.9-27, 12/23/2010 11:40:26 AM

Figure 2.9-28. Baseline Radiological Investigation Soil Sample Locations

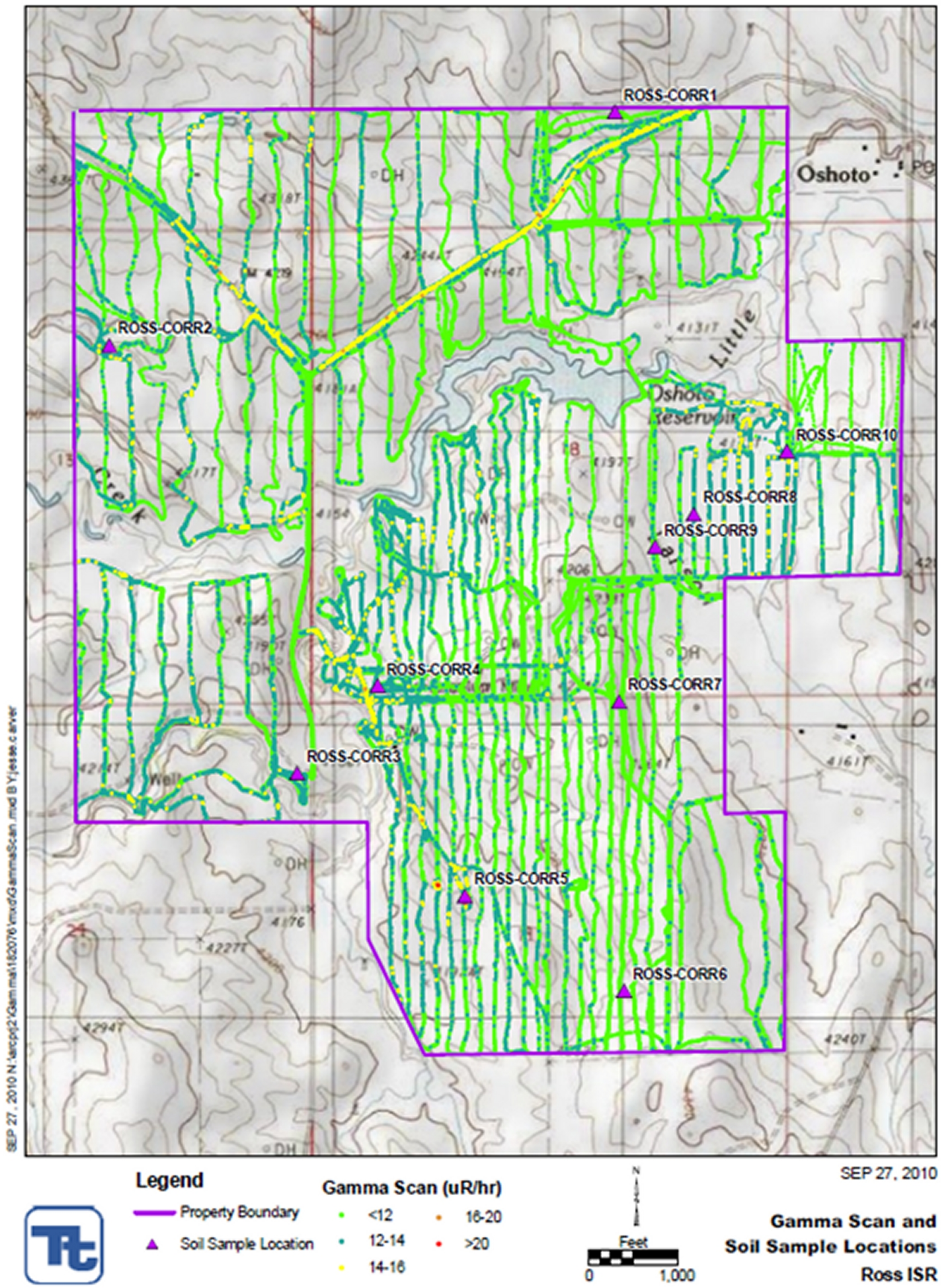


Figure 2.9-29 Raw Gamma Exposure Rate Data; Ross Proposed ISR Site

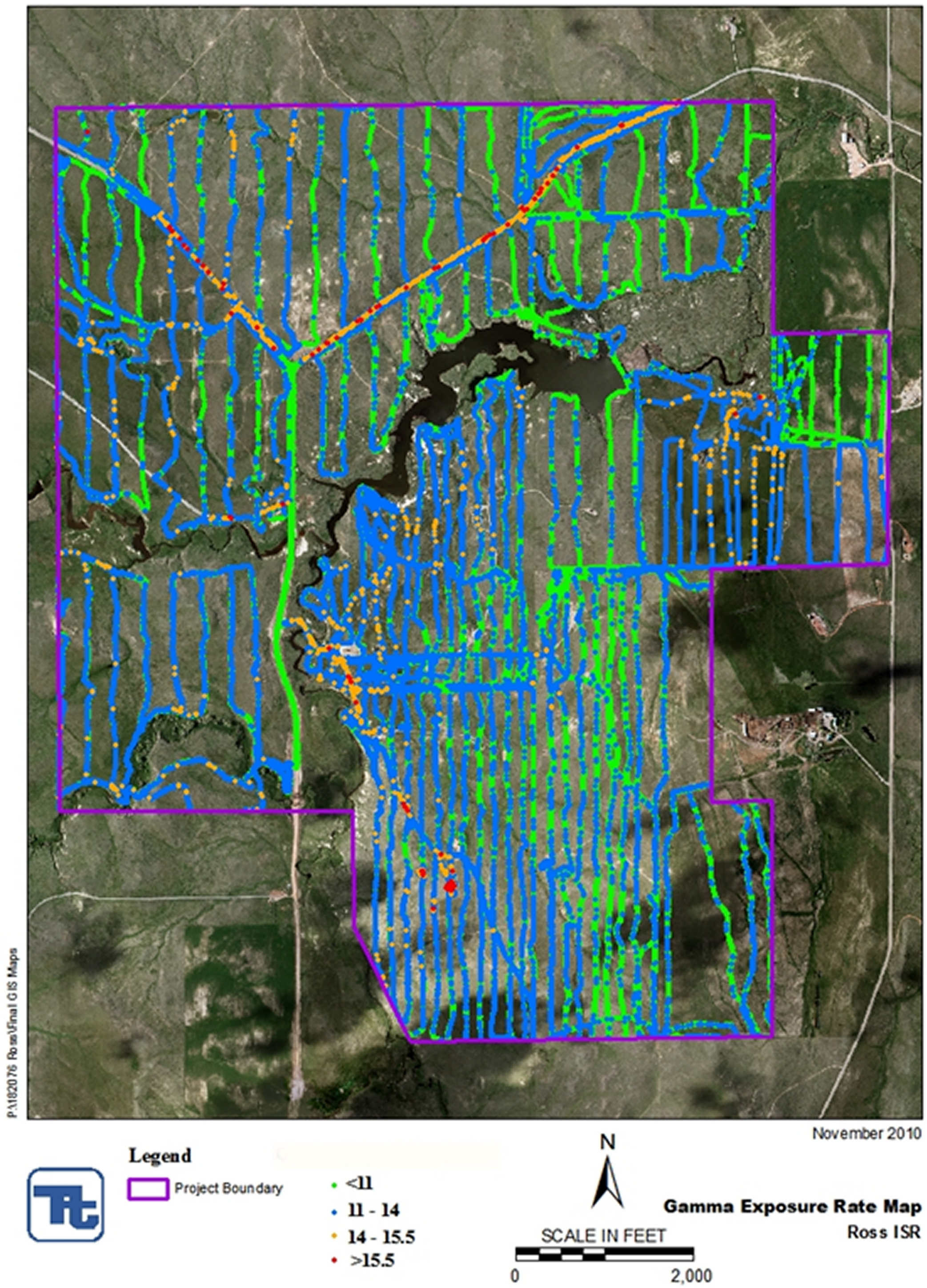
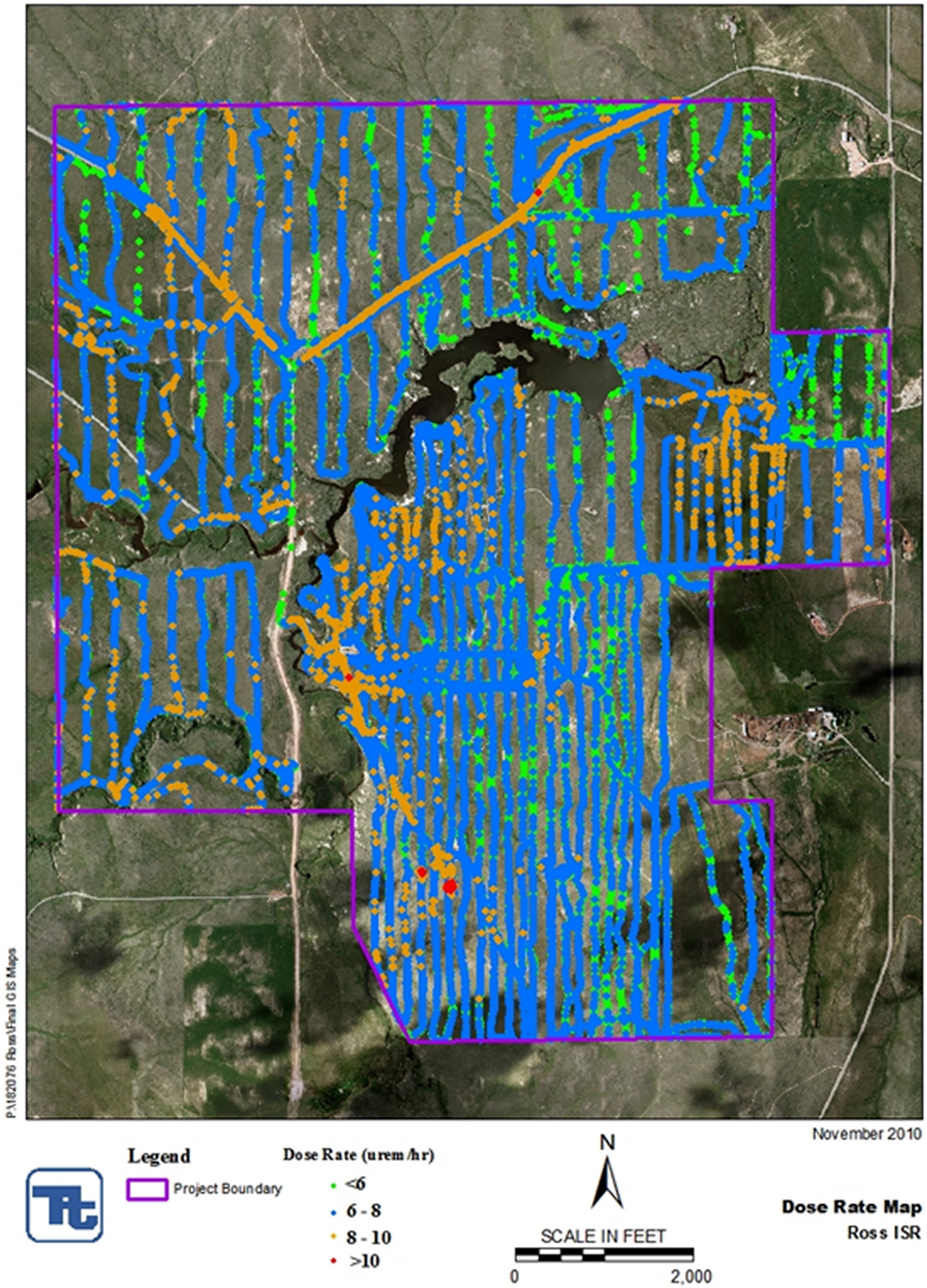
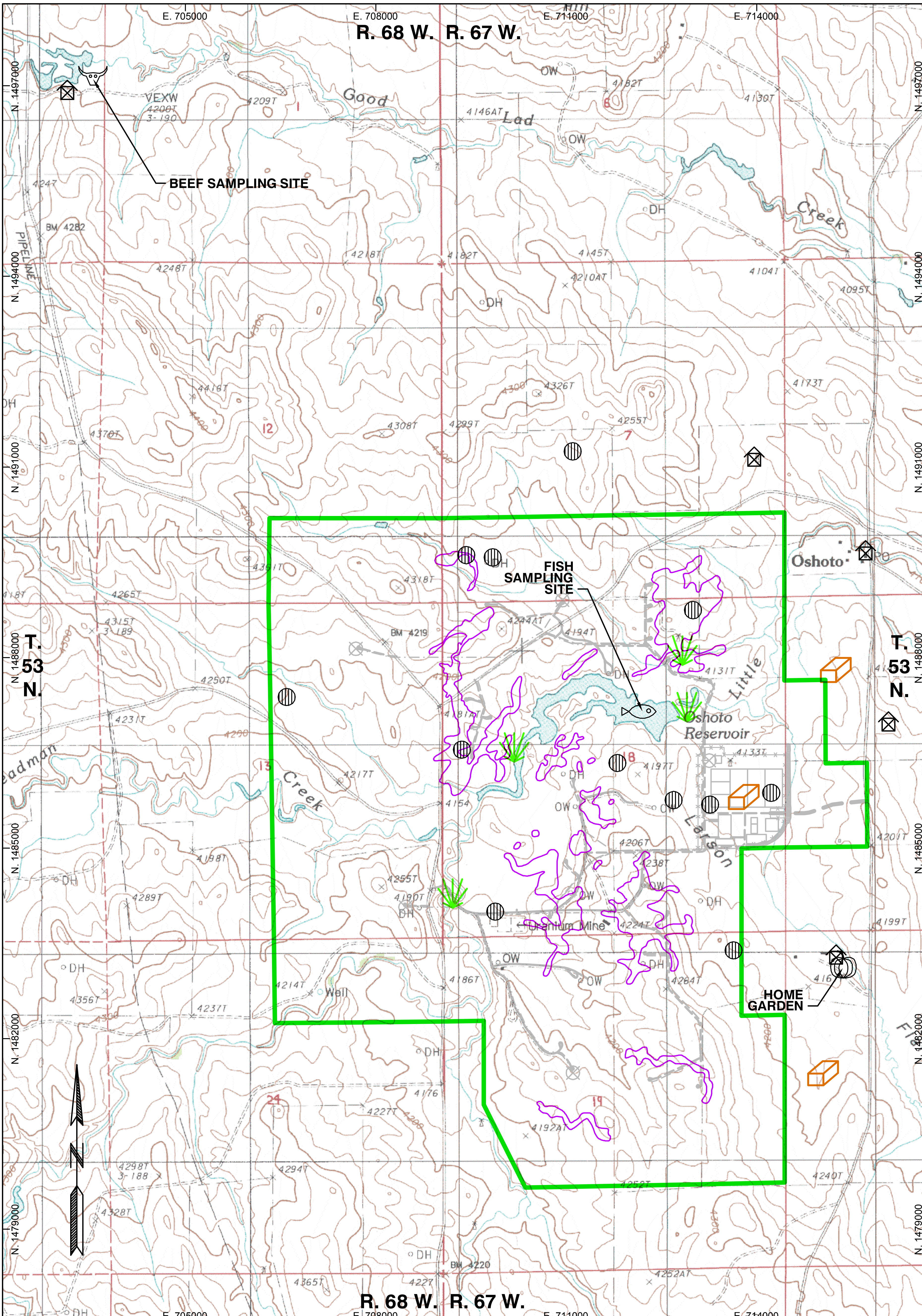


Figure 2.9-30. Dose Rate Estimates at the Ross ISR Site





Drawing Coordinates: WY83EF

LEGEND

- PROPOSED ROSS PERMIT BOUNDARY
- PROPOSED FACILITIES
- EXISTING RESIDENCE
- AREAS OF KNOWN MINERALIZATION
- GRAZING VEGETATION SAMPLING SITE
- HAY CROPS SAMPLING SITE
- WETLAND VEGETATION SAMPLING SITE

0 750 1500 3000

GRAPHIC SCALE (FEET)

STRATA ENERGY

ROSS ISR PROJECT
CROOK COUNTY, WY
P.O. BOX 2318
GILLETTE, WY 82716

REVISIONS	
Date	Description

TECHNICAL REPORT
FIGURE 2.9-31

VEGETATION, CROP, AND FOOD PRODUCT SAMPLING LOCATIONS

Drawn By: MBM
Checked By: BJS
Date: 11/29/10

WWC ENGINEERING
www.wwcengineering.com

FILE: ROSS_TR_RAD_VEG_SAMP

K:\Peninsula_Minerals\09142\DWGS_WY83E\ROSS_TR_RAD_VEG_SAMP.dwg, TR_FIGURE_2.9-31, 12/23/2010 11:43:27 AM

2.10 Other Environmental Features

Noise is the only other environmental feature that has not been addressed in the previous site characterization. The following section is a summary of noise characteristics within the proposed project area. A more detailed description is included in Section 3.7 of the ER.

2.10.1 Affected Environment

Existing noise sources within the proposed project area include county and local road traffic, livestock operations, crop production, oil production facilities, and wind. The nearest noise receptors are 11 residences within 2 miles (3.2 km) of the proposed project area. The nearest residence is 835 feet from the proposed project boundary or about 5,600 feet (1.1 miles) from the proposed CPP. The majority of the existing ambient noise in the vicinity is generated from wind, bentonite trucking and livestock hauling along the New Haven Road and D Road. Posted speed limits for D Road are 55 mph for automobiles and 45 mph for trucks. The speed limit along the New Haven Road is posted at 45 mph. The noise levels at the nearby residences due to existing traffic should generally not exceed 79 dBA. Noise originating from oil operations includes operating pump jacks, workover rigs, and vehicle traffic. The nearest receptor to a pump jack is approximately 0.6 mile (1 km) away.

2.10.2 Sound Level Standards

Under the authority of the Noise Control Act of 1972, EPA identifies a 24-hour exposure level of 70 dBA as the level of environmental noise which will not cause any measureable hearing loss over a lifetime. A level of 55 dBA outdoors is identified as preventing activity interference and annoyance. The 24-hour equivalent level is the sound energy averaged over a 24-hour period and is represented by Leq (24). The day-night (Ldn) is the A-weighted equivalent sound level for a 24-hour period with an additional 10 dBA imposed on the equivalent sound levels for night time hours of 10 p.m. to 7 a.m. (EPA 1974).

2.10.3 Noise Study

Studies were conducted in February 2010 to determine baseline noise levels at nearby residence and noise levels produced by oil production and exploratory drilling operations. Field measurements were made using a Quest SoundPro DL-2.

Baseline noise measurements were collected at two of the four residences closest to the proposed project area. The two residences studied are representative of all four of the nearest residences, which occur at very similar distances from the proposed project area. Noise levels were recorded for six 30-second intervals facing each of the four cardinal directions. During each 30-second interval the average, maximum and minimum noise level was recorded in dBA.

Noise measurements were also collected 130 feet from an operating pump jack located within the proposed project area and 200 feet from an operating exploratory drill rig. Noise level measurements were recorded for 12 minutes at 30-second intervals. Similar to measurements collected at residences, the sound lever meter recorded the average, maximum and minimum noise level in dBA for each 30-second interval.

A second noise study involved continuously measuring noise levels over a 7-day period at the Strata field office located just outside the northeast corner of the proposed project area. The study was performed to determine the average weekday and weekend levels as well as average day and night noise levels. The average, maximum, and minimum noise levels were recorded in 30-second intervals.

Results at the nearby residences indicate that baseline noise levels averaged between 35.4 dBA and 37.4 dBA. The maximum recorded noise level of 73.4 dBA is attributed to bentonite trucking traveling on the New Haven Road. The average noise level measured at a distance of 130 feet from a pump jack was approximately 42 dBA. The maximum level was approximately 49 dBA. Measured noise levels near operating drill rigs located in the northwestern corner of the proposed project area averaged approximately 52 dBA. Two drill rigs were in operation while noise levels were recorded. The rigs were located approximately 200 feet apart and noise levels were recorded 200 feet from the nearest drill rig. Noise levels ranged from 40 to 62 dBA which is a result from only one drill rig being in operation to both drill rigs being in operation simultaneously. Since nearby residences are more than 800 feet from the proposed project area, the average noise at the residences resulting from exploratory drilling is significantly less than the outdoors level of 55 dBA, which is identified as preventing activity interference and annoyance.

Results of the 7-day noise study at the Strata field office indicate the $L_{eq(24)}$ for the entire week averaged 38.0 dBA. The overall average nighttime noise level (36.2 dBA) was slightly lower than the daytime average (39.0 dBA). The average day-night noise level (L_{dn}) did not vary from weekday to weekend and average 41.6 dBA overall. Maximum noise levels typically ranged from 35 to 45 dBA. The peak noise level was between 80 and 90 dBA for each day of the study. Peak noise levels are attributed to trucks traveling on the nearby New Haven Road.

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