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1.0 INTRODUCTION

This section is intended to be a brief overview of the report. Detailed discussions of each of the PRSs follows in Chapter 5.

1.1 General Site History

OU 1132 is a diversely situated site consisting of mesas and numerous canyons (Ancho, Water and Indio) which both disseet and define the area (Figure 1.1-1). The one active technical area (TA), TA-39, is situated in the north fork of Ancho Canyon (Figure 1.1-2). Originally established in 1953 as a site for open-air testing of high explosives (HE), this site was selected for its remote location and has remained continuously occupied since that time.

Although radionuclides are regulated by the DOE and are not regulated under RCRA, it is more efficient and cost effective to investigate all types of potential contamination during a single site characterization. Therefore, radiochemical concerns are addressed in this report.

1.2 Overview

The overall objectives of field investigations at OU 1132, as stated in the Work Plan (LANL 1993, 1089), were to propose a methodology for determining the nature and extent of releases of hazardous and/or radioactive constituents from PRSs and to ascertain whether corrective measures studies are needed. ~~By fulfilling these stated objectives, LANL will have complied with those regulatory requirements that pertain to OU 1132 contained in LANL's permit to operate under RCRA.~~

This report presents the results of the Phase I sampling activities at the firing sites at OU 1132. Other reports (LANL 1993, 1089; LANL 1997, XXXX) presented the results of the 1993 field investigations for storage areas, septic systems and seepage pits and the 1994/1996 Material Disposal Area investigations. The firing sites (PRSs 39-004 a,b,c,d, and e and 39-008) ~~are~~ were recommended for deferred action because they have not been slated for decommissioning by the operating group (i.e., the sites are still active). to the New Mexico Environment Department on March 1997

1.3 Field Activities

Stream Channel Sediment Sampling

Two sampling efforts were conducted in August and September 1994 in order to characterize the distribution of materials in the stream channels and canyon bottom sediments. First, the stream channel between the firing sites and the TA-39 site boundary was surveyed, and second, based on the survey results, samples of stream channel sediment and bank deposits were collected for RCRA constituent analysis. During the screening effort, a geomorphologic evaluation was conducted in order to evaluate the potential for contaminant laden sediment to erode, deposit, and migrate within and out of the canyon. ~~(Reference RFI Report on Landfills).~~ Channel sediments were collected from the surface (0-6 in only) and the bank sediments were sampled as deep as 27 in. The channel sediments represent recent deposition from the upstream areas, while the bank sediments represent a historical accumulation of materials removed from upstream locations (firing sites) and deposited in the canyon bottom. The sampled sediments were screened by x-ray fluorescence (XRF) for metal element concentrations and for radioactivity to indicate areas for biased sampling for characterization. Based primarily on the geomorphology, samples of the channel and bank sediments were collected and submitted for metal, organic, and radionuclide analyses. rather than on field screening results [AND EXPLAIN WHY THIS IS SO]

Firing Sites Sampling

Sampling efforts were conducted at and around the TA-39 firing sites to characterize the distribution of materials deposited on the firing pads, surrounding hillsides, mesa tops, and in the adjacent stream

using what instrument? α? β? γ?

channels. Field investigations commenced in August of 1995 at the firing site PRSs and continued into October 1995. Because of the complexity of investigating potential contaminant dispersion and migration from an explosives site, these investigations consisted of a three-parts: firing pad areas, adjacent stream channels, and transects from the firing pads along the adjacent hill sides and mesa top. The initial sampling involved the collection of samples from within the physical boundary of the firing pads (approximately within a 100-ft diameter circle). All firing pads were gridded in 50-ft by 50-ft increments (see Chapter 5 for PRS-specific configurations), using traditional land survey techniques and then further gridded in 10-ft by 10-ft increments by the field team using measuring tape and siting to the 50-ft grid markers. A radiation survey was conducted by scanning the area around each 10-ft grid node and recording the highest measurement. The XRF measurements were also obtained at randomly selected 10-ft grid nodes. Approximately 10-20% of the grid nodes on the firing pads have associated XRF measurements. Sample locations for the firing pads were biased using, where possible, the two highest radiation measurements and the two highest XRF measurements obtained during these surveys. Any deviations from this approach are detailed in the specific PRS discussion in Chapter 5.

To characterize the extent of contaminant dispersion beyond the firing pads, three arbitrarily-drawn transects, using the firing pad as the hub, extended radially outward from the 100-ft diameter circle encompassing the firing pad to a distance of approximately 600 ft. The transects were surveyed using traditional survey techniques. Radiation measurements were made continuously along the transects. The highest readings and readings at every 150 ft along the transect were recorded and XRF measurements were taken where the unusually high radiation measurements were recorded. Sample locations (approximately 8 samples per transect) were then collected using this biased information.

The third component of the sampling and characterization of the firing sites was to assess the extent of contaminant migration (if any) due to surface water runoff into the stream channel segments adjacent to each of the firing sites. Each adjacent stream channel segment was surveyed for radiation and high sediment deposition. Samples were collected from sediment accumulation areas within the stream channel segments at locations approximately 50 ft apart starting 150 ft upstream to about 150 ft downstream from the firing point. The radiation surveys aided in selecting the sampling points.

All applicable LANL ER SOPs (LANL, 0875) were followed, unless otherwise noted in Chapter 5.

2.0 ENVIRONMENTAL SETTING

The environmental setting of the Laboratory is described in Section 2.4 of the Installation Work Plan (IWP) for Environmental Restoration (LANL 1995, 1275). A detailed discussion of the environmental setting for TA-39, including climate, geology, hydrology, and a conceptual hydrogeologic model for the area and its surroundings, is presented in the RFI Work Plan for OU 1132 (LANL, 1993, 1089). A summary is presented in the following sections.

2.1 Climate

Los Alamos County has a semiarid, temperate, mountain climate. Summers are generally sunny with moderate, warm days and cool nights. High altitude, light winds, clear skies, and dry atmosphere allow summer temperatures to range from 50°F to 87°F. During the winter, temperatures typically range from 15°F to 5°F. The average annual rainfall in the area of Ancho Canyon is estimated to range from 0.5 in. to 2.5 in. Of this total, approximately 40% occurs as brief intense thunderstorms during July and August. Stream flow in the canyons can occur as a result of these storms. Spring snowmelt runoff may also induce streamflow in the area canyons.

2.2 Geology

A detailed discussion of the geology of the entire Los Alamos area can be found in Section 2.5.1 of the IWP (LANL 1995, 1275). A summary of that material, emphasizing conditions expected near Ancho Canyon, is presented below.

2.2.1 Geologic Setting

At TA-39, the Bandelier Tuff ranges in thickness from several feet (along the northeast margin of the site) to 600 ft (in Borehole DT9, located just west of TA-39)(Purtyman 1984, 0196) (Figure 2-1). These significant variations in lateral thickness are related to pre-Bandelier Tuff paleotopography. Before eruptions that laid down the Bandelier Tuff, the area of TA-39 was in a valley between the southwestern flank of a basaltic shield volcano (now underlying the town of White Rock) and a scoria cone (now exposed within TA-33, to the south of TA-39). Depth to the main aquifer from the TA-39 Canyon bottom is estimated to be at least 300 feet.

2.2.2 Soils

Surface soils within the TA-39 study area include those associated with mesa tops, canyon walls, and the canyon bottom. All three soil settings in the areas of the firing sites have received materials dispersed as a result of explosives testing or from erosion and sedimentation. Those eroded sediments flow away from the firing sites and deposit along the stream banks during flooding events in the canyon bottom. The landfills are in the area of historic sediment deposition. The mesa top soils are represented by the Hackroy and Nyjac series and range from 10 cm thick near the mesa edges to several ft thick near the center of the mesas. Canyon walls adjacent to the firing sites may be very steep with no soil accumulation or less steep with colluvium, undeveloped soil material deposits interspersed (trapped) among large blocks of Bandelier Tuff sluffed from the canyon walls. Those accumulations of soil may trap debris from the firing site tests. Canyon bottom soils are poorly developed and are typical of the deep well-drained Totavi series having a gravelly-loamy-sand or sandy-loam texture.

which is discussed in the RFI Report on the landfills (REFERENCE)

The canyon and tributaries contain alluvium of varying thickness. Some subsurface data on the long-term history of the canyon bottom sediments was obtained from examining cores obtained from the landfill areas, ~~during this RFI and discussed in this report.~~ These data, discussed in Section 2.2.2.1, indicate the presence of very old sediments buried beneath part of the canyon ~~bottom~~ and relatively long-term stability of much of the canyon bottom. ~~There is a tendency for net deposition of sediment and relatively little potential for deep scour and~~ significant channel ~~migration over short time periods (10s to 100s of years).~~

This tendency for sediment deposition and relatively little channel migration suggests that engineering works designed to stabilize the channel in the areas of the landfills may be a viable strategy to assure long-term stabilization of the canyon bottoms.

2.2.2.1 Geomorphology of the Canyon Bottom at TA-39

Geomorphic characterization of the major operations areas in TA-39 (canyon bottoms, hillslopes, and landfills) was conducted in 1993 and 1994. Investigation of stream channel and bank sediments, and the evaluation of underground materials from drill cores obtained during the RFI sampling, provides a history of sediment erosion and deposition. Together with the geomorphic mapping and dating of sediments exposed in stream banks, a relativley long-term stability of much of the canyon bottom is suggested, with perhaps a tendency for net deposition of sediment and relatively little potential for deep scour and significant channel migration over short (10s to 100s of years) time periods. More detail on the geomorphic evaluation is presented in Appendix E.

2.3 Hydrology

The hydrology of the Pajarito Plateau is summarized in Section 2.5.2 of the IWP (LANL 1995. 1275). Site-specific conditions are summarized below.

2.3.1 Surface Water

TA-39 is drained by a number of intermittent streams, which are tributaries of the main stream channel that runs through Ancho Canyon (North Fork), and eventually joins Ancho Canyon beyond the boundary of TA-39, and joins the Rio Grande in White Rock Canyon (Figure 2-2). At TA-39, all stream channels carry intermittent flow. Runoff, when it does occur in these alluvial channels, is produced by intense summer thunderstorms as demonstrated in the summer of 1991, when roads and buildings at TA-39 were flooded. However, associated with these intense storms are episodes of erosion of sediments and possibly contaminants from the firing pads and adjacent canyon walls into the local stream channels. Other than these intermittently active stream channels, there are no other surface water sources or accumulations at TA-39.

Such occurrences can be controlled by notably best management practice (BMP's) for stormwater runoff, the are discussed in detail in Section —

2.3.2 Ground Water

The vadose zone of the Pajarito Plateau is very thick and consists mostly of Bandelier Tuff. The vadose zone of most interest is the unsaturated alluvium of the canyon bottoms since all TA-39 PRSs impact this zone. Six exploratory holes ranging in depths of 25 to 126 ft were drilled in the areas of the two landfills, PRS 39-001(a) and (b). To date, there has been no formation water recorded in the monitoring wells installed in these exploratory holes. This suggests that no perched alluvial reservoir has been observed in the landfill areas of Ancho Canyon. The main aquifer has been variously stated to be at a depth of at least 300 to 600 ft below the canyon bottom. However, during the drilling of ASC-15, -16, and -18 underneath the waste burial area at PRS 39-001(b), saturated conditions were observed at 70 to 80 ft into the angle hole (estimated depth of 50 to 60 ft). Logging information from two of the borings suggests a buried stream channel sand deposit that could be a perched alluvial reservoir beneath the buried waste. None of the other angle holes drilled to similar depths indicated saturated conditions so that the presumed alluvial reservoir is not widespread.

2.4 Biological Surveys

Biological resource field surveys have been conducted in the area of Ancho Canyon for compliance with the Federal Endangered Species Act of 1973; the New Mexico Wildlife Conservation Act; the New Mexico Endangered Species Act; Executive Order 11990,"Protection of Wetlands"; Executive Order11988,"Floodplain Management"; 10 CFR 1022; Compliance with Floodplain/Wetlands

Environmental Review Requirements (DOE 1979, 0633); and DOE Order 5400.1, General Environmental Protection Program (DOE 1988, 0075).

The results of these surveys and the habitat description for TA-39 described in this report will be included in the ecological RFI Report prepared by the Decision Support Counsel Ecological Risk Assessment Team for the ecological exposure unit in which TA-39 is located.

2.5 Cultural Resources

A cultural resource survey has also been conducted in the area of Ancho Canyon as required by the National Historic Preservation Act (amended). The survey, conducted in 1992, identified twenty-nine archeological sites located within TA-39. Because of their research potential, twenty-seven of these are eligible for inclusion on the National Register of Historic Places under Criterion D. For more detail regarding cultural resources at TA-39 refer to the RFI Workplan for OU 1132 (LANL 1993, 1089).

3.0 APPROACH TO SAMPLE ANALYSES AND DATA ASSESSMENT

The approach to data assessment used by the ER Project is described in the policy document Risk-Based Corrective Action Process (Dorries 1996, 1297). The approach includes

- sampling and analysis design,
- field investigation and collection of field and QA samples,
- chemical and radiochemical analyses of samples and reporting of analytical data,
- baseline verification and validation of analytical data,
- organization of field and analytical data into PRS-specific data set(s),
- exploratory data analysis,
- focused validation when necessary to further assess questionable data,
- comparison of validated analytical results with LANL background data,
- comparison of validated analytical results with SALs,
- evaluation of sufficiency of data set(s) to support the site decisions, and
- assessment of human health risk.

The following subsections provide overviews of the methods used to complete the steps listed above for the PRSs discussed in this RFI report.

3.1 Sample Analyses

Samples were collected in accordance with the sampling design specified in the RFI Workplan for OU 1132 (LANL 1993, 1089). All samples requiring chemical and radiochemical analyses and chain-of-custody documentation were submitted to the sample management office (SMO), ~~directly to an off-site laboratory (small portion of 1996 data)~~, mobile radiological analysis laboratory (MRAL) and to an on-site mobile chemical van for analyses.

3.1.1 Analytical Methods

The following analytical suites were used for the sample analyses in this ~~RFI~~ report: inorganic chemicals, VOCs, SVOCs, PCBs, cyanide, HE, total uranium, isotopic uranium, total thorium, isotopic thorium, and gamma spectroscopy. A list of target analytes for which analyses were performed for the purpose of this report can be found in Appendix A.

All samples were analyzed by contract analytical laboratories using methods specified in ER SMO analytical subcontracts (LANL 1995, 1278). The allowed methods are current EPA SW-846 and Contract Laboratory Program (CLP) methods or equivalent for inorganic chemicals, VOCs, SVOCs, PCBs, cyanide, HE, total uranium, isotopic uranium, total thorium, isotopic thorium, and gamma spectroscopy. Prior to analysis for inorganic chemicals, solid samples were digested according to the technologies identified in the subcontract (e.g., americium-241 by alpha spectroscopy, tritium by liquid scintillation, or multiple isotopes by gamma spectroscopy). Analytical method selection is described in Appendix IV of the ER Project Quality Assurance Project Plan Requirements for Sampling and Analysis (QAPP)(LANL 1996, 1292). For each analyte, quantitation or detection limits are specified as contract-required estimated quantitation limits (EQLs) for organic chemicals and radionuclides and estimated detection limits (EDLs) for inorganic chemicals. These limits are included in Appendix III of the ER Project QAPP along with the target analytes for each analytical suite.

3.1.2 Data Validation

Data verification and baseline validation procedures were used to determine whether data packages received from the analytical laboratory were generated according to specifications and contain the information necessary to determine data sufficiency for decision-making. For analytical data used for decisions discussed in this ~~RFI~~ report, baseline data validation under the ER protocol was performed as described in the QAPP (LANL 1996, 1292).

This process produced validation reports, with data qualifiers designating potential deficiencies for affected results. Each data qualifier is accompanied by a reason code that provides information about the deficiency which led to qualification of the data. The validation reports were used in the decision-making process and to direct the focused validations required to evaluate the usability of the data for this report.

Data were qualified (i.e., a marker was attached to the data results) for a variety of reasons during the baseline validation process. The baseline validation procedure used for routine analytical services provides information about the reason the qualifier was applied and its potential impact on the affected data. The purpose is not to reject data but rather to ensure that the relative quality of the data is understood so that the data may be used appropriately.

Data qualifiers used in the LANL ER Project baseline validation process are

- A The data required for data review and evaluation are not available.
- U The analyte was not positively identified in the sample, and the associated value is the sample-specific EQL/EDL
- J The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.

- J+ The analyte was positively identified, and the result is likely to be biased high.
- J- The analyte was positively identified, and the result is likely to be biased low.
- UJ The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific EQL/EDL.
- RPM Without further review of the raw data, the sample results are unusable due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. Presence or absence cannot be verified. NOTE: Any results qualified as RPM must be evaluated for relevance to data use.
- P Professional judgment should be applied to using the data in decision-making.
- PM Professional judgment should be applied to using the data in decision-making. A manual review of raw data is recommended to determine if the defect impacts data use for decision-making.

A focused data validation may be required as a follow up to the baseline validation. The purpose of a focused validation is to determine the technical adequacy of measurement data when

- the data are qualified as deficient or as requiring professional judgment during the verification/baseline validation process. For example, when holding times are exceeded or interferences are present, a focused validation may be required to assist in determining data adequacy for the intended use.
- the data quality assessment process requires additional information about the
  - variability or uncertainty of the reported data or
  - data quality prior to making a data use decision because of anomalies detected in a data set.

Details of quality assurance/quality control activities are presented in Chapter 4 of this RFI report. Qualifiers resulting from baseline and focused validation are shown in the analytical results tables included in Chapter 5 of this report. Summaries of data quality evaluations and focused validation of analytical data relevant to this report are given in Appendix B. The RPM, P and PM qualifiers do not appear in Chapter 5 data tables, nor in Appendix B, because they are replaced during focused validation according to the data use.

3.2 Process for the Identification of COPCs

3.2.1 Inorganic Chemicals

Detected inorganic chemicals are compared with natural background distributions to determine if they should be retained as COPCs or eliminated from further consideration. The inorganic background data used in this RFI report are from the following source:

- Soil and sediment samples collected throughout Los Alamos County for which chemical analyses were performed for certain inorganic (metal) chemicals (Longmire et al. 1995, 1142; 1995, 1266). The all-soil-horizon background data set was used because the soil master horizon was not identified during the sampling at the firing sites.

Comparisons between site data and background data are initially performed by comparing each observed concentration datum with a chemical-specific background screening value that is the upper tolerance limit (UTL), or the maximum reported concentration, or the detection limit of a nondetected chemical. The background screening values are derived from LANL-wide soil background data, and details on the calculation of these values are presented in Longmire et al. (1995, 1266). Certain inorganic chemicals in certain media have no LANL-wide background data. For these exceptions, PRS sample-specific detection limits are used as nominal background screening values. In this report, inorganic chemicals that lack background data include cyanide and silver.

Further statistical comparisons are performed for the analytes that exceed their UTLs to determine whether statistically significant differences exist between the observed site and background datasets. The Gehan/Wilcoxon Rank Sum test, the Quantile test, and the Slippage test are used for these evaluations (Gilbert 1987). The Gehan modification of the Wilcoxon Rank Sum test is best suited for

assessing complete shifts in distribution, whereas the Quantile test is better suited for assessing partial shifts. The Slippage test determines the probability of the observed number of site concentrations being greater than the maximum background concentration, given that the site data originates from the same distribution as the background data. Among the three tests, most types of differences between distributions can be determined. Observed significance levels (p-values) are reported for the tests. The p-value is the probability of observing data at least as different from the typical background data as the actual, observed site data; if the site concentration distribution is the same as background. If a p-value is less than 0.05, then there is reason to suspect that there is a difference between the background and site distributions; otherwise, no difference is indicated and the site concentrations are not statistically different than background. These tests are only performed for PRSs that have at least four samples, and only for the analytes that have adequate background datasets. For example, mercury data is not subjected to these tests because the background dataset is almost entirely composed of non-detected data. The p-values for any analytes that are shown not to be statistically different from background are included in chapter 5 where comparisons to background are discussed. Histograms, smoothed density images, and box plots for all analytes subjected to these analyses are presented in Appendix D.

3.2.2 Radionuclides

Comparing reported radionuclide results with minimum detectable activities and background data is necessary to determine the presence of radionuclides and to distinguish concentrations of radionuclides associated with Laboratory operations from those attributable to global fallout and/or to naturally occurring radionuclides.

The LANL ER Project requires that radiochemical data be reported by a laboratory on the basis of a detection test. Therefore, as part of the data validation/data assessment, reported results must be evaluated to ensure that only those results that represent detections be used to classify a radionuclide as a COPC. This is typically done by comparing the reported value with the associated minimum detectable activity if one is reported. When minum detectable activity is not available or does not meet the data quality needs of the ER Project, the reported value will be tested against an estimated minimum detectable activity. The estimated value is based on instrument counting error. The counting error is typically reported as the analytical uncertainty at a value of 1-sigma (i.e., one standard deviation), and the estimated minimum detectable activity is computed as 3-sigma. Detected radionuclides are retained as COPCs or eliminated from further consideration based on a comparison with natural or anthropogenic background distributions. The radionuclide background data used in this RFI report are from the following sources:

- Soil and sediment samples collected throughout Los Alamos County for which chemical analyses were performed for certain naturally occurring radioactive chemicals (Longmire et al. 1995, 1142; 1995, 1266). The soil background data set was used throughout the background comparison because the soil master horizon was not identified during sampling at the firing sites, and the landfill consisted of disturbed material. The backgound data sets from the geologic strata were not used because the geologic formation was not clearly defined in the drilling log. The use of the soil background data set is generally more conservative and should represent the majority of the chemicals analyzed.
- Background concentrations of radioactive chemicals associated with global fallout from atmospheric testing (e.g., plutonium, cesium, strontium, and tritium) reported in LANL Environmental Surveillance Reports (Purtymun et al. 1987; ESG 1988, 0408; ESG 1989, 0308; Environmental Protection Group 1990, 0497; Environmental Protection Group 1992, 0740).

Comparisons between site data and background data are initally performed by comparing each observed concentration datum with a radionuclide-specific background screening value that is either the UTL or the maximum reported activity. These background screening values are derived from LANL-wide soil background data. Details on the calculation of these values are presented in Longmire et al. (1995,

1266). Certain radionuclides in certain media have no LANL-wide background data. For these exceptions, PRS sample-specific minimum detectable activities are used as nominal background screening values. In this report, radionuclides that lack background data include thorium-227 and thorium-234.

3.2.3 Organic Chemicals

Background data are not available for organic chemicals. Organic chemicals positively identified in one or more samples have been carried forward in the screening assessment process for the PRS(s) in this ~~RPI~~ report. Chemicals not detected in any sample have been removed from further consideration.

3.2.4 Risk-Based Screening Assessment

Inorganic chemicals and radionuclides that exceed background and organic chemicals positively identified in one or more samples require further evaluation if they also exceed SALs. SALs for nonradioactive chemicals are based on EPA Region 9 preliminary remediation goals (PRGs) for residential soil and tap water. Where appropriate, certain EPA Region 9 water PRGs are replaced by Native American Pueblo, state, or federal water quality standards. Soil and water media have separate SALs for each chemical. The decision to identify a chemical as a COPC when a SAL is not available is made on a case-by-case basis, taking into account the availability of process knowledge and toxicological information.

If more than one COPC is present at the site, a multiple chemical evaluation (MCE) is performed to determine if the potentially additive effect of chemicals detected below SALs warrants additional investigation. The method for performing an MCE is summarized in the policy document Risk-Based Corrective Action Process (Dorries 1996, 1297). These comparisons are the last quantitative steps in the screening assessment process for human health concerns. If COPCs remain after this step, then further evaluation is required. If no COPCs remain after this step and the data set is sufficient to support the decision, a no further action (NFA) recommendation may be proposed based on human health concerns.

If COPCs remain after the screening assessment, several options exist for the PRSs. A further site-specific evaluation may lead to eliminating a COPC without going into a formal risk assessment. The site may be proposed for further sampling to more completely characterize the site or for rededication if it is cost effective to proceed without a risk assessment. A risk assessment may be conducted to determine if the remaining COPCs present an unacceptable human health risk.

Risk is associated with exposure to inorganic chemicals naturally occurring in soil. Calculation of background risks using the same methodology as site risk estimates provides a frame of reference for risk levels calculated at a site. This information provides a basis for determining risk-based remediation goals, which in some circumstances may be set at target risks comparable to background rather than default values, i.e., a cancer risk of 10^{-6} or a hazard index of 1. Background risks can also affect decisions at sites that have chemicals for which there is a toxicity threshold. For some inorganic chemicals, background intakes may be near a toxicity threshold such that incremental intakes associated with contamination may be unacceptable.

Background risk estimates provided in Table 3.3.1-1 were calculated using the same exposure assumptions by which SALs are calculated. SALs are based on health-protective assumptions for a residential scenario (EPA 1995, 1307). For soil exposure, the pathways include incidental soil ingestion, inhalation of resuspended dust, and dermal contact with soil. The background soil data used for these calculations were collected from several soil horizons at geographically diverse locations. Background risks are estimated to two statistics. One statistic is the median, which represents the midpoint in the concentration range (technically, the median is the concentration value that divides the results into two equal groups or where half of the data are above and half are below this value). The second statistic

represents the upper ~~range~~ of background concentration values, and is either a calculated UTL or a maximum concentration ~~value~~, depending on the number of sample results that are available for statistical analysis

The background risks based on the LANL SAL residential exposure model are provided in Table 3.3.-1. Risks due to background concentration are presented for both noncarcinogenic and carcinogenic outcomes. The potential for adverse noncarcinogenic health effects is estimated by a hazard quotient. A chemical intake leading to a hazard quotient of up to 1 is not associated with adverse health effects. None of the median or UTL background concentrations result in hazard quotients greater than 1.

Three of the background inorganic chemicals provided in Table 3.3.1-1 are ~~also~~ carcinogens. Applying the default exposure assumptions used for SALs, the lifetime cancer risks due to residential soil exposure to background concentrations (UTL column) are estimated at approximately 1 excess case of cancer in 100,000 people for beryllium, 2 in 100,000 for arsenic, and 2 in 1,000,000,000 for cadmium (carcinogenic only by inhalation). EPA uses a range of 1 excess case of cancer in 10,000 people to 1 in 1,000,000 as a guidance for an acceptable range of cancer risk (EPA 1990, 0559).

These background risk estimates provide a frame of reference for risk-based screening assessment and site decisions. If a site-specific risk assessment is necessary to further evaluate risks, background risks can also be calculated using site/scenario-specific assumptions to assist in any remedial action decisions for the site.

3.3.2 Risk Assessment

The human health risk assessments(s) presented in Sections 5.1.9 and 5.2.9 follow(s) the process outlined in the policy document Risk-Based Corrective Action Process (Dorries 1996, 1297) and consists of the following steps:

- identification of COPC concentrations,
- exposure assessment,
- toxicity assessment, and
- risk characterization.

TABLE 3.3.1-1
RISK DUE TO BACKGROUND CONCENTRATIONS OF INORGANIC CHEMICALS IN SOIL ASSUMING A RESIDENTIAL SCENARIO[a]

Inorganic Chemical	Background Soil Concentration[b] mg/kg		Hazard Quotient		Lifetime Cancer Risk	
	Median	UTL	Median	UTL	Median	UTL
Aluminum	10 000	38 700	0.1	0.5	NC[c]	NC
Antimony	0.6	[d]	0.02	0.03	NC	NC
Arsenic	4	7.82	0.2	0.4	$1x10^{-5}$	$2x10^{-5}$
Barium	130	315	0.03	0.06	NC	NC
Beryllium	0.895	1.95	0.003	0.006	$6x10^{-6}$	$1x10^{-5}$
Cadmium[e]	0.2	2.6[d]	0.005	0.07	$2x10^{-10}$	$2x10^{-9}$
Chromium[f]	8.6	19.3	0.00009	0.0002	NC	NC
Cobalt	6	19.2	0.001	0.004	NC	NC
Copper	5.75	15.5	0.002	0.01	NC	NC
Lead[g]	12	23.3	0.03	0.06	NC	NC

Manganese	320	714	0.1	0.2	NC	NC
Mercury	0.05	0.1[d]	0.002	0.004	NC	NC
Nickel	7	15.2	0.005	0.01	NC	NC
Selenium	0.3	1.7[d]	0.0008	0.005	NC	NC
Thallium	0.2	1[d]	0.03	0.2	NC	NC
Uranium	0.9	1.87	0.004	0.008	NC	NC
Vanadium	21	41.9	0.04	0.08	NC	NC
Zinc	30.7	50.8	0.001	0.002	NC	NC

a. Risk estimates are based on reference doses, slope factors, and EPA Region 9 default exposure assumptions effective April 1996.
b. Background concentrations taken from the Longmire et al. all soil horizons set (1995, 1142).
c. NC = noncarcinogen.
d. Maximum detected background value.
e. Cancer risks for cadmium are based solely on inhalation of resuspended dust.
f. Naturally occurring chromium is assumed to exist in a trivalent, rather than a hexavalent, state.
g. Hazard quotient based on biokinetic uptake model.

3.4 Ecological Assessment

In cooperation with the New Mexico Environmental Department and EPA Region 6, the Laboratory ER Project is developing an approach for ecological risk assessment. Further discussion of ecological risk assessment methodology will be deferred until the ecological exposure unit methodology being developed has been approved.

Reference:

Dunham, Daniel A. "Biological and Floodplain/Wetland Assessment for Environmental Restoration Program, Operable Unit 1132, TA-39", LA-UR-95-204, Reissue November 1995.

4.0 RESULTS OF QUALITY ASSURANCE/QUALITY CONTROL ACTIVITIES

Samples were collected, processed, and analyzed in accordance with the Environmental Restoration Quality Assurance/Quality Control (QA/QC) program documented in the Site-Specific Quality Assurance Project Plan (QAPP), Annex II of the RFI Work Plan for OU 1132 (LANL 1993, 1089), and the ER Project QAPP (LANL 1996, 1292). The QA objectives (precision, accuracy, etc.) for measured data were based on the ER Project QAPP (LANL 1996, 1292).

A variety of QA/QC samples are used to determine the quality and usability of the data generated from the various analyses. These samples include laboratory duplicates, internal standards, laboratory, field, and rinsate blanks, blind QC, analytical, and matrix spikes, surrogates, and laboratory control samples. A review of the technical quality of the data (baseline validation) requires that the data be compared to numerical acceptance criteria established either by the analytical laboratory or EPA for the QA samples mentioned above. The data that do not meet these criteria are qualified to indicate to the data user those sample results that have potential deficiencies associated with sample handling and analysis.

The data were validated through the Sample Management Office (SMO) of the Laboratory using a modification of the USEPA Functional Guidelines to perform baseline validation. The assessment of the QA/QC samples and the potential effect these results may have on data usability were evaluated for all samples presented in this report.

The QA/QC data associated with this investigation indicated that of the over 45,000 sample results data collected at and around the firing sites, approximately 99% are acceptable and defensible. The firing sites and the associated areas, including the adjacent stream channel segments [PRSs 39-004(a,d), (b), (c), and (e), and 39-008] had approximately 11,000 sample results for 39-004(a,d), 6300 sample results for 39-004(b), 10,700 sample results for 39-004(c), 10,000 sample results for 39-004(e), and 5200 sample results for 39-008 of which 99.1%, 100%, 99.8%, 99.6%, and 99.8%, respectively, are acceptable and defensible, i.e., 0% to 0.9% of the data are unusable. The stream channel data from 1994 (approximately 3,000 sample results) were approximately 99% acceptable and defensible. None of the radiochemistry data are considered unusable; however, data that are less than 3 sigma (σ) are considered usable as nondetects only. Similarly, less than 1% of the data are affected because of blank contamination problems; these data are usable as nondetects. Overall, approximately 5% of the data for the firing sites and the associated areas are qualified as estimated undetected (UJ) or estimated (J). The unusable data and the qualification of the data because of QA/QC problems did not affect the sufficiency of the data for decision-making purposes because the vast majority were acceptable and defensible. The QA/QC mechanisms were effective in ensuring the reliability of measured data within expected limits of sampling and analytical error.

This chapter summarizes the results of the data quality evaluation performed on the sample results associated with firing sites. The QA/QC problems for the firing pads (Tables B-1, B-3, B-5, and B-7), the transects for the firing sites (Tables B-2, B-4, B-6, and B-8), the gas gun site (Table B-9), and the associated stream channel segments adjacent to the firing sites and from the firing sites to past State Rd. 4 (Tables B-10, B-11, B-12, B-13, and B-14), are presented in Appendix B according to analytical suite and request/batch number, respectively.

4.1 Analyses for PRSs 39-004(a) and 39-004(d)

4.1.1 Inorganics

4.1.1.1 Firing Pads

Twelve samples were collected and submitted for inorganic and cyanide analyses around the firing pads at these PRSs.

Of what? to 75% The laboratory? If so, why was 35% acceptable?

All twelve samples from four request numbers had QA problems associated with the pre-digestion spike samples that resulted in several analytes being qualified as UJ, J-, or J+. The analytes included antimony and selenium (12 samples), manganese, vanadium, and zinc (8 samples), and cadmium, chromium, and silver (6 samples). The data are usable because the recoveries for all the analytes, except antimony in two samples and silver and zinc in four samples, were between 35% and 75% (the established lower limit), which were sufficient to detect and quantify these analytes if they were present. The detected concentrations of cadmium, chromium, manganese, and vanadium were one-sixth to one-half the background UTLs, while detected zinc concentrations for two samples were either well below the background UTL or slightly above the UTL but orders of magnitude below the SAL. Therefore, the biases resulting from the spike recoveries did not affect the data comparisons for these analytes. The data for silver and zinc in four samples were usable because the results were biased high. Antimony data for two samples were qualified as R,PM because recovery in the spike sample was <30%. Further review of the data indicate the R qualifier should be retained and the data not used in the screening assessment. Despite the unusable data, the site is adequately characterized for antimony.

Lithark

All twelve samples from four request numbers had QA problems associated with the relative percent differences (RPDs) of the laboratory duplicates for seven analytes. Lead (10 samples), aluminum, iron, and zinc (8 samples), calcium and copper (6 samples), and manganese (2 samples) were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for lead and zinc in six samples, and aluminum, iron, and manganese in two samples should not be qualified because the RPDs met EPA's control limits for soil (±35%, ±2X CRDL). Aluminum, copper, and lead data for six samples should be qualified as UJ or J and are usable because the RPDs reflect soil heterogeneity and do not affect method precision. The calcium and iron RPDs for six samples are unacceptable and the data should be qualified as R and not used in the screening assessment.

All twelve samples from four request numbers had several analytes detected in the laboratory blanks associated with these requests at concentrations below or equivalent to the method detection limits (MDLs). The sample concentrations that were less than 5X the blank values are qualified as U and are usable as nondetects in the screening assessment. The sample values that were greater than 5X the blank values are not qualified and are usable as reported.

All other inorganic and cyanide data around the firing pad areas are considered to be usable as reported.

4.1.1.2 Transects

Seventeen samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses along the transects from these firing pads.

Six samples from one request number had QA problems associated with the pre-digestion spike samples that resulted in several analytes being qualified as UJ, J-, or J+. The analytes included antimony, cadmium, chromium, manganese, selenium, silver, vanadium, and zinc. The data are

usable because the recoveries for antimony, cadmium, chromium, manganese, selenium, and vanadium were between 35% and 75% (the established lower limit), which were sufficient to detect and quantify these analytes if they were present. The detected concentrations of cadmium, chromium, and manganese were one-sixth to one-half the background UTLs and, therefore, the biases resulting from the spike recoveries did not affect the data comparisons for these analytes. The data for silver and zinc were usable because the results were biased high.

Eleven samples from two request numbers had QA problems associated with the matrix spike recoveries that resulted in seven analytes being qualified as J. The analytes included antimony, copper, lead, and thallium (8 samples), arsenic and manganese (3 samples), and selenium (11 samples). The data are usable because the recoveries for all the analytes, except lead, were between 50% and 75% (the established lower limit), and all the detected sample values were below the respective background UTLs or SALs. As a result, the biases resulting from the matrix spikes did not affect the data comparisons for these analytes. The data for lead are usable because the results are biased high.

Fourteen samples from two request numbers had QA problems associated with the RPDs of the laboratory duplicates for six analytes, aluminum, calcium, copper, iron, lead, and zinc. These data were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for aluminum in eight samples and zinc in six samples should not be qualified because the RPDs met EPA's control limits for soil (±35%, ±2X CRDL). Aluminum, copper, and lead data in six samples should be qualified as UJ or J and are usable because the RPDs reflect soil heterogeneity and do not affect method precision. The calcium and iron RPDs are unacceptable and the data should be qualified as R and not used in the screening assessment.

Seventeen samples from three request numbers had several analytes detected in the laboratory blanks associated with the requests at concentrations below or equivalent to the MDLs. The sample concentrations that were less than 5X the blank values are qualified as U and are usable as nondetects in the screening assessment. The sample values that were greater than 5X the blank values are not qualified and are usable as reported.

All other inorganic and cyanide data along the transects are considered to be usable as reported.

4.1.1.3 Stream Channel

Nineteen samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses along the intermittent stream channel segment that runs adjacent to the firing pads at these PRSs.

Four samples from one request number had QA problems associated with the pre-digestion spike samples that resulted in several analytes being qualified as UJ, J-, or J+. The analytes included antimony, cadmium, chromium, manganese, selenium, silver, vanadium, and zinc. The data are usable because the recoveries antimony, cadmium, chromium, manganese, selenium, and vanadium were between 35% and 75% (the established lower limit), which were sufficient to detect and quantify these analytes if they were present. The detected concentrations of cadmium, chromium, and manganese were one-sixth to one-half the background UTLs and, therefore, the biases resulting from the spike recoveries did not affect the data comparisons for these analytes. The data for silver and zinc were usable because the results were biased high.

Four samples from one request number had QA problems associated with the RPDs of the laboratory duplicates for six analytes, aluminum, calcium, copper, iron, lead, and zinc. These data were qualified as P indicating that professional judgment was needed to determine if the data

should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for zinc should not be qualified because the RPD met EPA's control limits for soil (±35%, ±2X CRDL). Aluminum, copper, and lead data should be qualified as UJ or J and are usable because the RPDs reflect soil heterogeneity and do not affect method precision. The calcium and iron RPDs are unacceptable and the data should be qualified as R and not used in the screening assessment.

Four samples from one request number had several analytes detected in the laboratory blank associated with this request at concentrations below or equivalent to the MDLs. The sample concentrations that were less than 5X the blank values were qualified as U and are usable as nondetects in the screening assessment. The sample values that were greater than 5X the blank values are not qualified and are usable as reported.

All other inorganic and cyanide data from the intermittent stream channel segment are considered to be usable as reported.

4.1.2 Organics

4.1.2.1 Firing Pads

SVOCs

Twelve samples were collected and submitted for SVOC analyses around the firing pads at these PRSs. All SVOC data are considered to be usable as reported.

VOCs

VOCs were not analyzed for around the firing pads at these PRSs.

HE

Twelve samples were collected and submitted for HE analyses around the firing pads at these PRSs.

Eight samples from five request numbers had the data qualified as PM because the spikes in the laboratory control sample (LCS) were only for seven of the fourteen analytes. These data should not be qualified because the spikes should accurately predict the recovery of the missing analytes and provide sufficient information on the accuracy of the method and the laboratory performance.

Six samples from two request numbers had a QA problem associated with the LCS that resulted in 2,4-dinitrotoluene being qualified as UJ. The data are usable because the results are biased high.

All other HE data around the firing pads are considered to be usable as reported.

PCBs/Pesticides

Twelve samples were collected and submitted for PCB/Pesticide analyses around the firing pads at these PRSs. All PCB/Pesticide data are considered to be usable as reported.

4.1.2.2 Transects

SVOCs

Seventeen samples, including one field duplicate, were collected and submitted for SVOC analysis along the transects from these firing pads.

Three samples from one request number had QA problems associated with the area counts for two internal standards that resulted in the target compounds for these standards being qualified as UJ. The data for the target compounds associated with the internal standards are usable because recoveries were sufficient ot detect and quantify the analytes, the sensitivity and responsiveness of the instrument were not compromised, and the soil matrix may have been the cause of the low counts. In addition, the recoveries for the other QC samples were within established limits for the target compounds.

One sample from one request number had QA problems associated with the recoveries of the surrogate compounds that resulted in all of the SVOC data being qualified as R,PM. The recoveries for both the acid extractable and base/neutral surrogates were below 10% for sample 0239-95-0135. Further review of the data indicated that the R qualifier should be retained and the data not used in the screening assessment. Despite the unusable data, there is sufficient SVOC data to characterize the sites.

All other SVOC data along the transects are considered to be usable as reported.

VOCs

Seven samples were collected and submitted for VOC analysis along the transects from these PRSs. All VOC data are considered to be usable as reported.

HE

Seventeen samples, including one field duplicate, were collected and submitted for HE analysis along the transects from these PRSs.

Six samples from one request number had the data qualified as PM because the spikes in the LCSs were only for seven of the fourteen analytes. These data should not be qualified because the spikes should accurately predict the recovery of the missing analytes and provide sufficient information on the accuracy of the method and the laboratory performance.

Six samples from one request number had a QA problem associated with the LCS that resulted in 2,4-dinitrotoluene being qualified as UJ. The data are usable because the results are biased high.

All other HE data along the transects are considered to be usable as reported.

PCBs/Pesticides

Seventeen samples, including one field duplicate, were collected and submitted for PCB/Pesticide analysis along the transects from these PRSs. All PCB/Pesticide data are considered to be usable as reported.

4.1.3.2 Transects

Seventeen samples, including one field duplicate, were collected and submitted for radionuclide analyses along the transects from these firing pads.

All data from the seventeen samples from three request numbers were qualified as PM because only thorium-230 was spiked into the LCSs rather than all three thorium isotopes. The data should be re-qualified as J and are usable because the chemistry of thorium-230 is similar to thorium-228 and thorium-232 and should therefore predict the recoveries of these two isotopes.

Fourteen samples from two request numbers had thorium-230 detected in the laboratory blanks at concentrations below or equivalent to the MDLs. The sample concentrations for six samples were less than 5X the blank values. The data are qualified as U and are usable as nondetects due to blank contamination. The sample concentrations for eight samples were greater than 5X the blank values. The data are not qualified and are usable as reported.

Three samples from one request number had a QA problem associated with the matrix spike sample that resulted in the total uranium data being qualified as J. The data are usable because the results are biased high.

All other radionuclide data along the transects are considered to be usable as reported.

4.1.3.3 Stream Channel

Nineteen samples, including one field duplicate, were collected and submitted for radionuclide analyses along the intermittent stream channel segment that runs adjacent to the firing pads at these PRSs.

All nineteen samples from two request numbers were qualified as PM because only thorium-230 was spiked into the LCSs rather than all three thorium isotopes. The data should be re-qualified as J and are usable because the chemistry of thorium-230 is similar to thorium-228 and thorium-232 and should therefore predict the recoveries of these two isotopes.

Fifteen samples from one request number had thorium-230 and thorium-232 detected in the laboratory blank and four samples from one request number had thorium-230 detected in the laboratory blank at concentrations below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects due to blank contamination.

All other radionuclide data from the intermittent stream channel segment are considered to be usable as reported.

4.2 Analyses for PRS 39-004(b)

4.2.1 Inorganics

4.2.1.2 Firing Pad

Seven samples were collected and submitted for inorganic and cyanide analyses around the firing pad at this PRS.

All seven samples from one request number had QA problems associated with the matrix spike recoveries for antimony and manganese that resulted in these analytes being qualified as J. Data are usable because antimony recovery was >50% and manganese recovery was greater than the

upper limit. All detected data are below their respective background UTLs or SALs so the biases did not affect the data comparisons.

All seven samples had QA problems associated with the RPDs of the laboratory duplicates for four analytes. Calcium, copper, lead, and manganese were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for calcium, lead, and manganese should not be qualified because the RPDs met EPA's control limits for soil (±35%, ±2X CRDL). Copper data did not meet the EPA limits and should be qualified as J. The data are usable because the RPD was not overly excessive and reflects the soil heterogeneity so the method precision was acceptable.

All seven samples had a problem with the holding time for cyanide analysis. The 14-day holding time for cyanide was exceeded and the data for all samples were qualified as PM. The holding time was not grossly exceeded, i.e., more than twice the holding time, so the sample results should be re-qualified as UJ. The data are usable because the samples were properly stored and were stable enough to prevent marked degradation within 28 days.

All seven samples had several analytes detected in the laboratory blank associated at concentrations below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.

All other inorganic and cyanide data around the firing pad are considered to be usable as reported.

4.2.1.2 Transects

Twelve samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses along the transects from the firing pad.

Five samples from one request number had QA problems associated with the pre-digestion spike sample that resulted in two analytes, antimony and selenium, being qualified as UJ. The data are usable because the recoveries were between 40% and 75% (the established lower limit), which were sufficient to detect and quantify these analytes if they were present. Therefore, the bias resulting from the spike recoveries did not affect the data comparisons for these analytes.

Seven samples from one request number had QA problems associated with the matrix spike recoveries that resulted in three analytes, arsenic, manganese, and selenium, being qualified as J. The data are usable because the recoveries for all the analytes were between 50% and 75% and all the detected sample values were below the respective background UTLs or SALs. As a result, the bias resulting from the matrix spikes did not affect the data comparisons for these analytes.

All twelve samples from two request numbers had several analytes detected in the laboratory blanks associated with the requests at concentrations below or equivalent to the MDLs. The sample concentrations that were less than 5X the blank values are qualified as U and are usable as nondetects in the screening assessment. The sample values that were greater than 5X the blank values are not qualified and are usable as reported.

All other inorganic and cyanide data along the transects are considered to be usable as reported.

4.2.1.3 Stream Channel

Fifteen samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS.

All fifteen samples from one request number had QA problems associated with the pre-digestion spike recoveries for manganese, mercury, and selenium that resulted in these analytes being qualified as J. The data are usable because the recoveries for manganese and mercury were between 50% and 75% (the established lower limit), which were sufficient to detect and quantify these analytes if they were present. The detected concentrations of all the analytes were below the respective background UTLs and SALs and, therefore, the bias resulting from the spike recoveries did not affect the data comparisons for these analytes. The data for selenium were usable because the results were biased high.

All fifteen samples had QA problems associated with the RPDs of the laboratory duplicates for three analytes. Aluminum, iron, and manganese were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for iron and manganese should not be qualified because the RPDs met EPA's control limits for soil (±35%, ±2X CRDL). Aluminum data did not meet the EPA limits and should be qualified as J. The data are usable because the RPD was not overly excessive and reflects the soil heterogeneity so the method precision was acceptable.

All fifteen samples had a problem with the holding time for cyanide analysis. The 14-day holding time for cyanide was exceeded by 26 days and the data for all samples were qualified as PM. The holding time was not grossly exceeded, i.e., more than twice the holding time, so the sample results should be re-qualified as UJ. The data are usable because the samples were properly stored and were stable enough to prevent marked degradation within 28 days.

All other inorganic and cyanide data from the intermittent stream channel segment are considered to be usable as reported.

4.2.2 Organics

4.2.2.1 Firing Pad

SVOCs

Seven samples were collected and submitted for SVOC analyses around the firing pad at this PRS. All SVOC data are considered to be usable as reported.

VOCs

VOCs were not analyzed for around the firing pad at this PRS.

HE

Seven samples were collected and submitted for HE analyses around the firing pad at this PRS. All HE data are considered to be usable as reported.

PCBs/Pesticides

Seven samples were collected and submitted for PCB/Pesticide analyses around the firing pad at this PRS. All PCB/Pesticide data are considered to be usable as reported.

4.2.2.2 Transects

SVOCs

Twelve samples, including one field duplicate, were collected and submitted for SVOC analysis along the transects from the firing pad. All SVOC data at these sites are considered to be usable as reported.

VOCs

Three samples were collected and submitted for VOC analysis along the transects from the firing pad. All VOC data at these sites are considered to be usable as reported.

HE

Twelve samples, including one field duplicate, were collected and submitted for HE along the transects from the firing pad. All HE data at these sites are considered to be usable as reported.

PCBs/Pesticides

Twelve samples, including one field duplicate, were collected and submitted for PCB/Pesticide analysis along the transects from the firing pad. All PCB/Pesticide data at these sites are considered to be usable as reported.

4.2.2.3 Stream Channel

SVOCs

Fifteen samples, including one field duplicate, were collected and submitted for SVOC analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS.

One sample, 0239-95-0022 was diluted in order to accurately quantitate the concentration of bis(2-ethylhexyl)phthalate. As a result, the second, diluted analysis should be used in the screening assessment.

All SVOC data from the intermittent stream channel segment are considered to be usable as reported.

VOCs

Seven samples were collected and submitted for VOC analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS. All VOC data at this site are considered to be usable as reported.

HE

Fifteen samples, including one field duplicate, were collected and submitted for HE along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS. All HE data at this site are considered to be usable as reported.

PCBs/Pesticides

Fifteen samples, including one field duplicate, were collected and submitted for PCB/Pesticide analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS. All PCB/Pesticide data at this site are considered to be usable as reported.

4.2.3 Radionuclides

4.2.3.1 Firing Pad

Seven samples were collected and submitted for radionuclide analyses around the firing pad at this PRS.

All seven samples are qualified as PM because thorium-230 and plutonium-239 were spiked into the LCS rather than all three thorium isotopes and both plutonium isotopes. The data should be re-qualified as J and are usable because the chemistries of thorium-230 and plutonium-239 are similar to thorium-228 and thorium-232 and plutonium-238, respectively, and should therefore predict the recoveries of the isotopes.

All seven samples had thorium-230 detected in the laboratory blank associated with these requests at concentrations below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.

All other radionuclide data around the firing pad are considered to be usable as reported.

4.2.3.2 Transects

Twelve samples, including one field duplicate, were collected and submitted for radionuclide analysis along the transects from the firing pad.

Seven samples from one request number were qualified as PM because only thorium-230 was spiked into the LCS rather than all three thorium isotopes. The data should be re-qualified as J and are usable because the chemistry of thorium-230 is similar to thorium-228 and thorium-232 and should therefore predict the recoveries of these two isotopes.

Seven samples from one request number had a QA problem associated with the matrix spike sample that resulted in the total uranium data being qualified as J. The data are usable because the results are biased high.

All other radionuclide data along the transects are considered to be usable as reported.

4.2.3.3 Stream Channel

Fifteen samples, including one field duplicate, were collected and submitted for radionuclide analyses along the intermittent stream channel segment that runs adjacent to the firing pad a this PRS.

All fifteen samples from one request number were qualified as PM because only thorium-230 was spiked into the LCSs rather than all three thorium isotopes. The data should be re-qualified as J and are usable because the chemistry of thorium-230 is similar to thorium-228 and thorium-232 and should therefore predict the recoveries of these two isotopes.

Fifteen samples from one request number had thorium-230 detected in the laboratory blank at a concentration below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects due to blank contamination.

The thorium-230 duplicate for all fifteen samples was outside of quality control limits and is qualified as J. The sample data were previously qualified as U due to blank contamination, but should be qualified as UJ because of the duplicate problem. The data are usable as nondetects in the screening assessment.

All other radionuclide data from the intermittent stream channel segment are considered to be usable as reported.

4.3 Analyses for PRS 39-004(e)

4.3.1 Inorganics

4.3.1.1 Firing Pad

Five samples were collected and submitted for inorganic and cyanide analyses around the firing pad at this PRS.

All five samples from one request number had QA problems associated with the matrix spike recoveries for antimony and manganese that resulted in these analytes being qualified as J. Data are usable because antimony recovery was >50% and manganese recovery was above the upper limit. All detected data are below their respective background UTLs or SALs so the biases did not affect the data comparisons.

All five samples had QA problems associated with the RPDs of the laboratory duplicates for four analytes. Calcium, copper, lead, and manganese were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for calcium, lead, and manganese should not be qualified because the RPDs met EPA's control limits for soil (±35%, ±2X CRDL). Copper data did not meet the EPA limits and should be qualified as J. The data are usable because the RPD was not overly excessive and reflects the soil heterogeneity so the method precision was acceptable.

All five samples had a problem with the holding time for cyanide analysis. The 14-day holding time for cyanide was exceeded and the data for all samples were qualified as PM. The holding time was not grossly exceeded, i.e., more than twice the holding time, so the sample results should be re-qualified as UJ. The data are usable because the samples were properly stored and were stable enough to prevent marked degradation within 28 days.

All five samples had several analytes detected in the laboratory blank associated at concentrations below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.

All other inorganic and cyanide data around the firing pad are considered to be usable as reported.

4.3.1.2 Transects

Twenty-six samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses along the transects from the firing pad.

All twenty-six samples from four request numbers had QA problems associated with the matrix spike recoveries that resulted in several analytes being qualified as J. The analytes included antimony (7 samples), arsenic and selenium (3 samples), cadmium and chromium (10 samples), copper (17 samples), lead (23 samples), manganese (9 samples), silver (6 samples), and thallium (17 samples). The data are usable because the recoveries for antimony in seven samples, copper in ten samples, lead in six samples, manganese in three samples, arsenic, cadmium, chromium, selenium, silver, and thallium were between 50% and 75% (the established lower limit), and all the detected sample values were below the respective background UTLs or SALs. The recoveries for manganese in six samples, lead in seventeen samples, and copper in ten samples were greater than 125% (the established upper limit) and were usable because the results were biased high. As a result, the biases resulting from the matrix spikes did not affect the data comparisons for these analytes.

Sixteen samples from two request numbers had QA problems associated with the matrix spike recoveries that resulted in two analytes, antimony and zinc, being qualified as R. The recoveries for antimony in ten samples and zinc in six samples were below 10%, which is the lowest acceptable limit, and therefore these data are not used in the screening assessment.

Twenty-three samples from three request numbers had QA problems associated with the RPDs of the laboratory duplicates for seven analytes, aluminum, copper, cyanide, lead, manganese, silver, and zinc. These data were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for aluminum, lead, manganese, and silver should not be qualified because the RPDs met EPA's control limits for soil (±35%, ±2X CRDL). Copper and cyanide data did not meet the EPA's limits and should be qualified as J and UJ, respectively. The data are usable because the RPDs reflect soil heterogeneity and do not affect method precision. Zinc also did not meet the EPA limits ,but are already unusable because of the extremely low matrix spike recovery.

All twenty-six samples from four request numbers had several analytes detected in the laboratory blanks associated with the requests at concentrations below or equivalent to the MDLs. The sample concentrations that were less than 5X the blank values are qualified as U and are usable as nondetects in the screening assessment. The sample values that were greater than 5X the blank values are not qualified and are usable as reported.

All other inorganic and cyanide data along the transects are considered to be usable as reported.

4.3.1.3 Stream Channel

Eleven samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS.

All eleven samples from one request number had QA problems associated with the matrix spike sample that resulted in three analytes (manganese, lead, and silver) being qualified as J, and one analyte (zinc) being qualified as R. The data for lead and silver are usable because the recoveries were between 50% and 75% (the established lower limit), which were sufficient to detect and quantify the analytes if they are present. All detects are below their respective background UTLs or SALs so the biases did not affect the data comparisons. The data for manganese are usable

because the results are biased high. The zinc recovery was <10%, which is the lowest acceptable limit, so the data are unusable and are not used in the screening assessment.

All eleven samples had QA problems associated with the RPDs of the laboratory duplicates for four analytes. Aluminum, manganese, silver, and zinc were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for aluminum, manganese, and silver (±35%, ±2X CRDL). Zinc did not meet the EPA limits, but are already unusable because of the extremely low matrix spike recovery.

All other inorganic and cyanide data from the intermittent stream channel segment are considered to be usable as reported.

4.3.2 Organics

4.3.2.1 Firing Pad

SVOCs

Five samples were collected and submitted for SVOC analyses around the firing pad at this PRS. All SVOC data are considered to be usable as reported.

VOCs

VOCs were not analyzed for around the firing pad at this PRS.

HE

Five samples were collected and submitted for HE analyses around the firing pad at this PRS. All HE data are considered to be usable as reported.

PCBs/Pesticides

Five samples were collected and submitted for PCB/Pesticide analyses around the firing pad at this PRS. All PCB/Pesticide data are considered to be usable as reported.

4.3.2.2 Transects

SVOCs

Twenty-six samples, including one field duplicate, were collected and submitted for SVOC analysis along the transects from the firing pad.

Di-n-butyl phthalate in one sample from one request number is qualified as J because it was detected below the estimated quantitation limit (EQL). The sample result has a high degree of uncertainty because the value cannot be accurately distinguished from the instrument "noise" levels. As a result, the datum is usable as an estimated value, but should be used with caution in the screening assesment because it cannot be accurately quantified

Two samples from one request number had QA problems associated with the area counts for two internal standards that resulted in the target compounds for these standards being qualified as UJ. The data for the target compounds associated with the internal standards are usable because recoveries were sufficient to detect and quantify the analytes, the sensitivity and responsiveness of the instrument were not compromised, and the soil matrix may have been the cause of the low

counts. In addition, the recoveries for other QC samples were within established limits for the target compounds.

All other SVOC data collected along the transects are considered to be usable as reported.

VOCs

Eleven samples were collected and submitted for VOC along the transects from the firing pad. All VOC data at these sites are considered to be usable as reported.

HE

Twenty-six samples, including two field duplicates, were collected and submitted for HE analysis along the transects from the firing pad. All HE data at these sites are considered to be usable as reported.

PCBs/Pesticides

Twenty-six samples, including two field duplicates, were collected and submitted for PCB/Pesticide analysis along the transects from the firing pad. All PCB/Pesticide data at these sites are considered to be usable as reported.

4.3.2.3 Stream Channel

SVOCs

Eleven samples, including one field duplicate, were collected and submitted for SVOC analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS.

Di-n-butyl phthalate in three samples from one request number are qualified as J because it was detected below the EQL. These sample results have a high degree of uncertainty because the values cannot be accurately distinguished from the instrument "noise" levels. As a result, the data are usable as estimated values, but should be used with caution in the screening assesment because they cannot be accurately quantified

All other SVOC data from the intermittent stream channel segment are considered to be usable as reported.

VOCs

Five samples were collected and submitted for VOC analyses along the intermittent stream channel that runs adjacent to the firing pad at this PRS. All VOC data at this site are considered to be usable as reported.

HE

Eleven samples, including one field duplicate, were collected and submitted for HE analyses along the intermittent stream channel that runs adjacent to the firing pad at this PRS. All HE data at this site are considered to be usable as reported.

PCBs/Pesticides

Eleven samples, including one field duplicate, were collected and submitted for PCB/Pesticide analyses along the intermittent stream channel that runs adjacent to the firing pad at this PRS. All PCB/Pesticide data at this site are considered to be usable as reported.

4.3.3 Radionuclides

4.3.3.1 Firing Pad

Five samples were collected and submitted for radionuclide analyses around the firing pad at this PRS.

All five samples were qualified as PM because thorium-230 and plutonium-239 were spiked into the LCS rather than all three thorium isotopes and both plutonium isotopes. The data should be re-qualified as J and are usable because the chemistries of thorium-230 and plutonium-239 are similar to thorium-228 and thorium-232 and plutonium-238, respectively, and should therefore predict the recoveries of the isotopes.

All five samples had thorium-230 detected in the laboratory blanks associated with these requests at concentrations below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.

All other radionuclide data around the firing pad are considered to be usable as reported.

4.3.3.2 Transects

Twenty-six samples, including two field duplicates, were collected and submitted for radionuclide analyses along the transects from the firing pad.

Seven samples from one request number were qualified as PM because only thorium-230 was spiked into the LCSs rather than all three thorium isotopes. The data should be re-qualified as J and are usable because the chemistry of thorium-230 is similar to thorium-228 and thorium-232 and should therefore predict the recoveries of these two isotopes.

Seven samples from one request number had thorium-230 detected in the laboratory blank at concentrations below or equivalent to the MDLs. The sample concentrations were greater than 5X the blank values. The data are not qualified and are usable as reported.

All other radionuclide data along the transects are considered to be usable as reported.

4.3.3.3 Stream Channel

Eleven samples, including one field duplicate, were collected and submitted for radionuclide analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS. All radionuclide data at this site are considered to be usable as reported.

4.4 Analyses for PRS 39-004(c)

4.4.1 Inorganics

4.4.1.1 Firing Pad

Five samples were collected and submitted for inorganic and cyanide analyses around the firing pad at this PRS.

All five samples from one request number had QA problems associated with the matrix spike recoveries for antimony and manganese that resulted in these analytes being qualified as J. Data are usable because antimony recovery was >50% and manganese recovery was high. All detected data are below their respective background UTLs or SALs so the biases did not affect the data comparisons.

All five samples had QA problems associated with the RPDs of the laboratory duplicates for four analytes. Calcium, copper, lead, and manganese were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for calcium, lead, and manganese should not be qualified because the RPDs met EPA's control limits for soil (±35%. ±2X CRDL). Copper data did not meet the EPA limits and should be qualified as J. The data are usable because the RPD was not overly excessive and reflects the soil heterogeneity so the method precision was acceptable.

All five samples had a problem with the holding time for cyanide analysis. The 14-day holding time for cyanide was exceeded and the data for all samples were qualified as PM. The holding time was not grossly exceeded, i.e., more than twice the holding time, so the sample results should be re-qualified as UJ. The data are usable because the samples were properly stored and were stable enough to prevent marked degradation within 28 days.

All five samples had several analytes detected in the laboratory blank associated at concentrations below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.

All other inorganic and cyanide data around the firing pad are considered to be usable as reported.

4.4.1.2 Transects

Nineteen samples, including two field duplicates, were collected and submitted for inorganic and cyanide analyses along the transects from the firing pad.

Eleven samples from one request number had QA problems associated with the matrix spike recoveries that resulted in three analytes, arsenic, manganese, and selenium, being qualified as J. The data are usable because the recoveries for all the analytes were between 50% and 75% (the established lower limit), and all the detected sample values were below the respective background UTLs or SALs. As a result, the biases resulting from the matrix spikes did not affect the data comparisons for these analytes.

Eleven samples from one request number had several analytes detected in the laboratory blanks associated with the requests at concentrations below or equivalent to the MDLs. The sample concentrations that were less than 5X the blank values are qualified as U and are usable as

nondetects in the screening assessment. The sample values that were greater than 5X the blank values are not qualified and are usable as reported.

All other inorganic and cyanide data along the transects are considered to be usable as reported.

4.4.1.3 Stream Channel

Twenty-one samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS.

All twenty-one samples from one request number had QA problems associated with the pre-digestion spike sample that resulted in four analytes, manganese, selenium, vanadium, and zinc, being qualified as either UJ or J-. The data are usable because the recoveries were between 50% and 75% (the established lower limit), which were sufficient to detect and quantify the analytes if they are present. The detected values of manganese and vanadium were more than one-half the background UTLs, while zinc values were either well below the background UTL or slightly above the background UTL but orders of magnitude below the SAL. Therefore, the biases resulting from the spike sample recoveries did not affect the data comparisons.

All twenty-one samples from one request number had a QA problem associated with the pre-digestion spike sample that resulted in antimony being qualified as R,PM. The recovery for antimony was <30%, which is the lowest acceptable limit. Further review of the data indicated that the R qualifier should be retained and the data not used in the screening assessment.

All twenty-one samples had several analytes detected in the laboratory blank associated with this request at concentrations below or equivalent to the MDLs. The sample concentrations that were less than 5X the blank values are qualified as U and are usable as nondetects in the screening assessment. The sample values that were greater than 5X the blank values are not qualified and are usable as reported.

All other inorganic and cyanide data from the intermittent stream channel segment are considered to be usable as reported.

4.4.2 Organics

4.4.2.1 Firing Pad

SVOCs

Five samples were collected and submitted for SVOC analyses around the firing pad at this PRS. All SVOC data are considered to be usable as reported.

VOCs

VOCs were not analyzed for around the firing pad at this PRS.

HE

Five samples were collected and submitted for HE analyses around the firing pad at this PRS. All HE data are considered to be usable as reported.

PCBs/Pesticides

~~Five samples were collected and submitted for PCB/Pesticide analyses around the firing pad at this PRS. All PCB/Pesticide data are considered to be usable as reported.~~

4.4.2.2 Transects

SVOCs

Nineteen samples, including two field duplicates, were collected and submitted for SVOC analysis along the transects from the firing pad.

One sample, 0239-95-0188, had the area counts for all internal standards below the established limits, which resulted in all the analytes being qualified as UJ,PM. Further review of the data indicated that all other QC samples, including the surrogates, were within established limits so that the data should be qualified as UJ and are usable as nondetects.

All other SVOC data along the transects are considered to be usable as reported.

VOCs

Seven samples were collected and submitted for VOC analysis along the transects from the firing pad. All VOC data at these sites are considered to be usable as reported.

HE

Nineteen samples, including two field duplicates, were collected and submitted for HE analysis along the transects from the firing pad. All HE data at these sites are considered to be usable as reported.

PCBs/Pesticides

~~Nineteen samples, including two field duplicates, were collected and submitted for PCB/Pesticide analysis along the transects from the firing pad. All PCB/Pesticide data at these sites are considered to be usable as reported.~~

4.4.2.3 Stream Channel

SVOCs

Twenty-one samples, including one field duplicate, were collected and submitted for SVOC analyses along the intermittent stream channel that runs adjacent to the firing pad at this PRS. All SVOC data at this site are considered to be usable as reported.

VOCs

Ten samples were collected and submitted for VOC analyses along the intermittent stream channel that runs adjacent to the firing pad at this PRS. All VOC data at this site are considered to be usable as reported.

HE

Twenty-one samples, including one field duplicate, were collected and submitted for HE analyses along the intermittent stream channel that runs adjacent to the firing pad at this PRS. All HE data at this site are considered to be usable as reported.

PCBs/Pesticides

Twenty-one samples, including one field duplicate, were collected and submitted for PCB/Pesticide analyses along the intermittent stream channel that runs adjacent to the firing pad at this PRS. All PCB/Pesticide data at this site are considered to be usable as reported.

4.4.3 Radionuclides

4.4.3.1 Firing Pad

Five samples were collected and submitted for radionuclide analyses around the firing pad at this PRS.

All five samples were qualified as PM because thorium-230 and plutonium-239 were spiked into the LCS rather than all three thorium isotopes and both plutonium isotopes. The data should be re-qualified as J and are usable because the chemistries of thorium-230 and plutonium-239 are similar to thorium-228 and thorium-232 and plutonium-238, respectively, and should therefore predict the recoveries of the isotopes.

All five samples had thorium-230 detected in the laboratory blank associated with these requests at concentrations below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.

All other radionuclide data around the firing pad are considered to be usable as reported.

4.4.3.2 Transects

Nineteen samples, including two field duplicates, were collected and submitted for radionuclide analyses along the transects from the firing pad.

Nineteen samples from two request numbers were qualified as PM because only thorium-230 was spiked into the LCSs rather than all three thorium isotopes. The data should be re-qualified as J and are usable because the chemistry of thorium-230 is similar to thorium-228 and thorium-232 and should therefore predict the recoveries of these two isotopes.

Eleven samples from one request number had a QA problem associated with the matrix spike sample that resulted in the total uranium data being qualified as J. The data are usable because the results are biased high.

Eight samples from one request number had thorium-230 detected in the laboratory blank at concentrations below or equivalent to the MDLs. The sample concentrations were greater than 5X the blank values. The data are not qualified and are usable as reported.

All other radionuclide data along the transects are considered to be usable as reported.

4.4.3.3 Stream Channel

Twenty-one samples, including one field duplicate, were collected and submitted for radionuclide analyses along the intermittent stream channel segment that runs adjacent to the firing pad at this PRS.

All twenty-one samples from one request number were qualified as PM because only thorium-230 was spiked into the LCS rather than all three thorium isotopes. The data should be re-qualified as J and are usable because the chemistry of thorium-230 is similar to thorium-228 and thorium-232 and should therefore predict the recoveries of these two isotopes.

All twenty-one samples had thorium-230 detected in the laboratory blank at a concentration below or equivalent to the MDLs. The sample concentrations were less than 5X the blank values. The data are qualified as U and are usable as nondetects due to blank contamination.

All twenty-one samples had the total uranium data incorrectly qualified as J because the duplicate recovery was outside of the 3-sigma error. The duplicate results did have a 3-sigma agreement using Sigma Overlap Excel Macro and should not be qualified. The data are usable as reported.

All other radionuclide data from the intermittent stream channel segment are considered to be usable as reported.

4.5 Analyses for PRS 39-008

4.5.1 Inorganics

Twenty-four samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses at this PRS.

Thirteen samples from two request numbers had QA problems associated with the matrix spike recoveries that resulted in three analytes (antimony, manganese, and silver) being qualified as J. The data are usable because the recoveries for antimony and silver were between 50% and 75% (the established lower limit) and all the detected sample values were below the respective background UTLs or SALs. The recoveries for manganese were greater than 125% (the established upper limit) and were usable because the results were biased high. As a result, the biases resulting from the matrix spikes did not affect the data comparisons for these analytes.

Eleven samples from one request number had QA problems associated with the matrix spike recoveries that resulted in selenium being qualified as R. The recoveries for selenium were zero and therefore the data are not used in the screening assessment.

All twenty-four samples from four request numbers had QA problems associated with the RPDs of the laboratory duplicates for nine analytes, aluminum, calcium, chromium, copper, iron, lead, manganese, silver, and zinc. These data were qualified as P indicating that professional judgment was needed to determine if the data should be qualified because the RPDs were above the established limit of 20%. Further review of the data found that the results for all of the analytes, except for copper, should not be qualified because the RPDs met EPA's control limits for soil (±35%, ±2X CRDL). Copper data did not meet the EPA's limits and should be qualified as J. The data are usable because the RPDs reflect soil heterogeneity and do not affect method precision.

All twenty-four samples had several analytes detected in the laboratory blanks associated with the requests at concentrations below or equivalent to the MDLs. The sample concentrations that were less than 5X the blank values are qualified as U and are usable as nondetects in the

screening assessment. The sample values that were greater than 5X the blank values are not qualified and are usable as reported.

All other inorganic and cyanide data at this site are considered to be usable as reported.

4.5.2 Organics

SVOCs

Twenty-four samples, including one field duplicate, were collected and submitted for SVOC analysis at this PRS.

One sample, 0239-95-0206, had eight of ten surrogate recoveries below 10%, which is the lowest acceptable limit, and all results are qualified as R,PM. The sample was re-extracted and had acceptable surrogate recoveries. However, the sample re-extraction occurred outside of the holding time resulting in the data being qualified as PM. Because the holding time was not grossly exceeded, the results of the re-extraction should be re-qualified as UJ and used as the sample results in the screening assessment.

Another sample, 0239-95-0213, had ten of ten surrogate recoveries below the established limits but greater than 10% and all results are qualified as UJ. The sample was re-extracted and had acceptable surrogate recoveries. However, the sample re-extraction occured outside of the holding time resulting in the data being qualified as PM. Because the holding time was not grossly exceeded, the results of the re-extraction should be qualified as UJ and used as the sample results in the screening assessment.

Eight samples from one request number (0239-95-0215, -0216, -0223, -0225, -0227, -0228, -0230, and -0231) had seven analytes, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, di-n-butyl phthalate, and indeno(1,2,3-cd)pyrene, incorrectly qualified as UJ because of internal standard problems. Further review of the data indicated that the internal standards for these analytes were within established limits and should not be qualified. The data for these eight samples are usable as reported, while the other three samples in this request number are correctly qualified.

Bis(2-ethylhexyl)phthalate in four samples from one request number is qualified as J because it was detected below the EQL. These sample results have a high degree of uncertainty because the values cannot be accurately distinguished from the instrument "noise" levels. As a result, the data are usable as estimated values, but should be used with caution in the screening assessment because they cannot be accurately quantified

All other SVOC data collected at this site are considered to be usable as reported.

VOCs

Ten samples were collected and submitted for VOC analysis at this PRS. All VOC data at this site are considered to be usable as reported.

HE

Twenty-four samples, including two field duplicates, were collected and submitted for HE analysis at this PRS. All HE data at this site are considered to be usable as reported.

PCBs

Twenty-four samples, including two field duplicates, were collected and submitted for PCB analysis at this PRS. All PCB data at this site are considered to be usable as reported.

4.5.3 Radionuclides

Twenty-four samples, including two field duplicates, were collected and submitted for radionuclide analyses at this PRS.

Twelve samples from two request numbers are qualified as PM because thorium-230 and plutonium-239 were spiked into the LCSs rather than all three thorium isotopes and both plutonium isotopes. The data should be re-qualified as J and are usable because the chemistries of thorium-230 and plutonium-239 are similar to thorium-228 and thorium-232, and plutonium-238, respectively, and should therefore predict the recoveries of the isotopes.

Twelve samples from two request numbers were qualified as PM because only thorium-230 was spiked into the LCSs rather than all three thorium isotopes. The data should be re-qualified as J and are usable because the chemistry of thorium-230 is similar to thorium-228 and thorium-232 and should therefore predict the recoveries of these two isotopes.

Thirteen samples from three request number had thorium-230 detected in the laboratory blanks at concentrations below or equivalent to the MDLs. The sample concentrations were greater than 5X the blank values. The data are not qualified and are usable as reported.

All other radionuclide data at this site are considered to be usable as reported.

4.6 Analyses for the Intermittent Stream Channel 1994 (Firing Sites to State Rd. 4)

4.6.1 Inorganics

Eighteen samples, including one field duplicate, were collected and submitted for inorganic and cyanide analyses along the intermittent stream channel.

Thirteen samples from one request number had QA problems associated with the blind QC sample that resulted in three analytes, aluminum, chromium, and vanadium, being qualified as UJ or J. The data are usable because the recoveries were between 65% and 75% (the established lower limit), which were sufficient to detect and qunatify the analytes if they are present. In addition, the detected analytes were more than a factor of two below their background UTLs so the biases did not affect the data comparisons.

Thirteen samples from one request number had a problem with holding times for mercury and cyanide analyses. The holding time for mercury (28 days) was not grossly exceeded, i.e., less than twice the holding time, and the data are qualified as either UJ or J. The data are usable as estimated values because the samples were preserved and properly stored so that degradation of material was minimized. The holding time for cyanide (14 days) was grossly exceeded, i.e., more than two times the holding time, in all of these samples and data are qualified as R (all sample results are <DL). The usability of the cyanide values is compromised because it is impossible to determine the concentrations present when the samples were collected versus the analytical results after more than 28 days. Despite the large amount of unusable data for cyanide, the remaining data are sufficient to determine whether these analytes are COPCs because usable data indicate that cyanide, when detected, is present at concentrations of 0.16 mg/kg or less, which is four orders of magnitude below its SAL. The cyanide data are presented in Section 5.8.5 of this report.

All other inorganic and cyanide data along the intermittent stream channel are considered to be usable as reported.

4.6.2 Organics

SVOCs

Eighteen samples, including one field duplicate, were collected and submitted for SVOC analyses along the intermittent stream channel. All SVOC data are considered to be usable as reported.

VOCs

VOCs were not analyzed in the intermittent stream channel.

HE

Seventeen samples, including one field duplicate, were collected and submitted for HE analyses along the intermittent stream channel.

Thirteen samples from one request number had QA problems associated with the blind QC sample that resulted in two analytes, nitrobenzene and 1,3,5-trichlorobenzene, being qualified as UJ. The data are usable because the recoveries were between 20% and 50% (the established lower limit), which were sufficient to detect and quantify the analytes if they are present.

Four samples from one request number had a problem with the holding times for HE analysis. The recommended 14 day extraction holding time and the 40 day analytical holding time were exceeded by 49 days and 109 days, respectively, which resulted in the analytes being qualified as UJ. However, because the soil samples were kept frozen before extraction, the extraction holding time can be extended up to 8 weeks (and probably longer). Following extraction, the samples are preserved and stored at 4°C to inhibit bacterial growth and prevent photodegradation of the analytes. This process appears to stop decomposition of material for at least 71 days (or longer). Therefore, these data can be used with caution despite the extreme exceedance of the holding times and are sufficient to adequately characterize the site for HE.

One sample from one request number had problems with the holding times for HE analysis as well as surrogate recoveries. The recommended 14 day extraction holding time and the 40 day analytical holding time were exceeded by 49 days and 109 days, respectively, and surrogate recovery was below the established limit (50%). As a result of the multiple QA problems the data are qualified as R and are not used in the screening assessment. Despite the unusable data, the site is adequately characterized for HE.

All other HE data from the intermittent stream channel are considered to be usable as reported.

PCBs/Pesticides

Eighteen samples, including one field duplicate, were collected and submitted for PCB/Pesticide analyses along the intermittent stream channel.

One sample from one request number had a QA problem with the quantitation value for p,p'-DDD that resulted in the datum being qualified as J. The quantitation value differed by >25% between the two columns indicating a false positive. However, the datum is usable because DDT and DDE were detected in the sample indicating that the presence of DDD is likely.

5.0 SPECIFIC RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

The objective of the sampling described in this report was to provide data of sufficient quality for determining the level of risk associated with contaminants found as outlined in Chapter 3.0 of this data summary report. Analytical results from samples collected from firing sites PRSs 39-004(a-e), single-stage gas gun site PRS 39-008, and stream channel sediments were used in this evaluation. None of the firing sites is considered for NFA because the sites are still active. Further evaluation and the determination of status will be deferred until decommissioning.

5.1 PRSs 39-004(a,d) - Firing Sites

PRSs 39-004(a,d) (Figure 5.1-1) are firing sites located along the northern tributary of the upper reach of Ancho Canyon (North Fork). The firing pads are located in the canyon bottom between a diverted ephemeral stream and the canyon wall. The two PRSs are being evaluated together because of the close proximity of one to the other and the overlap in the deposition of materials dispersed by explosive events. PRS 39-004(a) is associated with building TA-39-7 (an electronics and camera facility). This PRS is within the fall zone of a high cliff that erodes when explosive experiments are conducted at the site; the site is currently on stand-by status. Also, this site has not been recommended for decommissioning because it is within the influence of the active firing site PRS 39-004(d). PRS 39-004(d) is an active firing site associated with building TA-39-57 (also an electronics and camera facility). Beryllium, cadmium, cobalt, copper, lead, nickel, RDX, thorium-228, thorium-230, thorium-232, and uranium were retained as chemicals of potential concern (COPCs) in samples collected on the firing pads. Copper and uranium were retained as COPC along the hillslope transects. A risk assessment found that there is not an unacceptable risk to human health under a continued Laboratory use (i.e., industrial) scenario. The PRSs will be re-evaluated at the time the firing sites are decommissioned.

5.1.1 History

The PRS 39-004(a) firing site was constructed in 1953 and is currently on stand-by status. The PRS 39-004(d) firing site was established in 1958 and is currently active. Experiments at the sites include detonation of HE to support research in equation-of-state and shock wave phenomena and development of explosively produced pulses of electrical power and high magnetic fields. Typical experiments use 10 to 100 pounds of HE. Debris from the explosions is generally deposited within about 200 ft of the firing pad, but some debris has been deposited at greater distances on the adjacent hill slopes and mesa tops. Materials used in significant quantities over the years include beryllium, mercury, natural and depleted uranium, lead, aluminum, copper, brass, stainless steel, thallium, cadmium, chromium, thorium-232 (natural), dielectric oil, and various types of HE (RDX, HMX, Baratol, PETN, TATB, TNT, Composition B, and cyclotol). Use of some of the more toxic materials (e.g., lead, uranium, mercury, PCB-containing dielectric oil) was discontinued between 1978 and 1981 (personal communication, J. King, May 21, 1997). The experiments are conducted so that there is complete burn up of the HE. If a shot fails, so that not all of the HE is spent, an effort is made to pick up and destroy the unexploded HE.

Occasionally, construction and experiment debris left on the firing pad is removed along with a layer of the disturbed surface material and is replaced with a layer of fresh crushed tuff (sand). This activity effectively reduces the level of contaminants on the firing pad as protection for site workers. However, outside this cleaned area no major effort has been made to police or decontaminate the facility.

These PRSs are discussed in further detail in Section 5.3 of the RFI work plan for OU 1132 (LANL 1993, 1089).

5.1.2 Description

Beyond that discussed in Chapter 2 no additional geology, hydrology, soils, or wildlife habitat information is available. However, a geomorphic evaluation of the canyon bottom and associated runoff areas is presented in Appendix E.

5.1.3 Previous Investigations

Four soil sampling efforts were conducted between 1987 and 1993 on the firing pads at PRSs 39-004(a) or 39-004(d). The first was conducted in April 1987 and reported in a memo to Hansen from Drypolcher (HSE-87-473, April 15, 1987). The second was conducted in March 1993 and reported in a memo to Grieggs from Fresquez (ESH-8:94-0002, January 6, 1994). The third was conducted in October 1993 and reported in a memo to Tom Alexander from Becker (EES-3:94-213, June 23, 1994). During the 1993 RFI investigation at TA-39, sampling of soil associated with a waste storage area [PRS 39-002(d)] adjacent to the firing pad at PRS 004(d) represents the fourth sampling event and is reported in the RFI report (LANL 1995,LA-UR-95-1069, April 1995).

The initial sampling was conducted on the firing pad at PRS 39-004(d) specifically to determine the barium concentration in the pad sands. Five locations on the pad were cored (depth not given) and the cored material composited to give one sample for analysis of total barium. Reported results show the total barium concentration in the sand to be 24 mg/L with a corresponding background of <4 mg/L total barium (the information documented is specific that the analysis reported is "total barium" and not the "EP Toxicity" or "Extraction" procedure, therefore the actual concentration in the soil is unknown).

The second sampling effort involved the collection of 21 surface soil (0-3 inches) samples from four transects radiating (NSEW) from the firing point at PRS 39-004(a) to a distance of approximately 160 ft. Two surface sediment samples were collected in the adjacent stream channel segment down-gradient from the firing point and one debris rinsate sample was created by washing scattered surface debris (e.g., glass, plastic, metal, wood) with distilled water. Soil, sediment, and debris rinsate samples were analyzed for Toxicity Charateristic Leaching Procedure (TCLP) metals (arsenic, barium, cadmium, chromium, mercury, lead, selenium, and silver); total beryllium, mercury, and lead; SVOCs, VOCs, PCBs, HE, and total uranium. Samples were maintained under chain-of-custody documentation and analyses were supported with laboratory blanks, surrogates, and matrix spike samples, as appropriate. The maximum concentrations of analytes detected in the soil, sediment, or debris rinsate samples are summarized in Table 5.1.3-1.

No PCBs were detected in any of the samples. Di-n-butylphthalate was detected in the majority of the soil and sediment samples; however, it was also detected in the laboratory blank in concentrations comparable to those reported for the samples. Similarly, acetone and methylene chloride were found in laboratory blanks in concentration comparable to those reported for the samples. No SVOCs were detected in the debris rinsate samples. Little or no HE residues were detected beyond 80 ft from the detonation area nor in stream sediment or debris rinsate samples.

It should also be noted that the distribution of most analytes along the transects appears as a "donut," i.e., low concentrations at the detonation point (confluence of the four transects), increasing to a maximum at about 50 ft and then decreasing further along the transect. This observation is consistent with the operation of occasionally removing and replacing soil materials at the firing point.

TABLE 5.1.3-1
SUMMARY OF ANALYTICAL RESULTS FOR SOIL, SEDIMENT, AND DEBRIS RINSATE SAMPLES PRS 39-004(a)

Analysis/Analyte	Maximum Concentrations
TCLP Metals	(µg/mL)
Arsenic	0.008
Barium	14
Cadmium	0.6
Chromium	0.05
Mercury	0.001
Lead	4.4
Selenium	0.009
Silver	<1.0
Uranium	0.03
Total Metals	(µg/g)
Beryllium	7.1
Mercury	6.4
Lead	97
Uranium	1150
PCBs	(µg/g)
Total PCBs	<1.0
VOC	(µg/g)
Acetone	0.04
Methylene chloride	0.009
Bromoform	0.008
2-Bromoform	0.04
VOC Rinsate[2]	(µg/mL)
Acetone	0.025
Chlorodibromomethane	0.005
Bromoform	0.005
SVOC	(µg/g)
Di-n-butylphthalate[1]	2.8
Diethylphthalate	0.4
Bis-2-ethylhexylphthalate	0.6
2,4-Dinitrotoluene	5.7
n-Nitrosodiphenylamine	0.5
HE	(µg/g)
HMX	17.7
RDX	6.3

[1] Detected in laboratory blanks, possible laboratory contamination.
[2] Debris rinsate.

≤ BKG
< SAL

> SAL

The third sampling effort involved the collection and analysis of one surface soil sample (depth not given) from the area of the detonation point: the sample was analyzed for a suite of 14 HE compounds. The only HE detected was HMX at a concentration of 2.6 µg/g.

The fourth sampling event occurred in 1993 as part of the RFI investigation at a waste storage area (PRS 39-002(d)). The waste storage area was located adjacent to the entrance door to blockhouse 39-57 and was within approximately 20 ft of the firing point at PRS 39-004(d). Samples collected from the area identified uranium, beryllium, and dibenzofuran as COPCs.

5.1.4 Field Investigation

The objective of the investigation at PRSs 39-004(a,d) was to determine if COPCs are present in the soils around the firing pads, along the surrounding hillsides, and on the mesa tops. The conceptual model for the site deals primarily with the presence and redistribution of surface contamination that has been deposited as a result of dispersal of experimental materials by explosive destruction. Materials from the explosions are scattered across the firing sites and adjacent areas, and debris has been found as far away as 1 mile. Contaminated soil is potentially subject to transport by surface water and/or wind action,while some contaminants may be absorbed, inhaled, or ingested by exposed receptors.

Field sampling efforts at PRSs 39-004(a,d) were completed in September 1995 and consisted of establishing transects and sampling grids by land survey methods; conducting a radiation survey of the firing pad areas and the adjacent stream channel (conducted in 1993); conducting specific radiation and XRF surveys of the firing pads, stream channel segments, and transects; sampling surface soils from the firing pads, transects, and adjacent stream channel segment (discussed in Section 5.6); and determining by land survey sampling point location coordinates and elevations relative to a local benchmark.

5.1.4.1 Surveys

A radiation survey was conducted over the firing pads in 1993 based on a 20- by 20-ft survey grid. In 1995, an area of approximately 250-ft (E-W)by 350-ft (N-S), which included the two firing pads and the 1993 survey area, was extended by land survey into a 50-ft by 50-ft grid and then further gridded into a 10-ft by 10-ft grid by measuring tape and sighting between survey stakes. Just prior to sampling, an additional radiation survey was conducted on this 10-ft by 10-ft grid to update, refine, and expand the previous survey. In these surveys, the entire area within 5 ft along a grid line was surveyed to locate the highest radiation level; that location became a biased candidate for sampling. The radiation surveys were conducted with a FIDLER probe and a beta/gamma pancake probe to map the radiation levels at the soil surface.

A radiation survey similar to that conducted on the firing pads was conducted in 1993 in the adjacent stream channel segment where readings were taken about every 10 ft starting at 190 ft upstream continuing to 270 ft downstream from the firing point.

From a point central to the two firing pads, a series of three transects were land surveyed at 150-ft intervals extending to approximately 600 ft from the firing areas. Transect 1 was 12 degrees from N and terminated at approximately 530 ft on the mesa top. Transect 2 was 140 degrees from N along the base of the cliff approximately parallel to the stream channel and terminated at approximately 530 ft. Transect 3 was 240 degrees from N and was terminated at approximately 250 ft on a bench above the face of a cliff. A radiation survey similar to that conducted on the firing pads was conducted along the accessible portions of the transects. Generally, termination of the transects corresponded with the disappearance of elevated radioactivity levels.

An XRF (Energy Dispersive X-Ray Fluorescence by Spectrace 9000 X-Ray Spectormeter) survey was also conducted at the firing pads and transects. Signals for key analytes were evaluated as an aid in selecting biased sampling points. The analytes include: uranium, thorium, lead, cadmium, chromium, copper, arsenic, titanium, zinc, barium, silver, and strontium. The area encompassing the firing pad at PRS 39-004(a) was gridded into 308 points (resulting in 10-ft by 10-ft squares) from which 25 were selected using a random number generator. Twenty of these locations were

sampled from the accessible part of this area for XRF analysis. The area encompassing PRS-39-004(d) was similarly gridded into 526 points from which 25 were randomly selected. Twenty of these locations were sampled from the accessible part of this area for XRF analysis. Eight samples were collected from Transect 2 in selected locations of elevated radioactivity (one sample was collected from transect 1 and none were collected from transect 3). For the XRF measurements, a small amount of the surface material (0-1 in.) was collected, thoroughly mixed, dried under a heat lamp, and placed in the XRF sample cell for assay.

Results of the XRF and radiation measurements are summarized in two memos to the TA-39 Files from Essington (EES15-96-204, July 2, 1996; EES15-96-XXX **(in preparation)**, June XX, 1997).

MUST BE IN Appendix

5.1.4.2 Sampling

Surface soil samples (0-6 in) were collected from six locations in the vicinity of the PRS 39-004(a) firing pad (Fugure 5.1.4-1). Sampling locations based on elevated XRF readings are 39-1238 (arsenic, cadmium, and thorium) and 39-1254 (lead, uranium, cadmium, copper, and thorium); and sampling locations based on elevated radiation readings are 39-1239 and 39-1240. Two sampling locations in the talus pile at the base of the cliff on the west side of the firing pad were also sampled (39-1257 and 39-1258). These two sampling locations were to be sampled at depth, but sampling efforts were discontinued as discussed in Section 5.1.4.4, Deviations. Six locations were sampled in the vicinity of the PRS 39-004(d) firing pad (Figure 5.1.4-1). Sampling locations based on elevated XRF readings are 39-1237 (chromium and cadmium) and 39-1253 (cadmium); and sampling locations based on elevated radiation readings are 39-1255 and 39-1256. Both sampling locations 39-1255 and 39-1256 are located north of PRS 39-004(d), closer to PRS 39-004(a), but are still within the field of influence of PRS 39-004(d) as determined by the field team. Two sampling locations in the talus pile at the base of the cliff on the west side of the firing pad were also sampled (39-1241 and 39-1242). These two sampling locations were to be sampled at depth but sampling efforts were also discontinued (see Section 5.1.4.4).

Definition?

Sampling along the three transects included collection of surface (0-6 in) and subsurface (6-10 in) soil samples where sufficient material was available (Figure 5.1.4-1). In several cases, the soil layer was too thin to allow collection of the deeper sample, while in other cases, the terrain was too steep to allow safe access for sampling. Four sampling locations were sampled on Transect 1 (39-1294 through 39-1297), three on the steep hillside and one on the mesa top. Four sampling locations were sampled on Transect 2 (39-1298 through 39-1301), and only one sample location was sampled on Transect 3 (39-1302). Transect 3 is in common with Transect 5 associated with PRS 004(b) and is also intersected by Transect 7 originating from PRS 004(e).

In order to determine if the soil radioactivity detected at the firing pads, in the stream channel, or along the transects was due to contaminated shrapnel or pieces of depleted uranium, or to general soil contamination, the field team traversed the area searching for elevated radioactivity (beta/gamma). Upon finding an elevated radiation signal within 5 to 10 ft on either side of the defined measurement point the value was recorded (First Reading) and a search was made to determine if that radioactivity was due to general soil contamination or to a definitive piece of contaminated material. If a definitive piece of material was present, it was removed and the point was resurveyed to obtain a radiation reading of the soil (Second Reading). In several cases, removal of the contaminated pieces resulted in considerably reduced radioactivity from the underlying soil and, in some cases, a reduction to background was observed. The Second Reading is expected to be more representative of radioactivity in the soil. The two readings are compared to radioactivity measured on the collected mixed soil sample obtained for shipping purposes (Table 5.1.4-1).

TABLE 5.1.4-1
SUMMARY OF SAMPLES TAKEN[1]

Location ID	Sample ID	Depth (ft)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
				FIRING PADS				
39-1237	0239-95-0099	0-0.5	soil	1169	1171	1170	1172	Not Analyzed
39-1238	0239-95-0100	0-0.5	soil	1169	1171	1170	1172	Not Analyzed
39-1239	0239-95-0101	0-0.5	soil	1169	1171	1170	1172	1172
39-1240	0239-95-0103	0-0.5	soil	1169	1171	1170	1172	1172
39-1241	0239-95-0104	0-0.5	soil	1165	1167	1166	1168	1168
39-1242	0239-95-0107	0-0.5	soil	1165	1167	1166	1168	Not Analyzed
				TRANSECTS				
39-1294	0239-95-0129	0-0.5	soil	1169	1171	1170	1172	1172
39-1294	0239-95-0130	0.8	soil	1169	1171	1170	1172	1172
39-1295	0239-95-0131	0-0.5	soil	1169	1171	1170	1172	1172
39-1296	0239-95-0133	0-0.5	soil	1169	1171	1170	1172	1172
39-1296	0239-95-0134	0.8	soil	1169	1171	1170	1172	1172
39-1297	0239-95-0135	0-0.5	soil	1169	1171	1170	1172	1172
39-1298	0239-95-0137	0-0.5	soil	1085	1087	1086	1088	1088
39-1298	0239-95-0138	0.8	soil	1085	1087	1086	1088	1088
39-1299	0239-95-0139	0-0.5	soil	1085	1087	1086	1088	1088
39-1299	0239-95-0140	0.8	soil	1085	1087	1086	1088	1088
39-1300	0239-95-0141	0-0.5	soil	1085	1087	1086	1088	1088
39-1300	0239-95-0142	0.8	soil	1085	1087	1086	1088	1088
39-1301	0239-95-0143	0-0.5	soil	1085	1087	1086	1088	1088
39-1301	0239-95-0144	0.8	soil	1085	1087	1086	1088	1088
39-1302	0239-95-0145	0-0.5	soil	1186	1190	1188	1191	1191
39-1302	0239-95-0146	0-0.5	soil	1186	1190	1188	1191	1191
39-1302	0239-95-0147	0.8	soil	1186	1190	1188	1191	1191

[1] Numbers in the analyte columns are request numbers.

TABLE 5.1.4-1
DISCRIMINATION BETWEEN RADIOACTIVE SHRAPNEL AND RADIOACTIVE SOIL AT PRSs 39-004(a,d)

Location ID	Location Type	First Reading (c/m)	Second Reading (c/m)	Sample (c/m)	Comment
39-1253	Pad-XRF	300		350	
39-1254	Pad-XRF	850		400	
39-1255	Pad-Rad	11000	+	500	DU present, not removed
39-1256	Pad-Rad	10000	+	1200	DU present, not removed
39-1257	TP-0			600	
39-1258	TP-0			325	
39-1237	Pad-XRF			300	
39-1238	Pad-XRF			400	
39-1239	Pad-Rad			2000	
39-1240	Pad-Rad			1000	
39-1241	TP-0			375	
39-1242	TP-0			350	
39-1263	SC-0	400		275	
39-1263	SC-6			200	
39-1264	SC-0	350		300	
39-1264	SC-6			250	
39-1265	SC-0	27000	275	300	
39-1265	SC-6			300	
39-1266	SC-0	400		300	
39-1266	SC-6			350	
39-1267	SC-0	20000		275	
39-1267	SC-6			300	
39-1268	SC-0	105000	3000	400	
39-1268	SC-6			700	
39-1269	SC-0	130000	300	250	
39-1269	SC-6			300	
39-1270	SC-0	600	+	300	DU present, not removed
39-1270	SC-6			350	
39-1271	SC-0	40000	+	1500	DU present, not removed
39-1271	SC-6			350	
39-1294	T1-12-0	4500		400	
39-1294	T1-12-6			1500	
39-1295	T1-12-0	30000		3000	
39-1295	T1-12-6				NS
39-1296	T1-12-0			350	
39-1296	T1-12-6			350	
39-1297	T1-12-0	22000	12000	8000	Buried DU, 280000 c/m
39-1297	T1-12-6				NS
39-1298	T2-133-0	75000	500	400	
39-1298	T2-133-6			350	

TABLE 5.1.4-1
DISCRIMINATION BETWEEN RADIOACTIVE SHRAPNEL AND RADIOACTIVE SOIL AT PRSs 39-004(a,d)
Continued

Location ID	Location Type	First Reading (c/m)	Second Reading (c/m)	Sample (c/m)	Comment
39-1299	T2-133-0			500	
39-1299	T2-133-6			500	
39-1300	T2-133-0			350	
39-1300	T2-133-6			300	
39-1301	T2-133-0			300	
39-1301	T2-133-6			300	
39-1302	T3-253-0	11000	5000	400	
39-1302	T3-253-6			400	

Pad-Rad	Sample based on elevated Radioactivity
Pad-XRF	Sample based on elevated metal by XRF
Pad-0	Level area between gun and cliff, 0-6 in sample
XRF	Energy Dispersive X-Ray Fluorescence
DM	DM-0 = Debris Mound, 0-6 in
TP	TP-0 = Talus Pile at base of cliff, 0-6 in
SC	SC-0 = Stream Channel, 0-6 in
NS	No Sample collected
+	Very small pieces of depleted uranium present
T	T1-12-0 = Transect #1, 12 deg N, 0-6 in
(c/m)	Beta/gamma readings with 44-9 pancake detector
First Reading	Elevated radioactivity, undisturbed
Second Reading	Radioactivity after removal of offending material
Sample	Radioactivity of collected mixed soil sample

All soil samples from the firing pads were analyzed for SVOCs, metals, cyanide, HE, isotopic thorium, and total uranium. Only those samples from the elevated radiation points were analyzed by gamma spectrometry. All transect samples were analyzed for SVOCs, metals, cyanide, HE, isotopic thorium, total uranium, and by gamma spectrometry. Table 5.1.4-2 presents a summary of the samples collected and analyses requested for these PRSs, while sample locations are presented in Figure 5.1.4-1.

5.1.4.3 Field Screening

Each sampling point was further screened for HE using the "Modified Griess Reagent Spot Test for Explosives" field kit, and selected sampling points were screened for PCBs using the "D-Tech" field kit. No PCBs or HE were detected by the field screening.

5.1.4.4 Deviations from the RFI Work Plan Sampling Strategies

Debris Mounds (Section 5.3.4.1.3.1 of the RFI work plan): According to the work plan, samples from within the debris mounds (talus pile) accumulating at the base of the cliffs adjacent to firing points (a) and (d) were to be collected so that the distribution of possible contaminants within the mounds could be evaluated. The sampling effort successfully obtained surface samples (0-6 in.) from all of the specified locations, but was unsuccessful in obtaining samples at depth using a hand auger. Use of a drill rig and coring tool or back hoe were deemed inappropriate because of poor accessibility and looseness of the material. The need for such samples was re-evaluated and

TABLE 5.1.4-2
SUMMARY OF SAMPLES TAKEN[1]

Location ID	Sample ID	Depth (in)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
				FIRING PADS				
39-1237	0239-95-0099	0-6	soil	1169	1171	1170	1172	Not Analyzed
39-1238	0239-95-0100	0-6	soil	1169	1171	1170	1172	Not Analyzed
39-1239	0239-95-0101	0-6	soil	1169	1171	1170	1172	1172
39-1240	0239-95-0103	0-6	soil	1169	1171	1170	1172	1172
39-1241	0239-95-0104	0-6	soil	1165	1167	1166	1168	1168
39-1242	0239-95-0107	0-6	soil	1165	1167	1166	1168	Not Analyzed
				TRANSECTS				
39-1294	0239-95-0129	0-6	soil	1169	1171	1170	1172	1172
39-1294	0239-95-0130	10	soil	1169	1171	1170	1172	1172
39-1295	0239-95-0131	0-6	soil	1169	1171	1170	1172	1172
39-1296	0239-95-0133	0-6	soil	1169	1171	1170	1172	1172
39-1296	0239-95-0134	10	soil	1169	1171	1170	1172	1172
39-1297	0239-95-0135	0-6	soil	1169	1171	1170	1172	1172
39-1298	0239-95-0137	0-6	soil	1085	1087	1086	1088	1088
39-1298	0239-95-0138	10	soil	1085	1087	1086	1088	1088
39-1299	0239-95-0139	0-6	soil	1085	1087	1086	1088	1088
39-1299	0239-95-0140	10	soil	1085	1087	1086	1088	1088
39-1300	0239-95-0141	0-6	soil	1085	1087	1086	1088	1088
39-1300	0239-95-0142	10	soil	1085	1087	1086	1088	1088
39-1301	0239-95-0143	0-6	soil	1085	1087	1086	1088	1088
39-1301	0239-95-0144	10	soil	1085	1087	1086	1088	1088
39-1302	0239-95-0145	0-6	soil	1186	1190	1188	1191	1191
39-1302	0239-95-0146	0-6	soil	1186	1190	1188	1191	1191
39-1302	0239-95-0147	10	soil	1186	1190	1188	1191	1191

[1] Numbers in the analyte columns are request numbers.

discussed in Memo to Project Files, TA-39, FU2 from Essington, EES15-95-353, dated October 10, 1995. The field team recommended deleting such sampling from the work effort because,

- the amount of material included in the talus is small,
- the nature of contaminants in the talus would not differ from that on and around the firing pads,
- access by a drill rig or back hoe was not feasible, and
- the additional information obtained by such sampling would not identify a new exposure pathway nor change the severity of the estimated risk associated with the site.

The decision was reviewed and agreed to by the human health and environmental risk assessors assigned to the TA-39 project (Memo: "Risk-Based Sampling Decisions," From V. Smith, October 4, 1995).

Metals surveys (Section 5.3.4.1.3.1, RFI Work Plan): The work plan implies that XRF surveys will be conducted along the transects. Some XRF measurements were made along several of the transects but were discontinued due to lack of elevated metals signals and the fact that such information would not be used to bias sampling locations. The field team decided that elevated radiation would provide sufficient evidence as to the presence of contaminants for the purpose of locating sampling points.

Adjacent Hillslopes and Adjacent Mesa Tops (Section 5.3.4.1.3.1, RFI Work Plan): The work plan indicated sampling every 150 ft along the transect on the hill slopes and on the mesa tops with collection of additional samples at two of the highest radiation areas along the transect. In general, this was done only at the sampling locations that were at the highest radiation areas close to the 150-ft markers. Along many of the transects, hill slope sampling was not completed because of steepness and inaccessibility or because of rock outcrops. In general, transect samples were collected from sediment accumulations on the hill slopes. The transects were to be terminated when radiation readings were no longer positive for a distance of 50 ft. This was accomplished but such readings were not documented.

Section 5.3.4, Phase I Investigations, RFI Work Plan, specifies analyzing samples for total petroleum hydrocarbons. This analysis was not conducted on soils at PRSs 39-004(a,d) because site personnel indicated little or no use of petroleum-based oils at these firing sites and because the total petroleum hydrocarbon procedure would not quantify the compounds of concern. The alternative was to rely on SVOC analysis of surface samples to identify and quantify significant hazardous compounds attributable to the petroleum-based oil. This is supported by the information contained in "Policy for the Evaluation and Cleanup of Total Petroleum Hydrocarbons (TPHs) in Soil" (EM/ER:96-PCT-008, March 29, 1996).

Selection of biased sampling points at the highest radiation area may not always have been accomplished. One reason for this deviation was that some high radiation points are due to the presence of contaminated shrapnel. When the shrapnel was removed the soil radiation readings often drop considerably, even to a local background level. Another reason was that some high radiation points occur in areas of little available soil for sampling, for example, on the edge of asphalt paving or in rock outcrops. In those cases, alternative locations were chosen that still represent areas of elevated radioactivity.

5.1.5 Evaluation of Inorganic Chemicals

Firing Pads

Twelve surface soil samples were collected from the area around the firing pacs at PRSs 39-004(a,d) and analyzed for inorganics. Barium, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, uranium, and zinc were detected at concentrations greater than their respective background UTLs (Table 5.1.5-1). Barium, beryllium, cadmium, cobalt, and nickel were detected above their UTLs in one to two samples, while copper, lead, mercury, and zinc were detected above their UTLs in three to seven samples, and uranium was present above its UTL in all twelve samples. Statistical comparisons of site data to background distributions indicated that the site data sets for barium, beryllium, cadmium, cobalt, copper, lead, nickel, and zinc were consistent with background concentrations. Similar comparisons for mercury could not be conducted because of the high number of nondetects in the mercury background data set. The p-values for the statistical tests used in the comparisons are presented in Table 5.1.5-2. Because of the limited sample size and high detected concentrations of the inorganics in one or two samples, all of the inorganics were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.1.5-1.

TABLE 5.1.5-2
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF FIRING PAD DATA TO BACKGROUND FOR PRSs 39-004(a,d)

Analytes	Gehan Test	Quantile Test	Slippage Test
Barium	1.0	0.9	0.0
Beryllium	1.0	0.9	0.06
Cadmium	1.0	0.2	0.0
Cobalt	1.0	0.9	0.06
Copper	0.3	0.06	0.0
Lead	0.6	0.07	0.0
Nickel	1.0	0.9	0.06
Uranium	0.0	0.0	0.0
Zinc	0.7	0.07	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

Transects

Seventeen soil samples [ten surface (0-6 in.) and seven subsurface (10 in.)] were collected along the transects from the firing pads at PRSs 39-004(a,d) and analyzed for inorganics. Beryllium, copper, lead, mercury, uranium, and zinc were detected at concentrations greater than their respective background UTLs in surface and subsurface soil samples and silver, which has no background UTL, was detected in one surface soil sample along the transects from the firing pads (Table 5.1.5-1). Beryllium and zinc were each detected above background in only one soil sample, while copper and lead were each detected in two soil samples above background UTLs. Mercury was detected in nine soil samples and uranium was detected in fifteen soil samples above their background UTLs. Statistical comparisons of the site data to background distributions for beryllium, lead, and zinc indicates that the sample values were not statistically different from background, while copper and uranium were statistically different from background. Similar comparisons for mercury and silver could not be conducted because of the high number of

... CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRSs 39-004(a,d)

Sample ID	Location ID	Depth (in.)	Barium (mg/kg)	Beryllium (mg/kg)	Cadmium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Lead (mg/kg)
SAL	N/A[b]	N/A[b]	5300	No SAL	38	4600	2800	400
soil UTL[a]	N/A[b]	N/A[b]	315	1.95	2.7	19.2	15.5	23.3
FIRING PADS								
0239-95-0099	39-1237	0-6	31	0.6(U)	0.6(UJ)	1.1	3.3	6.4
0239-95-0100	39-1238	0-6	4.4	0.5(U)	0.5(UJ)	1.1(U)	1.1(U)	4.5
0239-95-0101	39-1239	0-6	68	0.5(U)	0.5(UJ)	2.0	54	54
0239-95-0103	39-1240	0-6	59	0.6	0.5(UJ)	1.1(U)	38	35
0239-95-0104	39-1241	0-6	20	0.9	0.6(U)	1.1(U)	5.7	3.4
0239-95-0107	39-1242	0-6	12	0.7	0.6(U)	1.2(U)	2.4	4.7
0239-95-0089	39-1253	0-6	67	0.6(U)	1.4	1.1	7.7	10
0239-95-0090	39-1254	0-6	150	1.1	7.6	440	3500	320
0239-95-0091	39-1255	0-6	63	0.6	0.8	1.1	13	120
0239-95-0092	39-1256	0-6	540	9.1	1.5	2.1	910	82
0239-95-0093	39-1257	0-6	7	0.7(U)	0.7(UJ)	1.3(U)	2.6	6.5
0239-95-0096	39-1258	0-6	16	0.6(U)	0.6(UJ)	1.1(U)	2.2	5.3
TRANSECTS								
0239-95-0129	39-1294	0-6	24	0.5(U)	0.5(UJ)	1.1(U)	2.1	5.7
0239-95-0130		10	31	0.5(U)	0.5(UJ)	1.0	4.1	6.0
0239-95-0131	39-1295	0-6	51	0.8	0.5(UJ)	2.1	5.3	10
0239-95-0133	39-1296	0-6	74	0.6	0.5(UJ)	2.1	11	7.6
0239-95-0134		10	52	0.6	0.5(UJ)	2.1	11	7.6
0239-95-0135	39-1297	0-6	43	0.9	0.5(UJ)	1.0	6.3	9.0
0239-95-0137	39-1298	0-6	28.9	0.5(U)	0.5(U)	1.4	77600(J-)	9.1(J+)
0239-95-0138		10	27.7	0.6	0.3(U)	1.4	14(J-)	6.8(J+)
0239-95-0139	39-1299	0-6	24.6	0.4(U)	0.3(U)	0.8(U)	11.9(J-)	6.2(J+)
0239-95-0140		10	23.7	0.4(U)	0.3(U)	1.0(U)	12(J-)	5.2(J+)
0239-95-0141	39-1300	0-6	27.9	0.6	0.3(U)	1.8(U)	9.3(J-)	7.3(J+)
0239-95-0142		10	30.5	0.5	0.3(U)	1.6(U)	2.6(UJ)	5.8(J+)
0239-95-0143	39-1301	0-6	47.8	0.4(U)	0.3(U)	1.7(U)	7.3(J-)	10.9(J+)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable

INORGANIC CHEMICALS WITH CONCENTRATIONS A OR ABOVE BACKGROUND SCREENING VALUES
FOR PRSs 39-004(a,d)
Continued

Sample ID	Location ID	Depth (in.)	Barium (mg/kg)	Beryllium (mg/kg)	Cadmium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Lead (mg/kg)
SAL	N/A[b]	N/A[b]	5300	No SAL	38	4600	2800	400
soil UTL[a]	N/A[b]	N/A[b]	315	1.95	2.7	19.2	15.5	23.3
TRANSECTS (CONT.)								
0239-95-0145	39-1302	0-6	51	0.7	0.7(U)	1.1	16.2(J-)	36.7
0239-95-0146		0-6	46.7	1.1	0.7(U)	1.0	15	27.5
0239-95-0147		10	36.6	3.6	0.7(U)	1.3	8.7	8.7

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are greater than SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable

TABLE 3.1.3-1

INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRSs 39-004(a,d)

Continued

Sample ID	Location ID	Depth (in.)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Uranium (mg/kg)	Zinc (mg/kg)
SAL	N/A[b]	N/A[b]	23	1500	380	230	23000
soil UTL[a]	N/A[b]	N/A[b]	0.1[c]	15.2	Not Available[d]	5.45	50.8
FIRING PADS							
0239-95-0099	39-1237	0-6	0.1(U)	2.2	2.2(U)	7.2	18(J+)
0239-95-0100	39-1238	0-6	0.1(U)	2.2(U)	2.2 (U)	6.6	9.8(J+)
0239-95-0101	39-1239	0-6	0.4	3.1	2.0(U)	551	40(J+)
0239-95-0103	39-1240	0-6	0.4	2.1	2.1(U)	166	37(J+)
0239-95-0104	39-1241	0-6	0.1(U)	2.3(U)	2.3(U)	9.8	23(J-)
0239-95-0107	39-1242	0-6	0.1(U)	5.9	2.4(U)	6.3	52(J-)
0239-95-0089	39-1253	0-6	0.4	2.2(U)	2.2(U)	76.8	26
0239-95-0090	39-1254	0-6	0.4	270	2.2(U)	264	63
0239-95-0091	39-1255	0-6	0.4	2.2(U)	2.2(U)	96.9	29
0239-95-0092	39-1256	0-6	6.8	7.4	2.1(U)	1300	690
0239-95-0093	39-1257	0-6	0.1(U)	2.6(U)	2.6(U)	9.4	9.7(J+)
0239-95-0096	39-1258	0-6	0.2	2.2(U)	2.2(U)	73.3	13(J+)
TRANSECTS							
0239-95-0129	39-1294	0-6	0.1(U)	2.1(U)	2.1(U)	8.9	16(J+)
0239-95-0130		10	0.1	3.1	2.1(U)	17	23(J+)
0239-95-0131	39-1295	0-6	0.1	4.2	2.1(U)	15.9	32(J+)
0239-95-0133	39-1296	0-6	0.1	3.1	2.1(U)	24.9	34(J+)
0239-95-0134		10	0.1(U)	3.1	2.1(U)	6.8	35(J+)
0239-95-0135	39-1297	0-6	0.1(U)	3.1	3.1	2796	21(J+)
0239-95-0137	39-1298	0-6	0.3	0.7(U)	1.2(U)	20	13.2
0239-95-0138		10	0.1	3.7(U)	0.3(U)	16.5	39.2
0239-95-0139	39-1299	0-6	0.1	0.7(U)	0.3(U)	39.3	22.4
0239-95-0140		10	0.07	0.7(U)	0.3(U)	137	21.4

Notes: Qualifiers used in table are defined in Section 3.1.2.

Values in cells with bold borders are greater than background; values in shaded cells are >SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable

[c] Maximum detected background value.

[d] Background data not available; sample-specific detection limits (DL) used as screening criteria.

TABLE .5-1
INORGANIC CHEMICALS WITH CONCENTRATIONS A, OR ABOVE BACKGROUND SCREENING VALUES
FOR PRSs 39-004(a,d)
Continued

Sample ID	Location ID	Depth (In.)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Uranium (mg/kg)	Zinc (mg/kg)
SAL	N/A[b]	N/A[b]	23	1500	380	230	23000
soil UTL[a]	N/A[b]	N/A[b]	0.1[c]	15.2	Not Available[d]	5.45	50.8
TRANSECTS (CONT.)							
0239-95-0141	39-1300	0-6	(U)	0.7(U)	0.3(U)	8.1	37.7
0239-95-0142		10	(U)	0.7(U)	0.3(U)	3.9	40.7
0239-95-0143	39-1301	0-6	0.1	1.3(U)	0.3(U)	9.9	34.2
0239-95-0145	39-1302	0-6	0.3	2.1	1.2(U)	61.9	48
0239-95-0146		0-6	0.8	1.7	1.2(U)	100	51.5
0239-95-0147		10	0.06	2.6	1.2(U)	10.3	42.5

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable

[c] Maximum detected background value.

[d] Background data not available; sample-specific detection limits (DL) used as screening criteria.

nondetects in the mercury background data set and the lack of background data for silver. The p-values for the statistical tests used in the comparisons are presented in Table 5.1.5-3. As a result of the background comparison, beryllium, lead, and zinc were eliminated from further evaluation, while copper, mercury, silver, and uranium were carried forward to the SAL comparison stage. All inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.1.5-2. 5.1-5-2

Missing

TABLE 5.1.5-3
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF TRANSECT DATA TO BACKGROUND FOR PRSs 39-004(a,d)

Analytes	Gehan Test	Quantile Test	Slippage Test
Beryllium	1.0	1.0	1.0
Copper	0.01	0.002	0.08
Lead	1.0	0.9	0.0
Uranium	0.0	0.0	0.0
Zinc	0.3	0.1	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

5.1.6 Evaluation of Radionuclides

Firing Pads

Twelve surface soil samples were collected from the area around the firing pads at PRSs 39-004(a,d) and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Thorium-228, thorium-230, thorium-232, uranium-235, and uranium were detected at concentrations greater than their respective background UTLs in the surface soil samples (Table 5.1.6-1). The background UTL for thorium-228 is the same as for thorium-232 because these radionuclides are in secular equilibrium in the environment. Similarly, the background UTL for thorium-230 is the same as the UTL for uranium-234. The background UTLs for the thorium isotopes were calculated by converting the total thorium results to its isotopic components. As a result, statistical comparisons of the site data to the background data are not appropriate because of the difference in analytical methods used to derive the two data sets. The background comparison indicates that the site data for thorium-228, thorium-230, and thorium-232 were greater than the background UTLs for several samples (Table 5.1.6-1). Therefore, thorium-228, thorium-230, thorium-232, uranium-235, and uranium were carried forward to the SAL comparison stage. Because the uranium-235 data were obtained from the gamma spectroscopy analysis, uranium-238, which does not emit gamma rays, and uranium-234, which emits very weak gamma rays, were not reported at this site. All other radionuclides were either undetected or detected at levels normally found in the environment and were eliminated from further evaluation.

In addition, thorium-234 was detected in six of the twelve soil samples but does not have a background UTL or SAL (Table 5.1.6-1). The detection of thorium-234 generally corresponded to high concentrations of uranium because thorium-234 is the first daughter product in the radioactive decay series for uranium-238. As a result, it is included in the SAL calculation for uranium and is not considered as a separate contaminant from the detected uranium.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.1.5-1.

HAL NUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRSs 39-004(a

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Thorium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium (mg/kg)
SAL	N/A[b]	N/A[b]	1.7	0.18	0.77	No SAL	10	130
soil UTL[a]	N/A[b]	N/A[b]	2.47[c]	1.94[c]	2.47[d]	Not Available[e]	0.084[d]	5.45
FIRING PADS								
0239-95-0099	39-1237	0-6	0.9(J)	0.7	0.9(J)	Not Analyzed	Not Analyzed	7.2
0239-95-0100	39-1238	0-6	2.3(J)	2.3	2.3(J)	Not Analyzed	Not Analyzed	6.6
0239-95-0101	39-1239	0-6	2.0(J)	1.4	1.8(J)	111	2.8	551
0239-95-0103	39-1240	0-6	1.7(J)	1.3	1.8(J)	117	2.2	166
0239-95-0104	39-1241	0-6	1.9(J)	2.0	2.0(J)	5.0	-0.1(U)	9.8
0239-95-0107	39-1242	0-6	2.1(J)	2.1	2.1(J)	Not Analyzed	Not Analyzed	6.3
0239-95-0089	39-1253	0-6	1.3(J)	1.1	1.2(J)	Not Analyzed	Not Analyzed	76.8(J)
0239-95-0090	39-1254	0-6	2.5(J)	1.9	2.6(J)	Not Analyzed	Not Analyzed	264(J)
0239-95-0091	39-1255	0-6	1.8(J)	1.6	1.9(J)	21.2	0.8	96.9(J)
0239-95-0092	39-1256	0-6	3.5(J)	1.8	3.5(J)	337	4.5	1300(J)
0239-95-0093	39-1257	0-6	3.2	3.2	3.0	24.8	-0.1(U)	9.4
0239-95-0096	39-1258	0-6	2.4	2.5	2.2	Not Analyzed	Not Analyzed	73.3
TRANSECTS								
0239-95-0129	39-1294	0-6	0.3(J)	0.9	1.2(J)	15.1	-0.07(U)	8.9
0239-95-0130		10	1.2(J)	0.8	1.2(J)	54.2	-0.6(U)	17
0239-95-0131	39-1295	0-6	1.8(J)	1.5	1.2(J)	76.2	-0.8(U)	15.9
0239-95-0133	39-1296	0-6	1.5(J)	1.1	1.2(J)	16.6	-0.05(U)	24.9
0239-95-0134		10	1.5(J)	1.2	1.5(J)	3.8	-0.04(U)	6.8
0239-95-0135	39-1297	0-6	1.3(J)	0.9	1.0(J)	685	18.3	2796
0239-95-0137	39-1298	0-6	2.4(J)	2.2	2.3(J)	Not Reported	Not Reported	20
0239-95-0138		10	2.5(J)	2.2	2.4(J)	Not Reported	Not Reported	16.5
0239-95-0139	39-1299	0-6	2.0(J)	1.8	1.8(J)	Not Reported	Not Reported	39.3
0239-95-0140		10	1.9(J)	1.8	1.7(J)	Not Reported	Not Reported	137

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL or for the thorium isotopes > background and SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable.

[c] Radionuclides are in secular equilibrium with thorium-232 and uranium-234, respectively; therefore, the background screening values are the same.

[d] Background screening values are converted from elemental concentrations reported in the LANL background report.

[e] Background data not available; sample-specific minimum detectable activities are used as screening criteria.

RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRSs 39-004(a,d) Continued

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Thorium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium (mg/kg)
SAL	N/A[b]	N/A[b]	1.7	0.18	0.77	No SAL	10	130
soil UTL[a]	N/A[b]	N/A[b]	2.47[c]	1.94[c]	2.47[d]	Not Available[e]	0.084[d]	5.45
TRANSECTS (CONT.)								
0239-95-0141	39-1300	0-6	1.9(J)	1.5	1.8(J)	Not Reported	Not Reported	8.1
0239-95-0143	39-1301	0-6	1.5(J)	1.3	1.6(J)	Not Reported	Not Reported	9.9
0239-95-0145	39-1302	0-6	2.6(J)	2.6	2.5(J)	21.5	0.6	61.9(J+)
0239-95-0146		0-6	2.6(J)	2.4	2.5(J)	55.2	1.1	100(J+)
0239-95-0147		10	2.5(J)	2.5	2.5(J)	6.2(U)	0.2(U)	10.3(J+)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL or for the thorium isotopes > background and SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable.

[c] Radionuclides are in secular equilibrium with thorium-232 and uranium-234, respectively; therefore, the background screening values are the same.

[d] Background screening values are converted from elemental concentrations reported in the LANL background report.

[e] Background data not available; sample-specific minimum detectable activities are used as screening criteria.

Transects

Seventeen soil samples [ten surface (0-6 in.) and seven subsurface (10 in.)] were collected along the transects from the firing pads at PRSs 39-004(a,d) and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Thorium-228, thorium-230, thorium-232, uranium-235, and uranium were detected at concentrations greater than their respective background UTLs in the surface and subsurface soil samples (Table 5.1.6-1). The background UTL for thorium-228 is the same as for thorium-232 because these radionuclides are in secular equilibrium in the environment. Similarly, the background UTL for thorium-230 is the same as the UTL for uranium-234. The background UTLs for the thorium isotopes were calculated by converting the total thorium results to its isotopic components. As a result, statistical comparisons of the site data to the background data are not appropriate because of the difference in analytical methods used to derive the two data sets. The background comparison indicates that the site data for thorium-228, thorium-230, and thorium-232 were greater than the background UTLs for several samples (Table 5.1.6-1). Therefore, thorium-228, thorium-230, thorium-232, uranium-235, and uranium were carried forward to the SAL comparison stage. Because the uranium-235 data were obtained from the gamma spectroscopy analysis, uranium-238, which does not emit gamma rays, and uranium-234, which emits very weak gamma rays, were not reported at this site. All other radionuclides were either undetected or detected at activity levels normally measured in the environment and were eliminated from further evaluation.

In addition, thorium-234 was detected in eight of the fifteen soil samples but does not have a background UTL or SAL (Table 5.1.6-1). The detection of thorium-234 generally corresponded to high concentrations of uranium because thorium-234 is the first daughter product in the radioactive decay series for uranium-238. As a result, it is included in the SAL calculation for uranium and is not considered as a separate contaminant from the detected uranium.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.1.5-2.

5.1.7 Evaluation of Organic Chemicals

Firing Pads

Twelve surface soil samples were collected from the area around the firing pads at PRSs 39-004(a,d) and analyzed for SVOCs and HE. HMX and RDX were detected in one surface soil sample around the firing pads (Table 5.1.7-1) and were carried forward to the SAL comparison stage. No other organics were detected in the samples collected around the firing pads. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.1.5-1.

Transects

Seventeen soil samples [ten surface (0-6 in.) and seven subsurface (10 in.)] were collected along the transects from the firing pads at PRSs 39-004(a,d) and analyzed for SVOCs and HE. HMX was detected in one surface soil sample (Table 5.1.7-1) and was carried forward to the SAL comparison stage. No other organics were detected in the samples collected along the transects from the firing pads. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.1.5-2.

TABLE 5.1.7-1
DETECTED ORGANIC CHEMICALS FOR PRSs 39-004(a,d)

Sample ID	Location ID	Depth (in)	HMX (mg/kg)	RDX (mg/kg)
SAL	N/A[a]	N/A[a]	3300	4.0
EQL	N/A[a]	N/A[a]	0.16	0.17
FIRING PADS				
0239-95-0099	39-1237	0-6	25.1	9.2
TRANSECTS				
0239-95-0133	39-1296	0-6	2.3	0.2(U)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are detected concentrations; values in shaded cells are >SAL.
[a] N/A = not applicable

5.1.8 Risk-Based Screening Assessment

Firing Pads

Beryllium and copper were each detected in one surface soil sample at a concentration that exceeded its SAL, while uranium was detected in three surface soil samples at concentrations that exceeded its systemic SAL (Table 5.1.8-1). These inorganics were retained as COPCs. The other inorganics that were detected above their background UTLs, but below their SALs, were submitted to an MCE (Table 5.1.8-3).

Because isotopic uranium analysis was not conducted on samples collected from the firing sites, it was not possible to determine whether the uranium detected was depleted or natural uranium. It is assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and the sample values were therefore compared to the SAL for depleted uranium (130 mg/kg) for the screening assesment. The results of this comparison found uranium to be present at concentrations greater than the DU SAL in four surface soil samples (Table 5.1.8-2). In addition, uranium-235 was detected at concentrations above the background UTL in four surface soil samples, but below its SAL (Table 5.1.6-1). It was not submitted to an MCE because it is included in the total uranium sample values because it is a constituent of uranium. Therefore, only depleted uranium was retained as a COPC.

In addition, thorium-228, thorium-230, and thorium-232 were detected above their background UTLs. Because the background UTLs were greater than the SALs for these radionuclides, the thorium isotopes were retained as COPCs (Table 5.1.8-2).

TABLE 5.1.8-1
PRSs 39-004(a,d) INORGANICS WITH CONCENTRATIONS IN SOIL FROM THE FIRING PADS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Beryllium (mg/kg)	Copper (mg/kg)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	1.95[b]	2800	230
0239-95-0101	39-1239	0-6	0.7(U)	54	551
0239-95-0103	39-1240	0-6	0.63	38	166
0239-95-0090	39-1254	0-6	1.1	3500	264(J)
0239-95-0092	39-1256	0-6	9.1	910	1300(J)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SAL.
[a] N/A = not applicable
[b] The SAL for beryllium is less than the Laboratory background UTL, which is used in the data comparison.

TABLE 5.1.8-2
PRSs 39-004(a,d) RADIONUCLIDES WITH CONCENTRATIONS IN SOIL FROM THE FIRING PADS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	1.7	0.18	0.77	130
0239-95-0100	39-1238	0-6	2.3(J)	2.3	2.3(J)	6.6
0239-96-0101	39-1239	0-6	2.0(J)	1.4	1.8(J)	551
0239-96-0103	39-1240	0-6	1.7(J)	1.3	1.8(J)	166
0239-95-0104	39-1241	0-6	1.9(J)	2.0	2.0(J)	9.8
0239-95-0107	39-1242	0-6	2.1(J)	2.1	2.1(J)	6.3
0239-95-0090	39-1254	0-6	2.5(J)	1.9	2.6(J)	264(J)
0239-95-0092	39-1256	0-6	3.5(J)	1.8	3.5(J)	1300(J)
0239-95-0093	39-1257	0-6	3.2	3.2	3.0	9.4
0239-95-0096	39-1258	0-6	2.4	2.5	2.2	73.3

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SAL.

[a] N/A = not applicable

Two high explosive organics, HMX and RDX, were detected in one surface soil sample. HMX was detected below its SAL of 3300 mg/kg and was submitted to the MCE for noncarcinogens. RDX was detected above its SAL of 4.0 mg/kg and was retained as a COPC (Table 5.1.7-1). No other organics were detected around the firing pads at PRSs 39-004(a,d).

Multiple Chemical Evaluation

The MCE included eight analytes in the noncarcinogenic effects category (Table 5.1.8-3). The sum of the maximum normalized concentrations was 1.7, which is above the target value of 1.0. Because the samples were located approximately 50 feet or more from each other, it is unlikely that an individual would be exposed to more than one sample at a time, the maximum normalized sum was calculated for each sample. Sample # 0239-95-0090 had the maximum sum of 1.3, which is above the target value of 1.0 (Table 5.1.8-3). The analytes in this sample that contributes 0.1 or more to the normalized sum were cadmium, lead, and nickel, which were retained as COPCs. The other analytes, cobalt, HMX, mercury, and zinc were not retained as COPCs.

TABLE 5.1.8-3
MULTIPLE CHEMICAL EVALUATION FOR SOIL SAMPLES FROM THE FIRING PADS AT PRSs 39-004(a,d)

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values	
Noncarcinogenic Effects (mg/kg)						
					All Samples	#0239-95-0090
Barium	39-1256	0239-95-0092	540	5300	0.10	0.03
Cadmium	39-1254	0239-95-0090	7.6	38	0.20	0.20
Cobalt	39-1254	0239-95-0090	440	4600	0.10	0.10
HMX	39-1237	0239-95-0099	25.1	3300	0.01	0.0
Lead	39-1254	0239-95-0090	320	400	0.80	0.80
Mercury	39-1256	0239-95-0092	6.8	23	0.30	0.02
Nickel	39-1254	0239-95-0090	270	1500	0.18	0.18
Zinc	39-1256	0239-95-0092	690	23000	0.03	0.0
				Total[b]:	1.7	1.3

[a] SAL = screening action level. [b] Total may not equal sum of normalized values due to rounding.

Transects

Copper was detected in one surface soil sample at a concentration that exceeded its SAL, while uranium was detected in another surface soil sample at a concentration greater than its systemic SAL (Table 5.1.8-4). These inorganics were retained as COPCs. The other inorganics that were detected above their background UTLs, but below their SALs were submitted to an MCE (Table 5.1.8-6).

Because isotopic uranium analysis was not conducted on samples collected along the transects from the firing pads, it was not possible to determine whether the uranium detected was depleted or natural uranium. It was assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and the sample values were therefore compared to the SAL for depleted uranium (130 mg/kg) for the screening assessment. The results of this comparison found uranium to be present at concentrations greater than the DU SAL in two surface soil samples (Table 5.1.8-5). In addition, uranium-235 was detected in one surface soil sample at a concentration greater than its SAL (Table 5.1.6-1). Because uranium-235 is included in the total uranium value, which is also greater than its SAL, uranium-235 is not a separate contaminant. Therefore, only depleted uranium was retained as a COPC.

In addition, thorium-228, thorium-230, and thorium-232 were detected above their background UTLs. Because the background UTLs were greater than the SALs for these radionuclides, the thorium isotopes were retained as COPCs (Table 5.1.8-5).

TABLE 5.1.8-4
PRSs 39-004(a,d) INORGANICS WITH CONCENTRATIONS IN SOIL ALONG THE TRANSECTS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Copper (mg/kg)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	2800	230
0239-95-0135	39-1297	0-6	11	2796
0239-95-0137	39-1298	0-6	77600(J-)	20

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SAL.
[a] N/A = not applicable

TABLE 5.1.8-5
PRSs 39-004(a,d) RADIONUCLIDES WITH CONCENTRATIONS IN SOIL ALONG THE TRANSECTS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	1.7	0.18	0.77	130
0239-96-0135	39-1297	0-6	1.3(J)	0.9	1.0(J)	2796
0239-95-0137	39-1298	0-6	2.4(J)	2.2	2.3(J)	20
0239-95-0138		10	2.5(J)	2.2	2.4(J)	16.5
0239-96-0140	39-1299	10	1.9(J)	1.8	1.7(J)	137
0239-95-0145	39-1302	0-6	2.6(J)	2.6	2.5(J)	61.9(J+)
0239-95-0146		0-6	2.6(J)	2.4	2.5(J)	100(J+)
0239-95-0147		10	2.5(J)	2.5	2.5(J)	10.3(J+)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SAL.
[a] N/A = not applicable

HMX was detected in one surface soil sample below its SAL of 3300 mg/kg (Table 5.1.7-1) and was submitted to the MCE for noncarcinogens. No other organics were detected along the transects from the firing pads.

Multiple Chemical Evaluation

The MCE included three analytes in the noncarcinogenic effects category (Table 5.1.8-6). The sum of the maximum normalized concentrations is 0.04, which is below the target value of 1.0. As a result, these analytes were not retained as COPCs.

TABLE 5.1.8-6
MULTIPLE CHEMICAL EVALUATIONFOR SOIL SAMPLES ALONG THE TRANSECTS AT PRSs 39-004(a,d)

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values
Noncarcinogenic Effects (mg/kg)					
HMX	39-1296	0239-95-0133	2.3	3300	0.0
Mercury	39-1302	0239-95-0146	0.76	23	0.03
Silver	39-1297	0239-95-0135	3.1	380	0.01
				Total:	0.04

[a] SAL = screening action level.

5.1.9 Human Health Risk Assessment

A human health risk assessment was performed on PRS 39-004(a,d) because several COPCs were retained as a result of the screening assessment and require further evaluation. Noncarcinogenic hazard and carcinogenic risk were evaluated using Laboratory site-specific exposure parameters and the guidance set forth in the Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989). The hazard and risk calculations were based on the current land use, i.e., continued Laboratory operations. The radionuclide risk was calculated using the Residual Radioactive (RESRAD) computer code version 5.61, which also incorporated Laboratory site-specific parameters and was based on the current land use. Risk calculations were performed to determine if the hazard index was greater than 1.0, the cancer risk was outside the target range of 10^{-4} to 10^{-6}, and the radionuclide dose was greater than the recommended dose limit of 30 mrem/yr.

5.1.9.1 Review of COPCs and Extent of Contamination

Beryllium, cadmium, cobalt, copper, lead, nickel, RDX, thorium-228, thorium-230, thorium-232, and uranium were retained as COPCs for the area around the firing pads at PRSs 39-004(a,d) and copper and uranium were retained as COPCs for the transects from the firing pads.

The extent of contamination was defined for the firing sites at PRSs 39-004(a,d). The area close to the firing pads as well as several hundred feet distant from the firing pads was sampled to determine whether contamination was present and what the extent of any contamination may be. As a result of the extensive sampling, eleven COPCs were retained. The highest detected values for five COPCs were from samples collected within 50 to 150 ft of the firing pads (Figure 5.1.4-2). The highest detected values for copper and uranium were from samples collected 600 ft and 250 ft, respectively, from the firing pads (Figure 5.1.4-3). The thorium radioisotopes were detected above background within 50 to150 ft of the firing pads as well as along the transects as far as 250 ft from the firing pads (Figures 5.1.4-2 and 5.1.4-3).

5.1.9.2 Exposure Assessment

The potential pathways by which individuals may be exposed to the COPCs must be identified and the exposures quantified in order to determine the potential risk at a given site. An exposure

pathway describes the course a chemical takes from the source to the exposed individual, and is defined by four elements: (1) a source and mechanism of chemical release to the environment; (2) an environmental transport medium for the released chemical; (3) a point of potential contact with the contaminated medium (i.e., an exposure point); and (4) an exposure route at the contact point. An exposure pathway is considered complete when all four elements are present: only complete exposure pathways are quantitatively evaluated in the risk assessment.

The contaminant sources are the firing pads, the contaminated medium is the surface soil, and the exposure routes include incidental ingestion, inhalation, and dermal contact under a non-intrusive industrial scenario. The exposure area (approximately 77,000 m^2) includes the firing pads, the transects, and adjacent stream channel segments (stream channels are presented in Section 5.6).

The exposure point concentrations were the reasonable maximum exposures (RME) and were derived based on the 95% upper confidence limit (UCL) of the arithmetic mean (Table 5.1.9-1), except for RDX. The exposure point concentration for RDX was the maximum detected concentration because of the high number of nondetects in the data set. The data set used to calculate the 95% UCLs consisted of all samples collected from within the exposure area and included firing pad areas, transects, and stream channel samples. The distributions of the COPC concentrations at the site are not consistent with either normal or lognormal distributions, the mathematical distributions commonly associated with environmental soil contamination. The Kolmogorov-Smirnov Test, a nonparametric goodness of fit test was used to compare the distributions of the COPC concentrations at the site and found that the concentrations are not consistent with either of the distributions.

Because the COPC concentrations are not consistent with commonly used distributions, a statistic (i.e., 95% UCLs) based on these distributions would not be valid. Therefore, the 95% UCLs are calculated using a resampling technique known as bootstrapping (Efron and Tibshirani 1988). Bootstrapping is a nonparametric, computer-based technique that makes use of a Monte Carlo algorithm applied to the observed data set. Resampling from the original data set is used to generate an approximate distribution for the sample mean, from which an approximate 95% UCL may be computed. In the cases of the COPC concentrations at this site, this statistic is more useful than a parametric or semi-parametric one because distributional assumptions about the data are not necessary.

TABLE 5.1.9-1
EXPOSURE POINT CONCENTRATIONS USED TO CALCULATE THE ESTIMATED INTAKES FOR EACH COPC

Analyte	Industrial Long-Term Worker	
	(mg/kg)	(pCi/g)
Beryllium	1.1	N/A[a]
Cadmium	0.8	N/A
Cobalt	28.4	N/A
Copper	5039	N/A
Lead	35	N/A
Nickel	18.8	N/A
RDX	9.2	N/A
Thorium-228	N/A	1.7
Thorium-230	N/A	1.5
Thorium-232	N/A	1.6
Uranium	273	109.2

[a] N/A = not applicable

To estimate dose, exposure point concentrations for each COPC are combined with information describing the extent, frequency, and duration of exposure for each potential receptor of

concern. The approaches used to quantify exposure are consistent with guidance provided by USEPA (1989, 1991, 1992a,b).

The quantification of exposure for ingestion, inhalation, and dermal exposure pathways involves the estimation of an average daily dose, expressed as mg chemical/kg body weight per day (mg/kg-day). Dose can be defined as an exposure rate to a chemical determined over an exposure period per unit body weight, and is calculated similarly for ingestion and dermal absorption pathways. Depending on whether the chemical is a noncarcinogen or a carcinogen, average daily doses are estimated differently because different toxicity criteria are available for these categories of chemicals. Average daily doses for noncarcinogens are averaged over the duration of exposure, and following USEPA (1992a) guidance, are given the acronym ADD for average daily doses. Average daily doses for carcinogens are averaged over a lifetime, and are given the acronym LADD for lifetime average daily doses. The ADDs and LADDs are estimated using exposure point concentrations along with exposure parameters that specifically describe the exposure pathway. The ADDs and LADDs for each pathway were derived by combining the selected exposure point concentrations of each chemical with exposure parameters that are quantitative estimates of the frequency, duration, and magnitude of exposure to various media (USEPA 1989, 1992a). The exposure parameters are either EPA default values or Laboratory site-specific default values for the exposure pathway of concern and are considered to be extremely conservative in nature. Because the firing pad areas are not utilized every day for 8 hours/day, the exposure time and exposure frequency are estimated based on conversations with current site personnel. The exposure time is estimated to be no more than 2 hrs/day and the exposure frequency is estimated to be 22 days/year.

The pathway-specific and radiological-specific doses from exposure to radionuclides are estimated by RESRAD 5.61. The exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD code estimates the dose contributions of the exposure media by mathematical modeling of the soil data. RESRAD calculates the annual dose estimates for individual radionuclides using site-specific exposure point concentrations and exposure assumptions (Appendix E). The dose contributions of daughter products are included in the dose estimates for the primary radionuclides. The annual dose estimates derived from RESRAD, expressed in mrem/yr, are then compared to the radiation dose limits for the appropriate exposure scenario. The recommended dose limit, as proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196 (EPA 1993, 06-0119), is 30 mrem/yr for the current industrial scenario. In addition, Department of Energy Order 5400.5 stipulates a target dose limit of 100 mrem/yr for industrial scenarios.

The intake equations and the exposure parameters used to calculate the ADDs and LADDs for the COPCs are presented in Tables C-1, C-2, and C-3 of Appendix C. The calculated ADDs for noncarcinogenic effects and LADDs for carcinogenic effects for each exposure pathway are presented in Tables 5.1.9-2, 5.1.9-3, and 5.1.9-4. The RESRAD summary output files for the radionuclides of concern for each exposure scenario are provided in Appendix E.

5.1.9.3 Toxicity Assessment

The methodology used for classifying health effects from exposure to chemicals is recommended by USEPA (1986a,b, 1989, 1995, 1996). The health effects analysis considers chronic exposures with chronic toxicity criteria being obtained from USEPA's Integrated Risk Information System (IRIS) (USEPA 1996) and Health Effects Assessment Summary (HEAST) (USEPA 1995). These sources list the most recent toxicity values recommended by USEPA for use in human health risk assessments. Appendix C, Table C-4, presents a summary of the toxicity criteria (cancer slope factors and RfDs) used to calculate the risk estimates for the COPCs at this site as well as summaries of the toxicological profiles for each COPC. Because toxicity criteria have not been specifically developed for the dermal route of exposure, oral toxicity criteria have been adjusted to assess this pathway. Oral toxicity criteria, which typically represent potential or administered doses, are modified to represent internal or absorbed doses (i.e., dermal dose estimates). The method for modifying toxicity criteria involves the determination of an absolute oral absorption factor for each chemical, which is then used to increase the chemical's cancer

slope or to decrease the RFD. Absolute oral absorption factors were obtained from the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles or, for those chemicals for which sufficient data are lacking, a default value of 1.0 was used (i.e., the oral toxicity criteria were not adjusted). Toxicological profiles for the COPCs retained by the screening assessment are presented in Appendix C.

Separate toxicity criteria are developed for chemicals depending on whether exposure may be associated with carcinogenic or noncarcinogenic effects. For carcinogens, it is assumed that a small number of molecular events can evoke changes in a single cell, or a small number of cells, that can lead to uncontrolled cellular proliferation, i.e., tumor formation. This hypothetical mechanism is referred to as nonthreshold, because there is essentially no level of exposure to a carcinogen that will not result in some finite possibility of developing cancer, i.e., no dose is thought to be risk-free. On the other hand for many noncarcinogens, organisms are believed to have protective mechanisms that must be overcome by some critical concentration (threshold) before an adverse effect is manifested. For example, if a large number of cells are performing the same or similar function, the cell population must be significantly depleted or impaired before an effect can be seen. Therefore, the threshold concept holds that a range of exposures from just above zero to some finite value can be tolerated by an organism without an appreciable risk of adverse effects.

The toxicity value calculated to quantitatively define the dose-response relationship for potential carcinogens is the slope factor. Cancer slope factors are expressed in terms of reciprocal dose, (mg chemical/kg body weight-day)$^{-1}$, which describes the upper-bound increase in an individual's risk of developing cancer over a 70-year lifetime per unit of exposure. These values are derived from the results of human epidemiological studies or chronic animal data. Because humans are expected to be exposed to lower doses than those used in the animal studies, the potential cancer risks are estimated using mathematical models. The animal data are typically fitted to a linearized multistage model to obtain a dose-response relationship from which the 95% upper confidence limit of the slope at low doses is calculated. This upper-bound limit is subjected to various adjustments and an interspecies scaling factor is applied to derive the slope factor for humans. Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves and provide rough, but plausible, estimates of the upper limits on lifetime risk. The slope factors derived by these methods are unlikely to underestimate the risks for a given level of exposure (EPA 1986).

In addition to the slope factors, USEPA (EPA 1989) has assigned weight-of-evidence classifications to potential carcinogens. Chemicals are classified as either Group A, Group B1, Group B2, Group C, Group D, or Group E. These categories represent an assessment of the amount and quality of data which support the finding that specific chemicals and elements can cause cancer in humans. Group A includes those substances for which high-quality studies have demonstrated a relationship between exposure to the substance and the development of cancer in human populations. Groups B1, B2, and C represent chemicals with limited (B1) or insufficient (B2) human evidence of carcinogenicity and sufficient (B1, B2) or insufficient (C) animal data. Group D substances are those for which there is insufficient or no evidence of carcinogenicity in humans or animals, while Group E substances are those for which no evidence of carcinogenicity is available in adequate human or animal studies. The weight-of-evidence classification should always accompany the slope factor in order to indicate the strength of evidence that the chemical is a human carcinogen.

The toxicity value used to evaluate chemicals exhibiting noncarcinogenic effects is the reference dose (RfD), which is expressed in units of dose (mg chemical/kg body weight-day), and is derived from either human or animal studies. These values are estimates of the daily exposure of the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are used to characterize the potential for the occurrence of noncarcinogenic effects associated with exposure durations greater than seven years and are the toxicity values used in this risk assessment.

The RfDs are derived using uncertainty factors that reflect scientific judgment regarding the various types of data used to estimate this value. The RfDs are typically estimated from no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) in human or animal studies. The NOAELs or LOAELs are divided by one or more uncertainty factors, as appropriate, as well as modifying factors in some cases to take into account other uncertainties in the toxicity database. The uncertainty factors, generally 10-fold factors, are intended to account for:

- The variation in sensitivity among members of the human population;
- the uncertainty in extrapolating animal data to humans;
- the uncertainty in extrapolating data obtained in a study that is less-than-lifetime exposure
- the uncertainty in using LOAEL data rather than NOAEL data; and
- the inability of any single study to adequately address all possible adverse effects in humans.

The net result is that RfDs are generally considered to be conservative estimates of the likelihood of adverse noncarcinogenic effects.

For radionuclides, the ratio of exposure to dose is expressed as a dose conversion factor (DCF). The DCFs used are default values provided in the RESRAD code and are listed in the summary output files in Appendix E. The output files contain DCFs for the radionuclides retained as COPCs as well as DCFs for important progeny of the parent radionuclide. Additional information regarding DCFs is provided in the Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD (Yu et al. 1993, 1177). The annual dose limit for the COPCs for each exposure scenario are calculated by RESRAD 5.81 using scenario-specific parameters (See Appendix E). These parameters were selected to result in a reasonable maximum exposure for an individual for each exposure scenario. The annual dose limits are compared to the recommended target dose limit of 30 mrem/yr for commercial/industrial exposure scenarios (EPA 1993, 06-0119). This target dose limit satisfies the "as low as reasonably achievable" (ALARA) principle to ensure that radiation exposure is minimized. The Department of Energy Order 5400.5 stipulates a target dose limit of 100 mrem/yr for industrial sites.

5.1.9.4 Risk and Dose Characterization

Nonradiological Risk

The potential human health risks associated with the selected human exposure pathways are assessed by combining the calculated doses with the toxicity criteria. USEPA has developed guidelines for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals, and uses separate methodologies for estimating the risks from these two classes of compounds.

For potential carcinogens, the individual upper-bound excess liftime cancer risk was calculated by multiplying the estimated LADD by the upper-bound cancer slope factor. Upper-bound is a term used by USEPA to describe cancer slope factors and indicates that the actual risks are unlikely to be higher than the risks predicted using the upper-bound cancer slope factors. Using this approach, a risk level of $1x10^{-6}$, for example, represents an upper-bound increase in the lifetime probability of one in one million that an individual could contract cancer as a result of exposure. In order to assess the upper-bound individual excess lifetime cancer risks associated with simultaneous exposure to all COPCs, the risks derived from the individual chemicals were summed within each pathway.

The potential risks for noncarcinogens were calculated by means of a hazard index technique as recommended by USEPA (1989). The ratio of the ADD to the reference dose (RfD) was derived for each chemical. Values of these ratios, called hazard quotients, that are greater than one are indicative of potential adverse health effects. The effects from simultaneous exposures to all COPCs were computed by summing the individual hazard quotients within each exposure pathway. This sum, termed the hazard index, serves the same function for the mixture as the

hazard quotient does for the individual compound, i.e., hazard indices greater than one are indicative of potential adverse health effects.

The upper-bound lifetime excess cancer risks derived in this risk assessment can be compared to USEPA's target risk range for health protectiveness of $1x10^{-6}$ to $1x10^{-4}$ (EPA 1990). In addition, USEPA's Office of Solid Waste and Emergency Response (EPA 1991) has issued a directive clarifying the role of risk assessment. The directive states that, where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than $1x10^{-4}$, and the noncarcinogenic hazard index is less than 1, action generally is not warranted unless there could be adverse environmental effects.

For current land use conditions, potential risks associated with incidental ingestion, dermal contact, and inhalation of fugitive dust by on-site workers were quantified for the entire firing site area. The potential risk associated with the inhalation exposure pathway was quantified for the carcinogens only because the noncarcinogens do not have inhalation RfDs. Beryllium and RDX were the COPCs for which the upper-bound excess lifetime cancer risks were calculated. Cadmium, cobalt, copper, nickel, lead, and uranium were the COPCs for which hazard indices were calculated. In the case of lead, EPA has not derived reference doses for evaluating lead toxicity. EPA Region VI has indicated that an industrial preliminary remediation goal (PRG) of 1000 mg/kg would result in the protection of a pregnant female worker. The exposure point concentration for lead (35 mg/kg) is below the industrial PRG and therefore is not considered to present a hazard to the on-site workers. The model used by EPA Region VI indicates that the fetal blood lead level due to this soil lead concentration would be 2.4 µg/dL, which is well below the 10 µg/dL blood lead level of concern. The equations and assumptions used to arrive at this level are presented in Appendix C. In order to provide an estimate of the total cumulative risk at the firing site, lead has been incorporated into the calculations by dividing the exposure point concentration by the PRG (1000 mg/kg). The quantitative risk estimates associated with the COPCs are presented in Tables 5.1.9-2, 5.1.9-3, and 5.1.9-4. The total upper-bound excess lifetime cancer risks and hazard indices for the various exposure pathways associated with the current land-use are presented in Table 5.1.9-5.

Individuals may be exposed to a combination of pathways at any given time and therefore the combined pathway risks for plausible multiple pathway exposures were calculated and are presented in Table 5.1.9-5. The hazard index for the current land use scenario was 0.1, which is below the target value of 1.0, and indicates that hazard from the noncarcinogenic COPCs at this site is unlikely. The potential cumulative cancer risk for long-term workers is $5x10^{-6}$ for the entire firing site area sampled in 1995. The risk is in the lower end of USEPA's target risk range of 10^{-6} to 10^{-4} for health protectiveness for the entire firing site area.

TABLE 5.1.9-2
EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Carcinogen	Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Slope Factor (mg/kg-day)$^{-1}$	Weight-of-Evidence Classification	Excess Lifetime Cancer Risk
Organics	**RME**	**RME**			**RME**
RDX	9.2	2.8E-07	0.11	C	3E-08
Inorganics					
Beryllium	1.1	3.4E-08	4.3	B2	2E-07
Total					2E-07
Non-carcinogen	**Exposure Point Concentration (mg/kg)**	**Average Daily Dose (mg/kg-day)**	**RFD (mg/kg-day)**	**Target Organ or Critical Effect**	**ADD:RfD Ratio**
Inorganics	**RME**	**RME**			**RME**
Beryllium	1.1	9.5E-08	5E-03	Skin	2E-05
Cadmium[a]	0.8	6.9E-08	5E-04	Kidney	1E-04
Cobalt	28.4	2.4E-06	6E-02	Lungs	4E-05
Copper	5039	4.3E-04	4E-02	Gastrointestinal	1E-02
Lead	35	N/A[b]	1E+03[c]	Central Nervous Sysytem	4E-02[d]
Nickel	18.8	1.6E-06	2E-02	Body Weight	8E-05
RDX	9.2	7.9E-07	3E-03	Prostate	3E-04
Uranium	273	2.4E-05	3E-03	Kidney	8E-03
Hazard Index					0.06

[a] Cadmium is a B1 carcinogen via the inhalation exposure pathway only.

[b] N/A = not applicable

[c] EPA has not derived RfDs for lead. The value presented is the industrial PRG for lead obtained from EPA Region VI, which uses a pregnant female worker as the exposed individual.

[d] The ratio for lead is derived by dividing the exposure point concentration by the industrial PRG.

TABLE 5.1.9-3
EXPOSURES AND RISKS ASSOCIATED WITH DERMAL CONTACT OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Carcinogen	Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Adjusted Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight-of-Evidence Classification	Excess Lifetime Cancer Risk
Organics	**RME**	**RME**			**RME**
RDX	9.2	9.1E-07	0.11	C	1E-07
Inorganics					
Beryllium	1.1	1.1E-08	4.3E+02	B2	5E-06
Total					5E-06
Non-carcinogen	**Exposure Point Concentration (mg/kg)**	**Average Daily Dose (mg/kg-day)**	**Adjusted RFD (mg/kg-day)**	**Target Organ or Critical Effect**	**ADD:RfD Ratio**
Inorganics	**RME**	**RME**			**RME**
Beryllium	1.1	3E-08	5E-05	Skin	6E-04
Cadmium[a]	0.8	2.2E-08	3.5E-05	Kidney	6E-04
Cobalt	28.4	7.8E-07	6E-02	Lungs	1E-05
Copper	5039	1.4E-04	3.7E-02	Gastrointestinal	4E-03
Lead	35	N/A[b]	1E+03[c]	Central Nervous Sysytem	4E-02[d]
Nickel	18.8	5.2E-07	2E-03	Body Weight	3E-04
RDX	9.2	2.5E-06	3E-03	Prostate	8E-04
Uranium	273	7.5E-06	3E-03	Kidney	3E-03
Hazard Index					0.05

[a] Cadmium is a B1 carcinogen via the inhalation exposure pathway only.

[b] N/A = not applicable

[c] EPA has not derived RfDs for lead. The value presented is the industrial PRG for lead obtained from EPA Region VI, which uses a pregnant female worker as the exposed individual.

[d] The ratio for lead is derived by dividing the exposure point concentration by the industrial PRG.

TABLE 5.1.9-4
EXPOSURES AND RISKS ASSOCIATED WITH INHALATION OF FUGITIVE DUST OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Carcinogen[a]	Exposure Point Concentration (mg/kg)	Lifetime Average Daily Dose (mg/kg-day)	Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight-of-Evidence Classification	Excess Lifetime Cancer Risk
Organics	**RME**	**RME**			**RME**
RDX	9.2	8.7E-10	NA[b]	C	NA[b]
Inorganics					
Beryllium	1.1	1E-10	8.4E+00	B2	8E-10
Cadmium[c]	0.8	7.5E-11	6.3E+00	B1	5E-10
Total					1E-09

[a] Noncarcinogenic hazard indices are not calculated because inhalation RfDs are not available.

[b] NA = inhalation cancer slope factor is not available.

[c] Cadmium is a B1 carcinogen via the inhalation exposure pathway only.

TABLE 5.1.9-5
SUMMARY OF ESTIMATED RISKS ASSOCIATED WITH EXPOSURES
AT PRSs 39-004(a,d)

Receptor/Pathway	Excess Lifetime Cancer Risk	Noncancer Hazard Index
CURRENT LAND-USE CONDITIONS		
	RME	RME
LONG-TERM WORKER (Whole Area)		
Incidental Ingestion of Soil	2E-07	0.06
Dermal Contact with Soil	5E-06	0.05
Inhalation of Fugitive Dust	1E-09	N/A[a]
Cumulative Risk	**5E-06**	**0.1**

[a] N/A = not applicable because there are no inhalation RfDs.

Radiological Dose

The potential dose from the radionuclides associated with the selected human exposure pathways are assessed for each exposure scenario using RESRAD 5.61. Dose contribution by daughter products are included in the dose estimates for depleted uranium. The long-term worker scenario exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD input parameters for each exposure scenario are provided in Appendix E and the exposure point concentrations are presented in Table 5.1.9-1. The RESRAD output in Appendix E is for exposure to 1.0 pCi/g of each radionuclide COPC and is not based on the exposure point concentrations.

The annual total dose contributions for individual radionuclides and pathways for the current land-use scenario are presented in Table 5.1.9-6. The estimated annual dose of 4.1 mrem/yr for the long-term worker is below the recommended dose limit of 30 mrem/yr. The estimated dose limit is driven by the external irradiation pathway, which accounts for 63% of the total estimated dose.

Uncertainties in the Human Health Risk Assessment

All risk assessments involve the use of assumptions, judgments, and incomplete data to varying degrees that contributes to the uncertainty of the final estimates of risk. Uncertainties result both from the use of assumptions or models in lieu of actual data and from the error inherent in the estimation of risk-related parameters, and may cause the risk to be overestimated or underestimated. Therefore, the results of the risk assessment should not be considered as an absolute estimate of the risk to the individuals potentially exposed to the chemicals.

Consideration of the uncertainties related to the various aspects of the risk assessment allows for a better interpretation of the results and an understanding of the potential adverse effects on human health. In general, the primary sources of uncertainty are associated with site conditions (e.g., land use assumptions) ; toxicological data (e.g., toxicity criteria); and exposure assessment (e.g., exposure pathways and parameters).

TABLE 5.1.9-6
ANNUAL DOSE CONTRIBUTION FOR INDIVIDUAL RADIONUCLIDES FOR THE CURRENT LAND-USE SCENARIO

Exposure Pathway	Thorium-228/232 (mrem/yr)	Thorium-230 (mrem/yr)	Uranium (mrem/yr)	Total by Pathway (mrem/yr)	Percent Contribution by Pathway
External irradiation	1.6	0.07	0.9	2.6	63%
Inhalation of dust	0.3	0.04	1.1	1.4	33.9%
Inhalation of radon gas	0.03	0.0005	0.0	0.03	0.7%
Ingestion of soil	0.02	0.04	0.07	0.1	2.4%
Total	2.0	0.1	2.0	Long-term worker scenario total: 4.1 mrem/yr	
Percent Contribution by Radionuclide	48.8%	2.4%	48.8%		

Site Conditions

The likelihood is high that the site conditions used to estimate the exposure and risk under the industrial exposure scenario will remain the same. The firing sites at TA-39 are still active and there are no immediate plans to decommission them. As a result, the entire area will remain under Laboratory control for now and the foreseeable future. Because no additional construction or excavation is planned for TA-39, the likelihood that the landfill area will be disturbed is minimal. Therefore, potential for exposure to the COPCs at this site by either long-term workers or construction workers is minimal.

Exposure Assessment

There is inherent uncertainty in the estimation of exposure. The estimation of exposure and risk is deterministic and is based on the assumption that a receptor will be exposed and, once exposed estimates the health hazard and/or risk. The probability of exposure s not accounted for in this approach. The primary areas of uncertainty involve the assumptions regarding exposure pathways, estimation of exposure points, and the exposure parameters.

The exposure pathways selected for evaluation in the risk assessment were based on potential and worst case exposures. For example, it was assumed that individuals would engage in regular activities under current land-use activities that would result in exposures to the COPCs. This assumption is conservative because it is more likely that the activity resulting in exposure would not occur.

In calculating the exposure point concentrations for the RME from sampling data, one-half of the reported detection limit was used for nondetects. Any approach dealing with nondetects is associated with some uncertainty because chemicals that were not detected at the specified detection limit may be absent from the medium or may be present at any concentration below the detection limit. The uncertainty of the exposure point concentration will increase as the number of nondetects in a data set increases, since the actual result is not available for the samples. Additional uncertainty is associated with high detection limits because the use of these elevated values may bias the exposure point concentration upward.

The parameters used to describe the extent, frequency, and duration of exposure are associated with some degree of uncertainty. Actual risks for certain individuals within an exposed population

may vary from those predicted depending upon their actual intake rates, nutritional status, or body weights. The exposure assumptions were selected to produce an upper-bound estimate of exposure in accordance with USEPA guidelines regarding potential exposures at a site. As a result, exposures and estimated potential risks for the majority of the evaluated receptors are likely to be overestimated.

Uncertainties associated with characterizing the frequency, duration, and activity-related variables for exposure of a human population to soil contaminants are similar for both radionuclides and nonradionuclides. However, model uncertainty for a complex code such as RESRAD, which has numerous submodels, is difficult to evaluate without empirical validation. Uncertainty is also associated with choice of exposure frequency and exposure area. Uncertainty is also involved in the calculation of the exposure point concentration as discussed previously for nonradiological contamination.

Toxicological Data

There is inherent uncertainty in the derivation of the toxicity criteria. The assessment of risks relied on toxicity criteria designed to protect sensitive subpopulations and are therefore conservative in nature and based on concepts and assumptions that bias an evaluation in the direction of overestimation of the associated risks. As noted in USEPA's Guidelines for Carcinogenic Risk Assessment (EPA 1986):

> There are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility. Human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns, and other cultural factors.

These uncertainties are compensated for by using upper-bound 95% upper confidence limits for cancer slope factors, and safety factors for reference doses. The assumptions used here provide a rough but plausible estimate of the upper limit of risk, i.e., it is not likely that the true risk would be much more than the estimated risk, but it could be considerably lower.

The absence of dermal toxicity criteria necessitated the adjustment of oral toxicity values in order to evaluate the dermal exposure pathway. As previously mentioned, absolute oral absorption factors were used to modify the oral toxicity criteria. For those chemicals for which sufficient information is lacking, a default oral absorption factor of 1.0 was used. The risk estimates for the dermal pathway may therefore be over or underestimated depending on how closely these values reflect the difference between oral and dermal routes.

The inhalation cancer slope factors for the PAHs are either provisional developed by EPA -ECAO (Environmental Criteria and Assessment Office) or, in the case of benzo(a)pyrene, withdrawn from IRIS (Integrated Risk Information System). These values are used in order to provide an estimate of the potential risk from the inhalation pathway. However, because of the uncertainty associated with these values, the risk estimates for the inhalation exposure pathways may be either over or underestimated.

The likelihood is moderate that the risk is not greater than that calculated as a result of the exclusion of some chemicals in the risk assessment. Several noncarcinogens, mercury, silver, HMX, and zinc, were eliminated from the risk assessment based on their contributions to the noncarcinogenic MCE analysis. The concentrations of these chemicals, which are well below SALs (all were 1/3 or more of the SAL) would not significantly alter the noncarcinogenic hazard estimate. Similarly, thorium-228, thorium-230, and thorium-232 were eliminated from the risk assessment based on comparisons to the background ranges. The concentrations of these radinuclides would not significantly alter the radionuclide risk estimate.

The DCFs used in the evaluation of radionuclide doses are associated with assumptions that contribute to uncertainty in dose estimates. Separate DCFs exist for internal and external

expsoure to radiation and do not evaluate the effects of radiation on children. Although external DCFs are applicable to both men and women, internal DCFs are based on radiation effects for an adult male. Gender differences that contribute to the uncertainty when applying internal DCFs to women include potential differences in sensitivity of reproductive organs and effects related to pregnancy and lactation.

5.1.10 Preliminary Ecological Assessment

In cooperation with the New Mexico Environment Department and EPA Region VI, the Laboratory ER Project is developing an approach to ecological risk assessment. Further ecological risk assessment at this site will be deferred until the site can be assessed as part of the ecological exposure unit methodology currently being developed.

5.1.11 Conclusions and Recommendations

Because the firing sites at PRSs 39-004(a,d) are still active and no unacceptable risk to the site personnel currently exists at the sites, no further action based on human health concerns is recommended until they are decommissioned. However, surface water concerns do exist that will require the implementation of best management practices (BMPs) at the firing site to address storm water runoff.

5.2 PRS 39-004(b) - Firing Site

PRS 39-004(b) (Figure 5.2-1) is a firing site located in the western tributary of the upper reach of Ancho Canyon (North Fork). The firing pad is located in the canyon bottom between an ephemeral stream and the northern canyon wall. Although this PRS may receive materials lofted from explosions at PRSs 39-004(a,d, and e), it is being evaluated separately because of its location in a different tributary than PRS 39-004(a,d) and has been used for a different spectrum of experiments than PRS 39-004(e). PRS 39-004(b) is associated with building TA-39-8 an electronics and camera facility. This PRS is within the fall zone of a high cliff that erodes when explosive experiments are conducted at the site; the site is currently not in use because of the danger of debris falling on the facilities. Mercury, thorium-228, thorium-230, thorium-232, and uranium were retained as COPCs in samples collected at the firing pad. Thorium-228, thorium-230, thorium-232, and uranium were retained as COPCs along the transects. A risk assessment found that there is not an unacceptable risk to human health under the continued Laboratory use (i.e., industrial) scenario. The PRS will be re-evaluated when the firing site is decommissioned.

5.2.1 History

This firing site has been in operation from 1953 to 1980 and is currently inactive. Experiments at the site included detonation of HE to support research in equation-of-state and shock wave phenomena and development of explosively produced pulses of electrical power and high magnetic fields. Typical experiments used 10 to 100 pounds of HE. Debris from the explosions was generally deposited within about 200 ft of the firing pad but some debris was deposited at greater distances on the adjacent hill slopes and mesa tops. Materials used in significant quantities over the years included beryllium, mercury, natural and depleted uranium, lead, aluminum, copper, brass, stainless steel, thallium, cadmium, chromium, thorium-232 (natural), dielectric oil, and various types of HE (RDX, HMX, Baratol, PETN, TATB, TNT, Composition B, and cyclotol). Use of some of the more toxic materials (e.g., lead, uranium, mercury, PCB-containing dielectric oil) was discontinued between 1978 and 1981 (personal communication, J. King, May 21, 1997). The experiments were conducted so that there was complete burn up of the HE. If a shot failed, so that not all of the HE was spent, an effort was made to pick up and destroy the unexploded HE.

Occasionally, construction and experiment debris left on the firing pad was removed along with a layer of the disturbed surface material and was replaced with a layer of fresh sand. This activity effectively reduced the level of contaminants on the firing pad as protection for site workers. However, outside this cleaned area no major effort has been made to police or decontaminate the facility.

This PRS is discussed in further detail in Section 5.3 of the RFI work plan for OU 1132 (LANL 1993, 1089).

5.2.2 Description

Beyond that discussed in Chapter 2 no additional geology, hydrology, soils, or wildlife habitat information is available. However, a geomorphic evaluation of the canyon bottom and associated runoff areas is presented in Appendix E.

5.2.3 Previous Investigations

No previous investigations were conducted at this site that would provide pertinent information on thesite characterization or contaminant dispersal.

5.2.4 Field Investigation

The objective of the investigation at PRS 39-004(b) was to determine if COPCs are present in the soils around the firing pad, on surrounding hill slopes, and on the mesa tops. The conceptual model for the site deals primarily with the presence and redistribution of surface contamination

that has been deposited as a result of dispersal of experimental materials by explosive destruction. Materials from the explosions are scattered across the firing sites and adjacent areas. and debris has been found as far away as 1 mile. Contaminated soil is subject to transport by surface water and wind action, while some contaminants can be absorbed, inhaled. or ingested by exposed receptors.

Field sampling efforts at PRS 39-004(b) were completed in August 1995 and consisted of establishing transects and sampling grids by land survey methods; conducting a radiation survey of the firing pad area and adjacent stream channel (conducted in 1993); conducting specific radiation and XRF surveys of the firing pad, stream channel, and transects; sampling surface soils from the firing pad, transects, and adjacent stream channel segment (discussed in Section 5.6); and determining by land survey sampling point location coordinates and elevations relative to a local benchmark.

5.2.4.1 Surveys

A radiation survey was conducted on 20-ft centers over the firing pad in 1993 within a 200- by 200-ft survey grid. In 1995, this same grid was augmented by adding radiation survey locations offset by 10 ft. Results of both surveys were used to help select potential biased sampling locations. In these surveys, the entire area within 5 ft of a grid point was surveyed to locate the highest radiation level; that location became a biased candidate for sampling. The radiation surveys were conducted with a FIDLER probe and a beta/gamma pancake probe to map the radiation levels at the soil surface.

A radiation survey similar to that conducted on the firing pad was conducted in 1993 in the adjacent stream channel where readings were taken about every 10 ft starting approximately 150 ft upstream and continuing to more than 100 ft downstream from the firing point.

From a point thought to be central to the firing pad, a series of three transects were land surveyed at 150-ft intervals and extending to approximately 600 ft. Transect 4 is 335 degrees from N and terminates at approximately 480 ft on the mesa top. Transect 5 is 75 degrees from N over the cliff toward PRS 39-004(d) and terminates at approximately 530 ft. This transect is common with Transect 3 from PRS 39-004(d) and intersects with Transect 7 from PRS 39-004(e). Transect 6 is 190 degrees from N and terminates at approximately 500 ft on the mesa top. A radiation survey similar to that conducted on the firing pad was conducted along the accessible portions of the transects. Generally, termination of the transects corresponded with the disappearance of elevated radioactivity.

An XRF survey was also conducted at the firing pad, stream channel segment, and along the transects. Signals for key analytes were evaluated as an aid in selecting biased sampling points. The analytes include: uranium, thorium, lead, cadmium, chromium, copper, arsenic, titanium, zinc, barium, silver, and strontium. A set of 25 random grid points encompassing the firing pad at PRS 39-004(b) were selected using a random number generator. Twenty of these locations were sampled from the accessible part of this area for XRF analysis. Six samples were collected from Transect 4 in selected locations of elevated radioactivity (no XRF samples were collected from Transects 5 or 6). For the XRF measurements, a small amount of the surface material (0-1 in) was collected, thoroughly mixed, dried under a heat lamp, and placed in the XRF sample cell for assay.

Results of the XRF and radiation measurements are summarized in two memos to the TA-39 Files from Essington (EES15-96-204, July 2, 1996; EES15-96-XXX (in preparation), June XX, 1997).

5.2.4.2 Sampling

Surface soil samples (0-6 in) were collected from 6 locations in the vicinity of PRS 39-004(b) firing pad (Figure 5.2.4-1). Sampling locations based on elevated XRF readings are 39-1243 (copper, lead, titanium, uranium, and zinc) and 39-1244 (copper, lead, titanium, uranium, and zinc); and sampling locations based on elevated radiation readings are 39-1245 and 39-1246. Two sampling locations in the talus pile at the base of the cliff on the north side of the firing pad were

TABLE 5.2.4-1
SUMMARY OF SAMPLES TAKEN[1]

Location ID	Sample ID	Depth (ft)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
FIRING PAD								
39-1243	0239-95-0048	0-0.5	soil	926	928	927	929	Not Analyzed
39-1244	0239-95-0049	0-0.5	soil	926	928	927	929	Not Analyzed
39-1245	0239-95-0050	0-0.5	soil	926	928	927	929	Not Analyzed
39-1245	0239-95-0051	0-0.5	soil	926	928	927	929	Not Analyzed
39-1246	0239-95-0052	0-0.5	soil	926	928	927	929	Not Analyzed
39-1247	0239-95-0053	0-0.5	soil	926	928	927	929	Not Analyzed
39-1248	0239-95-0056	0-0.5	soil	926	928	927	929	Not Analyzed
TRANSECTS								
39-1303	0239-95-0070	0-0.5	soil	1144	1146	1145	1147	1147
39-1303	0239-95-0071	0-0.5	soil	1144	1146	1145	1147	1147
39-1303	0239-95-0072	0.8	soil	1144	1146	1145	1147	1147
39-1304	0239-95-0073	0-0.5	soil	1144	1146	1145	1147	1147
39-1304	0239-95-0074	0.8	soil	1144	1146	1145	1147	1147
39-1304	0239-95-0075	0-0.5	soil	1186	1190	1188	1191	1191
39-1305	0239-95-0079	0-0.5	soil	1186	1190	1188	1191	1191
39-1307	0239-95-0080	0.8	soil	1186	1190	1188	1191	1191
39-1307	0239-95-0081	0-0.5	soil	1186	1190	1188	1191	1191
39-1308	0239-95-0083	0-0.5	soil	1186	1190	1188	1191	1191
39-1309	0239-95-0085	0-0.5	soil	1186	1190	1188	1191	1191
39-1311	0239-95-0087	0-0.5	soil	1186	1190	1188	1191	1191

[1] Numbers in the analyte columns are request numbers.

also sampled (39-1247 and 39-1248). These two sampling locations were to be sampled at depth but sampling efforts were discontinued as discussed in Section 5.2.4.4, Deviations.

Sampling along the three transects included collection of surface (0-6 in) and subsurface (6-10 in) soil samples where sufficient material was available (Figure 5.2.4-1). In several cases, the soil layer was too thin to allow collection of the deeper sample and in other cases the terrain was too steep to allow safe access for sampling. Three locations were sampled on Transect 4 (39-1303 through 39-1305); two on the steep hillside and one on the mesa top. One location was sampled on Transect 5 (39-1307) because most of the transect is along a steep cliff, and four locations were sampled on Transect 6 (39-1308 through 39-1311). Transect 5 is in common with Transect 3 associated with PRSs 39-004(a,d) and is also intersected by Transect 7 originating from PRS 39-004(e).

To determine if the soil radioactivity detected at the firing pad, in the stream channel segment, or along the transects was due to contaminated shrapnel or pieces of depleted uranium or general soil contamination, the field team traversed the area searching for elevated radioactivity (beta/gamma). Upon finding an elevated radiation signal within 5 to 10 ft on either side of the defined measurement point, the value was recorded (First Reading) and a search was made to determine if that radioactivity was due to general soil contamination or to a definitive piece of contaminated material. If a definitive piece of material was present, it was removed and the point was resurveyed to obtain a radiation reading of the soil (Second Reading). In several cases, removal of the contaminated piece(s) resulted in considerably reduced radioactivity from the underlying soil and, in some cases, a reduction to background was observed. The Second Reading is expected to be more representative of radioactivity in the soil. The two readings are compared to radioactivity measured on the collected mixed soil sample obtained for shipping purposes (Table 5.2.4-1).

TABLE 5.2.4-1
DISCRIMINATION BETWEEN RADIOACTIVE SHRAPNEL AND RADIOACTIVE SOIL AT PRS 39-004(b)

Location	Location Type	First Reading (c/m)	Second Reading (c/m)	Sample (c/m)	Comment
39-1243	Pad-XRF			2000	
39-1244	Pad-XRF			2500	
39-1245	Pad-Rad			1500	
39-1246	Pad-Rad			1500	
39-1247	TP-0			275	
39-1248	TP-0			325	
39-1277	SC-0	275		225	
39-1277	SC-6			275	
39-1278	SC-0	250		225	
39-1278	SC-6			200	
39-1279	SC-0	14000		240	
39-1279	SC-6			275	
39-1280	SC-0	3000		400	
39-1280	SC-6			400	
39-1281	SC-0	350		300	
39-1281	SC-6			325	
39-1282	SC-0	300		300	
39-1282	SC-6			325	

TABLE 5.2.4-1
DISCRIMINATION BETWEEN RADIOACTIVE SHRAPNEL AND RADIOACTIVE SOIL AT PRS 39-004(b)
Continued

Location	Location Type	First Reading (c/m)	Second Reading (c/m)	Sample (c/m)	Comment
39-1283	SC-0	350		600	
39-1283	SC-6			1000	
39-1303	T4-312-0			350	
39-1303	T4-312-6			350	
39-1304	T4-312-0			350	
39-1304	T4-312-6				Rain/no rad readings
39-1305	T4-312-0	230000	2900	300	
39-1305	T4-312-6				NS
39-1306	T4-312-0				NS
39-1306	T4-312-6				NS
39-1307	T5-72-0	2000		500	
39-1307	T5-72-6			450	
39-1308	T6-192-0	40000	+	15000	DU present, not removed
39-1308	T6-192-6				NS
39-1309	T6-192-0	10000		6000	
39-1309	T6-192-6				NS
39-1310	T6-192-0	10000		2500	
39-1310	T6-192-6				NS
39-1311	T6-192-0	10000	400	350	
39-1311	T6-192-6				NS

Pad-Rad	Sample based on elevated Radioactivity
Pad-XRF	Sample based on elevated metal by XRF
Pad-0	Level area between gun and cliff, 0-6 in sample
XRF	Energy Dispersive X-Ray Fluorescence
DM	DM-0 = Debris Mound, 0-6 in
TP	TP-0 = Talus Pile at base of cliff, 0-6 in
SC	SC-0 = Stream Channel, 0-6 in
NS	No Sample collected
+	Very small pieces of depleted uranium present
T	T1-12-0 = Transect #1, 12 deg N, 0-6 in
(c/m)	Beta/gamma readings with 44-9 pancake detector
First Reading	Elevated radioactivity, undisturbed
Second Reading	Radioactivity after removal of offending material
Sample	Radioactivity of collected mixed soil sample

All soil samples from the firing pads were analyzed for SVOCs, metals, cyanide, HE, isotopic thorium, and total uranium. Only those samples from the elevated radiation and talus pile points were analyzed by gamma spectrometry. All transect samples were analyzed for SVOCs, metals, cyanide, HE, isotopic thorium, total uranium, and by gamma spectrometry. The samples collected and the analyses requested for PRS 39-004(b) are summarized in Table 5.2.4-2, while sample locations are presented in Figure 5.2.4-1.

TABLE 5.2.4-2
SUMMARY OF SAMPLES TAKEN[1]

Location ID	Sample ID	Depth (in)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
FIRING PAD								
39-1243	0239-95-0048	0-6	soil	926	928	927	929	Not Analyzed
39-1244	0239-95-0049	0-6	soil	926	928	927	929	Not Analyzed
39-1245	0239-95-0050	0-6	soil	926	928	927	929	Not Analyzed
39-1245	0239-95-0051	0-6	soil	926	928	927	929	Not Analyzed
39-1246	0239-95-0052	0-6	soil	926	928	927	929	Not Analyzed
39-1247	0239-95-0053	0-6	soil	926	928	927	929	Not Analyzed
39-1248	0239-95-0056	0-6	soil	926	928	927	929	Not Analyzed
TRANSECTS								
39-1303	0239-95-0070	0-6	soil	1144	1146	1145	1147	1147
39-1303	0239-95-0071	0-6	soil	1144	1146	1145	1147	1147
39-1303	0239-95-0072	10	soil	1144	1146	1145	1147	1147
39-1304	0239-95-0073	0-6	soil	1144	1146	1145	1147	1147
39-1304	0239-95-0074	10	soil	1144	1146	1145	1147	1147
39-1304	0239-95-0075	0-6	soil	1186	1190	1188	1191	1191
39-1305	0239-95-0079	0-6	soil	1186	1190	1188	1191	1191
39-1307	0239-95-0080	10	soil	1186	1190	1188	1191	1191
39-1307	0239-95-0081	0-6	soil	1186	1190	1188	1191	1191
39-1308	0239-95-0083	0-6	soil	1186	1190	1188	1191	1191
39-1309	0239-95-0085	0-6	soil	1186	1190	1188	1191	1191
39-1311	0239-95-0087	0-6	soil	1186	1190	1188	1191	1191

[1] Numbers in the analyte columns are request numbers.

5.2.4.3 Field Screening

Surface material at each sampling point was screened for HE using the "Modified Griess Reagent Spot Test for Explosives" field kit, and selected sampling points were screened for PCBs using the "D-Tech" field kit. No PCBs or HE was detected in the screening efforts.

5.2.4.4 Deviations from the RFI Work Plan Sampling Strategies

Debris Mounds (Section 5.3.4.1.3.1 of the RFI work plan): According to the work plan, samples from within the debris mound (talus pile) accumulating at the base of the cliff adjacent to the firing point at PRS 39-004(b) was to be collected so that the distribution of possible contaminants within the mound could be evaluated. The sampling effort successfully obtained surface 0-6 in. samples from the two specified locations but was unsuccessful in obtaining samples at depth using a hand auger. Use of a drill rig and coring tool or back hoe was deemed inappropriate because of poor accessibility and looseness of the material. The need for such samples was re-evaluated and discussed in Memo to Project Files, TA-39, FU2 from Essington, EES15-95-353, dated October 10, 1995. The field team recommended deleting such sampling from the work effort because,

- the amount of material included in the talus is small,
- the nature of contaminants in the talus would not differ from that on and around the firing pads,
- access by a drill rig or back hoe was not feasible, and
- the additional information obtained by such sampling would not identify a new exposure pathway nor change the severity of the estimated risk associated with the site.

The decision was reviewed and agreed to by the human health and environmental risk assessors assigned to the TA-39 project (Memo: "Risk-Based Sampling Decisions," From V. Smith, October 4, 1995).

Metals surveys (Section 5.3.4.1.3.1, RFI Work Plan): The work plan implies that XRF surveys will be conducted along the transects. Some XRF measurements were made along one of the transects but were discontinued due to lack of elevated metals signals and the fact that such information would not be used to bias sampling locations. The field team decided that elevated radiation would provide sufficient evidence as to the presence of contaminants for the purpose of locating biased sampling points.

Adjacent Hillslopes and Adjacent Mesa Tops (Section 5.3.4.1.3.1, RFI Work Plan): The work plan indicates sampling every 150 ft along the transect on the hill slopes and on the mesa tops with collection of additional samples at two of the highest radiation areas along the transect. In general, this was done only at the sampling locations that were at the highest radiation areas close to the 150-ft markers. On many of the transects hill slope, sampling was not completed because of steepness and inaccessibility or because of rock outcrops. In general, transect samples were collected from sediment accumulations on the hill slopes. The transects were to be terminated on the mesa tops when radiation readings were no longer positive for a distance of 50 ft. This was accomplished but such readings were not documented.

Section 5.3.4, Phase I Investigations, RFI Work Plan, specifies analyzing samples for petroleum hydrocarbons. This analysis was not conducted on soils at PRS 39-004(b) because site personnel indicated little or no use of petroleum-based oils at this firing site and because the total petroleum hydrocarbon procedure would not quantify the compounds of concern. The alternative was to rely on SVOC analysis of surface samples to identify and quantify significant hazardous compounds attributable to the petroleum-based oil. This is supported by the information contained in "Policy for the Evaluation and Cleanup of Total Petroleum Hydrocarbons (TPHs) in Soil" (EM/ER:96-PCT-008, March 29, 1996).

Selection of biased sampling points at the highest radiation area may not always have been accomplished. One reason was that some high radiation points were due to the presence of contaminated shrapnel. When the shrapnel was removed the soil radiation readings often drop considerably; even to a local background level. Another reason was that some high radiation points occur in areas of little available soil for sampling, as on the edge of asphalt paving or in rock

outcrops. In those cases, alternative locations were chosen that represent areas of elevated radioactivity.

5.2.5 Evaluation of Inorganic Chemicals

Firing Pad

Seven surface soil samples were collected from the area around the firing pad at PRS 39-004(b) and analyzed for inorganics. Copper, lead, mercury, uranium, and zinc were detected at concentrations greater than their respective background UTLs (Table 5.2.5-1). Zinc was detected above its UTL in two samples, copper, lead, and mercury were detected above their UTLs in five samples, and uranium was present above its UTL in all seven samples. Statistical comparisons of site data to background distributions indicated that the site data sets for all the inorganics were greater than background. Similar comparisons for mercury could not be conducted because of the high number of nondetects in the mercury background data set. The p-values for the statistical tests for each inorganic are presented in Table 5.2.5-2. As a result of the background comparisons, all five inorganics were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

TABLE 5.2.5-2
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF FIRING PAD DATA TO BACKGROUND FOR PRS 39-004(b)

Analytes	Gehan Test	Quantile Test	Slippage Test
Copper	0.03	0.04	0.0
Lead	0.03	0.04	0.0
Uranium	0.0	0.0	0.0
Zinc	0.04	0.04	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.2.5-1.

Transects

Twelve soil samples [nine surface (0-6 in.) and three subsurface (10 in.)] were collected along the transects from firing pad and analyzed for inorganics. Copper, mercury, and uranium were detected at concentrations greater than their respective background UTLs in the surface and subsurface soil samples (Table 5.2.5-1). Copper was detected in four soil samples, mercury was detected in nine soil samples, and uranium was detected in all twelve soil samples above their background UTLs. Statistical comparisons of the site data sets to the background distributions for these inorganics indicate that the sample values were statistically greater than background (copper - Gehan p-value: 0.007, Quantile p-value: 0.0, Slippage p-value: 0.002; uranium - Gehan p-value: 0.0, Quantile p-value: 0.0, Slippage p-value: 0.0). Similar comparisons for mercury could not be conducted because of the high number of nondetects in the mercury background data set. As a result of the background comparisons, copper, mercury, and uranium were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.2.5-2.

TABLE 5.2.5-1
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRS 39-004(b)

Sample ID	Location ID	Depth (in.)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Uranium (mg/kg)	Zinc (mg/kg)
SAL	N/A[b]	N/A[b]	2800	400	23	230	23000
soil UTL[a]	N/A[b]	N/A[b]	15.5	23.3	0.1[c]	5.45	50.8
FIRING PAD							
0239-95-0048	39-1243	0-6	1290(J)	83.1	29.6	953	587
0239-95-0049	39-1244	0-6	206(J)	47.3	44.1	157	157
0239-95-0050	39-1245	0-6	609(J)	102	3.6	4465	47.1
0239-95-0051		0-6	137(J)	18.6	3.5	318	44.8
0239-95-0052	39-1246	0-6	345(J)	68.4	13.8	507	48.7
0239-95-0053	39-1247	0-6	6.9(J)	4.8	0.1(U)	8.5	14.2
0239-95-0056	39-1248	0-6	1.8(UJ)	4.9	0.1(U)	18.4	13.3
TRANSECTS							
0239-95-0070	39-1303	0-6	75	8.9	0.3	94.1	22
0239-95-0071		0-6	52	8.1	0.3	26.5	22
0239-95-0072		10	8.2	5.9	0.2	20	25
0239-95-0073	39-1304	0-6	1.1	11	0.6	20	21
0239-95-0074		10	11	16	0.5	26.4	40
0239-95-0075	39-1305	0-6	11.2	18.2	0.3	30.2	40.9
0239-95-0079	39-1307	0-6	9.5	17	0.2	29.5	47.2
0239-95-0080		10	4.1	7.0	0.05(U)	18	42.6
0239-95-0081	39-1308	0-6	15.6	12.3	0.7	1260	44.1
0239-95-0083	39-1309	0-6	21	19.4	0.7	2520	35.2
0239-95-0085	39-1310	0-6	10.8	11.8	0.09	569	33
0239-95-0087	39-1311	0-6	5.9	20.1	0.06(U)	12.8	28.2

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable

[c] Maximum detected background value.

5.2.6 Evaluation of Radionuclides

Firing Pad

Seven surface soil samples were collected from the area around the firing pad at PRS 39-004(b) and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Thorium-230 and uranium were detected at concentrations greater than their respective background UTLs in the surface soil samples (Table 5.2.6-1). Thorium-230 was detected in only one surface soil sample above its UTL, while uranium was detected in all seven surface soil samples above the background UTL. The background UTL for thorium-230 is the same as the UTL for uranium-234 because these radionuclides are in secular equilibrium in the environment. The background UTL for thorium-230 was calculated by converting the total thorium results to its isotopic components. As a result, statistical comparisons of the site data to the background data are not appropriate because of the difference in analytical methods used to derive the two data sets. The background comparison indicates that the site data for thorium-228, thorium-230, and thorium-232 were greater than the background UTLs for several samples (Table 5.2.6-1). Therefore, thorium-228, thorium-230, thorium-232, and uranium were carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at levels normally found in the environment and were eliminated from further evaluation.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.2.5-1.

Transects

Twelve soil samples [nine surface (0-6 in.) and three subsurface (10 in.)] were collected along the transects from firing pad and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Thorium-228, thorium-230, uranium-235, and uranium were detected at concentrations greater than their respective background UTLs in the surface and subsurface soil samples (Table 5.2.6-1). The background UTL for thorium-228 is the same as for thorium-232 because these radionuclides are in secular equilibrium in the environment. Similarly, the background UTL for thorium-230 is the same as the UTL for uranium-234. The background UTLs for the thorium-228 and thorium-230 were calculated by converting the total thorium results to its isotopic components. As a result, statistical comparisons of the site data to the background data are not appropriate because of the difference in analytical methods used to derive the two data sets. The background comparison indicates that the site data for thorium-228, thorium-230, and thorium-232 were greater than the background UTLs for several samples (Table 5.1.6-1). Therefore, thorium-228, thorium-230, thorium-232, uranium-235, and uranium were carried forward to the SAL comparison stage. Because the uranium-235 data were obtained from the gamma spectroscopy analysis, uranium-238, which does not emit gamma rays, and uranium-234, which emits very weak gamma rays, were not reported at this site. All other radionuclides were either undetected or detected at activity levels normally measured in the environment and were eliminated from further evaluation.

In addition, thorium-234 was detected in four of the twelve soil samples but does not have a background UTL or SAL (Table 5.2.6-1). In general, the detection of thorium-234 corresponded to high concentrations of uranium because thorium-234 is the first daughter product in the radioactive decay series for uranium-238. As a result, it is included in the SAL calculation for uranium and is not considered as a separate contaminant from the detected uranium.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.2.5-2.

TABLE 5.2.8-1

RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRS 39-004(b)

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Thorium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium (mg/kg)
SAL	N/A[b]	N/A[b]	1.7	0.18	0.77	No SAL	10	130
soil UTL[a]	N/A[b]	N/A[b]	2.47[c]	1.94[c]	2.47[d]	Not Available[e]	0.084[d]	5.45
[illegible]								
0239-95-0048	39-1243	0-6	1.4(J)	1.1	1.4(J)	Not Analyzed	Not Analyzed	953
0239-95-0049	39-1244	0-6	1.6(J)	1.3	1.6(J)	Not Analyzed	Not Analyzed	157
0239-95-0050	39-1245	0-6	1.4(J)	1.2	1.3(J)	Not Reported	Not Reported	4465
0239-95-0051		0-6	1.6(J)	1.1	1.6(J)	Not Reported	Not Reported	318
0239-95-0052	39-1246	0-6	1.6(J)	1.2	1.5(J)	Not Reported	Not Reported	507
0239-95-0053	39-1247	0-6	1.9(J)	1.9	1.9(J)	Not Reported	Not Reported	8.5
0239-95-0056	39-1248	0-6	2.1(J)	2.0	2.0(J)	Not Analyzed	Not Analyzed	18.4
[illegible]								
0239-95-0070	39-1303	0-6	2.5(J)	2.7	2.5(J)	27.3	0.85	94.1(J)
0239-95-0071		0-6	2.4(J)	2.6	2.4(J)	6.8(U)	0.2(U)	26.5(J)
0239-95-0072		10	2.7(J)	2.7	2.5(J)	7.5(U)	0.2(U)	20(J)
0239-95-0073	39-1304	0-6	2.0(J)	2.0	2.0(J)	6.0(U)	0.2(U)	20(J)
0239-95-0074		10	2.0(J)	1.9	1.8(J)	7.1(U)	0.2(U)	26.4(J)
0239-95-0075	39-1305	0-6	2.2(J)	2.1	2.1(J)	5.8(U)	0.2(U)	30.2(J+)
0239-95-0079	39-1307	0-6	2.0(J)	1.9	2.1(J)	5.6(U)	0.2(U)	29.5(J+)
0238-95-0080		10	2.0(J)	1.9	1.9(J)	6.9(U)	0.2(U)	18(J+)
0239-95-0081	39-1308	0-6	1.9(J)	1.7	1.8(J)	1120	18.6	1260(J+)
0239-95-0083	39-1309	0-6	1.9(J)	1.9	1.9(J)	839	13.2	2520(J+)
0239-95-0085	39-1310	0-6	2.0(J)	1.8	2.0(J)	252	2.6	569(J+)
0239-95-0087	39-1311	0-6	1.8(J)	1.6	1.8(J)	3.8(U)	0.2(U)	12.8(J+)

Notes: Qualifiers used in table are defined in Section 3.1.2.

Values in cells with bold borders are greater than background; values in shaded cells are >SAL or for the thorium isotopes > background and SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable.

[c] Radionuclides are in secular equilibrium with thorium-232 and uranium-234, respectively; the background screening values are therefore the same.

[d] Background screening values are converted from elemental concentrations reported in the LANL background report.

[e] Background data not available; sample-specific minimum detectable activities are used as screening criteria.

5.2.7 Evaluation of Organic Chemicals

Firing Pads

Seven surface soil samples were collected from the area around the firing pad at PRS 39-004(b) and analyzed for SVOCs and HE. No organics were detected in the samples collected around the firing pad at PRS 39-004(b). The undetected organics were eliminated from further evaluation.

Transects

Twelve soil samples [nine surface (0-6 in.) and three subsurface (10 in.)] were collected along the transects from firing pad and analyzed for SVOCs and HE. Bis(2-ethylhexyl)phthalate was detected in one subsurface soil sample and di-n-butyl phthalate was detected in one surface soil sample (Table 5.2.7-1). Although these analytes are common laboratory contaminants, they were carried forward to the screening assessment because they were not detected in any of the blanks and may have been generated as a result of the explosives testing at this site. No other organics were detected in the samples collected along the transects from the firing pads. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.2.5-2.

TABLE 5.2.7-1
DETECTED ORGANIC CHEMICALS FOR PRS 39-004(b)

Sample ID	Location ID	Depth (in)	Bis(2-ethylhexyl)phthalate (mg/kg)	Di-n-butyl phthalate (mg/kg)
SAL	N/A[a]	N/A[a]	32	1300
EQL	N/A[a]	N/A[a]	0.33	0.33
TRANSECTS				
0239-95-0074	39-1304	10	0.2	0.2(U)
0239-95-0083	39-1309	0-6	0.4(U)	0.04(J)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are detected concentrations.

[a] N/A = not applicable

5.2.8 Risk-Based Screening Assessment

Firing Pad

Mercury was detected in two surface soil samples at concentrations that exceeded its SAL, while uranium was detected in four surface soil samples at concentrations that exceeded its systemic SAL (Table 5.2.8-1). These inorganics were retained as COPCs. The other inorganics that were detected above their background UTLs, but below their SALs, were submitted to an MCE (Table 5.2.8-3).

Because isotopic uranium analysis was not conducted on samples collected from the firing site, it was not possible to determine whether the uranium detected was depleted or natural uranium. It was assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and, therefore, the sample values were compared to the SAL for depleted uranium (130 mg/kg) for the screening assesment. The results of this comparison found uranium to be present at concentrations greater than the DU SAL in five surface soil samples (Table 5.2.8-2) and it was retained as a COPC.

In addition, thorium-228, thorium-230, and thorium-232 were detected above their background UTLs. Because the background UTLs were greater than the SALs for these radionuclides, the thorium isotopes were retained as COPCs (Table 5.2.8-2).

TABLE 5.2.8-1
PRS 39-004(b) INORGANICS WITH CONCENTRATIONS IN SOIL FROM THE FIRING PAD THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Mercury (mg/kg)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	23	230
0239-95-0048	39-1239	0-6	29.6	953
0239-95-0049	39-1240	0-6	44.1	157
0239-95-0050	39-1254	0-6	3.6	4465
0239-95-0051	39-1256	0-6	3.5	318
0239-95-0052	39-1246	0-6	13.8	507

Notes: Values in shaded cells are >SAL.
[a] N/A = not applicable

TABLE 5.2.8-2
PRSs 39-004(b) RADIONUCLIDES WITH CONCENTRATIONS IN SOIL FROM THE FIRING PAD THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	1.7	0.18	0.77	130
0239-96-0048	39-1243	0-6	1.4(J)	1.1	1.4(J)	953
0239-96-0049	39-1244	0-6	1.6(J)	1.3	1.6(J)	157
0239-96-0050	39-1245	0-6	1.4(J)	1.2	1.3(J)	4465
0239-96-0051		0-6	1.6(J)	1.1	1.6(J)	318
0239-96-0052	39-1246	0-6	1.6(J)	1.2	1.5(J)	507
0239-96-0056	39-1248	0-6	2.1(J)	2.0	2.0(J)	18.4

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SAL.
[a] N/A = not applicable

No organics were detected around the firing pad at PRS 39-004(b).

Multiple Chemical Evaluation

The MCE included three analytes in the noncarcinogenic effects category (Table 5.2.8-3). The sum of the maximum normalized concentrations is 0.8, which is below the target value of 1.0. As a result, these analytes were not retained as COPCs.

MULTIPLE CHEMICAL EVALUATION FOR SOIL SAMPLES FROM THE FIRING PAD AT PRS 39-004(b)

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values
Noncarcinogenic Effects (mg/kg)					
Copper	39-1243	0239-95-0048	1290(J)	2800	0.46
Lead	39-1245	0239-95-0050	102	400	0.26
Zinc	39-1243	0239-95-0048	587	23000	0.03
				Total[n]:	0.8

[a] SAL = screening action level.

[n] Total may not equal sum of normalized values due to rounding.

Transects

Uranium was detected in three surface soil samples at concentrations that exceeded its systemic SAL of 230 mg/kg (Table 5.2.8-4) and was retained as a COPC. The other inorganics that were detected above their background UTLs, but below their SALs, were submitted to an MCE (Table 5.2.8-5).

Because isotopic uranium analysis was not conducted on samples collected along the transects from the firing pads, it was not possible to determine whether the uranium detected was depleted or natural uranium. It was assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and, therefore, the sample values were compared to the SAL for depleted uranium (130 mg/kg) for the screening assesment. The results of this comparison found uranium to be present at concentrations greater than the DU SAL in three surface soil samples (Table 5.2.8-4). In addition, uranium-235 was detected in two surface soil samples at concentrations greater than its SAL (Table 5.2.6-1). Because uranium-235 is included in the total uranium values, which are also greater than its SAL, uranium-235 is not a separate contaminant. Therefore, only depleted uranium was retained as a COPC.

In addition, thorium-228, thorium-230, and thorium-232 were detected above their background UTLs. Because the background UTLs are greater than the SALs for these radionuclides, the thorium isotopes were retained as COPCs (Table 5.2.8-4).

TABLE 5.2.8-4
PRS 39-004(b) INORGANICS/RADIONUCLIDES WITH CONCENTRATIONS IN SOIL ALONG THE TRANSECTS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	1.7	0.18	0.77	230/130[b]
0239-96-0070	39-1303	0-6	2.5(J)	2.7	2.5(J)	94.1(J)
0239-96-0071		0-6	2.4(J)	2.6	2.4(J)	26.5(J)
0239-96-0072		10	2.7(J)	2.7	2.5(J)	20(J)
0239-96-0073	39-1304	0-6	2.0(J)	2.0	2.0(J)	20(J)
0239-96-0074		10	2.0(J)	1.9	1.8(J)	26.4(J)
0239-96-0075	39-1305	0-6	2.2(J)	2.1	2.1(J)	30.2(J+)
0239-96-0081	39-1308	0-6	1.9(J)	1.7	1.8(J)	1260(J+)
0239-96-0083	39-1309	0-6	1.9(J)	1.9	1.9(J)	2520(J+)
0239-96-0085	39-1310	0-6	2.0(J)	1.8	2.0(J)	569(J+)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SAL.

[a] N/A = not applicable

[b] SAL of 230 mg/kg based on systemic effects; DU SAL of 130 mg/kg is based on radiation dose.

Bis(2-ethylhexyl)phthalate was detected in one subsurface soil sample below its SAL of 32 mg/kg and di-n-butyl phthalate was detected in one surface soil sample below its SAL of 1300 mg/kg (Table 5.2.7-1). Di-n-butyl phthalate was submitted to the MCE for noncarcinogens. Bis(2-ethylhexyl)phthalate was not submitted to an MCE because it was the only carcinogen detected and was eliminated from further evaluation. No other organics were detected along the transects from the firing pad.

Multiple Chemical Evaluation

The MCE included three analytes in the noncarcinogenic effects category (Table 5.2.8-5). The sum of the maximum normalized concentrations is 0.06, which is below the target value of 1.0. As a result, these analytes were not retained as COPCs.

TABLE 5.2.8-5
MULTIPLE CHEMICAL EVALUATION FOR SOIL SAMPLES FROM THE TRANSECTS AT PRS 39-004(b)

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values
Noncarcinogenic Effects (mg/kg)					
Copper	39-1303	0239-95-0070	75	2800	0.03
Di-n-butyl phthalate	39-1309	0239-95-0083	0.04(J)	1300	0.00
Mercury	39-1309	0239-95-0083	0.72	23	0.03
				Total[b]:	0.06

[a] SAL = screening action level.

5.2.9 Human Health Risk Assessment

A human health risk assessment was perfomed on PRS 39-004(b) because five COPCs that require further evaluation were retained as a result of the screening assessment. Noncarcinogenic hazard was evaluated using Laboratory site-specific exposure parameters and the guidance set forth in the Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989). The hazard calculations were based on the current land use, i.e., continued Laboratory operations. The radionuclide risk was calculated using RESRAD 5.61, which also incorporated Laboratory site-specific parameters and was based on the current land use. Risk calculations were performed to determine if the hazard index was greater than 1.0 or the radionuclide dose was above the recommended dose limit of 30 mrem/yr.

5.2.9.1 Review of COPCs and Extent of Contamination

Mercury, thorium-228, thorium-230, thorium-232, and uranium were retained as COPCs for the area around the firing pad at PRS 39-004(b) and thorium-228, thorium-230, thorium-232, and uranium were retained as COPCs for the transects.

The extent of contamination was defined for the firing site at PRS 39-004(b). The area within approximately a hundred-foot radius of the firing pad as well as several hundred feet from the firing pad were sampled for this investigation to determine whether contamination was present and the extent of any contamination originating from the firing pad. As a result of the extensive sampling, five COPCs were retained. The highest detected values of mercury and the four highest detected values of uranium around the firing pad area were from samples collected within 100 ft and to the south and southwest of the firing pad (Figure 5.2.4-2). The highest detected values of uranium from the transects were from surface samples collected at approximately 175 ft, 300 ft, and 400 ft south of the firing pad (Figure 5.2.4-3). The thorium radioisotopes were detected above background within 50 to75 ft of the firing pads as well as along the transects as far as 500 ft from the firing pads (Figures 5.2.4-2 and 5.2.4-3).

5.2.9.2 Exposure Assessment

The contaminant source is the firing pad, the contaminated medium is the surface soil, and the exposure routes include incidental ingestion, inhalation, and dermal contact under a non-intrusive industrial scenario. The exposure area (approximately 75,000 m^2) includes the firing pad, the transects, and adjacent stream channel segment (stream channel is presented in Section 5.6).

The pathway-specific and radiological-specific doses from exposure to radionuclides are estimated by RESRAD version 5.61. The exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD code estimates the dose contributions of the exposure media by mathematical modeling of the soil data. RESRAD calculates the annual dose estimates for individual radionuclides using site-specific exposure point concentrations and exposure assumptions (Appendix E). The dose contribution of daughter products is included in the dose estimates for the primary radionuclides. The annual dose estimates derived from RESRAD, expressed in mrem/yr, are then compared to the radiation dose limits for the appropriate exposure scenario. The recommended dose limit, as proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196 (EPA 1993, 06-0119), is 30 mrem/yr for the current industrial scenario. Department of Energy Order 5400.5 stipulates a dose limit of 100 mrem/yr for industrial sites.

The exposure point concentrations were the RMEs and were derived based on the 95% upper confidence limit (UCL) of the arithmetic mean (Table 5.2.9-1). The data set used to calculate the 95% UCLs consisted of all samples collected from within the exposure area and included firing pad area, transects, and stream channel samples. The distributions of the COPC concentrations at the site are not consistent with either normal or lognormal distributions, the mathematical distributions commonly associated with environmental soil contamination. The Kolmogorov-Smirnov Test, a nonparametric goodness of fit test was used to compare the distributions of the COPC concdentrations at the site and found that the concentrations are not consistent with either of the distributions.

Because the COPC concentrations are not consistent with commonly used distributions, a statistic (i.e., 95% UCLs) based on these distributions would not be valid. Therefore, the 95% UCLs are calculated using a resampling technique known as bootstrapping (Efron and Tibshirani 1988). Bootstrapping is a nonparametric, computer-based technique that makes use of a Monte Carlo algorithm applied to the observed data set. Resampling from the original data set is used to generate an approximate distribution for the sample mean, from which an approximate 95% UCL may be computed. In the cases of the COPC concentrations at this site, this statistic is more useful than a parametric or semi-parametric one because distributional assumptions about the data are not necessary.

TABLE 5.2.9-1
EXPOSURE POINT CONCENTRATIONS USED TO CALCULATE THE ESTIMATED INTAKES FOR EACH COPC

Analyte	Industrial Long-Term Worker	
	(mg/kg)	(pCi/g)
Mercury	6.8	N/A[a]
Thorium-228	N/A	1.7
Thorium-230	N/A	1.6
Thorium-232	N/A	1.7
Uranium	655	262

[a] N/A = not applicable

The pathway-specific and radiological-specific doses from exposure to radionuclides are estimated by the Residual Radioactive (RESRAD) computer code version 5.61. The exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD code estimates the dose contributions of the exposure media by

mathematical modeling of the soil data. RESRAD calculates the annual dose estimates for individual radionuclides using site-specific exposure point concentrations and exposure assumptions (Appendix E). The dose contribution of daughter products is included in the dose estimates for the primary radionuclides. The annual dose estimates derived from RESRAD, expressed in mrem/yr, are then compared to the radiation dose limits for the appropriate exposure scenario. The recommended dose limit, as proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196 (EPA 1993, 06-0119), is 30 mrem/yr for the current industrial scenario. In addition, Department of Energy Order 5400.5 stipulates a target dose limit of 100 mrem/yr for industrial scenarios.

Because the firing pad area is not utilized every day for 8 hours/day, the exposure time and exposure frequency are estimated based on conversations with current site personnel. The exposure time is estimated to be no more than 2 hrs/day and the exposure frequency is estimated to be 22 days/year. The intake equations and the exposure parameters used to calculate the ADDs for the COPCs are presented in Tables C-1, C-2, and C-3 of Appendix C. The calculated ADDs for noncarcinogenic effects for each exposure pathway are presented in Tables 5.2.9-2, 5.2.9-3, and 5.2.9-4. The RESRAD summary output files for the radionuclides of concern are provided in Appendix E.

Please refer to Section 5.1.9.2 of PRS 39-004(a,d) for a comprehensive presentation of the exposure assessment.

5.2.9.3 Toxicity Assessment

The toxicity assessment for the firing site at PRS 39-004(b) is the same as presented in Section 5.1.9.3 for the firing sites at PRSs 39-004(a,d). The toxicological profiles and toxicity criteria (Table C-4) for the COPCs are presented in Appendix C.

5.2.9.4 Risk and Dose Characterization

Nonradiological Risk

The potential human health risks associated with the selected human exposure pathways are assessed by combining the calculated doses with the toxicity criteria. USEPA has developed guidelines for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals, and uses separate methodologies for estimating the risks from these two classes of compounds. The risk and dose characterization discussion for the firing site at PRS 39-004(b) is the same as presented in Section 5.1.9.4 for the firing sites at PRSs 39-004(a,d).

For current land use conditions, potential risks associated with incidental ingestion, dermal contact, and inhalation of fugitive dust by on-site workers were quantified for the entire firing site area. No carcinogenic COPCs, for which an upper-bound excess lifetime cancer risk was calculated, were retained at this site. Mercury and uranium were the COPCs for which hazard indices were calculated. The quantitative risk estimates associated with the COPCs are presented in Tables 5.2.9-2, 5.2.9-3, and 5.2.9-4. The total hazard indices for the various exposure pathways associated with the current land-use are presented in Table 5.2.9-5.

Individuals may be exposed to a combination of pathways at any given time and therefore the combined pathway risks for plausible multiple pathway exposures were calculated and presented in Table 5.2.9-5. The hazard index for the current land use scenario was 0.03, which is below the target value of 1.0, and indicates that hazard from the noncarcinogenic COPCs at this site is unlikely.

TABLE 5.2.9-2
EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	RME	RME			RME
Mercury	6.8	5.9E-07	3E-04	Central Nervous System	2E-03
Uranium	655	5.6E-05	3E-03	Kidney	2E-02
Hazard Index					0.02

TABLE 5.2.9-3
EXPOSURES AND RISKS ASSOCIATED WITH DERMAL CONTACT OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	Adjusted RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	RME	RME			RME
Mercury	6.8	1.9E-07	3E-05	Central Nervous System	6E-03
Uranium	655	1.8E-05	3E-03	Kidney	6E-03
Hazard Index					0.01

TABLE 5.2.9-4
EXPOSURES AND RISKS ASSOCIATED WITH INHALATION OF FUGITIVE DUST OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	RME	RME			RME
Mercury	6.8	1.8E-09	8.4E-05	Central Nervous System	2E-05
Uranium	655	NA[a]	NA[a]	Kidney	NA[a]
Hazard Index					2E-05

[a] NA = not available; an inhalation RfD for uranium is not available.

TABLE 5.3.4-1
SUMMARY OF SAMPLES TAKEN[1]

Location ID	Sample ID	Depth (ft)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
FIRING PAD								
39-1249	0239-95-0148	0-0.5	soil	926	928	927	929	Not Analyzed
39-1250	0239-95-0149	0-0.5	soil	926	928	927	929	Not Analyzed
39-1251	0239-95-0150	0-0.5	soil	926	928	927	929	Not Analyzed
39-1252	0239-95-0151	0-0.5	soil	926	928	927	929	Not Analyzed
39-1253	0239-95-0152	0-0.5	soil	926	928	927	929	Not Analyzed
TRANSECTS								
39-1324	0239-95-0174	0-0.5	soil	1186	1190	1188	1191	1191
39-1324	0239-95-0175	0-0.5	soil	1186	1190	1188	1191	1191
39-1324	0239-95-0176	0.8	soil	1186	1190	1188	1191	1191
39-1327	0239-95-0181	0-0.5	soil	1186	1190	1188	1191	1191
39-1328	0239-95-0183	0-0.5	soil	1104	1103	1105	1107	1107
39-1328	0239-95-0184	0.8	soil	1104	1103	1105	1107	1107
39-1329	0239-95-0185	0-0.5	soil	1104	1103	1105	1107	1107
39-1329	0239-95-0186	0.8	soil	1104	1103	1105	1107	1107
39-1330	0239-95-0187	0-0.5	soil	1104	1103	1105	1107	1107
39-1330	0239-95-0188	0.8	soil	1104	1103	1105	1107	1107
39-1331	0239-95-0189	0-0.5	soil	1104	1103	1105	1107	1107
39-1331	0239-95-0190	0.8	soil	1104	1103	1105	1107	1107
39-1332	0239-95-0191	0-0.5	soil	1186	1190	1188	1191	1191
39-1332	0239-95-0192	0-0.5	soil	1186	1190	1188	1191	1191
39-1333	0239-95-0194	0-0.5	soil	1186	1190	1188	1191	1191
39-1333	0239-95-0195	0.8	soil	1186	1190	1188	1191	1191
39-1334	0239-95-0196	0-0.5	soil	1186	1190	1188	1191	1191
39-1334	0239-95-0197	0.8	soil	1186	1190	1188	1191	1191
39-1335	0239-95-0198	0-0.5	soil	1186	1190	1188	1191	1191

[1] Numbers in the analyte columns are request numbers.

5.3 PRS 39-004(e) - Firing Site

PRS 39-004(e) (Figure 5.3-1) is a firing site located in the western tributary of the upper reach of Ancho Canyon (North Fork) on the same tributary as PRS 39-004(b). The firing pad is located in the canyon bottom between an ephemeral stream and the southern hillslope. This PRS is within the deposition area of PRSs 39-004(a,d, and b); however, it is being evaluated separately because the experiments conducted there may represent a different spectrum of potential contaminants. PRS 39-004(e) is associated with blockhouse TA-39-88 (an electronics and camera facility) and support structures 39-95, 39-96, and 39-97. Chromium, copper, lead, and zinc were retained as COPCs in samples collected around the firing pad. Thorium-228, thorium-230, thorium-232, and total uranium were retained as COPCs along the transects which may be more representative of the deposition of debris from PRSs 39-004(a,d, and b). A risk assessment found that there was not an unacceptable risk to human health under the continued Laboratory use (i.e., industrial) scenario. The PRS will be re-evaluated when the site is decommissioned.

5.3.1 History

This firing site has been in operation since 1978 and is currently active. Experiments at the site include detonation of HE to support research in equation-of-state and shock wave phenomena and development of explosively produced pulses of electrical power and high magnetic fields. Typical experiments use 10 to 100 pounds of HE but the site is rated for greater than 1000 pounds. Debris from the explosions is generally deposited within about 200 ft of the firing pad but some is deposited at greater distances on the adjacent hill slopes and mesa tops. Materials used in significant quantities over the years include beryllium, mercury, natural and depleted uranium, lead, aluminum, copper, brass, stainless steel, thallium, cadmium, chromium, thorium-232 (natural), dielectric oil, and various types of HE (RDX, HMX, Baratol, PETN, TATB, TNT, Composition B, and cyclotol). Use of some of the more toxic materials (e.g., lead, uranium, mercury, PCB-containing dielectric oil) was discontinued between 1978 and 1981 (personal communication, J. King, May 21, 1997). However, remnants of those materials may still be observed at the sites. The experiments are conducted so that there is complete burn up of the HE. If a shot fails, so that not all of the HE is spent, an effort is made to pick up and destroy the unexploded HE.

Occasionally, construction and experiment debris left on the firing pad is removed along with a layer of the disturbed surface material and is replaced with a layer of fresh sand. This activity effectively reduces the level of contaminants on the firing pad as protection for site workers. However, outside this cleaned area no major effort has been made to police or decontaminate the facility.

This PRS is discussed in further detail in Section 5.3 of the RFI work plan for OU 1132 (LANL 1993, 1089).

5.3.2 Description

Beyond that discussed in Chapter 2 no additional geology, hydrology, soils, or wildlife habitat information is available. However, a geomorphic evaluation of the canyon bottom and associated runoff areas is presented in Appendix E.

5.3.3 Previous Investigations

Sampling was conducted at PRS 39-004(e) in April 1987 to determine the level of barium in firing pad sands; results are reported in a memo to Hansen from Drypolcher (HSE-87-473, April 15, 1987). Five sampling locations on the pad were cored (depth not given) and the cored material composited to give one sample for analysis of total barium. Reported results show the total barium concentration in the sand to be <4 mg/L with a site "background" of <4 mg/L total barium (the information documented is specific that the analysis reported is "total barium" and not the "EP Toxicity" or "Extraction" procedure, therefore the actual concentration in the soil is unknown).

A second sampling event occurred in 1993 as part of the RFI of waste storage areas (RFI LA-UR-95-1069, April 1995). A waste storage area [PRS 39-002(f)] located adjacent to the entrance door to blockhouse 39-88 was 20 ft of the firing point. Samples collected from that area retained copper as a COPC.

5.3.4 Field Investigation

The objective of the investigation at PRS 39-004(e) is to determine if COPCs are present in the soils of the firing pad and surrounding hill slopes and mesa tops. The conceptual model for the site deals primarily with the presence and redistribution of surface contamination that has been deposited as a result of dispersal of experimental materials by explosive destruction. Materials from the explosions are scattered across the firing sites and adjacent areas, and debris has been found as far away as 1 mile. Contaminated soil is subject to transport by surface water and wind action, while some contaminants may be absorbed, inhaled, or ingested by exposed receptors.

Field sampling efforts at PRS 39-004(e) were completed in August 1995 and consisted of establishing transects and sampling grids by land survey methods; conducting a radiation survey of the firing pad area and adjacent stream channel (conducted in 1993); conducting specific radiation and XRF surveys of the firing pads, stream channel, and transects; sampling surface soils from the firing pads, transects, and adjacent stream channel (discussed in Section 5.6); and determining by land survey sampling point location coordinates and elevations relative to a local benchmark.

5.3.4.1 Surveys

A radiation survey was conducted on 20-ft centers over the firing pad in 1993 within a 200- by 200-ft survey grid. In 1995, this same grid was augmented adding radiation survey locations offset by 10 ft. Results of both surveys were used to help select potential biased sampling locations. In these surveys, the entire area within 5 ft along a grid line was surveyed to locate the highest radiation level; that location became a biased candidate for sampling. The radiation surveys were conducted with a FIDLER probe and a beta/gamma pancake probe to map the radiation levels at the soil surface.

A radiation survey similar to that conducted on the firing pad was conducted in 1993 in the adjacent stream channel where readings were taken about every 10 ft starting at the end of the survey associated with PRS 39-004(b) just upstream from the culvert under the site access road to approximately 680 ft downstream.

From a point thought to be a central to the firing pad, a series of three transects were hand surveyed at 150-ft intervals out to approximately 600 ft. Transect 7 is 340 degrees from N and terminated at approximately 570 ft on the mesa top. This transect intersects Transect 3 from PRS 004(d) and Transect 5 from PRS 39-004(b). Transect 8 is 115 degrees from N along the base of the hill slope roughly parallel to the stream channel and terminated at approximately 530 ft. Transect 9 is 230 degrees from N and terminated at approximately 530 ft on the mesa top to the southwest. A radiation survey similar to that conducted on the firing pad was conducted along the accessible portions of the transects. Generally, termination of the transects corresponded to the disappearance of elevated radioactivity.

An XRF survey was also conducted at the firing pad, stream channel, and transects. Signals for key analytes were evaluated as an aid in selecting biased sampling points. The analytes include: uranium, thorium, lead, cadmium, chromium, copper, arsenic, titanium, zinc, barium, silver, and strontium. A set of 25 random grid points encompassing the firing pad at PRS 39-004(e) were selected in locations of elevated radioactivity, where possible, using a random number generator. Twenty of these locations were sampled from the accessible part of the pad area for XRF analysis. Eight samples were collected from Transect 7, 16 samples were collected from Transect 8, and 10 samples were collected from Transect 9. For the XRF measurements, a small amount of the surface material (0-1 in) was collected, thoroughly mixed, dried under a heat lamp, and placed in the XRF sample cell for assay.

Results of the XRF and radiation measurements are summarized in two memos to TA-39 Files from Essington (EES15-96-204, July 2, 1996; EES15-96-XXX **(in preparation)**, June XX, 1997).

5.3.4.2 Sampling

Surface soil samples (0-6 in) were collected from four locations in the vicinity of the PRS 39-004(e) firing pad (Figure 5.3.4-1). Sampling locations based on elevated XRF readings are 39-1261 (chromium, copper, and zinc) and 39-1262 (chromium and copper); sampling locations based on elevated radiation readings are 39-1259 and 39-1260.

Sampling along the three transects included collection of surface (0-6 in) and subsurface (6-10 in) soil samples, where sufficient material was available (Figure 5.3.4-1). In several cases, the soil layer was too thin to allow collection of the deeper sample and, in other cases, the terrain was too steep to allow safe access for sampling. Four sampling locations were sampled on Transect 7 (39-1312 through 39-1315); three near the base of the cliffs and one on the mesa top. Sample location 39-1307, associated with Transect 5 of PRS 39-004(b), is also located near Transect 7. Six sampling locations were sampled on Transect 8 (39-1316 through 39-1319, 39-1382 and 39-1383). Four sampling locations were sampled on Transect 9 (39-1320 through 39-1323).

To determine if the soil radioactivity detected at the firing pad, in the stream channel, or along the transects was due to contaminated shrapnel or pieces of depleted uranium, or to general soil contamination, the field team traversed the area searching for elevated radioactivity (beta/gamma). Upon finding an elevated radiation signal within 5 to 10 ft on either side of the defined measurement point, the value was recorded (First Reading) and a search was made to determine if that radioactivity was due to general soil contamination or to a definitive piece of contaminated material. If a definitive piece of material was present, it was removed and the point was resurveyed to obtain a radiation reading of the soil (Second Reading). In several cases, removal of the contaminated pieces resulted in considerably reduced radioactivity from the underlying soil and in some cases a reduction to background was observed. The Second Reading is expected to be more representative of radioactivity in the soil. The two readings are compared to radioactivity measured on the collected mixed soil sample that was obtained for shipping purposes (Table 5.3.4-1).

TABLE 5.3.4-1
DISCRIMINATION BETWEEN RADIOACTIVE SHRAPNEL AND RADIOACTIVE SOIL AT PRS 39-004(e)

Location	Location Type	First Reading (c/m)	Second Reading (c/m)	Sample (c/m)	Comment
39-1259	Pad-Rad			275	
39-1260	Pad-Rad			225	
39-1261	Pad-XRF			150	
39-1262	Pad-XRF			150	
39-1272	SC-0	250		300	
39-1272	SC-6			275	
39-1273	SC-0	3500		1200	
39-1273	SC-6			300	
39-1274	SC-0	250		1200	
39-1274	SC-6			375	
39-1275	SC-0	300		300	
39-1275	SC-6			275	
39-1276	SC-0	250		350	
39-1276	SC-6			300	

TABLE 5.3.4-1
DISCRIMINATION BETWEEN RADIOACTIVE SHRAPNEL AND RADIOACTIVE SOIL AT PRS 39-004(e)

Location	Location Type	First Reading (c/m)	Second Reading (c/m)	Sample (c/m)	Comment
39-1312	T7-350-0			400	
39-1312	T7-350-6			400	
39-1313	T7-350-0			38000	
39-1313	T7-350-6			400	
39-1314	T7-350-0			375	
39-1314	T7-350-6			400	
39-1315	T7-350-0	85000	500	300	
39-1315	T7-350-6				NS
39-1316	T8-119-0			8000	
39-1316	T8-119-6			350	
39-1317	T8-119-0			1200	
39-1317	T8-119-6			1200	
39-1318	T8-119-0			350	
39-1318	T8-119-6			325	
39-1319	T8-119-0			300	
39-1319	T8-119-6			275	
39-1382	T8-119-0			2500	
39-1383	T8-119-0			300	
39-1320	T9-230-0	360000	15000	600	
39-1320	T9-230-6			350	
39-1321	T9-230-0	300		300	
39-1321	T9-230-6			550	
39-1322	T9-230-0	25000		4300	
39-1322	T9-230-6			600	
39-1323	T9-230-0	300		400	
39-1323	T9-230-6			300	

Pad-Rad	Sample based on elevated Radioactivity
Pad-XRF	Sample based on elevated metal by XRF
Pad-0	Level area between gun and cliff, 0-6 in sample
XRF	Energy Dispersive X-Ray Fluorescence
DM	DM-0 = Debris Mound, 0-6 in
TP	TP-0 = Talus Pile at base of cliff, 0-6 in
SC	SC-0 = Stream Channel, 0-6 in
NS	No Sample collected
+	Very small pieces of depleted uranium present
T	T1-12-0 = Transect #1, 12 deg N, 0-6 in
(c/m)	Beta/gamma readings with 44-9 pancake detector
First Reading	Elevated radioactivity, undisturbed
Second Reading	Radioactivity after removal of offending material
Sample	Radioactivity of collected mixed soil sample

All soil samples from the firing pad were analyzed for SVOCs, metals, cyanide, HE, isotopic thorium, and total uranium. Only those samples from the elevated radiation points were analyzed by gamma spectrometry. All transect samples were analyzed for SVOCs, metals, cyanide, HE, isotopic thorium, total uranium, and by gamma spectrometry. The samples collected and the analyses requested for PRS 39-004(e) are summarized in Table 5.3.4-2, while sample locations are presented in Figure 5.3.4-1.

TABLE 5.3.4-2
SUMMARY OF SAMPLES TAKEN[1]

Location ID	Sample ID	Depth (in)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
FIRING PAD								
39-1259	0239-95-0003	0-6	soil	926	928	927	929	Not Analyzed
39-1260	0239-95-0004	0-6	soil	926	928	927	929	Not Analyzed
39-1261	0239-95-0005	0-6	soil	926	928	927	929	Not Analyzed
39-1262	0239-95-0006	0-6	soil	926	928	927	929	Not Analyzed
39-1262	0239-95-0007	0-6	soil	926	928	927	929	Not Analyzed
TRANSECTS								
39-1312	0239-95-0023	0-6	soil	1044	1042	1045	1043	1043
39-1312	0239-95-0024	10	soil	1044	1042	1045	1043	1043
39-1313	0239-95-0025	0-6	soil	1044	1042	1045	1043	1043
39-1313	0239-95-0026	10	soil	1044	1042	1045	1043	1043
39-1314	0239-95-0027	0-6	soil	1044	1042	1045	1043	1043
39-1314	0239-95-0028	10	soil	1044	1042	1045	1043	1043
39-1315	0239-95-0029	0-6	soil	1186	1190	1188	1191	1191
39-1316	0239-95-0031	0-6	soil	1062	1064	1063	1065	1065
39-1316	0239-95-0032	10	soil	1062	1064	1063	1065	1065
39-1317	0239-95-0033	0-6	soil	1062	1064	1063	1065	1065
39-1317	0239-95-0034	10	soil	1062	1064	1063	1065	1065
39-1318	0239-95-0035	0-6	soil	1062	1064	1063	1065	1065
39-1318	0239-95-0036	10	soil	1062	1064	1063	1065	1065
39-1319	0239-95-0037	0-6	soil	1062	1064	1063	1065	1065
39-1319	0239-95-0038	10	soil	1062	1064	1063	1065	1065
39-1382	0239-95-0202	0-6	soil	1062	1064	1063	1065	1065
39-1383	0239-95-0203	0-6	soil	1062	1064	1063	1065	1065
39-1320	0239-95-0039	0-6	soil	1085	1087	1086	1088	1088
39-1320	0239-95-0040	0-6	soil	1085	1087	1086	1088	1088
39-1320	0239-95-0041	10	soil	1085	1087	1086	1088	1088
39-1321	0239-95-0042	0-6	soil	1085	1087	1086	1088	1088
39-1321	0239-95-0043	10	soil	1085	1087	1086	1088	1088
39-1322	0239-95-0045	0-6	soil	1085	1087	1086	1088	1088
39-1322	0239-95-0044	10	soil	1085	1087	1086	1088	1088
39-1323	0239-95-0046	0-6	soil	1186	1190	1188	1191	1191
39-1323	0239-95-0047	10	soil	1186	1190	1188	1191	1191

[1] Numbers in the analyte columns are request numbers.

5.3.4.3 Field Screening

Surface material at each sampling point was screened for HE using the "Modified Griess Reagent Spot Test for Explosives" field kit, and selected sampling points were screened for PCBs using the "D-Tech" field kit. No PCBs or HE were detected by the screening efforts.

5.3.4.4 Deviations from the RFI Work Plan Sampling Strategies

Metals surveys (Section 5.3.4.1.3.1, RFI Work Plan): The work plan implies that XRF surveys will be conducted along the transects. The XRF measurements were made along the transects but were discontinued due to lack of elevated metals signals and because such information would not be used to bias sampling locations. The field team decided that elevated radiation would provide sufficient evidence as to the presence of contaminants for the purpose of locating sampling points.

Adjacent Hillslopes and Adjacent Mesa Tops (Section 5.3.4.1.3.1, RFI Work Plan): The work plan indicates sampling every 150 ft along the transect on the hill slopes and on the mesa tops with collection of additional samples at two of the highest radiation areas along the transect. In general, this was done only at the sampling locations that were at the highest radiation areas close to the 150-ft markers. On many of the transects, hill slope sampling was not completed because of steepness and inaccessibility or because of rock outcrops. In general, transect samples were collected from sediment accumulations on the hill slopes. The transects were to be terminated when radiation readings were no longer positive for a distance of 50 ft. This was accomplished but such readings were not documented.

Section 5.3.4, Phase I Investigations, RFI Work Plan, specifies analyzing samples for total petroleum hydrocarbons. This analysis was not conducted on soils at PRS 39-004(e) because site personnel indicated little or no use of petroleum-based oils at this firing site and because the total petroleum hydrocarbon procedure would not quantify the compounds of concern. The alternative was to rely on SVOC analysis of surface samples to identify and quantify significant hazardous compounds attributable to the petroleum-based oil. This is supported by the information contained in "Policy for the Evaluation and Cleanup of Total Petroleum Hydrocarbons (TPHs) in Soil" (EM/ER:96-PCT-008, March 29, 1996).

Selection of biased sampling points at the highest radiation area may not always have been accomplished. One reason was that some high radiation points were due to the presence of contaminated shrapnel. When the shrapnel was removed the soil radiation readings often drop considerably and even to a local background level. Another reason was that some high radiation points occur in areas of little available soil for sampling, as on the edge of asphalt paving or in rock outcrops. In those cases, alternative locations were chosen that represented areas of elevated radioactivity.

5.3.5 Evaluation of Inorganic Chemicals

<u>Firing Pad</u>

Five surface soil samples were collected from the area around the firing pad at PRS 39-004(e) and analyzed for inorganics. Antimony, chromium, copper, lead, nickel, uranium, and zinc were detected at concentrations greater than their respective background UTLs in the surface soil samples and silver, which has no background UTL, was detected in four surface soil samples (Table 5.3.5-1). Antimony, uranium, and zinc were each detected above their UTLs in one sample, nickel was detected above its UTL in two samples, and chromium, copper, and lead were detected above their UTLs in three to five samples. Statistical comparisons of the site data sets to the background distributions indicated that the site data for nickel, uranium, and zinc were not statistically greater than background. However, because of the limited sample size and the presence of high concentrations of uranium and zinc in the data sets, these inorganics were not eliminated, while nickel was eliminated from further evaluation. Similar comparisons for antimony and silver could not be conducted because of the high number of nondetects in the antimony

background data set and the lack of background data for silver. The p-values for the statistical tests for the inorganics detected above background UTLs, except for antimony and silver, are presented in Table 5.3.5-2. As a result of the background comparisons, seven inorganics (antimony, chromium, copper, lead, silver, uranium, and zinc) were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

TABLE 5.3.5-2
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF FIRING PAD DATA TO BACKGROUND FOR PRS 39-004(e)

Analytes	Gehan Test	Quantile Test	Slippage Test
Chromium	0.02	0.06	0.0
Copper	0.001	0.003	0.0
Lead	0.03	0.05	0.0
Nickel	0.1	0.06	1.0
Uranium	0.3	0.3	0.0
Zinc	0.07	0.05	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.3.5-1.

Transects

Twenty-seven soil samples [fifteen surface (0-6 in.) and twelve subsurface (10 in.)] were collected along the transects from the firing pad at PRS 39-004(e) and analyzed for inorganics. Antimony, copper, mercury, uranium, and zinc were detected at concentrations greater than their respective background UTLs in surface and subsurface soil samples and silver, which has no background UTL, was detected in two surface soil samples (Table 5.3.5-1). Zinc was detected in one soil sample, antimony was detected in two soil samples, copper was detected in five soil samples, mercury was detected in seven soil samples, and uranium was detected in all twenty-two soil samples above their background UTLs. Statistical comparisons of the site data to background distributions for these inorganics indicated that the sample values for zinc were not statistically greater than background and this inorganic was eliminated from further evaluation. Similar comparisons for antimony, mercury, and silver could not be conducted because of the high number of nondetects in the antimony and mercury background data sets and the lack of background data for silver. The p-values for the statistical tests used in the comparisons are presented in Table 5.3.5-3. As a result, five inorganics (antimony, copper, mercury, silver, and uranium) were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

TABLE 5.3.5-3
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF TRANSECT DATA TO BACKGROUND FOR PRS 39-004(e)

Analytes	Gehan Test	Quantile Test	Slippage Test
Copper	0.0	0.01	0.0
Uranium	0.0	0.0	0.0
Zinc	0.4	0.04	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.3.5-2.

TABLE 5.3.5-1
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES
FOR PRS 39-004(e)

Sample ID	Location ID	Depth (in.)	Antimony (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Uranium (mg/kg)	Zinc (mg/kg)
SAL	N/A[b]	N/A[b]	31	210	2800	400	23	1500	380	230	23000
soil UTL[a]	N/A[b]	N/A[b]	1.0	19.3	15.5	23.3	0.1[c]	15.2	Not Available[d]	5.45	50.8
FIRING PAD											
0239-95-0003	39-1259	0-6	0.77(J-)	3.3	209(J)	33.8	0.1(U)	2.6	1.4	120	43.2
0239-95-0004	39-1260	0-6	0.89(J-)	86.8	1710(J)	25.9	0.1(U)	28.3	0.07(U)	4.3	41.8
0239-95-0005	39-1261	0-6	1.5(J-)	28.3	8280(J)	355	0.09(U)	23.6	1.5	1.6	4020
0239-95-0006	39-1262	0-6	0.66(UJ)	19.5	240(J)	15	0.09(U)	9.0	1.1	3.4	28.9
0239-95-0007		0-6	0.67(UJ)	11.7	1040(J)	13.6	0.09(U)	6.5	4.2	4.6	26.7
TRANSECT											
0239-95-0023	39-1312	0-6	12.8	1.0	7.3	7.4(J-)	0.06(U)	3.8	3.0(J-)	77	154(J-)
0239-95-0024		10	5.7(U)	1.9	24.1	4.5(J-)	0.05(U)	1.8	0.5(UJ)	6.4	24.2(J-)
0239-95-0025	39-1313	0-6	6.0(U)	0.6(U)	20.3	7.4(J-)	0.1	1.5(U)	0.6(UJ)	2231	38.1(J-)
0239-95-0026		10	5.7(U)	2.0	8.3	6.3(J-)	0.07	1.6	0.5(UJ)	314	24.4(J-)
0239-95-0027	39-1314	0-6	5.7(U)	0.7	7.6	11(J-)	0.05(U)	1.4(U)	0.5(UJ)	7.6	13.5(J-)
0239-95-0028		10	5.7(U)	1.6	10.6	17.2(J-)	0.05(U)	2.5	0.5(UJ)	7.7	13.4(J-)
0239-95-0029	39-1315	0-6	5.6(U)	3.5	5.0	7.7	0.05(U)	4.5	1.1(U)	5.5	33.5
0239-95-0031	39-1316	0-6	<11.1(R)	1.8(UJ)	198(J+)	9.9(J+)	0.1(U)	5.0	4.8	4416	18
0239-95-0032		10	<10.3(R)	3.6(J-)	8.6(J+)	4.6(J+)	0.1(U)	5.7	1.7(U)	247	15.6
0239-95-0033	39-1317	0-6	<10.8(R)	4.4(J-)	19.6(J+)	16(J+)	0.3	4.2	1.7(U)	598	29.5
0239-95-0034		10	<9.7(R)	3.9(J-)	4.2(J+)	7.6(J+)	0.1(U)	3.9	1.6(U)	53	22
0239-95-0035	39-1318	0-6	<9.9(R)	5.7(J-)	6.1(J+)	9.6(J+)	0.09	5.1	1.6(U)	12.1	35.2
0239-95-0202	39-1382	0-6	<10.5(R)	3.7(J-)	6.1(J+)	10(J+)	0.1(U)	3.6	1.7(U)	481	31
0239-95-0203	39-1383	0-6	<10.4(R)	7.2(J-)	6.5(J+)	10.2(J+)	0.1(U)	6.1	1.7(U)	2434	33.6
0239-95-0039	39-1320	0-6	2.9(UJ)	4.3	11.1(J-)	7.3(J+)	0.1	2.6(U)	0.3(U)	196	21.8
0239-95-0040		0-6	2.9(UJ)	5.4	8.3(J-)	7.4(J-)	0.1	3.5(U)	0.3(U)	10.4	29.3
0239-95-0041		10	2.9(UJ)	5.4	6.6(J-)	5.9(J-)	0.05(U)	4.8(U)	0.3(U)	10.1	23.5

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bolded borders are greater than background; values in shaded cells are >SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable

[c] Maximum detected background value.

[d] Background data not available; sample-specific detection limits (DL) used as screening criteria.

TABLE 5.3.5-1
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES
FOR PRS 39-004(e)

Sample ID	Location ID	Depth (in.)	Antimony (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Silver (mg/kg)	Uranium (mg/kg)	Zinc (mg/kg)
SAL	N/A[b]	N/A[b]	31	210	2800	400	23	1500	380	230	23000
soil UTL[a]	N/A[b]	N/A[b]	1.0	19.3	15.5	23.3	0.1[c]	15.2	Not Available[d]	5.45	50.8
[illegible]	[illegible]										
0239-95-0042	39-1321	0-6	3.2(J-)	5.8	20.6(J-)	16.3(J-)	0.2	4.0(U)	0.3(U)	7.3	41
0239-95-0044	39-1322	10	2.9(UJ)	6.0	8.1(J-)	10(J-)	0.1	3.9(U)	0.3(U)	10.4	38.5
0239-95-0045		0-6	2.9(UJ)	4.7	9.1(J-)	12.3(J-)	0.1	4.1(U)	0.3(U)	162	30.3
0239-95-0046	39-1323	0-6	6.0(U)	4.1	8.0	12.1	0.06(U)	7.5	1.3(U)	5.5	40.5
0239-95-0047		10	6.0(U)	6.9	7.1	12.8	0.06(U)	9.2	1.3(U)	50.4	43.5

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bolded borders are greater than background; values in shaded cells are >SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons

[b] N/A = not applicable

[c] Maximum detected background value.

[d] Background data not available; sample-specific detection limits (DL) used as screening criteria.

5.3.6 Evaluation of Radionuclides

Firing Pad

Five surface soil samples were collected from the area around the firing pad at PRS 39-004(e) and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Uranium was the only radionuclide detected at a concentration greater than its background UTL in the surface soil samples (Table 5.3.6-1). Uranium was detected in only one of five surface soil samples above its UTL and was carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at levels normally found in the environment and were eliminated from further evaluation.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.3.5-1.

Transects

Twenty-seven soil samples [fifteen surface (0-6 in.) and twelve subsurface (10 in.)] were collected along the transects from the firing pad at PRS 39-004(e) and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Thorium-228, thorium-230, thorium-232, and uranium were detected at concentrations greater than their respective background UTLs in the surface and subsurface soil samples (Table 5.3.6-1). The background UTL for thorium-228 is the same as for thorium-232 because these radionuclides are in secular equilibrium in the environment. Similarly, the background UTL for thorium-230 is the same as the UTL for uranium-234. The background UTLs for the thorium isotopes were calculated by converting the total thorium results to its isotopic components. As a result, statistical comparisons of the site data to the background data are not appropriate because of the difference in analytical methods used to derive the two data sets. The background comparison indicates that the site data for thorium-228, thorium-230, and thorium-232 were greater than the background UTLs for several samples (Table 5.3.6-1). Therefore, thorium-228, thorium-230, thorium-232, and uranium were carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at levels normally found in the environment and were eliminated from further evaluation.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.3.5-2.

5.3.7 Evaluation of Organic Chemicals

Firing Pads

Five surface soil samples were collected from the area around the firing pad at PRS 39-004(e) and analyzed for SVOCs and HE. Bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected in four surface soil samples (Table 5.3.7-1). Although these analytes are common laboratory contaminants, they were carried forward to the screening assessment because they were not detected in any of the blanks and may have been generated as a result of the explosives testing at this site. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.3.5-1.

TABLE 5.3.6-1
RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRS 39-004(e)

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Uranium (mg/kg)
SAL	N/A[b]	N/A[b]	1.7	0.18	0.77	130
soil UTL[a]	N/A[b]	N/A[b]	2.47[c]	1.94[c]	2.47[c]	5.45
FIRING PAD						
0239-95-0003	39-1259	0-6	1.8(J)	1.7	1.8(J)	120
TRANSECT						
0239-95-0023	39-1312	0-6	2.0(J)	1.7	1.7(J)	77
0239-95-0024		10	2.0(J)	2.0	1.8(J)	6.4
0239-95-0025	39-1313	0-6	2.4(J)	2.6	2.5(J)	2231
0239-95-0026		10	2.4(J)	2.4	2.5(J)	314
0239-95-0027	39-1314	0-6	2.6(J)	2.6	2.5(J)	7.6
0239-95-0028		10	2.8(J)	2.5	2.7(J)	7.7
0239-95-0029	39-1315	0-6	2.1(J)	1.8	2.0(J)	5.5(J+)
0239-95-0031	39-1316	0-6	1.9(J)	1.7	1.9(J)	4416
0239-95-0032		10	2.0(J)	1.7	2.2(J)	247
0239-95-0033	39-1317	0-6	1.9(J)	1.4	1.8(J)	598
0239-95-0034		10	1.8(J)	1.4	1.7(J)	53
0239-95-0035	39-1318	0-6	1.7(J)	1.4	1.6(J)	12.1
0239-95-0202	39-1382	0-6	1.8(J)	1.3	1.6(J)	481
0239-95-0203	39-1383	0-6	1.6(J)	1.3	1.7(J)	2434
0239-95-0039	39-1320	0-6	1.8(J)	1.4	1.6(J)	196
0239-95-0040		0-6	1.9(J)	1.5	1.8(J)	10.4
0239-95-0041		10	2.0(J)	1.6	2.0(J)	10.1
0239-95-0042	39-1321	0-6	1.9(J)	1.5	1.7(J)	7.3
0239-95-0044	39-1322	10	1.9(J)	1.3	1.7(J)	10.4
0239-95-0045		0-6	1.5(J)	1.3	1.6(J)	162
0239-95-0046	39-1323	0-6	2.0(J)	1.8	1.9(J)	5.5(J+)
0239-95-0047		10	2.2(J)	1.6	2.0(J)	50.4(J+)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL or for the thorium isotopes > background and SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable.

[c] Radionuclides are in secular equilibrium with thorium-232 and uranium-234, respectively; the background screening values are therefore the same.

[d] Background screening values are converted from elemental concentrations reported in the LANL background report.

Transects

Twenty-seven soil samples [fifteen surface (0-6 in.) and twelve subsurface (10 in.)] were collected along the transects from the firing pad at PRS 39-004(e) and analyzed for SVOCs and HE. Benzoic acid was detected in one subsurface soil sample and di-n-butyl phthalate was detected in one surface soil sample (Table 5.3.7-1). Although di-n-butyl phthalate is a common laboratory contaminant, it was carried forward to the screening assessment because it was not detected in any of the blanks and may have been generated as a result of the explosives testing at this site. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.3.5-2.

TABLE 5.3.7-1
DETECTED ORGANIC CHEMICALS FOR PRS 39-004(e)

Sample ID	Location ID	Depth (in)	Bis(2-ethylhexyl)phthalate (mg/kg)	Benzoic Acid (mg/kg)	Di-n-butyl phthalate (mg/kg)
SAL	N/A[a]	N/A[a]	32	100000	6500
EQL	N/A[a]	N/A[a]	0.33	3.5	0.33
FIRING PAD					
0239-95-0004	39-1260	0-6	0.4	1.7(U)	0.3(J)
0239-95-0005	39-1261	0-6	0.8	1.7(U)	1.0
0239-95-0006	39-1262	0-6	1.1	1.7(U)	0.6
0239-95-0007		0-6	0.7	1.6(U)	0.8
TRANSECTS					
0239-95-0023	39-1312	0-6	0.4(U)	1.9(U)	0.06(J)
0239-95-0044	39-1322	10	0.4(U)	0.2(J)	0.4(U)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bolded borders are detected concentrations.

[a] N/A = not applicable

5.3.8 Risk-Based Screening Assessment

Firing Pad

Copper was detected in one surface soil sample at a concentration that exceeded its SAL (Table 5.3.5-1) and was retained as a COPC. The other inorganics that were detected above their background UTLs, but below their SALs, were submitted to an MCE (Table 5.3.8-1).

Because isotopic uranium analysis was not conducted on samples collected from the firing sites, it was not possible to determine whether the uranium detected was depleted or natural uranium. It was assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and the sample values were therefore compared to the SAL for depleted uranium (130 mg/kg) for the screening assesment. The results of this comparison found uranium to be present at concentrations less than the DU SAL in all five surface soil samples (Table 5.3.6-1). Because uranium was the only radionuclide detected above background, an MCE for radionuclides was not conducted. Therefore, uranium was not retained as a radionuclide COPC.

Bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected in four surface soil samples below their respective SALs of 32 mg/kg and1300 mg/kg (Table 5.3.7-1). Di-n-butyl phthalate was submitted to the MCE for noncarcinogens (Table 5.3.8-1). Bis(2-ethylhexyl)phthalate was not submitted to an MCE because it was the only carcinogen detected and was eliminated from further evaluation. No other organics were detected in the area around the firing pad.

Multiple Chemical Evaluation

The MCE included seven analytes in the noncarcinogenic effects category (Table 5.3.8-1). The sum of the maximum normalized concentrations is 2.1, which is above the target value of 1.0. Because the samples are more than 50 ft apart, an individual would be exposed to more than one

TABLE 5.3.8-1
MULTIPLE CHEMICAL EVALUATION FOR SOIL SAMPLES FROM THE FIRING PAD AT PRS 39-004(e)

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values	
Noncarcinogenic Effects (mg/kg)						
					All Samples	#0239-95-0005
Antimony	39-1261	0239-95-0005	1.5(J-)	31	0.05	0.05
Chromium	39-1260	0239-95-0004	86.8	210	0.41	0.14
Di-n-butyl phthalate	39-1261	0239-95-0005	1.0	1300	0.00	0.00
Lead	39-1261	0239-95-0005	355	400	0.89	0.89
Silver	39-1262	0239-95-0007	4.2	380	0.01	0.00
Uranium	39-1259	0239-95-0003	120	230	0.52	0.01
Zinc	39-1261	0239-95-0005	4020	23000	0.18	0.18
				Total[b]:	2.1	1.3

[a] SAL = screening action level.

[b] Total may not equal sum of normalized values due to rounding.

sample at a time. Therefore, the maximum normalized sum was calculated for each sample. As a result, sample # 0239-95-0005 had the maximum sum of 1.3, which is slightly above the target value of 1.0 (Table 5.3.8-1). The analytes in this sample that contribute 0.1 or more to the normalized sum are chromium, lead, and zinc. These analytes were retained as COPCs, while the other analytes, antimony, di-n-butyl phthalate, silver, and uranium, were not retained as COPCs.

Transects

Uranium was detected in five surface and two subsurface soil samples at concentrations that exceeded its systemic SAL of 230 mg/kg (Table 5.3.5-1) and was retained as a COPC. The other inorganics that were detected above their background UTLs, but below their SALs were submitted to an MCE (Table 5.3.8-3).

Because isotopic uranium analysis was not conducted on samples collected along the transects from the firing pads, it was not possible to determine whether the uranium detected was depleted or natural uranium. It was assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and, therefore, the sample values were compared to the SAL for depleted uranium (130 mg/kg) for the screening assessment. The results of this comparison found uranium to be present at concentrations greater than the DU SAL in six surface and two subsurface soil samples (Table 5.3.6-1) and was retained as a COPC.

In addition,thorium-228, thorium-230, and thorium-232 were detected above their background UTLs. Because the background UTLs were greater than the SALs for these radionuclides, the thorium isotopes were retained as COPCs (Table 5.3.8-2).

TABLE 5.3.8-2
PRS 39-004(e) RADIONUCLIDES WITH CONCENTRATIONS IN SOIL ALONG THE TRANSECTS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	1.7	0.18	0.77	130
0239-96-0025	39-1313	0-6	2.4(J)	2.6	2.5(J)	2231
0239-96-0026		10	2.4(J)	2.4	2.5(J)	314
0239-96-0027	39-1314	0-6	2.6(J)	2.6	2.5(J)	7.6
0239-96-0028		10	2.8(J)	2.5	2.7(J)	7.7
0239-96-0031	39-1316	0-6	1.9(J)	1.7	1.9(J)	4416
0239-96-0032		10	1.8(J)	1.7	2.2(J)	247
0239-96-0033	39-1317	0-6	2.0(J)	1.4	1.8(J)	598
0239-96-0203	39-1383	0-6	1.6(J)	1.3	1.7(J)	2434
0239-96-0039	39-1320	0-6	1.8(J)	1.4	1.6(J)	196
0239-96-0045	39-1322	0-6	1.5(J)	1.3	1.6(J)	162

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bolded borders are greater than background; values in shaded cells are >SAL.
[a] N/A = not applicable

No organics were detected at concentrations that exceeded their SALs in any of the samples collected along the transects from the firing pad. Benzoic acid was detected in one subsurface soil sample and di-n-butyl phthalate was detected in one surface soil sample below their respective SALs of 100,000 mg/kg and 1300 mg/kg (Table 5.3.7-1). Both organics were submitted to the MCE for noncarcinogens (Table 5.3.8-3).

Multiple Chemical Evaluation

The MCE included six analytes in the noncarcinogenic effects category (Table 5.3.8-3). The sum of the maximum normalized concentrations is 0.5, which is below the target value of 1.0. As a result, these analytes were not retained as COPCs.

TABLE 5.3.8-3
MULTIPLE CHEMICAL EVALUATION FOR SOIL SAMPLES ALONG THE TRANSECTS AT PRS 39-004(e)

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values
Noncarcinogenic Effects (mg/kg)					
Antimony	39-1312	0239-95-0023	12.8	31	0.41
Benzoic Acid	39-1322	0239-95-0044	0.18(J)	100000	0.0
Copper	39-1316	0239-95-0031	198(J+)	2800	0.07
Di-n-butyl phthalate	39-1312	0239-95-0023	0.06(J)	1300	0.0
Mercury	39-1317	0239-95-0033	0.32	23	0.01
Silver	39-1316	0239-95-0031	4.8	380	0.01
				Total[b]:	0.5

[a] SAL = screening action level.
[b] Total may not equal sum of normalized values due to rounding.

5.3.9 Human Health Risk Assessment

A human health risk assessment was conducted on PRS 39-004(e) because several COPCs that require further evaluation were retained as a result of the screening assessment. Noncarcinogenic hazard were evaluated using Laboratory site-specific exposure parameters and the guidance set forth in the Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989). The hazard calculations were based on the current land use, i.e., continued Laboratory operations. The radionuclide dose was calculated using RESRAD 5.81, which also incorporated Laboratory site-specific parameters and was based on the current land use. Risk calculations were performed to determine if the hazard index was greater than 1.0 or the radionuclide dose was greater than the recommended dose limit of 30 mrem/yr.

5.3.9.1 Review of COPCs and Extent of Contamination

Chromium, copper, lead, and zinc were retained as COPCs for the area around the firing pad at PRS 39-004(e) and thorium-228, thorium-230, thorium-232, and uranium were retained as COPCs for the transects from the firing pad.

The extent of contamination was defined for the firing site at PRS 39-004(e). The area close to the firing pad and approximately hundred feet west and southeast from the firing pad as well as approximately 600 ft from the firing pad in several directions were sampled for this investigation to determine whether contamination was present and the extent of any contamination. As a result of the extensive sampling, eight COPCs around the firing pad and four COPCs along the transects were retained. The highest detected values for chromium, copper, lead, and zinc were from samples collected approximately 20 ft and 100 ft southeast of the firing pad (Figure 5.3.4-2). The high concentrations of uranium were detected in samples collected approximately 200 ft north, approximately 200 to 250 ft and 450 ft southeast, and approximately 350 to 400 ft southwest of the firing pad (Figure 5.3.4-3). The thorium radioisotopes were not detected above background around the firing pad, but were detected along all three transects from 300 to 450 ft from the firing pad (Figure 5.3.4-3).

5.3.9.2 Exposure Assessment

The contaminant source is the firing pad, the contaminated medium is the surface soil, and the exposure routes include incidental ingestion, inhalation, and dermal contact under a non-intrusive industrial scenario. The exposure area (approximately 63,000 m^2) includes the firing pad, the transects, and adjacent stream channel segment (stream channel is presented in Section 5.6).

The exposure point concentrations were the RMEs and were derived based on the 95% upper confidence limit (UCL) of the arithmetic mean (Table 5.3.9-1). The data set used to calculate the 95% UCLs consisted of all samples collected from within the exposure area and included firing pad area, transects, and stream channel samples. The distributions of the COPC concentrations at the site are not consistent with either normal or lognormal distributions, the mathematical distributions commonly associated with environmental soil contamination. The Kolmogorov-Smirnov Test, a nonparametric goodness of fit test was used to compare the distributions of the COPC concentrations at the site and found that the concentrations are not consistent with either of the distributions.

Because the COPC concentrations are not consistent with commonly used distributions, a statistic (i.e., 95% UCLs) based on these distributions would not be valid. Therefore, the 95% UCLs are calculated using a resampling technique known as bootstrapping (Efron and Tibshirani 1988). Bootstrapping is a nonparametric, computer-based technique that makes use of a Monte Carlo algorithm applied to the observed data set. Resampling from the original data set is used to

generate an approximate distribution for the sample mean, from which an approximate 95% UCL may be computed. In the cases of the COPC concentrations at this site, this statistic is more useful than a parametric or semi-parametric one because distributional assumptions about the data are not necessary.

TABLE 5.3.9-1
EXPOSURE POINT CONCENTRATIONS USED TO CALCULATE THE ESTIMATED INTAKES FOR EACH COPC

Analyte	Industrial Long-Term Worker	
	(mg/kg)	(pCi/g)
Chromium	12.1	N/A[a]
Copper	728	N/A
Lead	35.6	N/A
Thorium-228	N/A	1.7
Thorium-230	N/A	1.5
Thorium-232	N/A	1.7
Uranium	553	221.2
Zinc	327	N/A

[a] N/A = not applicable

The pathway-specific and radiological-specific doses from exposure to radionuclides are estimated by RESRAD version 5.61. The exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD code estimates the dose contributions of the exposure media by mathematical modeling of the soil data. RESRAD calculates the annual dose estimates for individual radionuclides using site-specific exposure point concentrations and exposure assumptions (Appendix E). The dose contribution of daughter products is included in the dose estimates for the primary radionuclides. The annual dose estimates derived from RESRAD, expressed in mrem/yr, are then compared to the radiation dose limits for the appropriate exposure scenario. The dose limit, as proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196 (EPA 1993, 06-0119), is 30 mrem/yr for the current industrial scenario. In addition, Department of Energy Order 5400.5 stipulates a target dose limit of 100 mrem/yr for industrial scenarios.

Because the firing pad area is not utilized every day for 8 hours/day, the exposure time and exposure frequency are estimated based on conversations with current site personnel. The exposure time is estimated to be no more than 2 hrs/day and the exposure frequency is estimated to be 22 days/year. The intake equations and the exposure parameters used to calculate the ADDs for the COPCs are presented in Tables C-1, C-2, and C-3 of Appendix C. The calculated ADDs for noncarcinogenic effects for each exposure pathway are presented in Tables 5.3.9-2, 5.3.9-3, and 5.3.9-4. The RESRAD summary output files for the radionuclides of concern are provided in Appendix E.

Please refer to Section 5.1.9.2 of PRS 39-004(a,d) for a comprehensive presentation of the exposure assessment.

5.3.9.3 Toxicity Assessment

The toxicity assessment for the firing site at PRS 39-004(e) is the same as presented in Section 5.1.9.3 for the firing sites at PRSs 39-004(a,d). The toxicological profiles and toxicity criteria (Table C-4) for the COPCs are presented in Appendix C.

5.3.9.4 Risk and Dose Characterization

Nonradiological Risk

The potential human health risks associated with the selected human exposure pathways are assessed by combining the calculated doses with the toxicity criteria. USEPA has developed guidelines for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals, and uses separate methodologies for estimating the risks from these two classes of compounds. The risk and dose characterization discussion for the firing site at PRS 39-004(e) is the same as presented in Section 5.1.9.4 for the firing sites at PRSs 39-004(a,d).

For current land use conditions, potential risks associated with incidental ingestion and dermal contact by on-site workers were quantified for the entire firing site area. The potential risk associated with the inhalation exposure pathway was not quantified because the noncarcinogens do not have inhalation RfDs. No carcinogenic COPCs, for which an upper-bound excess lifetime cancer risk was calculated, were retained at this site. Chromium, copper, lead,uranium, and zinc were the COPCs for which hazard indices were calculated. In the case of lead, EPA has not derived reference doses for evaluating lead toxicity. EPA Region VI has indicated that an industrial preliminary remediation goal (PRG) of 1000 mg/kg would result in the protection of a pregant female worker. The exposure point concentration for lead (35.6 mg/kg) is below the industrial PRG and therefore is not considered to present a hazard to the on-site workers. The model used by EPA Region VI indicates that the fetal blood lead level due to this soil lead concentration would be 2.4 µg/dL, which is well below the 10 µg/dL blood lead level of concern. The equations and assumptions used to arrive at this level are presented in Appendix C. In order to provide an estimate of the total cumulative risk at the firing site, lead has been incorporated into the calculations by dividing the exposure point concentration by the PRG. The quantitative risk estimates associated with the COPCs are presented in Tables 5.3.9-2 and 5.3.9-3. The total hazard indices for the various exposure pathways associated with the current land-use are presented in Table 5.3.9-4.

Individuals may be exposed to a combination of pathways at any given time and, therefore, the combined pathway risks for plausible multiple pathway exposures were calculated and presented in Table 5.3.9-4. The hazard index for the current land use scenario was 0.1, which is below the target value of 1.0, and indicates that hazard from the noncarcinogenic COPCs at this site is unlikely.

TABLE 5.3.9-2
EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	RME	RME			RME
Chromium	12.1	1E-06	1E+00	Liver	1E-06
Copper	728	6.3E-05	4E-02	Gastrointestinal	2E-03
Lead	35.6	N/A[a]	1E+03[b]	Central Nervous System	4E-02[c]
Uranium	553	4.8E-05	3E-03	Kidney	2E-02
Zinc	327	2.8E-05	3E-01		9E-05
Hazard Index					0.06

[a] N/A = not applicable

[b] EPA has not derived RfDs for lead. The value presented is the industrial PRG for lead obtained from EPA Region VI, which uses a pregnant female worker as the exposed individual.

[c] The ratio for lead is derived by dividing the exposure point concentration by the industrial PRG.

TABLE 5.3.9-3
EXPOSURES AND RISKS ASSOCIATED WITH DERMAL CONTACT OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	Adjusted RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	RME	RME			RME
Chromium	12.1	3.3E-07	4E-03	Liver	8E-05
Copper	728	2E-05	4E-02	Gastrointestinal	5E-04
Lead	35.6	N/A[a]	1E+03[b]	Central Nervous System	4E-02[c]
Uranium	553	1.5E-05	3E-03	Kidney	5E-03
Zinc	327	9E-06	2E-01		4E-05
Hazard Index					0.05

[a] N/A = not applicable
[b] EPA has not derived RfDs for lead. The value presented is the industrial PRG for lead obtained from EPA Region VI, which uses a pregnant female worker as the exposed individual.
[c] The ratio for lead is derived by dividing the exposure point concentration by the industrial PRG.

TABLE 5.3.9-4
SUMMARY OF ESTIMATED RISKS ASSOCIATED WITH EXPOSURES AT PRS 39-004(e)

Receptor/Pathway	Noncancer Hazard Index
CURRENT LAND-USE CONDITIONS	
	RME
LONG-TERM WORKER (Whole Area)	
Incidental Ingestion of Soil	0.06
Dermal Contact with Soil	0.05
Inhalation of Fugitive Dust	N/A[a]
Cumulative Risk	0.1

[a] N/A = not applicable because there are no inhalation RfDs for the COPCs.

Radiological Dose

The potential dose of the radionuclides associated with the selected human exposure pathways are assessed for each exposure scenario using RESRAD 5.61. Dose contribution by daughter products are included in the dose estimates for depleted uranium. The long-term worker scenario exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD input parameters for each exposure scenario are provided in Appendix E and the exposure point concentrations are presented in Table 5.3.9-1. The RESRAD output in Appendix E is for exposure to 1.0 pCi/g of each radionuclide COPC and is not based on the exposure point concentrations.

The annual total dose contributions for individual radionuclides and pathways for the current land-use scenario are presented in Table 5.3.9-5. The estimated annual dose of 6.2 mrem/yr for the long-term worker is below the recommended dose limit of 30 mrem/yr. The estimated dose limit is driven by the external irradiation and inhalation pathways, which accounts for 96.3% of the total estimated dose.

TABLE 5.3.9-5
ANNUAL DOSE CONTRIBUTION FOR INDIVIDUAL RADIONUCLIDES FOR THE CURRENT LAND-USE SCENARIO

Exposure Pathway	Thorium-228/232 (mrem/yr)	Thorium-230 (mrem/yr)	Uranium (mrem/yr)	Total by Pathway (mrem/yr)	Percent Contribution by Pathway
External irradiation	1.6	0.07	1.8	3.5	56.2%
Inhalation of dust	0.3	0.04	2.2	2.5	40.1%
Inhalation of radon gas	0.03	0.0004	0.0	0.03	0.5%
Ingestion of soil	0.02	0.04	0.14	0.2	3.2%
Total	2.0	0.1	4.1	Long-term worker scenario total: 6.2 mrem/yr	
Percent Contribution by Radionuclide	32.3%	1.6%	66.1%		

Uncertainties in the Human Health Risk Assessment

All risk assessments involve the use of assumptions, judgments, and incomplete data to varying degrees that contributes to the uncertainty of the final estimates of risk. Uncertainties result both from the use of assumptions or models in lieu of actual data and from the error inherent in the estimation of risk-related parameters, and may cause the risk to be overestimated or underestimated. Therefore, the results of the risk assessment should not be considered as an absolute estimate of the risk to the individuals potentially exposed to the chemicals.

Consideration of the uncertainties related to the various aspects of the risk assessment allows for a better interpretation of the results and an understanding of the potential adverse effects on human health. In general, the primary sources of uncertainty are associated with site conditions (e.g., land use assumptions); toxicological data (e.g., toxicity criteria); and exposure assessment (e.g., exposure pathways and parameters).

The uncertainties associated with the risk assessment for the firing site at PRS 39-004(e) are the same as presented in Section 5.1.9.4 for the firing sites at PRSs 39-004(a,d).

5.3.10 Preliminary Ecological Assessment

In cooperation with the New Mexico Environment Department and EPA Region VI, the Laboratory ER Project is developing an approach to ecological risk assessment. Further ecological risk assessment at this site will be deferred until the site can be assessed as part of the ecological exposure unit methodology currently being developed.

5.3.11 Conclusions and Recommendations

Because the firing site at PRSs 39-004(e) is still active and no unacceptable risk to the site personnel currently exists at the site, no further action based on humanhealth concerns is recommended until it is decommissioned. However, surface water concerns do exist that will require the implementation of BMPs at the firing site to address storm water runoff.

5.4 PRS 39-004(c) - Firing Site

PRS 39-004(c) (Figure 5.4-1) is a firing site located in the southern-most western tributary of Ancho Canyon (North Fork). The firing pad is located in the canyon bottom between an ephemeral stream and a steep hill slope to the north and a steep hill slope to the south. PRS 39-004(c) is associated with buildings 39-6 (an electronics and camera facility), 39-67 (a support facility), and 39-138 (a radioactive materials storage vault). Copper, lead, thorium-230, and uranium were retained as COPCs in samples collected on the firing pad. Thorium-228, thorium-230, and thorium-232 were retained as COPCs along the transects from the firing pad. A risk assessment found that there was not an unacceptable risk to human health based on the continued Laboratory use (i.e., Industrial) scenario. The PRS will be re-evaluated when the firing site is decommissioned.

5.4.1 History

The firing site has been in operation since 1953 and is currently active. Experiments at the site include detonation of HE to support research in equation-of-state and shock wave phenomena and development of explosively produced pulses of electrical power and high magnetic fields. Typical experiments use 10 to 100 pounds of HE. Debris from the explosions is generally deposited within approximately 200 ft of the firing pad but some debris is deposited at greater distances on the adjacent hill slopes and mesa tops. Materials used in significant quantities over the years include beryllium, mercury, natural and depleted uranium, lead, aluminum, copper, brass, stainless steel, thallium, cadmium, chromium, thorium-232 (natural), dielectric oil, and various types of HE (RDX, HMX, Baratol, PETN, TATB, TNT, Composition B, and cyclotol). Use of some of the more toxic materials (e.g., lead, uranium, mercury, PCB-containing dielectric oil) was discontinued between 1978 and 1981 (**personal communication, J. King, May 21, 1997**). The experiments are conducted so that there is complete burn up of the HE. If a shot fails, so that not all of the HE is spent, an effort is made to pick up and destroy the unexploded HE.

Occasionally, construction and experiment debris left on the firing pad is removed along with a layer of the disturbed surface material and is replaced with a layer of fresh sand. This activity effectively reduces the level of contaminants on the firing pad as protection for site workers. However, outside this cleaned area no serious effort has been made to police or decontaminate.

This PRS is discussed in further detail in Section 5.3 of the RFI work plan for OU 1132 (LANL 1993, 1089).

75 bls

5.4.2 Description

Beyond that discussed in Chapter 2 no additional geology, hydrology, soils, or wildlife habitat information is available. However, a geomorphic evaluation of the canyon bottom and associated runoff areas is presented in Appendix E.

5.4.3 Previous Investigations

Sampling was conducted at PRS 39-004(c) in April 1987 to determine the level of barium in firing pad sands; results are reported in a memo to Hansen from Drypolcher (HSE-87-473, April 15, 1987). Five sampling locations on the pad were cored (depth not given) and the cored material composited to give one sample for analysis of total barium. Reported results indicated that the total barium concentration in the sand was 6 mg/L with a corresponding background of <4 mg/L (the information documented is specific that the analysis reported is "total barium" and not the "EP Toxicity" or "Extraction" procedure, therefore the actual concentration in the soil is unknown).

A second sampling was conducted in March 1993 on the firing pad at PRS 004(c) and reported in a memo to Grieggs from Fresquez (ESH-8/EFS:94-00047, February 25, 1994). Sampling included collection of 20 surface soil samples (0-3 in) from four transects radiating (NSEW) from the firing point and extending to approximately 160 ft. Two surface sediment samples were collected downgradient in the adjacent stream channel segment and one debris rinsate sample was created by washing scattered surface debris (e.g., glass, plastic, metal, wood) with distilled water. Soil, sediment, and debris rinsate samples were analyzed for TCLP metals (arsenic, barium, cadmium, chromium, mercury, lead, selenium, and silver); total beryllium, mercury, and lead; SVOCs, VOCs, PCBs, HE, and total uranium. Samples were maintained under chain-of-custody documentation and analyses were supported with laboratory blanks, surrogates, and matrix spike samples, as appropriate. Maximum concentrations of analytes detected in the soil, sediment, or debris rinsate samples are summarized in Table 5.4.3-1.

TABLE 5.4.3-1
SUMMARY OF ANALYTICAL RESULTS FOR SOIL, SEDIMENT, AND DEBRIS RINSATE SAMPLES, PRS 39-004(c)

Analysis/Analyte	Maximum Concentrations
TCLP Metals	(µg/mL)
Arsenic	0.008
Barium	7.5
Cadmium	0.02
Chromium	<0.008
Mercury	0.06
Lead	16
Selenium	<0.002
Silver	<1.0
Uranium[1]	0.05
Total Metals	(µg/g)
Beryllium	0.8
Mercury	3.8
Lead	870
Uranium	72

TABLE 5.4.3-1
SUMMARY OF ANALYTICAL RESULTS FOR SOIL, SEDIMENT, AND DEBRIS RINSATE SAMPLES, PRS 39-004(c)
Continued

Analysis/Analyte	Maximum Concentrations
PCBs	(µg/g)
Total PCBs	1.1
VOC	(µg/g)
Acetone	<0.05
Methylene chloride	<0.02
1,1,1-Trichloroethane	0.03
2-Butanone	0.02
p-Isopropyltoluene	0.01
SVOC	(µg/g)
Di-n-octylphthalate	0.8
Butylbenzylphthalate	28.6
Bis-2-ethylhexylphthalate	0.5
Di-n-bytylphthalate	3.6
Phenol[1]	0.02

[1] Debris rinsate.

No HE residues were detected in any of the soil, sediment, or debris rinsate samples. PCBs were detected in only one soil sample approximately 80 ft east of the detonation point. Uranium was detected in all soil, sediment and debris rinsate samples.

It should also be noted that the distribution of most analytes along the transects appears as a "donut," i.e., low concentrations at the detonation point (confluence of the four transects), increasing to a maximum at approximately 50 ft and then decreasing further along the transect. This observation is consistent with the operation of periodically removing and replacing soil materials at the firing point.

A third sampling event occurred in 1993 as part of the RFI characterization of waste storage areas (RFI LA-UR-95-1069, April 1995). A waste storage area [PRS 39-002(b)] located adjacent to the entrance door to blockhouse 39-6 was within 20 ft of the firing point. Samples collected from the PRS retained PCBs and copper as COPCs.

5.4.4 Field Investigation

The objective of the investigation at PRS 39-004(c) was to determine if COPCs are present in the soils at and around the firing pad as well as on surrounding hill slopes, and on the mesa tops. The conceptual model for the site deals primarily with the presence and redistribution of surface contamination that has been deposited as a result of dispersal of experimental materials by explosive destruction. Materials from the explosions are scattered across the firing site and adjacent areas, and debris has been found as far away as 1 mile. Contaminated soil is subject to transport by surface water and wind action and may be absorbed, inhaled, or ingested by exposed receptors.

Field sampling efforts at PRS-004(c) were completed in August 1995 and consisted of establishing transects and sampling grids by land survey methods; conducting a radiation survey

of the firing pad area and adjacent stream channel (conducted in 1993); conducting specific radiation and XRF surveys of the firing pad, stream channel segment, and transects; sampling surface soils from the firing pad, transects, and the adjacent stream channel segment (discussed in Section 5.6); and determining by land survey sampling point location coordinates and elevations relative to a local benchmark.

5.4.4.1 Surveys

A radiation survey was conducted on 20-ft centers over the firing pad in 1993 within a 200- by 200-ft survey grid. In 1995, this same grid was augmented by adding radiation survey locations offset by 10 ft. Results of both surveys were used to help select potential biased sampling locations. In these surveys, the entire area within 5 ft of a grid point was surveyed to locate the highest radiation level; that location became a biased candidate for sampling. The radiation surveys were conducted with a FIDLER probe and a beta/gamma pancake probe to map the radiation levels at the soil surface.

A radiation survey of that portion of the adjacent stream channel within the griddec area was conducted in 1993. That data were not recorded separately as stream channel survey data except for the statement that "no detectable readings" were observed.

From a point central to the firing pad, a series of three transects were land surveyed at 150-ft intervals extending to approximately 600 ft. Transect 10 was 30 degrees from N and terminated at approximately 500 ft on the mesa top. Transect 11 was 140 degrees from N and terminated at approximately 500 ft. Transect 12 was 265 degrees from N and terminated at approximately 580 ft on the mesa top. A radiation survey similar to that conducted on the firing pad was conducted along the accessible portions of the transects. Generally, termination of the transects corresponded with the disappearance of elevated radioactivity.

An XRF survey was also conducted at the firing pad, along the stream channel, and along the transects. Signals for key analytes were evaluated as an aid in selecting biased sampling points. The analytes include: uranium, thorium, lead, cadmium, chromium, copper, arsenic, titanium, zinc, barium, silver, and strontium. A set of 25 random grid points encompassing the firing pad at PRS 39-004(c) were selected using a random number generator. Twenty of these locations were sampled from the accessible part of this area for XRF analysis. The screening samples were collected, where possible, at locations of elevated radioactivity; one XRF sample was collected from Transect 10; seven samples were collected from Transect 11; and seven samples were collected from Transect 12. For the XRF measurements, a small amount of the surface material (0-1 in) was collected, thoroughly mixed, dried under a heat lamp, and placed in the XRF sample cell for assay.

Results of the XRF and radiation measurements are summarized in two memos to TA-39 Files from Essington (EES15-96-204, July 2, 1996; EES15-96-XXX (in preparation), June XX, 1197).

5.4.4.2 Sampling

Surface soil samples (0-6 in) were collected from 4 locations in the vicinity of the PRS 39-004(c) firing pad (Figure 5.4.4-1). Sampling locations based on elevated XRF readings are 39-1251 (lead and copper) and 39-1252 (lead and copper); and sampling locations based on elevated radiation readings are 39-1249 and 39-1250. There was no talus pile associated with this firing site.

Sampling along the three transects included the collection of surface (0-6 in) and subsurface (6-10 in) soil samples, where sufficient material was available (Figure 5.4.4-1). In several cases, the soil layer was too thin to allow collection of the deeper sample and in other cases the terrain was too steep to allow safe access for sampling. Two sampling locations were sampled on Transect 10

(39-1324 and 39-1327); the former was offset to the east from the transect line approximately 80 ft and the latter was on the mesa top. Four sampling locations were sampled on Transect 11 (39-1328 through 39-1331) all on the steep slope to the south, and four sampling locations were sampled on Transect 12 (39-1332 through 39-1335) with three on the steep slope to the west and one on the mesa top.

To determine if the soil radioactivity detected at the firing pad, in the stream channel, or along the transects was due to contaminated shrapnel or pieces of depleted uranium or general soil contamination, the field team traversed the area searching for elevated radioactivity (beta/gamma). Upon finding an elevated radiation signal within 5 to 10 ft on either side of the defined measurement point, the value was recorded (First Reading) and a search was made to determine if that radioactivity was due to general soil contamination or to a definitive piece of contaminated material. If a definitive piece of material was present, it was removed and the point was resurveyed to obtain a radiation reading of the soil (Second Reading). In several cases, removal of the contaminated piece(s) resulted in considerably reduced radioactivity from the underlying soil and in some cases a reduction to background was observed. The Second Reading is expected to be more representative of radioactivity in the soil. The two readings are compared to radioactivity measured on the collected mixed soil sample that was obtained for shipping purposes (Table 5.4.4-1).

TABLE 5.4.4-1
DISCRIMINATION BETWEEN RADIOACTIVE SHRAPNEL AND RADIOACTIVE SOIL AT PRS 39-004(c)

Location	Location Type	First Reading (c/m)	Second Reading (c/m)	Sample (c/m)	Comment
39-1249	Pad-Rad			1000	
39-1250	Pad-Rad	300000		30000	
39-1251	Pad-XRF			325	
39-1252	Pad-XRF			250	
39-1284	SC-0	325		400	
39-1284	SC-6			300	
39-1285	SC-0	250		350	
39-1285	SC-6			300	
39-1286	SC-0	450		350	
39-1286	SC-6			310	
39-1287	SC-0	300		200	
39-1287	SC-6			330	
39-1288	SC-0	420		420	
39-1288	SC-6			350	
39-1289	SC-0	250		350	
39-1289	SC-6			170	
39-1290	SC-0	250		200	
39-1290	SC-6			250	
39-1291	SC-0	325		310	
39-1291	SC-6			170	
39-1292	SC-0	5000		200	
39-1292	SC-6			250	
39-1293	SC-0			500	

TABLE 5.4.4-1
DISCRIMINATION BETWEEN RADIOACTIVE SHRAPNEL AND RADIOACTIVE SOIL AT PRS 39-004(c)
Continued

Location	Location Type	First Reading (c/m)	Second Reading (c/m)	Sample (c/m)	Comment
39-1293	SC-6			350	
39-1324	T10-25-0	500		500	
39-1324	T10-25-6			450	
39-1325	T10-25-0				NS
39-1325	T10-25-6				NS
39-1326	T10-25-0				NS
39-1326	T10-25-6				NS
39-1327	T10-25-0	275		300	
39-1327	T10-25-6				NS
39-1328	T11-145-0	11500	450	300	
39-1328	T11-145-6			300	
39-1329	T11-145-0	100000	350	350	
39-1329	T11-145-6			350	
39-1330	T11-145-0	4000	300	250	
39-1330	T11-145-6			275	
39-1331	T11-145-0	350		350	
39-1331	T11-145-6			300	
39-1332	T12-265-0	350		300	
39-1332	T12-265-6				NS
39-1333	T12-265-0	400		375	
39-1333	T12-265-6			375	
39-1334	T12-265-0			350	
39-1334	T12-265-6			350	
39-1335	T12-265-0			230	
39-1335	T12-265-6				NS

Pad-Rad	Sample based on elevated Radioactivity
Pad-XRF	Sample based on elevated metal by XRF
Pad-0	Level area between gun and cliff, 0-6 in sample
XRF	Energy Dispersive X-Ray Fluorescence
DM	DM-0 = Debris Mound, 0-6 in
TP	TP-0 = Talus Pile at base of cliff, 0-6 in
SC	SC-0 = Stream Channel, 0-6 in
NS	No Sample collected
+	Very small pieces of depleted uranium present
T	T1-12-0 = Transect #1, 12 deg N, 0-6 in
(c/m)	Beta/gamma readings with 44-9 pancake detector
First Reading	Elevated radioactivity, undisturbed
Second Reading	Radioactivity after removal of offending material
Sample	Radioactivity of collected mixed soil sample

All soil samples from the firing pads were analyzed for SVOCs, metals, cyanide, HE, isotopic thorium, and total uranium. Only those samples from the elevated radiation points were analyzed by gamma spectrometry. All transect samples were analyzed for SVOCs, metals, cyanide, HE,

isotopic thorium, total uranium, and by gamma spectrometry. The samples collected and the analyses requested for PRS 39-004(c) are summarized in Table 5.4.4-2, while sample locations are presented in Figure 5.4.4-1.

5.4.4.3 Field Screening

Each sampling point was further screened for HE using the "Modified Griess Reagent Spot Test for Explosives" field kit, and selected sampling points were screened for PCBs using the "D-Tech" field kit. No PCBs or HE was detected in the screening efforts.

5.4.4.4 Deviations from the RFI Work Plan Sampling Strategies

Metals surveys (Section 5.3.4.1.3.1, RFI Work Plan): The work plan implies that XRF surveys will be conducted along the transects. The XRF measurements were made on samples collected along the transects but only elevated metals signals were recorded leaving comparisons and assessment difficult. The information on these measurements was not used to bias sampling locations. The field team decided that elevated radiation would provide sufficient evidence as to the presence of contaminants for the purpose of locating biased sampling points.

Adjacent Hillslopes and Adjacent Mesa Tops (Section 5.3.4.1.3.1, RFI Work Plan): The work plan indicates sampling every 150 ft along the transect on the hill slopes and on the mesa tops with collection of additional samples at two of the highest radiation areas along the transect. In general, this was done only at the sampling locations that were at the highest radiation areas close to the 150-ft markers. On many of the transects hillslopes, sampling was not completed because of steepness and inaccessibility or because of rock outcrops. In general, transect samples were collected from sediment accumulations on the hillslopes. The transects were to be terminated when radiation readings were no longer positive for a distance of 50 ft. This was accomplished but such readings were not documented.

Section 5.3.4, Phase I Investigations, RFI Work Plan, specifies analyzing samples for total petroleum hydrocarbons. This analysis was not conducted on soils at PRS 39-004(c) even though site personnel indicated considerable use of petroleum-based oils at this firing site (personal communication, J. King, May 21, 1997). The total petroleum hydrocarbon procedure would not quantify the compounds of concern; however, the alternative was to rely on SVOC analysis of surface samples to identify and quantify significant hazardous compounds attributable to the petroleum-based oil. This is supported by the information contained in "Policy for the Evaluation and Cleanup of Total Petroleum Hydrocarbons (TPHs) in Soil" (EM/EF:96-PCT-008, March 29, 1996).

Selection of biased sampling points at the highest radiation area may not always have been accomplished. One reason was that some high radiation points were due to the presence of contaminated shrapnel. When the shrapnel was removed, the soil radiation readings often drop considerably and even to a local background level. Another reason was that some high radiation points occurred in areas of little available soil for sampling, as on the edge of asphalt paving or in rock outcrops. In those cases, alternative locations were chosen that represented areas of elevated radioactivity.

TABLE 5.4.4-2
SUMMARY OF SAMPLES TAKEN[1]

Location ID	Sample ID	Depth (in)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
FIRING PAD								
39-1249	0239-95-0148	0-6	soil	926	928	927	929	Not Analyzed
39-1250	0239-95-0149	0-6	soil	926	928	927	929	Not Analyzed
39-1251	0239-95-0150	0-6	soil	926	928	927	929	Not Analyzed
39-1252	0239-95-0151	0-6	soil	926	928	927	929	Not Analyzed
39-1253	0239-95-0152	0-6	soil	926	928	927	929	Not Analyzed
TRANSECTS								
39-1324	0239-95-0174	0-6	soil	1186	1190	1188	1191	1191
39-1324	0239-95-0175	0-6	soil	1186	1190	1188	1191	1191
39-1324	0239-95-0176	10	soil	1186	1190	1188	1191	1191
39-1327	0239-95-0181	0-6	soil	1186	1190	1188	1191	1191
39-1328	0239-95-0183	0-6	soil	1104	1103	1105	1107	1107
39-1328	0239-95-0184	10	soil	1104	1103	1105	1107	1107
39-1329	0239-95-0185	0-6	soil	1104	1103	1105	1107	1107
39-1329	0239-95-0186	10	soil	1104	1103	1105	1107	1107
39-1330	0239-95-0187	0-6	soil	1104	1103	1105	1107	1107
39-1330	0239-95-0188	10	soil	1104	1103	1105	1107	1107
39-1331	0239-95-0189	0-6	soil	1104	1103	1105	1107	1107
39-1331	0239-95-0190	10	soil	1104	1103	1105	1107	1107
39-1332	0239-95-0191	0-6	soil	1186	1190	1188	1191	1191
39-1332	0239-95-0192	0-6	soil	1186	1190	1188	1191	1191
39-1333	0239-95-0194	0-6	soil	1186	1190	1188	1191	1191
39-1333	0239-95-0195	10	soil	1186	1190	1188	1191	1191
39-1334	0239-95-0196	0-6	soil	1186	1190	1188	1191	1191
39-1334	0239-95-0197	10	soil	1186	1190	1188	1191	1191
39-1335	0239-95-0198	0-6	soil	1186	1190	1188	1191	1191

[1] Numbers in the analyte columns are request numbers.

5.4.5 Evaluation of Inorganic Chemicals

Firing Pad

Five surface soil samples were collected from the area around the firing pad at PRS 39-004(c) and analyzed for inorganics. Chromium, copper, lead, mercury, uranium, and zinc were detected at concentrations greater than their respective background UTLs in the surface soil samples and silver, which has no background UTL, was detected in two surface soil samples (Table 5.4.5-1). Chromium and mercury were each detected above their UTLs in one sample, and copper, lead, uranium, and zinc were detected above their UTLs in all five samples. Statistical comparisons of the site data sets to the background distribution indicated that the site data for chromium were not statistically greater than background. However, because of a high chromium concentration in one sample, chromium was not eliminated from further evaluation. Similar comparisons for mercury and silver could not be conducted because of the high number of nondetects in the mercury background data set and the lack of background data for silver. The p-values for the statistical tests for the inorganics detected above background UTLs, except for mercury and silver, are presented in Table 5.4.5-2. As a result of the background comparisons, seven inorganics were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

TABLE 5.4.5-2
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF FIRING PAD DATA TO BACKGROUND FOR PRS 39-004(c)

Analytes	Gehan Test	Quantile Test	Slippage Test
Chromium	0.9	0.7	0.0
Copper	0.001	0.003	0.0
Lead	0.001	0.002	0.0
Uranium	0.001	0.002	0.0
Zinc	0.001	0.002	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.4.5-1.

Transects

Nineteen soil samples [twelve surface (0-6 in.) and seven subsurface (10 in.)] were collected along the transects from the firing pad at PRS 39-004(c) and analyzed for inorganics. Copper, cyanide, lead, uranium, and zinc were detected at concentrations greater than their respective background UTLs in surface and subsurface soil samples (Table 5.4.5-1). Cyanide and zinc were each detected in one subsurface soil sample, copper and lead were each detected in two soil samples, and uranium was detected in thirteen of the nineteen soil samples from the transects above their background UTLs. Statistical comparisons of the site data sets to the background distributions for these inorganics indicate that the sample values for lead and zinc were not statistically greater than background and therefore these inorganics were eliminated from further evaluation. A similar comparison for cyanide could not be conducted because of the lack of background data for this analyte. The p-values for the statistical tests for the inorganics detected above background UTLs, except for cyanide, are presented in Table 5.4.5-3. As a result of the background comparisons, copper, cyanide, and uranium were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.4.5-2.

INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES
FOR PRS 39-004(c)

Sample ID	Location ID	Depth (in.)	Chromium (mg/kg)	Copper (mg/kg)	Cyanide (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Silver (mg/kg)	Uranium (mg/kg)	Zinc (mg/kg)
SAL	N/A[b]	N/A[b]	210	2800	1300	400	23	380	230	23000
soil UTL[a]	N/A[b]	N/A[b]	19.3	15.5	Not Available[d]	23.3	0.1[c]	Not Available[d]	5.45	50.8
[illegible]										
0239-95-0148	39-1249	0-6	6.9	630(J)	0.65(UJ)	238	8.5	0.5(U)	146	183
0239-95-0149	39-1250	0-6	104	290(J)	0.6(UJ)	419	0.1(U)	55.1	34540	53
0239-95-0150	39-1251	0-6	4.9	2640(J)	0.6(UJ)	978	0.1(U)	4.1	88	115
0239-95-0151	39-1252	0-6	4.2	1050(J)	0.5(UJ)	438	0.09(U)	0.8(U)	81	155
0239-95-0152		0-6	4.7	2080(J)	0.5(UJ)	401	0.09(U)	0.8(U)	53.1	116
[illegible]										
0239-95-0174	39-1324	0-6	1.1(U)	9	0.01(U)	19.2	0.05(U)	1.2(U)	9.0	26.3
0239-95-0175		0-6	1.1(U)	11.5	0.01(U)	22.4	0.05(U)	1.2(U)	9.6	22.8
0239-95-0176		10	1.1(U)	11.6	0.01(U)	10.4	0.05(U)	1.2(U)	12.7	18.7
0239-95-0185	39-1329	0-6	5.3(J-)	15	0.5(U)	15	0.1(U)	2.1(U)	9.2	27(J-)
0239-95-0186		10	4.3(J-)	9.6	0.5(U)	11	0.1(U)	2.1(U)	14.3	20(J-)
0239-95-0187	39-1330	0-6	4.2(J-)	5.3	0.5(U)	11	0.1(U)	2.1(U)	5.6	29(J-)
0239-95-0188		10	4.2(J-)	5.3	0.5(U)	11	0.1(U)	2.1(U)	22.6	33(J-)
0239-95-0190	39-1331	10	2.1(J-)	3.1	1.6	9.3	0.1(U)	2.1(U)	7.1	40(J-)
0239-95-0191	39-1332	0-6	2.4	48.3	0.01(U)	68.7	0.05(U)	1.1(U)	15.2	50.2
0239-95-0192		0-6	3.2	10.4	0.5(U)	17.1	0.05(U)	0.9(U)	8.1	44.3
0239-95-0195	39-1333	10	3.3	9.9	0.5(U)	24.2	0.05(U)	0.9(U)	7.7	52.7
0239-95-0196	39-1334	0-6	3.9	16.7	0.5(U)	22.3	0.05(U)	0.9(U)	10.6	27.2
0239-95-0197		10	2.8	11.2	0.5(U)	17.3	0.05(U)	0.9(U)	6.9	22.8

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable

[c] Maximum detected background value.

[d] Background data not available; sample-specific detection limits (DL) used as screening criteria.

TABLE 5.4.5-3
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF TRANSECT DATA TO BACKGROUND FOR PRS 39-004(c)

Analytes	Gehan Test	Quantile Test	Slippage Test
Copper	0.001	0.0	0.09
Lead	0.02	0.05	0.0
Uranium	0.0	0.0	0.0
Zinc	0.4	0.06	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

5.4.6 Evaluation of Radionuclides

Firing Pad

Five surface soil samples were collected from the area around the firing pad at PRS 39-004(c) and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Thorium-230 and uranium were detected at concentrations greater than their respective background UTLs in the surface soil samples (Table 5.4.6-1). Thorium-230 was detected in one surface soil sample above its UTL, while uranium was detected in all five surface soil samples above its background UTL. The background UTL for thorium-230 is the same as the UTL for uranium-234 because these radionuclides are in secular equilibrium in the environment. The background UTL for thorium-230 was calculated by converting the total thorium results to its isotopic components. As a result, statistical comparisons of the site data to the background data are not appropriate because of the difference in analytical methods used to derive the two data sets. The background comparison indicates that the site data for thorium-230 were greater than the background UTLs for several samples (Table 5.4.6-1). Therefore, thorium-230 and uranium were carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at levels normally found in the environment and were eliminated from further evaluation.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.4.5-1.

Transects

Nineteen soil samples [twelve surface (0-6 in,.) and seven subsurface (10 in.)] were collected along the transects from the firing pad at PRS 39-004(c) and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Thorium-228, thorium-230, thorium-232, and uranium were detected at concentrations greater than their respective background UTLs in the surface and subsurface soil samples (Table 5.4.6-1). The background UTL for thorium-228 is the same as for thorium-232 because these radionuclides are in secular equilibrium in the environment. Similarly, the background UTL for thorium-230 is the same as the UTL for uranium-234. The background UTLs for the thorium isotopes were calculated by converting the total thorium results to its isotopic components. As a result, statistical comparisons of the site data to the background data are not appropriate because of the difference in analytical methods used to derive the two data sets. The background comparison indicates that the site data for thorium-228, thorium-230, and thorium-232 were greater than the background UTLs for several samples (Table 5.4.6-1). Therefore, thorium-228, thorium-230, thorium-232, and uranium were carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at activity levels normally measured in the environment and awee eliminated from further evaluation.

In addition, thorium-234 was detected in four of the nineteen soil samples but does not have a background UTL or SAL (Table 5.4.6-1). In general, the detection of thorium-234 corresponded to high concentrations of uranium because thorium-234 is the first daughter product in the radioactive decay series for uranium-238. As a result, it is included in the SAL calculation for uranium and is not considered as a separate contaminant from the detected uranium.

RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRS 39-004(c)

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Thorium-234 (pCi/g)	Uranium (mg/kg)
SAL	N/A[b]	N/A[b]	1.7	0.18	0.77	No SAL	130
soil UTL[a]	N/A[b]	N/A[b]	2.47[c]	1.94[c]	2.47[d]	Not Available[e]	5.45
FRING PAD							
0239-95-0148	39-1249	0-6	1.0(J)	0.8	0.9(J)	Not Analyzed	146
0239-95-0149	39-1250	0-6	1.4(J)	2.1	1.4(J)	Not Analyzed	34540
0239-95-0150	39-1251	0-6	1.3(J)	1.1	1.3(J)	Not Reported	88
0239-95-0151	39-1252	0-6	0.7(J)	0.6	0.7(J)	Not Reported	81
0239-95-0152		0-6	0.7(J)	0.6	0.7(J)	Not Reported	53.1
TRANSECTS							
0239-95-0174	39-1324	0-6	2.4(J)	2.5	2.4(J)	6.7(U)	9.0(J+)
0239-95-0175		0-6	2.2(J)	2.2	2.2(J)	7.0(U)	9.6(J+)
0239-95-0176		10	2.6(J)	2.8	2.6(J)	6.9(U)	12.7(J+)
0239-95-0183	39-1328	0-6	1.7(J)	1.4(J)	1.5(J)	1.7	3.8(J)
0239-95-0184		10	1.4(J)	1.3(J)	1.5(J)	21.9	3.4(J)
0239-95-0185	39-1329	0-6	1.4(J)	1.2(J)	1.4(J)	6.0	9.2(J)
0239-95-0186		10	1.5(J)	1.3(J)	1.5(J)	3.3	14.3(J)
0239-95-0187	39-1330	0-6	1.7(J)	1.3(J)	1.7(J)	-0.05(U)	5.6(J)
0239-95-0188		10	1.6(J)	1.2(J)	1.9(J)	-0.07(U)	22.6(J)
0239-95-0190	39-1331	10	2.2(J)	1.6(J)	1.8(J)	-0.2(U)	7.1(J)
0239-95-0191	39-1332	0-6	2.1(J)	1.8	1.9(J)	6.9(U)	15.2(J+)
0239-95-0192		0-6	1.7(J)	2.0	2.0(J)	6.4(U)	8.1(J+)
0239-95-0194	39-1333	0-6	2.2(J)	2.1	2.2(J)	6.4(U)	5.4(J+)
0239-95-0195		10	2.4(J)	2.2	2.3(J)	6.1(U)	7.7
0239-95-0196	39-1334	0-6	1.7(J)	1.5	1.7(J)	5.7(U)	10.6
0239-95-0197		10	1.6(J)	1.6	1.6(J)	5.8(U)	6.9

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL or for the thorium isotopes > background and SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable.

[c] Radionuclides are in secular equilibrium with thorium-232 and uranium-234, respectively; the background screening values are therefore the same.

[d] Background screening values are converted from elemental concentrations reported in the LANL background report.

[e] Background data not available; sample-specific minimum detectable activities are used as screening criteria.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.4.5-2.

5.4.7 Evaluation of Organic Chemicals

Firing Pad

Five surface soil samples were collected from the area around the firing pad at PRS 39-004(c) and analyzed for SVOCs and HE. Bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were each detected in four of the five surface soil samples, and butylbenzyl phthalate was detected in one surface soil sample (Table 5.4.7-1). Although these analytes are common laboratory contaminants, they were carried forward to the screening assessment because they were not detected in any of the blanks and may have been generated as a result of the explosives testing at this site. No other organics were detected in the samples collected from the area around the firing pad. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.4.5-1.

Transects

Nineteen soil samples [twelve surface (0-6 in.) and seven subsurface (10 in.)] were collected along the transects from the firing pad at PRS 39-004(c) and analyzed for SVOCs and HE. Benzoic acid, 2-amino-4,6-dinitrotoluene, and ortho-nitrotoluene were each detected in one surface soil sample and di-n-butyl phthalate was detected in three of the nineteen soil samples (Table 5.4.7-1). These four organics were carried forward to SAL comparison stage. Although di-n-butyl phthalate is a common laboratory contaminant, it was carried forward because it was not detected in any of the blanks and may have been generated as a result of the explosives testing at this site. No other organics were detected in the samples collected along the transects from the firing pads. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.4.5-2.

5.4.8 Risk-Based Screening Assessment

Firing Pad

Lead was detected in four surface soil samples at concentrations that exceeded its SAL, while uranium was detected in one surface soil sample at a concentration that exceeded the SAL based on systemic effects (Table 5.4.8-1). These inorganics were retained as COPCs. The other inorganics that were detected above their background UTLs, but below their SALs, were submitted to an MCE (Table 5.4.8-3).

Because isotopic uranium analysis was not conducted on samples collected from the firing site, it was not possible to determine whether the uranium detected was depleted or natural uranium. It was assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and the sample values were therefore compared to the SAL for depleted uranium (130 mg/kg) for the screening assesment. The results of this comparison found uranium to be present at concentrations greater than the DU SAL in two surface soil samples (Table 5.4.8-2) and it was retained as a COPC.

TABLE 5.4.7-1
DETECTED ORGANIC CHEMICALS FOR PRS 39-004(c)

Sample ID	Location ID	Depth (in)	Bis(2-ethylhexyl)phthalate (mg/kg)	Benzoic Acid (mg/kg)	Butylbenzyl phthalate (mg/kg)	Di-n-butyl phthalate (mg/kg)	2-Amino-4,6-dinitrotoluene (mg/kg)	ortho-Nitrotoluene (mg/kg)
SAL	N/A[a]	N/A[a]	32	100000	13000	1300	65[b]	650[c]
EQL	N/A[a]	N/A[a]	0.33	3.5	0.33	0.33	0.2	0.2
[illegible]								
0239-95-0148	39-1249	0-6	0.8	1.7(U)	0.4(U)	0.5	0.3(U)	0.3(U)
0239-95-0149	39-1250	0-6	0.2(J)	1.9(U)	0.2(J)	0.4(U)	0.3(U)	0.3(U)
0239-95-0150	39-1251	0-6	0.09(J)	1.8(U)	0.4(U)	0.7	0.3(U)	0.3(U)
0239-95-0151	39-1252	0-6	0.2	1.7(U)	0.3(U)	0.4	0.3(U)	0.3(U)
0239-95-0152		0-6	0.2(U)	1.7(U)	0.3(U)	0.1(J)	0.3(U)	0.3(U)
[illegible]								
0239-95-0186	39-1329	10	0.2(U)	0.9(U)	0.2(U)	0.2(U)	0.9	0.3(U)
0239-95-0190	39-1331	10	0.2(U)	0.9(U)	0.2(U)	0.5	0.3(U)	0.3(U)
0239-95-0191	39-1332	0-6	0.3(U)	1.7(U)	0.3(U)	0.04(J)	0.3(U)	0.3(U)
0239-95-0192		0-6	0.3(U)	1.7(U)	0.3(U)	0.08(J)	0.3(U)	0.3(U)
0239-95-0196	39-1334	0-6	0.4(U)	0.05(J)	0.4(U)	0.4(U)	0.3(U)	0.3(U)
0239-95-0197		10	0.4(U)	1.8(U)	0.4(U)	0.4(U)	0.3(U)	0.6

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are detected concentrations.

[a] N/A = not applicable

[b] There is no SAL for 2-amino-4,6-dinitrotoluene because toxicity criteria are not available; the toxicity criteria and SAL for 2,6-dinitrotoluene were used as surrogate values based on similarity in chemical structure.

[c] There is no SAL for ortho-nitrotoluene because toxicity criteria are not available; the toxicity criteria and SAL for para-nitrotoluene were used as surrogate values based on similarity in chemical structure.

TABLE 5.4.8-1
PRS 39-004(c) INORGANICS WITH CONCENTRATIONS IN SOIL FROM THE FIRING PAD THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Lead (mg/kg)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	400	230
0239-95-0149	39-1250	0-6	419	34540
0239-95-0150	39-1251	0-6	978	88
0239-95-0151	39-1252	0-6	438	81
0239-95-0152		0-6	401	53.1

Notes: Values in shaded cells are >SALs.
[a] N/A = not applicable

TABLE 5.4.8-2
PRS 39-004(c) RADIONUCLIDES WITH CONCENTRATIONS IN SOIL FROM THE FIRING PAD THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Thorium-230 (pCi/g)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	0.18	130
0239-96-0148	39-1249	0-6	0.8	146
0239-96-0149	39-1250	0-6	2.1	34540

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SALs.
[a] N/A = not applicable

In addition, thorium-230 was detected above its background UTLs. Because the background UTL is greater than the SAL for this radionuclide, the thorium-230 was retained as a COPC (Table 5.4.8-2).

Butylbenzyl phthalate was detected in one surface soil sample below its SAL of 13000 mg/kg, while bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were each detected in four surface soil sample below below their SALs of 32 mg/kg and1300 mg/kg, respectively (Table 5.4.7-1). Butylbenzyl phthalate and di-n-butyl phthalate were submitted to the MCE for noncarcinogens. Bis(2-ethylhexyl)phthalate was not submitted to an MCE because it was the on y carcinogen detected and was eliminated from further evaluation. No other organics were detected along the transects from the firing pad.

Multiple Chemical Evaluation

The MCE included seven analytes in the noncarcinogenic effects category (Table 5.4.8-3). The sum of the maximum normalized concentrations is 2.0, which is above the target value of 1.0. Because the samples are more than 50 ft apart, an individual would not be exposed to more than one sample at a time. Therefore, the maximum normalized sum was calculated for each sample. As a result, sample # 0239-95-0150 had the maximum sum of 0.99, which was slightly below the target value of 1.0 (Table 5.4.8-3). The only analyte in this sample that significantly contributed to the normalized sum was copper, which has a normalized concentration of 0.94. As a result, copper was retained as a COPC and the other analytes (butylbenzyl phthalate, chromium, di-n-butyl phthalate, mercury, silver, and zinc) were eliminated from further evaluation.

TABLE 5.4.8-3
MULTIPLE CHEMICAL EVALUATION FOR SOIL SAMPLES FROM THE FIRING PAD AT PRS 39-004(c)

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values	
Noncarcinogenic Effects (mg/kg)						
					All Samples	#0239-95-0150
Butylbenzyl phthalate	39-1250	0239-95-0149	0.22(J)	13000	0.0	0.0
Chromium	39-1250	0239-95-0149	104	210	0.50	0.02
Copper	39-1251	0239-95-0150	2640	2800	0.94	0.94
Di-n-butyl phthalate	39-1251	0239-95-0150	0.72	6500	0.0	0.0
Mercury	39-1249	0239-95-0148	8.5	23	0.37	0.01
Silver	39-1250	0239-95-0149	55.1	380	0.15	0.01
Zinc	39-1249	0239-95-0148	183	23000	0.01	0.01
				Total[b]:	2.0	0.99

[a] SAL = screening action level.

[b] Total may not equal sum of normalized values due to rounding.

Transects

No inorganics were detected at concentrations greater than their SALs in any of the samples collected along the transects from the firing pad at PRS 39-004(c). Cyanide and copper were each detected in only one subsurface soil sample at concentrations below their SALs of 1300 mg/kg and 2800 mg/kg, respectively, while uranium was detected in thirteen of the nineteen surface and subsurface soil samples at concentrations below its systemic SAL of 230 mg/kg (Table 5.4.5-1). All of these inorganics were submitted to an MCE (Table 5.4.8-5).

Thorium-228, thorium-230, and thorium-232 were detected above their background UTLs. Because the background UTLs were greater than the SALs for these radionuclides, the thorium isotopes were retained as COPCs (Table 5.4.8-4).

TABLE 5.4.8-4
PRS 39-004(c) RADIONUCLIDES WITH CONCENTRATIONS IN SOIL ALONG THE TRANSECTS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)
SAL	N/A[a]	N/A[a]	1.7	0.18	0.77
0239-96-0174	39-1324	0-6	2.4(J)	2.5	2.4(J)
0239-96-0175		0-6	2.2(J)	2.2	2.2(J)
0239-96-0176		10	2.6(J)	2.8	2.6(J)
0239-96-0192	39-1332	0-6	1.7(J)	2.0	2.0(J)
0239-96-0194	39-1333	0-6	2.2(J)	2.1	2.2(J)
0239-96-0195		10	2.4(J)	2.2	2.3(J)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SALs.

[a] N/A = not applicable

Because isotopic uranium analysis was not conducted on samples collected along the transects from the firing pads, it was not possible to determine whether the uranium detected was depleted or natural uranium. It was assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and, therefore, the sample values were compared to the

SAL for depleted uranium (130 mg/kg) for the screening assesment. The results of this comparison found uranium to be present at concentrations less than the DU SAL in thirteen surface soil samples (Table 5.4.6-1). Uranium was not submitted to an MCE for radionuclides because it was the only radionuclide, besides the thorium radioisotopes, that was above background. Therefore, uranium was not retained as a radionuclide COPC.

No organics were detected at concentrations greater than their SALs in any of the samples collected along the transects from the firing pad at PRS 39-004(c). Benzoic acid was detected in one surface soil sample below its SAL of 100,000 mg/kg and di-n-butyl phthalate was detected in two surface soil samples and one subsurface soil sample at concentrations below its SAL of 1300 mg/kg (Table 5.4.7-1). 2-Amino-4,6-dinitrotoluene and ortho-nitrotoluene were each detected in one subsurface soil sample at concentrations slightly above the detection limits. Benzoic acid, 2-amino-4,6-dinitrotoluene, ortho-nitrotoluene, and di-n-butyl phthalate were submitted to the MCE for noncarcinogens (Table 5.4.8-5). No other organics were detected along the transects from the firing pad.

Multiple Chemical Evaluation

The MCE included seven analytes in the noncarcinogenic effects category (Table 5.4.8-5). The sum of the maximum normalized concentrations is 0.1, which is below the target value of 1.0. As a result, these analytes were not retained as COPCs.

TABLE 5.4.8-5
MULTIPLE CHEMICAL EVALUATION FOR SOIL SAMPLES ALONG THE TRANSECTS AT PRS 39-004(c)

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values
Noncarcinogenic Effects (mg/kg)					
2-Amino-4,6-dinitrotoluene	39-1329	0239-95-0186	0.9	65	0.01
Benzoic Acid	39-1334	0239-95-0196	0.05(J)	100000	0.0
Copper	39-1332	0239-95-0190	48.3	2800	0.02
Cyanide	39-1331	0239-95-0190	1.6	1300	0.00
Di-n-butyl phthalate	39-1331	0239-95-0190	0.46	1300	0.00
ortho-Nitrotoluene	39-1334	0239-95-0197	0.6	650	0.00
Uranium	39-1330	0239-95-0188	22.6	230	0.10
				Total[b]:	0.1

[a] SAL = screening action level.

[b] Total may not equal sum of normalized values due to rounding.

5.4.9 Human Health Risk Assessment

A human health risk assessment was performed on PRS 39-004(c) because several COPCs that require further evaluation were retained as a result of the screening assessment. Noncarcinogenic hazard were evaluated using Laboratory site-specific exposure parameters and the guidance set forth in the Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989). The hazard calculations were based on the current land use, i.e., cont nued Laboratory operations. The radionuclide dose was calculated using RESRAD 5.61, which also incorporated Laboratory site-specific parameters and was based on the current land use. Risk calculations were performed to determine if the hazard index was greater than 1.0 or the radionuclide dose was greater than the recommended dose limit of 30 mrem/yr.

5.4.9.1 Review of COPCs and Extent of Contamination

Copper, lead, thorium-230, and uranium were retained as COPCs for the area around the firing pad at PRS 39-004(c), while thorium-228, thorium-230, and thorium-232 were retained as COPCs for the transects.

The extent of contamination was defined for the firing site at PRS 39-004(c). The area close to the firing pads and approximately hundred feet west and southwest from the firing pads as well as several hundred feet from the firing pad in several directions were sampled for this investigation to determine whether contamination was present and the extent of any contamination. As a result of the extensive sampling, six COPCs were retained. The highest detected values for copper and lead were from a sample collected approximately 100 ft west of the firing pad (Figure 5.4.4-2). The highest detected value of uranium was from a sample collected approximately 100 ft southwest of the firing pad (Figure 5.4.4-2). The thorium radioisotopes were detected above background in one sample collected within 100 ft of the firing pad as well as along the transects as far as 300 ft west of the firing pad (Figures 5.3.4-2 and 5.3.4-3).

5.4.9.2 Exposure Assessment

The contaminant source is the firing pad, the contaminated medium is the surface soil, and the exposure routes include incidental ingestion, inhalation, and dermal contact under a non-intrusive industrial scenario. The exposure area (approximately 128,000 m^2) includes the firing pad, the transects, and adjacent stream channel segment (stream channel is presented in Section 5.6).

The exposure point concentrations were the RMEs and were derived based on the 95% upper confidence limit (UCL) of the arithmetic mean (Table 5.4.9-1). The data set used to calculate the 95% UCLs consisted of all samples collected from within the exposure area and included firing pad area, transects, and stream channel samples. The distributions of the COPC concentrations at the site are not consistent with either normal or lognormal distributions, the mathematical distributions commonly associated with environmental soil contamination. The Kolmogorov-Smirnov Test, a nonparametric goodness of fit test was used to compare the distributions of the COPC concentrations at the site and found that the concentrations are not consistent with either of the distributions.

Because the COPC concentrations are not consistent with commonly used distributions, a statistic (i.e., 95% UCLs) based on these distributions would not be valid. Therefore, the 95% UCLs are calculated using a resampling technique known as bootstrapping (Efron and Tibshirani 1988). Bootstrapping is a nonparametric, computer-based technique that makes use of a Monte Carlo algorithm applied to the observed data set. Resampling from the original data set is used to generate an approximate distribution for the sample mean, from which an approximate 95% UCL may be computed. In the cases of the COPC concentrations at this site, this statistic is more useful than a parametric or semi-parametric one because distributional assumptions about the data are not necessary.

TABLE 5.4.9-1
EXPOSURE POINT CONCENTRATIONS USED TO CALCULATE THE ESTIMATED INTAKES FOR EACH COPC

Analyte	Industrial Long-Term Worker	
	(mg/kg)	(pCi/g)
Copper	327	N/A[a]
Lead	125	N/A
Thorium-228	N/A	1.5
Thorium-230	N/A	1.4
Thorium-232	N/A	1.5
Uranium	2322	928.8

[a] N/A = not applicable

The pathway-specific and radiological-specific doses from exposure to radionuclides are estimated by RESRAD version 5.61. The exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD code estimates the dose contributions of the exposure media by mathematical modeling of the soil data. RESRAD calculates the annual dose estimates for individual radionuclides using site-specific exposure point concentrations and exposure assumptions (Appendix E). The dose contribution of daughter products is included in the dose estimates for the primary radionuclides. The annual dose estimates derived from RESRAD, expressed in mrem/yr, are then compared to the radiation dose limits for the appropriate exposure scenario. The dose limit, as proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196 (EPA 1993, 06-0119), is 30 mrem/yr for the current industrial scenario. In addition, Department of Energy Order 5400.5 stipulates a target dose limit of 100 mrem/yr for industrial scenarios.

Because the firing pad area is not utilized every day for 8 hours/day, the exposure time and exposure frequency are estimated based on conversations with current site personnel. The exposure time is estimated to be no more than 2 hrs/day and the exposure frequency is estimated to be 22 days/year. The intake equations and the exposure parameters used to calculate the ADDs for the COPCs are presented in Tables C-1, C-2, and C-3 of Appendix C. The calculated ADDs for noncarcinogenic effects for each exposure pathway are presented in Tables 5.4.9-2, 5.4.9-3, and 5.4.9-4. The RESRAD summary output files for the radionuclides of concern are provided in Appendix E.

Please refer to Section 5.1.9.2 of PRS 39-004(a,d) for a comprehensive presentation of the exposure assessment.

5.4.9.3 Toxicity Assessment

The toxicity assessment for the firing site at PRS 39-004(c) is the same as presented in Section 5.1.9.3 for the firing sites at PRSs 39-004(a,d). The toxicological profiles and toxicity criteria (Table C-4) for the COPCs are presented in Appendix C.

5.4.9.4 Risk and Dose Characterization

Nonradiological Risk

The potential human health risks associated with the selected human exposure pathways are assessed by combining the calculated doses with the toxicity criteria. USEPA has developed guidelines for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals, and uses separate methodologies for estimating the risks from these two classes of compounds. The risk and dose characterization discussion for the firing site at PRS 39-004(c) is the same as presented in Section 5.1.9.4 for the firing sites at PRSs 39-004(a,d).

For current land use conditions, potential risks associated with incidental ingestion and dermal contact by on-site workers were quantified for the entire firing site area. The potential risk associated with the inhalation exposure pathway was not quantified because the noncarcinogens do not have inhalation RfDs. No carcinogenic COPCs, for which an upper-bound excess lifetime cancer risk was calculated, were retained at this site. Copper, lead, and uranium were the COPCs for which hazard indices were calculated. In the case of lead, EPA has not derived reference doses for evaluating lead toxicity. EPA Region VI has indicated that an industrial preliminary remediation goal (PRG) of 1000 mg/kg would result in the protection of a pregnant female worker. The exposure point concentration for lead (125 mg/kg) is below the industrial PRG and therefore is not considered to present a hazard to the on-site workers. The model used by EPA Region VI indicates that the fetal blood lead level due to this soil lead concentration would be 4.8 µg/dL, which is well below the 10 µg/dL blood lead level of concern. The equations and assumptions used to arrive at this level are presented in Appendix C. In order to provide an estimate of the total cumulative risk at the firing site, lead has been incorporated into the calculations by dividing the exposure point concentration by the PRG. The quantitative risk estimates associated with the COPCs are presented in Tables 5.4.9-2 and 5.4.9-3. The total hazard indices for the various exposure pathways associated with the current land-use are presented in Table 5.4.9-4.

Individuals may be exposed to a combination of pathways at any given time and therefore the combined pathway risks for plausible multiple pathway exposures were calculated and presented in Table 5.4.9-4. The hazard index for the current land use scenario was 0.3, which is below the target value of 1.0, and indicates that hazard from the noncarcinogenic COPCs at this site is unlikely.

TABLE 5.4.9-2
EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	RME	RME			RME
Copper	327	2.8E-05	4E-02	Gastrointestinal	7E-04
Lead	125	N/A[a]	1E+03[b]	Central Nervous System	1E-01[c]
Uranium	2322	2E-04	3E-03	Kidney	7E-02
Hazard Index					0.2

[a] N/A = not applicable

[b] EPA has not derived RfDs for lead. The value presented is the industrial PRG for lead obtained from EPA Region VI, which uses a pregnant female worker as the exposed individual.

[c] The ratio for lead is derived by dividing the exposure point concentration by the industrial PRG.

TABLE 5.4.9-3
EXPOSURES AND RISKS ASSOCIATED WITH DERMAL CONTACT OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	Adjusted RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	**RME**	**RME**			**RME**
Copper	327	9E-06	3.7E-02	Gastrointestinal	2E-04
Lead	125	N/A[a]	1E+03[b]	Central Nervous System	1E-01[c]
Uranium	2322	6.4E-05	3E-03	Kidney	2E-02
Hazard Index					0.1

[a] N/A = not applicable

[b] EPA has not derived RfDs for lead. The value presented is the industrial PRG for lead obtained from EPA Region VI, which uses a pregnant female worker as the exposed individual.

[c] The ratio for lead is derived by dividing the exposure point concentration by the industrial PRG.

TABLE 5.4.9-4
SUMMARY OF ESTIMATED RISKS ASSOCIATED WITH EXPOSURES AT PRS 39-004(c)

Receptor/Pathway	Noncancer Hazard Index
CURRENT LAND-USE CONDITIONS	
	RME
LONG-TERM WORKER (Whole Area)	
Incidental Ingestion of Soil	0.2
Dermal Contact with Soil	0.1
Inhalation of Fugitive Dust	N/A[a]
Cumulative Risk	**0.3**

[a] N/A = not applicable because there are no inhalation RfDs.

Radiological Dose

The potential dose of the radionuclides associated with the selected human exposure pathways are assessed for each exposure scenario using RESRAD 5.61. Dose contribution by daughter products are included in the dose estimates for depleted uranium. The long-term worker scenario exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD input parameters for each exposure scenario are provided in Appendix E and the exposure point concentrations are presented in Table 5.4.9-1. The RESRAD output in Appendix E is for exposure to 1.0 pCi/g of each radionuclide COPC and is not based on the exposure point concentrations.

The annual total dose contributions for individual radionuclides and pathways for the current land-use scenario are presented in Table 5.4.9-5. The estimated annual dose of 19.1 mrem/yr for the long-term worker is below the recommended dose limit of 30 mrem/yr. The estimated dose limit is driven by the external irradiation and inhalation pathways, which accounts for 96.9% of the total estimated dose.

TABLE 5.4.9-5
ANNUAL DOSE CONTRIBUTION FOR INDIVIDUAL RADIONUCLIDES FOR THE CURRENT LAND-USE SCENARIO

Exposure Pathway	Thorium-228/232 (mrem/yr)	Thorium-230 (mrem/yr)	Uranium (mrem/yr)	Total by Pathway (mrem/yr)	Percent Contribution by Pathway
External irradiation	1.4	0.06	7.6	9.2	48.1%
Inhalation of dust	0.2	0.04	9.1	9.3	48.6%
Inhalation of radon gas	0.03	0.0008	0.0	0.03	0.2%
Ingestion of soil	0.02	0.03	0.6	0.6	3.1%
Total	1.7	0.1	17.3	Long-term worker scenario total: 19.1 mrem/yr	
Percent Contribution by Radionuclide	8.9%	0.5%	90.6%		

Uncertainties in the Human Health Risk Assessment

All risk assessments involve the use of assumptions, judgments, and incomplete data to varying degrees that contributes to the uncertainty of the final estimates of risk. Uncertainties result both from the use of assumptions or models in lieu of actual data and from the error inherent in the estimation of risk-related parameters, and may cause the risk to be overestimated or underestimated. Therefore, the results of the risk assessment should not be considered as an absolute estimate of the risk to the individuals potentially exposed to the chemicals.

Consideration of the uncertainties related to the various aspects of the risk assessment allows for a better interpretation of the results and an understanding of the potential adverse effects on human health. In general, the primary sources of uncertainty are associated with site conditions (e.g., land use assumptions) ; toxicological data (e.g., toxicity criteria); and exposure assessment (e.g., exposure pathways and parameters).

The uncertainties associated with the risk assessment for the firing site at PRS 39-004(c) are the same as presented in Section 5.1.9.4 for the firing sites at PRSs 39-004(a,d).

5.4.10 Preliminary Ecological Assessment

In cooperation with the New Mexico Environment Department and EPA Region VI, the Laboratory ER Project is developing an approach to ecological risk assessment. Further ecological risk assessment at this site will be deferred until the site can be assessed as part of the ecological exposure unit methodology currently being developed.

5.4.11 Conclusions and Recommendations

Because the firing site at PRSs 39-004(c) is still active and no unacceptable risk to the site personnel currently exists at the site, no further action based on human health concerns is recommended until it is decommissioned. However, surface water concerns do exist that will require the implementation of BMPs at the firing site to address storm water runoff.

5.5 PRS 39-008 - Gas Gun Site

PRS 39-008 (Figure 5.5-1) is a gas gun firing site located in the upper reach of Ancho Canyon (North Fork). The gas gun site is located in the canyon bottom between the main ephemeral stream channel and the cliff face target area to the west. This PRS is directly west and across the main access road from the landfill area at PRS 39-001(b). This PRS is being evaluated separately from the firing sites because the nature of the experiments conducted represent a different spectrum of potential contaminants (primarily depleted uranium projectiles) and a different mode of dispersal. The single-stage gas gun is housed in building 39-137 which is adjacent to blockhouse 39-56. A storage shed, 39-64, is located just south of these structures. Lead, thorium-228, thorium-230, thorium-232, and total uranium were retained as COPCs in the area between the gas gun building and the cliff face. A debris mound located just south of this area had thorium-228, thorium-230 and thorium-232 retained as COPCs. A risk assessment found that there was not an unacceptable risk to human health under the continued Laboratory use (i.e., industrial) scenario. However, RESRAD calculated a dose of 36 mrem/yr, which is above the DOE specification of 30 mrem/yr acceptable dose for this scenario but below the DOE 5400.5 specification of 100 mrem/yr. The PRS will be re-evaluated when the gas gun site is decommissioned.

5.5.1 History

Operations at this site began in 1960, were suspended from1975 to 1987, and then resumed in 1988. Currently, no experiments are being conducted at this site. Experiments at the site involve the firing of projectiles, primarily uranium, at targets attached to the end of the gun. In the past, the area between the gun building and the cliff was used for outdoor gas-gun experiments. Most of the debris from these outdoor firings is scattered over the area between building 39-56 and the cliff face, with fragments probably imbedded in the cliff face. The debris mound on the south side of the test area was created when surface materials excavated from the area between the gun and the cliff face were cached.

A few feet north of the gas gun enclosure (Building 39-137) is a buried dry concrete-lined tank or cistern that once housed a gas gun used to fire plutonium projectiles. Apparently, the gun, target, and projectile stop were completely contained so that no plutonium could leak to the outside of the apparatus. In addition, the apparatus was mounted vertically and aimed downward into this cistern.

Potential contaminants at this site include beryllium, depleted uranium, and lead. No plutonium was released during the firing of plutonium projectiles and monitoring found no plutonium in the area; however, no official documentation is available supporting the monitoring results. Therefore, plutonium is considered a potential contaminant in the area.

This PRS is discussed in further detail in Section 5.3 of the RFI work plan for OU 1132 (LANL 1993, 1089).

5.5.2 Description

Beyond that discussed in Chapter 2 no additional geology, hydrology, soils, or wildlife habitat information is available. However, a geomorphic evaluation of the canyon bottom and associated runoff areas is presented in Appendix E.

5.5.3 Previous Investigations

Sampling was conducted at PRS 39-008 in April 1987 to determine the level of barium in soils near the gas gun facility; results are reported in a memo to Hansen from Drypolcher (HSE-87-473, April 15, 1987). Five locations in the area were cored (depth not given) and the cored material composited to give one sample for analysis of total barium. Reported results show the total barium concentration in the soil to be <4 mg/L with a site "background" of <4 mg/L total barium (the information documented is specific that the analysis reported is "total barium" and not the "EP Toxicity" or "Extraction" procedure, therefore the actual concentration in the soil is unknown).

A second sampling event occurred in 1993 as part of the RFI of waste storage areas (RFI LA-UR-95-1069, April 1995). A waste storage area [PRS 39-002(c)] located at the southeast corner of blockhouse 39-56 was approximately 50 ft beyond the radiation control boundary. Samples collected from that area identified PCBs, lead, and uranium as COPCs. In August 1995, that area was remediated as part of a voluntary corrective action (VCA) reported in "VCA Completion Report for PRS 39-002(c)," LA-UR-96-447, January 1996.

5.5.4 Field Investigation

The objective of the investigation at PRS 39-008 is to determine if COPCs are present in the soils between the gas gun and the cliff backstop, the debris mound, and the local drainage. The conceptual model for the site deals primarily with the presence and redistribution of surface contamination that have been deposited as a result of dispersal of experimental materials by operation of the gun. Contaminated soil is subject to transport by surface water and wind action, while some contaminants may be absorbed, inhaled, or ingested by exposed receptors.

Field sampling efforts at PRS-008 were completed in October 1995 and began with establishing a sampling grid by land survey methods. A radiation survey of the grid area and adjacent drainage was conducted in 1993. Sampling surface soils from the levelled area and adjacent drainage and sampling surface and subsurface regions of the debris mound were then completed. Finally, a land survey of the actual sampling points was completed to determine their location coordinates and elevations relative to a local benchmark.

5.5.4.1 Surveys

In 1993, a 200- by 200-ft grid was installed on 50-ft centers by land survey between the main road and the cliff face encompassing the site buildings and the posted radiation control area. A radiation survey was conducted on 10-ft centers within the grid area. In this survey, the entire area within 5 ft along a grid line was surveyed to locate the highest radiation level; that location became a biased candidate for sampling. The radiation surveys were conducted with a FIDLER probe and a beta/gamma pancake probe to map the radiation levels at the soil surface. No additional radiation or XRF measurements were conducted in 1995.

5.5.4.2 Sampling

Surface (0-6 in) and near-surface (6-10 in) soil samples were collected from six locations between the gun building (39-137) and the cliff face (Figure 5.5.4-1). Sampling locations based on elevated radiation readings are 39-1349 and 39-1352. Theremaining sampling locations, 39-1347, 39-1348, 39-1350, and 39-1351, were evenly spaced between the gun building and the cliff face. Four sampling locations 39-1355 through 39-1358 were established on the debris mound, where surface (0-6 in) samples and samples at various depths were collected. At 39-1355, the hand augered hole was refused at a depth of 6 ft, the soil tuff interface, where a sample was collected. At 39-1356, the hand augered hole was similarly refused at a depth of 7 ft, where a sample was collected. At 39-1357, the interface sample was collected at a depth of 3.5 ft and, at 39-1358, the deepest penetration was 5 ft, where a sample was collected. The highest radiation location in the drainage channel was sampled at the surface (0-3 in) at sampling location 39-1359.

Figure 5.5.4-1 shows sampling locations 39-1351 and 39-1352 on the steep part of the terrain. The cliff face has been considerably undercut probably due to projectile impact and these

sampling locations are actually on the same plane as the level area; projecting under the cliff overhang.

To determine if the soil radioactivity detected at the site was due to contaminated shrapnel or pieces of depleted uranium, or to general soil contamination, the field team traversed the area searching for elevated radioactivity (beta/gamma). The field team measured radioactivity of a piece of shrapnel at 39-1349 (First Reading), removed the offending piece and re-measured the soil surface (Second Reading). In this case, removal of the contaminated piece resulted in reducing the radioactivity from 2,000,000 to 100,000 c/m suggesting that the contamination was more widely spread than only on the surface of the piece of shrapnel.

All soil samples from this site were analyzed for SVOCs, metals, cyanide, total uranium, isotopic thorium (thorium-228, -230, and -232), isotopic plutonium (plutonium-239 and -239+240), and by gamma spectrometry. Only samples from sampling locations 39-1349, the high radiation location, and 39-1352, one of the debris mound locations, were analyzed for HE because HE was not expected to be present at this site. The samples collected and the analyses requested for PRS 39-004(c) are summarized in Table 5.5.4-1, while sample locations are presented in Figure 5.5.4-1.

5.5.4.3 Field Screening

Surface material at each sampling point was screened for HE using the "Modified Griess Reagent Spot Test for Explosives" field kit, and selected sampling points were screened for PCBs using the "D-Tech" field kit. No PCBs or HE was detected in the screening efforts.

5.5.4.4 Deviations from the RFI Work Plan Sampling Strategies

Section 5.3.4.1.3.2, Gas-Gun Site, of the RFI Work Plan indicated that two locations on the cliff face were to be sampled. A possible cave-in under the cliff overhang while attempting to hammer out sufficient tuff material for a sample and the height necessary to access the most likely spot for sampling were serious safety concerns and the field team was advised not to attempt the sampling. The cliff face was obviously a target for the projectiles representing the same material found in the level area, therefore, characterization of the cliff face would be adequately accomplished by inference to the results from the level area.

Section 5.3.4.1.3.2, Gas-Gun Site, of the RFI Work Plan indicated that three samples were to be collected from the debris mound, at the surface, at the interface between the mound and the original land surface, and from the center or elevated radiation location along the core. Because of the shallowness of the borings (maximum 7 ft) and the problem of cuttings falling out of the hand auger tool only the surface and interface samples were collected. This limitation on the number of samples from the bore hole was judged not to detract from the characterization of the debris mound.

Section 5.3.4.1.3.2, Gas-Gun Site, of the RFI Work Plan indicated that two sampling locations were to be based on the 1993 radiation survey, the two highest radiation locations. One of the highest radiation locations was sampled (39-1352) but the field team found a location of considerably higher radiation than that found in the 1993 survey (39-1349). A decision was made to sample the location with the considerably higher reading instead.

Section 5.3.4, Phase I Investigations, RFI Work Plan, specified analyzing samples for total petroleum hydrocarbons. This analysis was not conducted on soils at PRS 39-008 because site personnel indicated little or no use of petroleum-based oils at this site and because the total petroleum hydrocarbon procedure would not quantify the compounds of concern. The alternative was to rely on SVOC analysis of surface samples to identify and quantify significant hazardous compounds attributable to the petroleum-based oil. This is supported by the information contained in "Policy for the Evaluation and Cleanup of Total Petroleum Hydrocarbons (TPHs) in Soil" (EM/ER:96-PCT-008, March 29, 1996).

TABLE 5.5.4-1
SUMMARY OF SAMPLES TAKEN[1]

Location ID	Sample ID	Depth (in)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso. Th	Iso. Pu	Gamma Spec
39-1347	0239-95-0204	0-6	soil	1245	Not Analyzed	1246	1247	1247	1247
39-1347	0239-95-0205	10	soil	1245	Not Analyzed	1246	1247	1247	1247
39-1348	0239-95-0206	0-6	soil	1245	Not Analyzed	1246	1247	1247	1247
39-1348	0239-95-0207	10	soil	1245	Not Analyzed	1246	1247	1247	1247
39-1349	0239-95-0208	0-6	soil	1248	1248	1249	1250	1250	1250
39-1349	0239-95-0209	0-6	soil	1245	1245	1246	1247	1247	1247
39-1349	0239-95-0210	10	soil	1245	1245	1246	1247	1247	1247
39-1350	0239-95-0211	0-6	soil	1245	Not Analyzed	1246	1247	1247	1247
39-1350	0239-95-0212	10	soil	1245	Not Analyzed	1246	1247	1247	1247
39-1351	0239-95-0213	0-6	soil	1245	Not Analyzed	1246	1247	1247	1247
39-1351	0239-95-0214	10	soil	1245	Not Analyzed	1246	1247	1247	1247
39-1352	0239-95-0215	0-6	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1352	0239-95-0216	10	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1355	0239-95-0219	0-6	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1355	0239-95-0221	180	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1356	0239-95-0222	0-6	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1356	0239-95-0223	84	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1357	0239-95-0225	0-6	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1357	0239-95-0227	180	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1358	0239-95-0228	0-6	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1358	0239-95-0230	180	soil	1264	1265	1266	1267	Not Analyzed	1267
39-1359	0239-95-0231	0-3	soil	1264	1265	1266	1267	Not Analyzed	1267

[1] Numbers in the analyte columns are request numbers.

5.5.5 Evaluation of Inorganic Chemicals

Twenty-two soil samples [twelve surface (0-6 in.) and ten subsurface (six 10 in. and four 7 ft or 15 ft)] were collected at the gas gun site, PRS 39-008, and analyzed for inorganics. Chromium, lead, and uranium were detected at concentrations greater than their respective background UTLs in the surface and subsurface soil samples (Table 5.5.5-1). In addition, cyanide and silver, which have no background UTLs, were detected in eight and three surface and subsurface soil samples, respectively (Table 5.5.5-1). Chromium was detected above its UTL in one sample, lead was detected above its UTL in six samples, and uranium was detected above its UTL in all twenty-two samples collected at this PRS. Statistical comparisons of the site data sets to the background distributions indicated that the site data for chromium and lead were not statistically greater than background, while uranium was statistically greater than background. However, because of the presence of a high concentration of chromium in one sample and two concentrations of lead above the SAL, these inorganics were not eliminated from further evaluation. Similar comparisons for cyanide and silver could not be conducted because of the lack of background data. The p-values for the statistical tests for the inorganics detected above background UTLs, except for cyanide and silver, are presented in Table 5.5.5-2. As a result of the background comparisons, five inorganics (chromium, cyanide, lead, silver, and uranium) were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

TABLE 5.5.5-2
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF DATA TO BACKGROUND FOR PRS 39-008

Analytes	Gehan Test	Quantile Test	Slippage Test
Chromium	1.0	1.0	0.0
Lead	0.2	0.3	0.0
Uranium	0.0	0.0	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.5.5-1.

5.5.6 Evaluation of Radionuclides

Twenty-two soil samples [twelve surface (0-6 in.) and ten subsurface (six 10 in. and four 7ft or 15 ft)] were collected at the gas gun site, PRS 39-008, and analyzed for uranium and isotopic thorium, and by gamma spectroscopy. Thorium-228, thorium-230, thorium-232, uranium-235, and uranium were detected at concentrations greater than their respective background UTLs in the surface and subsurface soil samples (Table 5.5.6-1). The background UTL for thorium-228 is the same as for thorium-232 because these radionuclides are in secular equilibrium in the environment. Similarly, the background UTL for thorium-230 is the same as the UTL for uranium-234. The background UTLs for the thorium isotopes were calculated by converting the total thorium results to its isotopic components. As a result, statistical comparisons of the site data to the background data are not appropriate because of the difference in analytical methods used to derive the two data sets. The background comparison indicates that the site data for thorium-228, thorium-230, and thorium-232 were greater than the background UTLs for several samples (Table 5.4.6-1). Therefore, thorium-228, thorium-230, thorium-232, uranium-235, and uranium were carried forward to the SAL comparison stage. Because the uranium-235 data were obtained from the gamma spectroscopy analysis, uranium-238, which does not emit gamma rays, and uranium-234, which emits very weak gamma rays, were not reported at this site. All other radionuclides were either undetected or detected at levels normally found in the environment and were eliminated from further evaluation.

TABLE 5.5.5-1
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES
FOR PRS 39-008

Sample ID	Location ID	Depth (in.)	Chromium (mg/kg)	Cyanide (mg/kg)	Lead (mg/kg)	Silver (mg/kg)	Uranium (mg/kg)
SAL	N/A[b]	N/A[b]	210	1300	400	380	230
soil UTL[a]	N/A[b]	N/A[b]	19.3	Not Available[c]	23.3	Not Available[c]	5.45
LOOSELEAF AREA							
0239-95-0204	39-1347	0-6	0.4(U)	0.2(UJ)	32.5	0.5(U)	21
0239-95-0205		10	2.4	0.2(UJ)	16.8	1.0(U)	19.1
0239-95-0206	39-1348	0-6	1.5(U)	0.2(UJ)	16.3	0.6(U)	23.9
0239-95-0207		10	1.6	0.21(J)	13.1	0.4(U)	24.7
0239-95-0208	39-1349	0-6	111	0.2(J)	138	100	23330
0239-95-0209		0-6	3.6	0.3(J)	11.6	2.3(U)	6323
0239-95-0210		10	4.1	0.4(J)	10.9	2.2(U)	12200
0239-95-0211	39-1350	0-6	0.6(U)	0.2(J)	14.6	0.5(U)	164
0239-95-0212		10	15.6	0.2(UJ)	26.7	14.5	59.9
0239-95-0213	39-1351	0-6	0.4(U)	0.43(J)	31.6	0.5(U)	18.7
0239-95-0214		10	0.4(U)	0.3(J)	425	0.5(U)	15.8
0239-95-0215	39-1352	0-6	9.4(U)	0.6(U)	13.1	4.1(J-)	1350
0239-95-0216		10	3.2(U)	0.6(U)	1880	0.4(UJ)	325
DEBRIS MOUND							
0239-95-0219	39-1355	0-6	1.7(U)	0.5(U)	8.8	0.2(UJ)	6.1
0239-95-0221		180	0.2(U)	0.5(U)	7.5	0.2(UJ)	5.6
0239-95-0222	39-1356	0-6	1.7(U)	0.5(U)	9.8	0.2(UJ)	6.1
0239-95-0223		84	0.3(U)	0.6	8.1	0.2(UJ)	6.5
0239-95-0225	39-1357	0-6	0.7(U)	0.5(U)	7.6	0.2(UJ)	6.0
0239-95-0227		180	0.2(U)	0.5(U)	6.3	0.2(UJ)	7.6
0239-95-0228	39-1358	0-6	1.3(U)	0.5(U)	9.9	0.2(UJ)	11.1
0239-95-0230		180	0.4(U)	0.5(U)	8.6	0.2(UJ)	7.1
DRAINAGE							
0239-95-0231	39-1359	0-2	0.7(U)	0.5(U)	13.7	0.2(UJ)	30.5

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable

[c] Background data not available; sample-specific detection limits (DL) used as screening criteria.

TABLE 5.5.6-1
RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR PRS 39-008

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Thorium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium (mg/kg)
SAL	N/A[b]	N/A[b]	1.7	0.18	0.77	No SAL	10	130
soil UTL[a]	N/A[b]	N/A[b]	2.47[c]	1.94[c]	2.47[d]	Not Available[e]	0.084[d]	5.45
DEVELOPED AREA								
0239-95-0204	39-1347	0-6	1.4	1.2	1.3	10	-0.3(U)	21
0239-95-0205		10	1.4	1.3	1.4	13	-0.1(U)	19.1
0239-95-0206	39-1348	0-6	1.6	1.5	1.7	18.1	-0.1(U)	23.9
0239-95-0207		10	1.7	1.5	1.6	8.2	-0.06(U)	24.7
0239-95-0208	39-1349	0-6	1.7(J)	2.2	1.7(J)	3560	105	23330
0239-95-0209		0-6	1.8	1.7	1.7	1740	52.1	8323
0239-95-0210		10	1.7	1.7	1.8	3500	44.8	12200
0239-95-0211	39-1350	0-6	1.2	0.7	1.2	27.6	-0.3(U)	164
0239-95-0212		10	1.0	0.8	1.0	18.8	-0.08(U)	59.9
0239-95-0213	39-1351	0-6	2.3	2.3	2.3	9.3	-0.1(U)	18.7
0239-95-0214		10	2.3	2.4	2.3	14.7	-0.4(U)	15.6
0239-95-0215	39-1352	0-6	1.7	1.6	1.8	734	9.9	1350
0239-95-0216		10	1.8	1.6	1.7	163	2.5	385
DEBRIS MOUND								
0239-95-0219	39-1355	0-6	1.7(J)	1.6	1.8(J)	5.3	0.1(U)	6.1
0239-95-0221		180	2.1(J)	2.0	2.1(J)	4.2	0.4	5.6
0239-95-0222	39-1356	0-6	2.0(J)	1.9	2.0(J)	2.1(U)	0.1(U)	6.1
0239-95-0223		84	2.0(J)	2.1	2.0(J)	2.4(U)	0.1(U)	6.5
0239-95-0225	39-1357	0-6	1.9(J)	1.7	1.9(J)	2.1(U)	0.1(U)	6.0
0239-95-0227		180	2.5(J)	2.6	2.6(J)	2.5(U)	0.4	7.6
0239-95-0228	39-1358	0-6	1.8(J)	1.9	2.1(J)	6.0	0.1(U)	11.1
0239-95-0230		180	2.4(J)	2.4	2.4(J)	8.5	0.5	7.1
	39-1359	0-2	1.6(J)	1.6	1.7(J)	11.3	0.4	30.5

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL or for the thorium isotopes > background and SAL.

[a] Upper tolerance limit of LANL-wide soil background data from A, B, and C horizons.

[b] N/A = not applicable.

[c] Radionuclides are in secular equilibrium with thorium-232 and uranium-234, respectively; the background screening values are therefore the same.

[d] Background screening values are converted from elemental concentrations reported in the LANL background report.

In addition, thorium-234 was detected in most of the soil samples but does not have a background UTL or SAL (Table 5.5.6-1). In general, the detection of thorium-234 corresponded to high concentrations of uranium because thorium-234 is the first daughter product in the radioactive decay series for uranium-238. As a result, it is included in the SAL calculation for uranium and is not considered as a separate contaminant from the detected uranium.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.5.5-1.

5.5.7 Evaluation of Organic Chemicals

Twenty-two soil samples [twelve surface (0-6 in.) and ten subsurface (six 10 in. and four 7ft or 15 ft)] were collected at the gas gun site,PRS 39-008, and analyzed for SVOCs and HE. Bis(2-ethylhexyl)phthalate was detected in three surface and two subsurface soil samples and di-n-butyl phthalate was detected in one surface and one subsurface soil sample (Table 5.5.7-1). Although these analytes are common laboratory contaminants, they were carried forward to the screening assessment because they were not detected in any of the blanks and may have been generated as a result of the explosives testing at this site. No other organics were detected in the samples collected from the area around the gas gun. The undetected organics were eliminated from further evaluation.

The locations of samples with detected organics are presented in Figure 5.5.5-1.

TABLE 5.5.7-1
DETECTED ORGANIC CHEMICALS FOR PRS 39-008

Sample ID	Location ID	Depth (in)	Bis(2-ethylhexyl)phthalate (mg/kg)	Di-n-butyl phthalate (mg/kg)
SAL	N/A[a]	N/A[a]	32	6500
EQL	N/A[a]	N/A[a]	0.33	0.33
LEVELED AREA				
0239-95-0205	39-1347	10	0.4(U)	2.6
0239-95-0207	39-1348	10	0.7	0.4(U)
DEBRIS MOUND				
0239-95-0222	39-1356	0-6	0.4(U)	0.5
0239-95-0225	39-1357	0-6	0.05(J)	0.4(U)
0239-95-0227		180	0.06(J)	0.4(U)
0239-95-0228	39-1358	0-6	0.04(J)	0.4(U)
DRAINAGE				
0239-95-0231	39-1359	0-2	0.05(J)	0.4(U)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are detected concentrations.

[a] N/A = not applicable

5.5.8 Risk-Based Screening Assessment

Lead was detected in two subsurface soil samples and uranium was detected in three surface and two subsurface soil samples from the leveled area at concentrations that exceeded their respective SALs (Table 5.5.8-1) and were retained as COPCs. The other inorganics that were detected above background UTLs, but below SALs, were submitted to an MCE (Table 5.5.8-3).

TABLE 5.5.8-1
PRS 39-008 INORGANICS WITH CONCENTRATIONS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Lead (mg/kg)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	400	230
0239-95-0208	39-1349	0-6	138	23330
0239-95-0209		0-6	11.6	8323
0239-95-0210		10	10.9	12200
0239-95-0214	39-1351	0-6	425	15.6
0239-95-0215	39-1352	0-6	13.1	1350
0239-95-0216		10	1880	385

Notes: Values in shaded cells are >SAL.
[a] N/A = not applicable

Because isotopic uranium analysis was not conducted on samples collected from the gas gun site, it was not possible to determine whether the uranium detected was depleted or natural uranium. It was assumed, based upon historical knowledge, that the uranium present in the samples was depleted uranium (DU) and, therefore, the sample values were compared to the SAL for depleted uranium (130 mg/kg) for the screening assesment. The results of this comparison found uranium to be present at concentrations greater than the DU SAL in six soil samples from the leveled area (Table 5.5.8-2). In addition, uranium-235 was detected at concentrations above the background UTL in five of the soil samples where uranium was detected above SAL. In three of these samples, uranium-235 was also detected above its SAL (Table 5.5.6-1). However, because uranium-235 is included in the total uranium value, which is also greater than its SAL, uranium-235 is not a separate contaminant. Therefore, only depleted uranium was retained as a COPC.

In addition, thorium-228, thorium-230, and thorium-232 were detected above their background UTLs. Because the background UTLs were greater than the SALs for these radionuclides, the thorium isotopes were retained as COPCs (Table 5.5.8-2).

TABLE 5.5.8-2
PRS 39-008 RADIONUCLIDES WITH CONCENTRATIONS THAT EXCEED SALs

Sample ID	Location ID	Depth (in.)	Thorium-228 (pCi/g)	Thorium-230 (pCi/g)	Thorium-232 (pCi/g)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	1.7	0.18	0.77	130
0239-96-0208	39-1349	0-6	1.7(J)	2.2	1.7(J)	23330
0239-96-0209		0-6	1.8	1.7	1.7	8323
0239-96-0210		10	1.7	1.7	1.8	12200
0239-96-0211	39-1350	0-6	1.2	0.7	1.3	164
0239-96-0213	39-1351	0-6	2.3	2.3	2.3	18.7
0239-96-0214		10	2.3	2.4	2.3	15.6
0239-96-0215	39-1352	0-6	1.7	1.6	1.8	1350
0239-96-0216		10	1.8	1.6	1.7	385
0239-96-0221	39-1355	180	2.1(J)	2.0	2.1(J)	5.6
0239-96-0223	39-1356	84	2.0(J)	2.1	2.0(J)	6.5
0239-96-0227	39-1357	180	2.5(J)	2.6	2.6(J)	7.6
0239-96-0230	39-1358	180	2.4(J)	2.4	2.4(J)	7.1

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in shaded cells are >SAL.
[a] N/A = not applicable

No organics were detected at concentrations greater than their respective SALs in any of the samples collected at PRS 39-008. Bis(2-ethylhexyl)phthalate was detected in three surface soil samples and two subsurface soil samples and di-n-butyl phthalate was detected in one surface soil sample and one subsurface soil sample below their respective SALs of 32 mg/kg and 1300 mg/kg (Table 5.5.7-1). Di-n-butyl phthalate was submitted to the MCE for noncarcinogens (Table 5.5.8-3). Bis(2-ethylhexyl)phthalate was not submitted to an MCE because it was the only carcinogen detected and was eliminated from further evaluation. No other organics were detected at the gas gun site.

Multiple Chemical Evaluation

The MCE included four analytes in the noncarcinogenic effects category (Table 5.5.8-3). The sum of the maximum normalized concentrations is 0.8, which is below the target value of 1.0. Therefore, these analytes were not retained as COPCs.

TABLE 5.5.8-3
MULTIPLE CHEMICAL EVALUATION FOR SOIL SAMPLES FROM THE GAS GUN SITE AT PRS 39-008

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values
Noncarcinogenic Effects (mg/kg)					
Chromium	39-1349	0239-95-0208	111	210	0.53
Cyanide	39-1356	0239-95-0223	0.59	1300	0.05
Di-n-butyl phthalate	39-1347	0239-95-0205	2.6	1300	0.0
Silver	39-1349	0239-95-0208	100	380	0.26
				Total[b]:	0.8

[a] SAL = screening action level.

[b] Total may not equal sum of normalized values due to rounding.

5.5.9 Human Health Risk Assessment

A human health risk assessment was conducted on PRS 39-008 because several COPCs that require further evaluation were retained as a result of the screening assessment. Noncarcinogenic hazards were evaluated using Laboratory site-specific exposure parameters and the guidance set forth in the Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989). The hazard calculations were based on the current land use, i.e., continued Laboratory operations. The radionuclide dose was calculated using RESRAD 5.61, which also incorporated Laboratory site-specific parameters and was based on the current land use. Risk calculations were performed to determine if the hazard index was greater than 1.0 or the radionuclide dose was greater than the recommended dose limit of 30 mrem/yr.

5.5.9.1 Review of COPCs and Extent of Contamination

Lead, thorium-228, thorium-230, thorium-232, and uranium were retained as COPCs for the gas gun site, PRS 39-008.

The area associated with the gas gun (PRS 39-008) including the debris mound and the drainage channel was adequately sampled to determine the extent of any contamination originating from this site. The highest concentrations of uranium were confined to the surface and subsurface soil samples at two sample locations, 39-1349 and 39-1352 (Figure 5.5.4-1 and Table 5.5.5-3).

Sample location 39-1352 is under the overhang of the cliff into which projectiles were fired from the single stage gas gun, while sample location 39-1349 is approximately 75 ft in front of the overhang and approximately 15 to 20 ft north of the debris mound (Firgure 5.5.4-1). Uranium was also detected at a concentration slightly above the DU SAL in a surface soil sample collected from sample location 39-1350, which is approximately 50 ft north of sample location 39-1349 (Figure 5.5.4-1). Both sample locations 39-1349 and 39-1350 are within the area of influence of the cliff into which projectiles are fired. The high concentrations of lead were detected in two subsurface soil samples (10 in. depth) collected from sample locations 39-1351 and 39-1352 (Figure 5.5.4-1), which are under the overhang of the cliff into which projectiles were fired. The high lead concentrations in the subsurface layer are probably due to the burial of the projectiles by debris from the cliff following detonation. The thorium radioisotopes were detected above background along the cliff face and approximately 40 to 60 ft in front of the cliff. Thorium radioistopes were also detected above background in the debris mound. The debris mound and the drainage channel both had uranium concentrations greater than background but below the DU SAL (Table 5.5.5-3).

5.5.9.2 Exposure Assessment

The contaminant source is the area of impact from the gas gun, the contaminated media are the surface and subsurface soils, and the exposure routes include incidental ingestion, inhalation, and dermal contact under a non-intrusive industrial scenario. The exposure area (approximately 6500 m^2) includes the leveled area and the debris mound.

The exposure point concentrations were RMEs and were derived based on the 95% upper confidence limit (UCL) of the arithmetic mean (Table 5.5.9-1). The data set used to calculate the 95% UCLs consisted of all samples collected from within the exposure area. The distributions of the COPC concentrations at the site are not consistent with either normal or lognormal distributions, the mathematical distributions commonly associated with environmental soil contamination. The Kolmogorov-Smirnov Test, a nonparametric goodness of fit test was used to compare the distributions of the COPC concentrations at the site and found that the concentrations are not consistent with either of the distributions.

Because the COPC concentrations are not consistent with commonly used distributions, a statistic (i.e., 95% UCLs) based on these distributions would not be valid. Therefore, the 95% UCLs are calculated using a resampling technique known as bootstrapping (Efron and Tibshirani 1988). Bootstrapping is a nonparametric, computer-based technique that makes use of a Monte Carlo algorithm applied to the observed data set. Resampling from the original data set is used to generate an approximate distribution for the sample mean, from which an approximate 95% UCL may be computed. In the cases of the COPC concentrations at this site, this statistic is more useful than a parametric or semi-parametric one because distributional assumptions about the data are not necessary.

TABLE 5.5.9-1
EXPOSURE POINT CONCENTRATIONS USED TO CALCULATE THE ESTIMATED INTAKES FOR EACH COPC

Analyte	Industrial Long-Term Worker	
	(mg/kg)	(pCi/g)
Lead	312	N/A[B]
Thorium-228	N/A	2.0
Thorium-230	N/A	1.9
Thorium-232	N/A	2.0
Uranium	4759	1903.6

[B] N/A = not applicable

The pathway-specific and radiological-specific doses from exposure to radionuclides are estimated by RESRAD version 5.61. The exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD code estimates the dose contributions of the exposure media by mathematical modeling of the soil data. RESRAD calculates the annual dose estimates for individual radionuclides using site-specific exposure point concentrations and exposure assumptions (Appendix E). The dose contribution of daughter products is included in the dose estimates for the primary radionuclides. The annual dose estimates derived from RESRAD, expressed in mrem/yr, are then compared to the radiation dose limits for the appropriate exposure scenario. The dose limit, as proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196 (EPA 1993, 06-0119), is 30 mrem/yr for the current industrial scenario. In addition, Department of Energy Order 5400.5 stipulates a target dose limit of 100 mrem/yr for industrial scenarios.

Because the area is not utilized every day for 8 hours/day, the exposure time and exposure frequency are estimated based on conversations with current site personnel. The exposure time is estimated to be no more than 2 hrs/day and the exposure frequency is estimated to be 22 days/year. The intake equations and the exposure parameters used to calculate the ADDs for the COPCs are presented in Tables C-1, C-2, and C-3 of Appendix C. The calculated ADDs for noncarcinogenic effects for each exposure pathway are presented in Tables 5.5.9-2, 5.5.9-3, and 5.5.9-4. The RESRAD summary output files for the radionuclides of concern are provided in Appendix E.

Please refer to Section 5.1.9.2 of PRS 39-004(a,d) for a comprehensive presentation of the exposure assessment.

5.5.9.3 Toxicity Assessment

The toxicity assessment for PRS 39-008 is the same as presented in Section 5.1.9.3 for the firing sites at PRSs 39-004(a,d). The toxicological profiles and toxicity criteria (Table C-4) for the COPCs are presented in Appendix C.

5.5.9.4 Risk and Dose Characterization

Nonradiological Risk

The potential human health risks associated with the selected human exposure pathways are assessed by combining the calculated doses with the toxicity criteria. USEPA has developed guidelines for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals, and uses separate methodologies for estimating the risks from these two classes of compounds. The risk and dose characterization discussion for PRS 39-008 is the same as presented in Section 5.1.9.4 for the firing sites at PRSs 39-004(a,d).

For current land use conditions, potential risks associated with incidental ingestion and dermal contact by on-site workers were quantified for the entire firing site area. The potential risk associated with the inhalation exposure pathway was not quantified because the noncarcinogens do not have inhalation RfDs. No carcinogenic COPCs, for which an upper-bound excess lifetime cancer risk was calculated, were retained at this site. Lead and uranium were the COPCs for which hazard indices were calculated. In the case of lead, EPA has not derived reference doses for evaluating lead toxicity. EPA Region VI has indicated that an industrial preliminary remediation goal (PRG) of 1000 mg/kg would result in the protection of a pregnant female worker. The exposure point concentration for lead (312 mg/kg) is below the industrial PRG and therefore is not considered to present a hazard to the on-site workers. The model used by EPA Region VI indicates that the fetal blood lead level due to this soil lead concentration would be 6.6 µg/dL,

which is below the 10 µg/dL blood lead level of concern. The equations and assumptions used to arrive at this blood lead level are presented in Appendix C. In order to provide an estimate of the total cumulative risk at the firing site, lead has been incorporated into the calculations by dividing the exposure point concentration by the PRG (see below). The quantitative risk estimates associated with the COPCs are presented in Tables 5.5.9-2 and 5.5.9-3. The total hazard indices for the various exposure pathways associated with the current land-use are presented in Table 5.4.9-4.

Individuals may be exposed to a combination of pathways at any given time and therefore the combined pathway risks for plausible multiple pathway exposures were calculated and presented in Table 5.5.9-4. The hazard index for the current land use scenario was 0.7, which is below the target value of 1.0, and indicates that hazard from the noncarcinogenic COPCs at this site is unlikely.

Radiological Dose

The potential dose of the radionuclides associated with the selected human exposure pathways are assessed for each exposure scenario using RESRAD 5.61. Dose contribution by daughter products are included in the dose estimates for depleted uranium. The long-term worker scenario exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD input parameters for each exposure scenario are provided in Appendix E and the exposure point concentrations are presented in Table 5.2.9-1. The RESRAD output in Appendix E is for exposure to 1.0 pCi/g of each radionuclide COPC and is not based on the exposure point concentrations.

TABLE 5.5.9-2
EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	**RME**	**RME**			**RME**
Lead	312	N/A[a]	1E+03[b]	Central Nervous System	3E-01[c]
Uranium	4759	4.1E-04	3E-03	Kidney	1E-01
Hazard Index					0.4

[a] N/A = not applicable

[b] EPA has not derived RfDs for lead. The value presented is the industrial PRG for lead obtained from EPA Region VI, which uses a pregnant female worker as the exposed individual.

[c] The ratio for lead is derived by dividing the exposure point concentration by the industrial PRG.

TABLE 5.5.9-3
EXPOSURES AND RISKS ASSOCIATED WITH DERMAL CONTACT OF SOIL BY LONG-TERM WORKERS FOR THE WHOLE FIRING SITE AREA UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	Adjusted RfD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	**RME**	**RME**			**RME**
Lead	312	N/A[a]	1E+03[b]	Central Nervous System	3E-01[c]
Uranium	4759	1.3E-04	3E-03	Kidney	4E-02
Hazard Index					0.3

[a] N/A = not applicable

[b] EPA has not derived RfDs for lead. The value presented is the industrial PRG for lead obtained from EPA Region VI, which uses a pregnant female worker as the exposed individual.

[c] The ratio for lead is derived by dividing the exposure point concentration by the industrial PRG.

TABLE 5.5.9-4
SUMMARY OF ESTIMATED RISKS ASSOCIATED WITH EXPOSURES AT PRS 39-008

Receptor/Pathway	Noncancer Hazard Index
CURRENT LAND-USE CONDITIONS	
	RME
LONG-TERM WORKER (Whole Area)	
Incidental Ingestion of Soil	0.4
Dermal Contact with Soil	0.3
Inhalation of Fugitive Dust	N/A[a]
Cumulative Risk	**0.7**

[a] N/A = not applicable because there are no inhalation RfDs.

The annual total dose contributions for individual radionuclides and pathways for the current land-use scenario are presented in Table 5.5.9-5. The estimated annual dose of 36.7 mrem/yr for the long-term worker is slightly above the recommended dose limit of 30 mrem/yr, but below the 100 mrem/yr dose limit required by DOE Order 5400.5. The estimated dose limit is driven by the external irradiation and inhalation pathways, which accounts for 96.7% of the total estimated dose.

TABLE 5.5.9-5
ANNUAL DOSE CONTRIBUTION FOR INDIVIDUAL RADIONUCLIDES FOR THE CURRENT LAND-USE SCENARIO

Exposure Pathway	Thorium-228/232 (mrem/yr)	Thorium-230 (mrem/yr)	Uranium (mrem/yr)	Total by Pathway (mrem/yr)	Percent Contribution by Pathway
External irradiation	1.9	0.08	15	17	46.3%
Inhalation of dust	0.3	0.05	18.2	18.5	50.4%
Inhalation radon gas	0.06	0.00006	2.8E-09	0.06	0.02%
Ingestion of soil	0.02	0.05	1.2	1.2	3.3%
Total	2.2	0.1	34.4	Long-term worker scenario total: 36.7 mrem/yr	
Percent Contribution by Radionuclide	6%	0.3%	93.7%		

Uncertainties in the Human Health Risk Assessment

All risk assessments involve the use of assumptions, judgments, and incomplete data to varying degrees that contributes to the uncertainty of the final estimates of risk. Uncertainties result both from the use of assumptions or models in lieu of actual data and from the error inherent in the estimation of risk-related parameters, and may cause the risk to be overestimated or underestimated. Therefore, the results of the risk assessment should not be considered as an absolute estimate of the risk to the individuals potentially exposed to the chemicals.

Consideration of the uncertainties related to the various aspects of the risk assessment allows for a better interpretation of the results and an understanding of the potential adverse effects on human health. In general, the primary sources of uncertainty are associated with site conditions (e.g., land use assumptions) ; toxicological data (e.g., toxicity criteria); and exposure assessment (e.g., exposure pathways and parameters).

The uncertainties associated with the risk assessment for PRS 39-008 are the same as presented in Section 5.1.9.4 for the firing sites at PRSs 39-004(a,d).

5.5.10 Preliminary Ecological Assessment

In cooperation with the New Mexico Environment Department and EPA Region VI, the Laboratory ER Project is developing an approach to ecological risk assessment. Further ecological risk assessment at this site will be deferred until the site can be assessed as part of the ecological exposure unit methodology currently being developed.

5.5.11 Conclusions and Recommendations

The nonradiological hazard was found to be less than the target value of 1.0, indicating that there is no unacceptable hazard to site personnel from these COPCs. Although the total estimated dose for the radiological COPCs was slightly greater than 30 mrem/yr, the estimated dose of 36.7 mrem/yr was well below the 100 mrem/yr stipulated in DOE Order 5400.5. In addition, the site personnel partake in the Laboratory monitoring program for exposure to radiation as well as routine medical monitoring. Based on conversations with current site personnel, there has not been any serious exposure to radiation or medical problems reported for the individuals that work at the site. Therefore, because the gas gun site, PRS 39-008, is still active, and no unacceptable risk is present, no further action is recommended at the gas gun site until it is decommissioned. However, surface water concerns do exist that will require the implementation of BMPs at the firing site to address storm water runoff.

5.6 Intermittent Stream Channels

This section describes the efforts and results of sampling the intermittent stream channel segments associated with the firing sites and the main Ancho Canyon (North Fork) channel area that runs from the firing areas to the boundary of TA-39 (State Rd. 4). Stream channel characterization was conducted as part of the firing site evaluations. The study area of the main intermittent stream channel is presented in Figure 5.6-1. The firing sites [PRSs 39-004(a,b,c,d, and e) all have stream channel drainages that run adjacent to the firing areas; all of which drain into the main Ancho Canyon channel. Uranium was retained as a COPC in the upper reach of the canyon adjacent to the firing sites, but was not detected downstream at concentrations of concern. A risk assessment found that there was not an unacceptable risk to human health from the level of uranium detected under the continued Laboratory use (i.e., industrial) scenario. The stream channel will be re-evaluated when the firing sites are decommissioned.

5.6.1 History

Operations affecting the stream channel segments are those associated with the firing sites and are discussed in Sections 5.1 through 5.4 of this report. Operations began in 1953 and are still active; however, use of hazardous materials (e.g., depleted uranium, mercury) was discontinued between 1978 and 1981 (personal communication, J. King, May 21, 1997).

Materials used in significant quantities over the years and that may have entered the stream channel system include barium, beryllium, natural and depleted uranium, mercury, lead, aluminum, copper, brass, stainless steel, thallium cadmium, chromium, thorium-232 (natural), dielectric oil, PCBs, and various types of HE (RDX, HMX, Baratol, PETN, TATB, TNT, Composition-B, and cyclotol).

The stream channel system is discussed in further detail in Section 5.3 of the RFI work plan for OU 1132 (LANL 1993, 1089).

5.6.2 Description

Beyond that discussed in Chapter 2 no additional geology, hydrology, soils, or wildlife habitat information is available. However, a geomorphic evaluation of the canyon bottom and associated runoff areas is presented in Appendix E.

5.6.3 Previous Investigations

No previous investigations were conducted on the intermittent stream channel that provides pertinent information on the assessment of contaminant distribution, redistribution, or human health risk. However, two sediment samples at PRSs 39-004(a,d) and two at PRS 39-004(c) were collected in the stream channel adjacent to the firing pads. Discussion of these samples and the associated analytical results are included in Sections 5.1 and 5.3, respectively.

5.6.4 Field Investigation

The objective of the investigation of the stream channel is to determine if COPCs are present in the channel or bank sediments. The conceptual model for the canyon bottom deals primarily with the erosion and redistribution of surface contaminants that have been deposited on the firing pads, hill slopes, mesa tops, and in stream channels traversing the firing sites as a result of dispersal by explosive experiments. Contaminated soil is subject to transport to and within the stream channel by surface water and wind action, while some contaminants may be absorbed, inhaled, or ingested by exposed receptors.

Field surveys and sampling efforts in the stream channels were started in 1993 and were completed in September 1995. These efforts included: 1) a radiation survey of segments of the stream channel adjacent to each firing site in 1993; 2) a radiation and XRF survey based on a geomorphic evaluation of likely contaminant accumulation points along the entire main channel in 1994; 3) a radiation survey of portions of the old main channel that remained after engineering a diversion around the "soil dump" area in 1995; 4) sample collection in the main channel based on the information obtained in the radiation and XRF surveys in 1994; 5) sample collection in the stream channels adjacent to each of the firing sites in 1995; and 6) a land survey of the actual sampling points after sample collection to determine their location coordinates and elevations relative to a local benchmark.

5.6.4.1 Surveys

5.6.4.1.1 1993 Radiation Survey

The 1993 radiation survey was conducted in each stream channel segment adjacent to its firing pad to map the radiation levels in the channel sediments documenting the radiation readings at 10-ft intervals. The radiation surveys were conducted with a FIDLER probe and a beta/gamma pancake probe. The area was further scanned about 5 ft either side of the traverse between the 10-ft intervals with the pancake detector for elevated radioactivity. Upon finding an elevated reading, a search was made for the highest reading in the area and the reading and location were recorded along with a FIDLER reading at the same point. The radiation survey information and summary is contained in a memo to the TA-39 files from Essington, (In preparation).

At PRSs 39-004(a,d), the stream channel was surveyed from approximately 190 ft upstream to approximately 270 downstream of the firing point reference. Radioactivity ranged from background to 168,000 c/m beta/gamma at a point 150 ft downstream of the reference point. Most of the highly elevated readings were associated with contaminated shrapnel in the stream channel or bank sediments.

At PRS 39-004(b), the stream channel was surveyed from approximately 90 ft upstream to approximately 100 ft downstream of the firing point reference, but the survey continued downstream another 180 ft to a culvert adjacent to PRS 39-004(e) and then for another 390 ft further downstream beyond the culvert. The highest beta/gamma reading adjacent to PRS 39-004(b) was 86,000 c/m; however a higher reading (115,000 c/m) was observed at the mouth of the culvert between PRSs 39-004(b and e). Eighty feet downstream from the culvert, which is also approximately 80 ft downstream from PRS 39-004(e) reference point, the highest beta/gamma reading was 22,000 c/m. At 220 ft further downstream the reading was 7100 c/m relative to a site background ranging from 90 to 170 c/m.

At PRS 39-004(c), the stream channel was surveyed as part of the 200 ft by 200 ft grid at the firing pad; however, specific readings attributed to the stream channel were not separately recorded. Radiation survey notes state that, "A small dry stream bed went through the grid with no detectable readings in it." As a result, the stream channel survey was not extended beyond this point.

5.6.4.1.2 1994 Radiation and XRF Surveys

During August 1994, the stream channels in tributaries adjacent to PRSs 39-004(b and e), PRSs 39-004(a,d), and PRS 39-004(c), as well as the main channel to a point beyond the site boundary just east of State Road 4, were surveyed for inorganics using XRF and radiation. Based on a geomorphic evaluation, 13 surface locations in the stream channels where sediments had accumulated were surveyed (beta/gamma) and a small amount of material was collected and analyzed by XRF. Similar surveying and sampling were conducted on and in the adjacent bank

deposits to collect material from various strata representing the most likely historical deposits of materials from upstream, i.e., the firing sites. For the XRF measurements, a small amount of material was collected from the stream channel sediment accumulations (0-3 in), and submitted to CST-9 under chain of custody control for XRF assay.

Results of the survey are reported in a memo to the TA39 Files from Essington, Dated July 1997 (In preparation). The survey indicated elevated radioactivity in the stream channel and bank sediments close to the firing sites and no elevated readings throughout the main channel except for one piece of radioactive shrapnel between State Road 4 and the TA-39 boundary. This piece of shrapnel was flat (about 3 mm thick) and about 3 in. diameter, which was apparently composed of beryllium,with signs of oxidized uranium imbedded in the surface. The XRF results did not reveal elevated metals concentrations downstream from the firing sites but did indicate a difference between the stream channel sediments and the bank deposits. Although the differences were small, there was a significantly (95% confidence level) higher average level of barium and titanium in the bank deposits than in the stream channel sediments. The relative levels of zinc were reversed.

In 1995, a walkover radiation survey was conducted on the portion of stream channel immediately downstream from the last 1995 stream sampling point at the firing sites. The survey was conducted with a beta/gamma detector recording the major elevated readings. Nine radiation readings were obtained in the channel downstream from PRS 39-004(e) extending 300 ft from sampling location 39-1276 to the confluence with the main channel from PRS 39-004(a, d). Actual distances for the readings were not recorded and most of the elevated readings were associated with small pieces of uranium or shrapnel (the highest was 50,000 c/m at about the confluence). Seven additional readings were obtained in the main channel below the confluence to a distance of approximately 510 ft. Elevated readings (the highest was 30,000 c/m close to the confluence) were associated with small pieces of uranium or shrapnel. Eight readings were recorded for radiation measurements made in the stream channel from PRS 39-004(c) starting at the last sampling location (39-1293) to the confluence of the tributary with the main canyon stream channel. The highest reading was 25,000 c/m just upstream from the main road culvert. Most of the elevated readings were associated with small pieces of uranium or shrapnel.

The main channel that flows adjacent to the soil dump was diverted in 1993 to provide erosion protection for materials in the soil dump. Remnants of the old main channel still exist as an upper and a lower "old channel"; these were surveyed as part of the effort described above. The highest reading of 10,000 c/m was observed about 130 ft upstream from the confluence of the old upper and main channels. Similarly, the highest reading of 35,000 c/m in the old lower channel occurred approximately 186 ft upstream from the confluence; this latter reading was noted to be associated with a small piece of uranium or shrapnel.

5.6.4.2 Sampling

Geomorphic, radiation, and XRF survey efforts in 1994 aided in selecting eight sampling locations in the main stream channel and in the tributaries. Surface samples (0-6 in) were collected from deposition areas in the stream channel and from the adjacent stream bank. Sampling locations 39-1124 and 39-1125 were midway between PRSs 39-004(b and e) (Figure 5.6.4-1). Sampling locations 39-1126 and 39-1127 were apporximately midway between PRS 39-004(e) and the confluence with the main channel (Figure 5.6.4-1). Sampling locations 39-1128 and 39-1129 were within the first major deposition zone about midway between PRS 39-004(d) and the confluence (Figure 5.6.4-1). Sampling locations 39-1130 and 39-1131 were a short distance downstream from that confluence. Sampling locations 39-1136 and 39-1137 were midway between PRS 39-004(c) and the confluence of that tributary with the main channel (Figure 5.6.4-2). Sampling locations 39-1138 and 39-1139 were a short distance downstream from that confluence. Sampling locations 39-1140 and 39-1154 were in the main channel opposite the

landfill at PRS 39-001(a) and sampling locations 39-1155 and 39-1156 were in the main channel between State Road 4 and confluence of the main Ancho Canyon channel with the Ancho Canyon (North Fork) channel (see Section 5.6.4.4 for deviations to the sampling plan) (Figure 5.6.4-3). A reference surface (0-6 in) sample was collected between the Ancho Canyon main channel and the base of the hill slope to the south in TA-33. This sample was to provide an indication of whether contaminants from the TA-33 testing areas had impacted the eastern region of TA-39. These samples were analyzed for SVOCs, metals, cyanide, HE, total uranium, total thorium, isotopic uranium and thorium, and by gamma spectrometry.

A series of nine sampling locations were identified in the stream channel adjacent to PRSs 39-004(a,d) from approximately 450-ft upstream to 370 ft downstream from the firing point reference at roughly 150-ft intervals or at high radiation areas (Figure 5.6.4-1). After screening, the samples for radioactivity, surface material (0-6 in) and shallow subsurface material (6-10 in) were collected from sampling locations 39-1263 through 1271. At PRS 39-004(b), sampling locations 39-1272 through 39-1276 were similarly screened and sampled (Figure 5.6.4-1). Sampling began approximately 450 ft upstream and ended approximately 250 downstream from the firing point; however, this stream channel continues adjacent to PRS 39-004(e) and sampling continued downstream. Sample locations assigned to the latter PRS are 39-1277 through 39-1283 ending at approximately 600 ft downstream from the firing point (Figure 5.6.4-1). At PRS 39-004(c), locations 39-1284 through 39-1293 were similarly sampled starting approximately 900 ft upstream from the firing point and ending approximately 600 ft downstream (Figure 5.6.4-2). All samples were analyzed for SVOCs, metals, cyanide, isotopic thorium, and total uranium; selected samples were analyzed for HE and by gamma spectrometry.

Two samples of surface soil (0-3 in) representing the area background were collected from between the base of the steep hill and the main road on the south side of the access road opposite the explosives bunkers and processing laboratory (Buildings 39-4 and 39-5). These sampling locations (39-1360 and 39-1361) were thought to be well away from the direct influence of the closest firing site PRS 39-004(c). These samples were analyzed for SVOCs, metals, cyanide, total uranium, and HE; isotopes of uranium and thorium; and by gamma spectrometry.

The samples collected and the analyses requested for the stream channel segments are summarized in Tables 5.6.4-1 and 5.6.4-2.

5.6.4.3 Field Screening

Surface material at each sampling point was screened for HE using the "Modified Griess Reagent Spot Test for Explosives" No HE was detected in the screening efforts.

5.6.4.4 Deviations from the RFI Work Plan Sampling Strategies

Section 5.3.4.1.3.1, Firing Sites, (Downstream Canyon Bottom) of the RFI Work Plan indicated that the canyon bottom would be sampled along three transects located more or less perpendicular to the stream channel to intercept major zones of contaminant deposition. The field team evaluated the trenching and sampling procedures and proposed an alternative sampling strategy. The new strategy was to conduct a geomorphic survey directed at locating areas of sedimentation. At those locations and strata deemed to represent historical accumulations of potential contamination from the firing sites, radiation surveys for detection of uranium and XRF analyses for potential metal contaminants were proposed. Based on the screening results, sampling of the stream channel and bank sediments was to be conducted at eight or more locations (instead of three) starting in the stream channels near firing points and

TABLE 5.6.4-1
SUMMARY OF SAMPLES TAKEN FROM THE STREAM CHANNEL IN 1994[1]

Location ID	Sample ID	Depth (in)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U & Th + Iso U & Th	Gamma Spec
39-1124	AAB0588	0-6	soil	19343	19345	19520	19520	19991
39-1124	AAB0589	0-6	soil	19368	19369	19666	19666	19993
39-1125	AAB0590	0-6	soil	19368	19369	19666	19666	19993
39-1126	AAB0591	0-6	soil	19368	19369	19666	19666	19993
39-1127	AAB0592	0-6	soil	19368	19369	19666	19666	19993
39-1128	AAB0593	0-6	soil	19343	19345	19520	19520	19991
39-1129	AAB0594	0-6	soil	19368	19369	19666	19666	19993
39-1130	AAB0595	0-6	soil	19343	19345	19520	19520	19991
39-1131	AAB0596	0-6	soil	19343	19345	19520	19520	19991
39-1136	AAB0597	0-6	soil	19368	19369	19666	19666	19993
39-1137	AAB0598	0-6	soil	19343	19345	19520	19520	19991
39-1138	AAB0599	0-6	soil	19368	19369	19666	19666	19993
39-1139	AAB0600	0-6	soil	19368	19369	19666	19666	19993
39-1140	AAB0601	0-6	soil	19368	19369	19666	19666	19993
39-1154	AAB0602	0-6	soil	19368	19369	19666	19666	19993
39-1155	AAB0603	0-6	soil	19368	19369	19666	19666	19993
39-1156	AAB0604	0-6	soil	19368	19369	19666	19666	19993
39-1157	AAB0605	0-6	soil	19368	19369	19666	19666	19993

[1] Numbers in the analyte columns are request numbers.

SUMMARY OF SAMPLES TAKEN FROM THE STREAM CHANNEL IN 1995[1]

Location ID	Sample ID	Depth (in)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
PRS 39-004(a,d)								
39-1263	0239-95-0110	0-6	soil	1124	1129	1127	1130	1130
39-1263	0239-95-0111	10	soil	1124	1129	1127	1130	1130
39-1264	0239-95-0112	0-6	soil	1124	Not Analyzed	1127	1130	Not Analyzed
39-1264	0239-95-0113	10	soil	1124	Not Analyzed	1127	1130	Not Analyzed
39-1265	0239-95-0114	0-6	soil	1124	Not Analyzed	1127	1130	Not Analyzed
39-1265	0239-95-0115	10	soil	1124	Not Analyzed	1127	1130	Not Analyzed
39-1266	0239-95-0116	0-6	soil	1124	1129	1127	1130	1130
39-1266	0239-95-0117	0-6	soil	1124	1129	1127	1130	1130
39-1266	0239-95-0118	10	soil	1124	1129	1127	1130	1130
39-1267	0239-95-0119	0-6	soil	1124	Not Analyzed	1127	1130	Not Analyzed
39-1267	0239-95-0120	10	soil	1124	Not Analyzed	1127	1130	Not Analyzed
39-1268	0239-95-0121	0-5	soil	1124	Not Analyzed	1127	1130	Not Analyzed
39-1268	0239-95-0122	10	soil	1124	Not Analyzed	1127	1130	Not Analyzed
39-1269	0239-95-0123	0-6	soil	1124	1129	1127	1130	1130
39-1269	0239-95-0124	10	soil	1124	1129	1127	1130	1130
39-1270	0239-95-0125	0-6	soil	1169	1171	1170	1172	1172
39-1270	0239-95-0126	10	soil	1169	1171	1170	1172	Not Analyzed
39-1271	0239-95-0127	0-6	soil	1169	1171	1170	1172	1172
39-1271	0239-95-0128	10	soil	1169	1171	1170	1172	Not Analyzed
PRS 39-004(b)								
39-1277	0239-95-0008	0-6	soil	975	973	976	974	Not Analyzed
39-1277	0239-95-0009	10	soil	975	973	976	974	Not Analyzed
39-1278	0239-95-0010	0-6	soil	975	973	976	974	Not Analyzed
39-1278	0239-95-0011	10	soil	975	973	976	974	Not Analyzed
39-1279	0239-95-0012	0-6	soil	975	973	976	974	Not Analyzed
39-1279	0239-95-0013	10	soil	975	973	976	974	Not Analyzed
39-1280	0239-95-0014	0-6	soil	975	973	976	974	Not Analyzed
39-1280	0239-95-0015	10	soil	975	973	976	974	Not Analyzed
39-1281	0239-95-0016	0-6	soil	975	973	976	974	Not Analyzed
39-1281	0239-95-0017	10	soil	975	973	976	974	Not Analyzed
39-1282	0239-95-0018	0-6	soil	975	973	976	974	Not Analyzed
39-1282	0239-95-0019	0-6	soil	975	973	976	974	Not Analyzed
39-1282	0239-95-0020	10	soil	975	973	976	974	Not Analyzed
39-1283	0239-95-0021	0-6	soil	975	973	976	974	Not Analyzed
39-1283	0239-95-0022	10	soil	975	973	976	974	Not Analyzed

[1] Numbers in the analyte columns are request numbers.

TABLE 3.0.4-2

SUMMARY OF SAMPLES TAKEN FROM THE STRREAM CHANNEL IN 1995[1]

Continued

Location ID	Sample ID	Depth (in)	Media	SVOCs	HE	TAL Metals + Cyanide	Total U + Iso Thorium	Gamma Spec
PRS 39-004(e)								
39-1272	0239-95-0059	0-6	soil	1044	1042	1045	1043	1043
39-1272	0239-95-0060	10	soil	1044	1042	1045	1043	1043
39-1273	0239-95-0061	0-6	soil	1044	Not Analyzed	1045	1043	1043
39-1273	0239-95-0062	10	soil	1044	Not Analyzed	1045	1043	1043
39-1274	0239-95-0063	0-6	soil	1044	1042	1045	1043	1043
39-1274	0239-95-0064	0-6	soil	1044	1042	1045	1043	1043
39-1274	0239-95-0065	10	soil	1044	1042	1045	1043	1043
39-1275	0239-95-0066	0-6	soil	1044	Not Analyzed	1045	1043	1043
39-1275	0239-95-0067	10	soil	1044	Not Analyzed	1045	1043	1043
39-1276	0239-95-0068	0-6	soil	1044	1042	1045	1043	1043
39-1276	0239-95-0069	10	soil	1044	1042	1045	1043	1043
PRS 39-004(c)								
39-1284	0239-95-0153	0-6	soil	1165	1167	1166	1168	1168
39-1284	0239-95-0154	10	soil	1165	1167	1166	1168	1168
39-1285	0239-95-0155	0-6	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1285	0239-95-0156	10	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1286	0239-95-0157	0-6	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1286	0239-95-0158	10	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1287	0239-95-0159	0-6	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1287	0239-95-0160	10	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1288	0239-95-0161	0-6	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1288	0239-95-0162	0-6	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1288	0239-95-0163	10	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1289	0239-95-0164	0-6	soil	1165	1167	1166	1168	1168
39-1289	0239-95-0165	10	soil	1165	1167	1166	1168	1168
39-1290	0239-95-0166	0-6	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1290	0239-95-0167	10	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1291	0239-95-0168	0-6	soil	1165	1167	1166	1168	1168
39-1291	0239-95-0169	10	soil	1165	1167	1166	1168	1168
39-1292	0239-95-0170	0-6	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1292	0239-95-0171	10	soil	1165	Not Analyzed	1166	1168	Not Analyzed
39-1293	0239-95-0172	0-6	soil	1165	1167	1166	1168	1168
39-1293	0239-95-0173	10	soil	1165	1167	1166	1168	1168

[1] Numbers in the analyte columns are request numbers.

ranging down stream to the boundary of TA-39. Sampling at discrete locations along the stream channel to include areas of deposition and the associated stream bank deposits was thought to provide a better biased sampling strategy, with better site coverage, and a more direct opportunity for locating eroded site contaminants.

Section 5.3.4, Phase I Investigations, RFI Work Plan, specified analyzing samples for total petroleum hydrocarbons. This analysis was not conducted on stream channel samples because the likelihood of total petroleum hydrocarbons accumulating in the stream channel sediments or bank deposits at a distance away from the firing point sources was thought to be unlikely. In addition, the total petroleum hydrocarbon procedure would not quantify the compounds of concern. The alternative was to rely on SVOC analysis of surface sediments to identify and quantify significant hazardous compounds attributable to the petroleum-based oil. This is supported by the information contained in "Policy for the Evaluation and Cleanup of Total Petroleum Hydrocarbons (TPHs) in Soil" (EM/ER:96-PCT-008, March 29, 1996).

5.6.5 Evaluation of Inorganic Chemicals

In 1994, the intermittent stream channel was sampled from below the firing sites at PRSs 39-004(a,b,c,d, and e) in the northern part of TA-39 to just past State Rd. 4 at the southern end of TA-39 (Figure 5.6.4-1). The samples collected during this field season found copper, lead, mercury, and uranium at concentrations greater than their respective background UTLs as well as cyanide and silver, which have no background UTLs, detected in the bank and/or channel samples (Table 5.6.5-1). Uranium was also reported as undetected in four samples, but had detection limits above background (84.7 to 86.9 mg/kg). Lead was detected in three samples at concentrations above the background UTL, while mercury, copper, and uranium were detected above background UTLs in six, seven, and seven of the eighteen samples, respectively. Cyanide and silver were also detected in one sample each.

In addition, stream channel samples were collected in 1995 as part of the extensive sampling strategy for the firing sites (Figures 5.6.4-1, 5.6.4-2, 5.6.4-3). This sampling effort found several inorganics (barium, cobalt, copper, lead, mercury, uranium, and zinc) at concentrations greater than their background UTLs in samples collected from the upper stream channel segments adjacent to PRSs 39-004(a,d), 39-004(b), and 39-004(e) (Tables 5.6.5-2, 5.6.5-3, 5.6.5-4). Silver, which has no background UTL, was also detected in one sample in the stream channel adjacent to PRS 39-004(e) (Table 5.6.5-4). Copper, lead, and uranium were detected above background UTLs in the middle stream channel segment adjacent to PRS 39-004(c) (Table 5.6.5-5). The highest concentrations for all of the inorganics detected above background UTLs were in samples collected in the upper stream channel segments above the confluence of the stream channels that run adjacent to the firing sites at PRSs 39-004(a,d), 39-004(b), and 39-004(e) (Figure 5.6.5-1).

<u>Stream Channel Adjacent to PRS 39-004(a,d)</u>

Nineteen sediment samples [ten surface (0-6 in.) and nine subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRSs 39-004(a,d) and were analyzed for inorganics. Copper and uranium were detected at concentrations greater than their respective background UTLs in surface and subsurface sediment samples from the intermittent stream channel segment that runs adjacent to the firing pads (Table 5.6.5-2). Copper was detected in one of ten surface sediment samples above its background UTL, while uranium was detected in four of ten surface and four of nine subsurface samples. Statistical comparisons of the site data to the background distributions indicated that the sample values for copper were not statistically different from background, while uranium data were different from background (copper: Gehan p-value = 1.0, Quantile p-value = 1.0, Slippage p-value = 0.1;uranium: Gehan p-value = 0.005, Quantile p-value = 0.0, Slippage p-value = 0.0). Copper was, therefore, eliminated from further evaluation and uranium was carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.6.5-1.

Stream Channel Adjacent to PRS 39-004(b)

Eleven sediment samples [six surface (0-6 in.) and five subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRS 39-004(b) and were analyzed for inorganics. Barium, cobalt, copper, lead, mercury, uranium, and zinc were detected at concentrations greater than their respective background UTLs in surface and subsurface sediment samples from the intermittent stream channel segment that runs adjacent to the firing pad (Table 5.6.5-3). Cobalt and lead were detected in three of eight surface samples, copper was detected in four of eight surface and three of seven subsurface samples, mercury was detected in four of eight surface and two of seven subsurface soil samples, uranium was detected in five of eight surface and four of seven subsurface soil samples, and barium and zinc were detected in two samples (one surface and one subsurface) above their UTLs. Statistical comparisons of the site data sets to the background distributions indicated that the sample values for lead and zinc were not statistically greater than background. Lead and zinc were, therefore, eliminated from further evaluation. Similar comparisons for mercury could not be conducted because of the high number of nondetects in the background data set. The p-values for the statistical tests for each inorganics are presented in Table 5.6.5-6. As a result of the background comparisons, copper, mercury, and uranium were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.6.5-1.

TABLE 5.6.5-6
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF STREAM CHANNEL DATA TO BACKGROUND FOR PRS 39-004(b)

Analytes	Gehan Test	Quantile Test	Slippage Test
Copper	0.08	0.005	0.0
Lead	1.0	0.8	0.0
Uranium	0.09	0.04	0.0
Zinc	0.9	0.3	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

Stream Channel Adjacent to PRS 39-004(e)

Fifteen sediment samples [eight surface (0-6 in.) and seven subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRSs 39-004(e) and were analyzed for inorganics. Copper, mercury, uranium, and zinc were detected at concentrations greater than their respective background UTLs in surface and subsurface sediment samples and silver, which has no background UTL, was detected in one surface sample in the intermittent stream channel segment that runs adjacent to the firing pad (Table 5.6.5-4). Copper was detected in five of six surface and three of five subsurface samples, uranium was detected in five of six surface and three of five subsurface samples, and mercury and zinc were detected in two soil samples (one surface and one subsurface) above their UTLs. Silver was detected in one surface sample. Statistical comparisons of the site data to the background distributions indicated that the sample values for zinc were not statistically greater than background. Zinc was, therefore, eliminated from further evaluation. Similar comparisons for mercury and silver could not be conducted because of the high number of nondetects in the mercury background data set and the lack of background data for silver. The p-values for the statistical tests used in the comparisons are presented in Table 5.6.5-7. As a result, four inorganics (copper, mercury, silver, and uranium) were carried forward to the SAL comparison

stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.6.5-1.

TABLE 5.6.5-7
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF STREAM CHANNEL DATA TO BACKGROUND FOR PRS 39-004(e)

Analytes	Gehan Test	Quantile Test	Slippage Test
Copper	0.0	0.0	0.0
Uranium	0.0	0.0	0.0
Zinc	0.6	0.4	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

Stream Channel Adjacent to PRS 39-004(c)

Twenty-one sediment samples [eleven surface (0-6 in.) and ten subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRSs 39-004(c) and were analyzed for inorganics. Copper, lead, and uranium were detected at concentrations greater than their respective background UTLs in surface and subsurface sediment samples collected from the stream channel segment that runs adjacent ot the firing pad (Table 5.6.5-5). Copper was detected in five of eleven surface and four of ten subsurface samples, uranium was detected in three of eleven surface and three of ten subsurface samples, and lead was detected in three samples (one surface and two subsurface) above their UTLs. Statistical comparisons of the the site data sets to the background distributions indicated that the sample values for lead and zinc were not statistically greater than background. Lead and zinc were, therefore, eliminated from further evaluation. The p-values for the statistical tests for the inorganics detected above background UTLs are presented in Table 5.6.5-8. As a result of the background comparisons, copper and uranium were carried forward to the SAL comparison stage. All other inorganics that were undetected or detected below their background UTLs were eliminated from further evaluation.

The location of samples with analyte values exceeding background UTLs are presented in Figure 5.6.5-2.

TABLE 5.6.5-8
P-VALUES[a] FROM STATISTICAL TESTS FOR COMPARISONS OF STREAM CHANNEL DATA TO BACKGROUND FOR PRS 39-004(c)

Analytes	Gehan Test	Quantile Test	Slippage Test
Copper	0.02	0.001	0.001
Lead	1.0	1.0	0.0
Uranium	0.1	0.004	0.0
Zinc	1.0	0.4	0.0

[a] See Section 3.2.1 of this report for an explanation of the p-values.

5.6.6 Evaluation of Radionuclides

The samples collected in 1994 found uranium-235 and uranium detected at concentrations greater than their background UTLs in the bank and channel samples collected from the upper and middle intermittent stream channel segments (Table 5.6.6-1). Uranium was also reported as undetected in four samples, but had detection limits above background (84.7 to 86.9 mg/kg). Uranium-235 and uranium were detected in four and seven of the eighteen samples, respectively, collected from the stream channel. In addition, thorium-227 and thorium-234 were

detected in several 1994 samples, but do not have background UTLs or SALs (Table 5.6.6-1). In general, the detection of thorium-227 and thorium-234 corresponded to high concentrations of uranium-235 and uranium because thorium-227 is the fourth daughter product in the radioactive decay series for uranium-235 and thorium-234 is the first daughter product in the radioactive decay series for uranium-238. As a result, these radionuclides are included in the SAL calculations for uranium-235 and uranium and, therefore, are not considered as separate contaminants. All other radionuclides were either undetected or detected at activity levels normally measured in the environment and were eliminated from further evaluation. No radionuclides were detected above background in the lower stream channel segment.

The 1995 sampling effort also found uranium detected above background in the upper and middle stream channel segments (Table 5.6.6-2; Figures 5.6.5-1 and 5.6.5-2). As with the inorganics, the highest concentrations of uranium were detected in the samples collected above the confluence of the upper stream channel segments that run adjacent to the firing sites at PRSs 39-004(a,d), 39-004(b), and 39-004(e) (Figure 5.6.5-1).

The locations of samples with radionuclides that exceeded background UTLs are presented in Figures 5.6.5-1, 5.6.5-2, and 5.6.5-3.

Stream Channel Adjacent to PRSs 39-004(a,d)

Nineteen sediment samples [ten surface (0-6 in.) and nine subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRSs 39-004(a,d). All of the samples were analyzed for uranium and isotopic thorium, and eleven samples were analyzed by gamma spectroscopy. Uranium was detected at concentrations greater than its background UTL in the surface and subsurface sediment samples in the intermittent stream channel segment that runs adjacent to the firing pads (Table 5.6.6-2). Uranium was detected above background in four of ten surface and four of nine subsurface samples and was carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at activity levels normally measured in the environment and were eliminated from further evaluation.

In addition, thorium-234 was detected in eight of the nineteen sediment samples but does not have a background UTL or SAL. In general, the detection of thorium-234 corresponded to high concentrations of uranium because thorium-234 is the first daughter product in the radioactive decay series for uranium-238. As a result, it is included in the SAL calculation for uranium and is not considered as a separate contaminant from the detected uranium.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.6.5-1.

Stream Channel Adjacent to PRS 39-004(b)

Eleven sediment samples [six surface (0-6 in.) and five subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRS 39-004(b). All of the samples were analyzed for uranium and isotopic thorium, and seven samples were analyzed by gamma spectroscopy. Uranium was detected at concentrations greater than its background UTL in the surface and subsurface sediment samples collected in the intermittent stream channel segment that runs adjacent ot the firing pad (Table 5.6.6-2). Uranium was detected above background in six of eight surface and three of seven subsurface samples and was carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at activity levels normally measured in the environment and were eliminated from further evaluation.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.6.5-1.

Stream Channel Adjacent to PRS 39-004(e)

Fifteen sediment samples [eight surface (0-6 in.) and seven subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRSs 39-004(e). All of the samples were analyzed for uranium and isotopic thorium, and six samples were analyzed by gamma spectroscopy. Uranium was detected at concentrations greater than its background UTL in the surface and subsurface sediment samples collected from the intermittent stream channel segment that runs adjacent to the firing pad (Table 5.6.6-2). Uranium was detected above background in five of six surface and two of five subsurface samples and was carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at levels normally found in the environment and were eliminated from further evaluation.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.6.5-1.

Stream Channel Adjacent to PRS 39-004(c)

Twenty-one sediment samples [eleven surface (0-6 in.) and ten subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRSs 39-004(c). All of the samples were analyzed for uranium and isotopic thorium, and eight samples were analyzed by gamma spectroscopy. Uranium was detected at concentrations greater than its background UTL in the surface and subsurface sediment samples collected in the intermittent stream channel segment that runs adjacent ot the firing pad (Tab e 5.6.6-2). Uranium was detected above background in six of eleven surface and none of the subsurface samples and was carried forward to the SAL comparison stage. All other radionuclides were either undetected or detected at activity levels normally measured in the environment and were eliminated from further evaluation.

In addition, thorium-234 was detected in five of the twenty-one sediment samples but does not have a background UTL or SAL. In general, the detection of thorium-234 corresponded to high concentrations of uranium because thorium-234 is the first daughter product in the radioactive decay series for uranium-238. As a result, it is included in the SAL calculation for uranium and is not considered as a separate contaminant from the detected uranium.

The location of samples with radionuclides exceeding background UTLs are presented in Figure 5.6.5-2.

5.6.7 Evaluation of Organic Chemicals

No organics were detected in the stream bank and stream channel samples collected in 1994 from the intermittent stream that runs the length of TA-39. Bis(2-ethylhexyl)phthalate and/or di-n-butyl phthalate were detected in the stream channel segments associated with the firing sites at PRSs 39-004(b and e) in 1995. No organics were detected in the samples collected in the intermittent stream channel segments that run adjacent to the firing pads at PRSs 39-004(a,d) and 39-004(c). The undetected organics were eliminated from further evaluation.

TABLE 5.6.5-1
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR THE 1994 SAMPLES FROM THE STREAM CHANNEL FROM THE FIRING SITES TO STATE ROAD 4

Sample ID	Location ID/Stake No.	Depth (In.)	Copper (mg/kg)	Cyanide (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Silver (mg/kg)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	2800	1300	400	23	380	230
sediment UTL	N/A[a]	N/A[a]	9.85	Not Available[b]	13.8	0.1[c]	Not Available[c]	7.6
AAB0588	39-1124/SCB-A	0-6	39.3	0.5(U)	13.4	1.0	0.3	85(U)
AAB0589		0-6	26.8	0.2(U)	13.9	1.3	2.0(U)	24.5
AAB0590	39-1125/SCB-B	0-6	2.0(U)	0.2(U)	25.5	0.05	2.0(U)	3.0
AAB0591	39-1126/SCB-C	0-6	39.6	0.2(U)	9.0	0.2	2.1(U)	17.1
AAB0592	39-1127/SCB-D	0-6	7.9	<0.2(R)	6.7	0.3(UJ)	2.0(U)	9.3
AAB0593	39-1128/SCB-E	0-6	29	0.5(U)	7.7	0.4	0.3(U)	113
AAB0594	39-1129/SCB-F	0-6	79.5	<0.2(R)	5.0	0.02(UJ)	2.0(U)	316
AAB0595	39-1130/SCB-G	0-6	59.2	0.5(U)	6.1	0.1(U)	0.1(U)	85.2(U)
AAB0596	39-1131/SCB-H	0-6	1.5(U)	0.5(U)	3.5	0.1(U)	0.1(U)	84.7(U)
AAB0597	39-1136/SCB-I	0-6	17.4	<0.2(R)	14.1	0.02(UJ)	2.1(U)	12
AAB0598	39-1137/SCB-J	0-6	5.0(U)	0.5(U)	5.1	0.1(U)	0.2(U)	86.9(U)
AAB0599	39-1138/SCB-K	0-6	7.6	<0.2(R)	9.9	0.11(J)	2.1(U)	14.8
AAB0600	39-1139/SCB-L	0-6	1.5(U)	<0.2(R)	4.4	0.02(UJ)	2.1(U)	2.7
AAB0601	39-1140/SCB-M	0-6	2.8(U)	<0.2(R)	6.9	0.13(J)	2.0(U)	5.0
AAB0605	39-1157/SCR	0-6	4.0	0.2	10.3	0.02(UJ)	2.0(U)	4.6

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; values in shaded cells are >SAL.

[a] N/A = not applicable

[b] Background data not available; sample-specific detection limits (DL) used as screening criteria.

[c] Maximum detected background value.

TABLE 5.6.5-2
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR 1995 SAMPLES FROM THE STREAM CHANNEL SEGMENT ADJACENT TO PRSs 39-004(a,d)

Sample ID	Location ID	Depth (in.)	Copper (mg/kg)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	2800	230
sediment UTL	N/A[a]	N/A[a]	9.85	7.6
0239-95-0117	39-1266	0-6	31	7.2
0239-95-0120	39-1267	10	1.1(U)	9.6
0239-95-0121	39-1268	0-6	3.2	32.1
0239-95-0122		10	3.2	54.9
0239-95-0123	39-1269	0-6	4.3	16.4
0239-95-0124		10	5.3	23.4
0239-95-0125	39-1270	0-6	2.1	29.8
0239-95-0126		10	2.1	21.2
0239-95-0127	30-1271	0-6	2.1	21.6

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background.

[a] N/A = not applicable

TABLE 5.6.5-3
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR 1995 SAMPLES FROM THE STREAM CHANNEL SEGMENT ADJACENT TO PRS 39-004(b)

Sample ID	Location ID	Depth (in.)	Barium (mg/kg)	Cobalt (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Uranium (mg/kg)	Zinc (mg/kg)
SAL	N/A[a]	N/A[a]	5300	4600	2800	400	23	230	23000
sediment UTL	N/A[a]	N/A[a]	141	5.2	9.85	13.8	0.1[b]	7.6	62.1
0239-95-0012	39-1279	0-6	24	5.6	4.5	5.1	0.11(UJ)	2.5	18.6
0239-95-0014	39-1280	0-6	227	2.4	142	21	4.3(J-)	35.1	73.5
0239-95-0015		10	362	3	84.4	26.8	7.4(J-)	86	79.4
0239-95-0016	39-1281	0-6	55.4	1.3	10.3	6.4	0.5(J-)	11.5	27
0239-95-0017		10	76.7	2.2	130	16.2	0.8(J-)	17.1	35.4
0239-95-0018	39-1282	0-6	28	7.7	37.2	5.9	0.1(J-)	19.5	50.3
0239-95-0019		0-6	34.1	1.1	9.5	5.5	0.1(J-)	14.2	31.3
0239-95-0020		10	35.9	1.3	8.6	5.5	0.2(J-)	13.9	19.6
0239-95-0021	39-1283	0-6	36.1	6.5	40.9	10	0.10(UJ)	23.7	38.7
0239-95-0022		10	33.1	0.9	152	10.3	0.11(UJ)	26.8	28.7

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background.

[a] N/A = not applicable

[b] Maximum detected background value.

TABLE 5.6.5-4
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES
FOR 1995 SAMPLES FROM THE STREAM CHANNEL SEGMENT ADJACENT TO PRS 39-004(e)

Sample ID	Location ID	Depth (in.)	Copper (mg/kg)	Mercury (mg/kg)	Silver (mg/kg)	Uranium (mg/kg)	Zinc (mg/kg)
SAL	N/A[a]	N/A[a]	2800	23	380	230	23000
sediment UTL	N/A[a]	N/A[a]	9.85	0.1[b]	Not Available[c]	7.6	62.1
0239-95-0059	39-1272	0-6	22	0.06	0.5(UJ)	14.2	31.3(J-)
0239-95-0060		10	58.2	0.05(U)	0.5(UJ)	5.2	25.3(J-)
0239-95-0061	39-1273	0-6	24.7	0.08	0.5(UJ)	17.1	24.8(J-)
0239-95-0063	39-1274	0-6	9.8	0.06	0.5(UJ)	9.3	25(J-)
0239-95-0064		0-6	10.2	0.06	0.5(UJ)	6.9	22.4(J-)
0239-95-0066	39-1275	0-6	12.5	0.07	0.5(UJ)	45.2	37.7(J-)
0239-95-0067		10	12.5	0.06	0.5(UJ)	20.8	33.9(J-)
0239-95-0068	39-1276	0-6	31.8	0.2	0.6(J-)	51.6	100(J-)
0239-95-0069		10	149	0.1	0.6(UJ)	44.9	105(J-)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background.

[a] N/A = not applicable

[b] Maximum detected background value.

[c] Background data not available; sample-specific detection limits (DL) used as screening criteria.

TABLE 5.6.5-5
INORGANIC CHEMICALS WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR 1995 SAMPLES FROM THE STREAM CHANNEL SEGMENT ADJACENT TO PRS 39-004(c)

Sample ID	Location ID	Depth (in.)	Copper (mg/kg)	Lead (mg/kg)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	2800	400	230
sediment UTL	N/A[a]	N/A[a]	9.85	13.8	7.6
0239-95-0160	39-1287	10	11	25	2.4
0239-95-0161	39-1288	0-6	16	9.5	5.8
0239-95-0162		0-6	23	7.3	4.4
0239-95-0164	39-1289	0-6	15	26	12.7
0239-95-0165		10	21	15	11.7
0239-95-0166	39-1290	0-6	23	10	23.4
0239-95-0167		10	16	8.5	3.9
0239-95-0171		10	6.3	3.4	12.4
0239-95-0172	39-1293	0-6	55	8.9	33.1
0239-95-0173		10	9.2	6.7	26.4

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background.

[a] N/A = not applicable

TABLE 5.6.6-1
RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR THE 1994 SAMPLES FROM THE STREAM CHANNEL FROM THE FIRING SITES TO STATE ROAD 4

Sample ID	Location ID/Stake No.	Depth (in.)	Thorium-227 (pCi/g)	Thorium-234 (pCi/g)	Uranium-235 (pCi/g)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	No SAL	No SAL	10	130
sediment UTL	N/A[a]	N/A[a]	Not Available[b]	Not Available[b]	0.12[c]	7.6
AAB0588	39-1124/SCB-A	0-6	3.2	9.2	0.09(U)	85(U)
AAB0589		0-6	Not Reported	7.6	Not Reported	24.5
AAB0591	39-1126/SCB-C	0-6	Not Reported	Not Reported	Not Reported	17.1
AAB0592	39-1127/SCB-D	0-6	Not Reported	Not Reported	Not Reported	9.3
AAB0593	39-1128/SCB-E	0-6	1.0	14.1	0.3	113
AAB0594	39-1129/SCB-F	0-6	Not Reported	9.8	Not Reported	316
AAB0595	39-1130/SCB-G	0-6	0.9	3.9	0.1	85.2(U)
AAB0596	39-1131/SCB-H	0-6	1.4	1.1	0.09	84.7(U)
AAB0597	39-1136/SCB-I	0-6	Not Reported	4.0	Not Reported	12
AAB0598	39-1137/SCB-J	0-6	3.1	5.3	0.2	86.9(U)
AAB0599	39-1138/SCB-K	0-6	Not Reported	3.9	Not Reported	14.8

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background; value in shaded cell is >SAL.

[a] N/A = not applicable

[b] Background data not available; sample-specific minimum detectable activities are used as screening criteria.

[c] Background screening values are converted from elemental concentrations reported in the LANL background report.

TABLE 5.6.6-2
RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR THE 1995 SAMPLES FROM THE STREAM CHANNEL SEGMENTS ADJACENT TO THE FIRING SITES

Sample ID	Location ID	Depth (in.)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	130
sediment UTL	N/A[a]	N/A[a]	7.6
[illegible]			
0239-95-0120	39-1267	10	9.6
0239-95-0121	39-1268	0-6	32.1
0239-95-0122		10	54.9
0239-95-0123	39-1269	0-6	16.4
0239-95-0124		10	23.4
0239-95-0125	39-1270	0-6	29.8
0239-95-0126		10	21.2
0239-95-0127	30-1271	0-6	21.6
[illegible]			
0239-95-0014	39-1280	10	35.1
0239-95-0015		0-6	86
0239-95-0016	39-1281	10	11.5
0239-95-0017		0-6	17.1
0239-95-0018	39-1282	0-6	19.5
0239-95-0019		10	14.2
0239-95-0020		0-6	13.9
0239-95-0021	39-1283	0-6	23.7
0239-95-0022		0-6	26.8
[illegible]			
0239-95-0059	39-1272	0-6	14.2
0239-95-0061	39-1273	0-6	17.1
0239-95-0063	39-1274	0-6	9.3
0239-95-0066	39-1275	0-6	45.2
0239-95-0067		10	20.8
0239-95-0068	39-1276	0-6	51.6
0239-95-0069		10	44.9

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background.

[a] N/A = not applicable

TABLE 5.6.6-2
RADIONUCLIDES WITH CONCENTRATIONS AT OR ABOVE BACKGROUND SCREENING VALUES FOR THE 1995 SAMPLES FROM THE STREAM CHANNEL SEGMENTS ADJACENT TO THE FIRING SITES
Continued

Sample ID	Location ID	Depth (in.)	Uranium (mg/kg)
SAL	N/A[a]	N/A[a]	130
sediment UTL	N/A[a]	N/A[a]	7.6
[illegible]			
0239-95-0164	39-1289	0-6	12.7
0239-95-0165		0-6	11.7
0239-95-0166	39-1290	0-6	23.4
0239-95-0171		0-6	12.4
0239-95-0172	39-1293	0-6	33.1
0239-95-0173		0-6	26.4

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are greater than background.

[a] N/A = not applicable

Stream Channel Adjacent at PRS 39-004(b)

Eleven sediment samples [six surface (0-6 in.) and five subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing sites at PRS 39-004(b). All of the samples were analyzed for SVOCs and seven samples were analyzed for HE. Bis(2-ethylhexyl)phthalate was detected in one of seven subsurface samples and di-n-butyl phthalate was detected in one of eight surface samples collected from the intermittent stream channel segment that runs adjacent to the firing pad (Table 5.6.7-1). Although these analytes are common laboratory contaminants, they were carried forward to the screening assessment because they were not detected in any of the blanks and may have been generated as a result of the explosives testing at this site. No other organics were detected in the samples collected from this stream channel segment. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.6.5-1.

TABLE 5.6.7-1
DETECTED ORGANIC CHEMICALS FROM THE STREAM CHANNNEL SEGMENT ADJACENT TO PRS 39-004(b)

Sample ID	Location ID	Depth (in)	Bis(2-ethylhexyl)phthalate (mg/kg)	Di-n-butyl phthalate (mg/kg)
SAL	N/A[a]	N/A[a]	32	1300
EQL	N/A[a]	N/A[a]	0.33	0.33
0239-95-0021	39-1283	0-6	0.3(U)	0.2(J)
0239-95-0022		10	26	0.4(U)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are detected concentrations.

[a] N/A = not applicable

Stream Channel Adjacent at PRS 39-004(e)

Fifteen sediment samples [eight surface (0-6 in.) and seven subsurface (10 in.)] were collected from the intermittent stream channel segment that runs adjacent to the firing site at PRS 39-004(e). All of the sampes were analyzed for SVOCs, and six samples were analyzed for HE. Di-n-

butyl phthalate was detected in two of six surface and one of five subsurface samples collected from the intermittent stream channel segment that runs adjacent to the firing pad (Table 5.6.7-2). Although this analyte is a common laboratory contaminant, it was carried forward to the screening assessment because it was not detected in any of the blanks and may have been generated as a result of the explosives testing at this site. The undetected organics were eliminated from further evaluation.

The location of samples with detected organics are presented in Figure 5.6.5-1.

TABLE 5.6.7-2
DETECTED ORGANIC CHEMICALS FROM THE STREAM CHANNNEL SEGMENT ADJACENT TO PRS 39-004(e)

Sample ID	Location ID	Depth (in)	Di-n-butyl phthalate (mg/kg)
SAL	N/A[a]	N/A[a]	1300
EQL	N/A[a]	N/A[a]	0.33
0239-95-0063	39-1274	0-6	0.04(J)
0239-95-0064		0-6	0.05(J)
0239-95-0065		10	0.04(J)

Notes: Qualifiers used in table are defined in Section 3.1.2.
Values in cells with bold borders are detected concentrations.

[a] N/A = not applicable

5.6.8 Risk-Based Screening Assessment

Uranium was consistently detected at concentrations greater than the background UTL in the stream channel segments adjacent to and downstream from the firing sites. It is not possible to determine whether the uranium is the result of site runoff or due to deposition following detonations at the firing pads. Uranium was detected at a concentration (316 mg/kg) greater than its systemic SAL of 230 mg/kg in one surface sediment sample collected in 1994 (sample location 39-1129) approximately 500 ft downstream from PRS 39-004(a,d) (Table 5.6.5-1). Except for uranium, no other inorganics were detected above background or SAL in the stream channel segment adjacent to PRSs 39-004(a,d). The inorganics that were detected at concentrations above their background UTLs but below their SALs in the other stream channel segments were submitted to an MCE (Table 5.6.8-1). The inorganics included barium, cobalt, copper, mercury, uranium, and zinc for PRS 39-004(b), copper, mercury, silver, uranium, and zinc forPRS 39-004(e), and copper, lead, and uranium for PRS 39-004(c).

Because isotopic uranium analysis was not conducted on samples collected from the intermittent stream channel, it is not possible to determine whether the uranium detected is depleted or natural uranium. It is assumed, based upon historical knowledge, that the uranium present in the samples originated from the firing sites and, therefore, is depleted uranium (DU). As a result, the sample values are compared to the SAL for depleted uranium (130 mg/kg) for the screening assessment. The results of this comparison found uranium to be present at a concentration greater than the DU SAL in a channel sample collected in 1994 at sample location 39-1129, which is approximately 500 ft downstream from PRSs 39-004(a,d) (Table 5.6.6-1 and Figure 5.6.5-1). Uranium-235 was detected at concentrations below its SAL (Table 5.6.6-1), but was not submitted to an MCE because it is the only other radionuclide detected above background and is included in the total uranium data values. Uranium at PRSs 39-004(b,e, and c) was detected below the depleted uranium SAL and was not submitted to an MCE because it was the only radionuclide detected above background. Therefore, depleted uranium in the stream channel segment adjacent to PRS 39-004(a,d) is the only radionuclide retained as a COPC.

No organics were detected in the intermittent stream channel in 1994. The organics detected in the 1995 samples at PRSs 39-004(b and e) were below their SALs and were submitted to an MCE (Table 5.6.8.1).

Multiple Chemical Evaluation

The MCE for the noncarcinogenic effects category included four analytes at PRS 39-004(b), five analytes for PRS 39-004(e), and two analytes for PRS 39-004(c) (Table 5.6.8-1). The sample values were the maximum detected concentrations from the combined 1994 and 1995 data sets where applicable. The sums of the maximum normalized concentrations were 0.7, 0.3, and 0.2, respectively. These values are below the target value of 1.0 and, therefore, the analytes are eliminated from further evaluation. The MCEs for radionuclide effects or carcinogenic effects were not performed for stream channels.

TABLE 5.6.8-1
MULTIPLE CHEMICAL EVALUATION FOR THE STREAM CHANNEL SEGMENTS ADJACENT TO THE FIRING SITES

Chemical	Location ID	Sample ID	Maximum Sample Values	Soil SAL[a]	Normalized Values
Noncarcinogenic Effects (mg/kg)					
PRS 39-004(b)					
Copper	39-1283	0239-95-0022	152	2800	0.05
Di-n-butyl phthalate	39-1283	0239-95-0021	0.23(J)	6500	0.00
Mercury	39-1280	0239-95-0015	7.4(J-)	23	0.32
Uranium	39-1280	0239-95-0015	86	230	0.37
				Total[b]:	0.7
PRS 39-004(e)					
Copper	39-1276	0239-95-0069	149	2800	0.05
Di-n-butyl phthalate	39-1274	0239-95-0064	0.05(J)	6500	0.00
Mercury	39-1276	0239-95-0068	0.21	23	0.01
Silver	39-1276	0239-95-0068	0.58(J-)	380	0.00
Uranium	39-1276	0239-95-0068	51.6	230	0.22
				Total[b]:	0.3
PRS 39-004(c)					
Copper	39-1292	0239-95-0172	55	2800	0.02
Uranium	39-1292	0239-95-0172	33.1	230	0.14
				Total[b]:	0.2

Note: Qualifiers used in table are defined in Section 3.1.2.

[a] SAL = screening action level.

[b] Total may not equal sum of normalized values due to rounding.

5.6.9 Human Health Risk Assessment

A human health risk assessment was performed because uranium was detected above SAL in the stream channel and was, therefore, retained as a COPC.

5.6.9.1 Review of COPCs and Extent of Contamination

Based on the Phase I sampling results and the RFI human health screening assessment for the stream channel, one COPC, uranium, has been retained. Uranium was retained as a result of the 1994 stream channel sampling, while no COPCs were retained as a result of the 1995 sampling. A noncarcinogenic hazard index was calculated using Laboratory site-specific exposure parameters and the guidance set forth in the Risk Assessment Guidance for Superfund (RAGS), Part A (EPA 1989). The hazard calculations were based on the most realistic assumptions of the current land use, i.e., non-intrusive industrial. The radionuclide dose was calculated using RESRAD 5.61, which also incorporated Laboratory site-specific parameters and current land use scenario.

5.6.9.2 Exposure Assessment

The potential pathways by which individuals may be exposed to the COPCs must be identified and the exposures quantified in order to determine the potential risk at a given site. An exposure pathway describes the course a chemical takes from the source to the exposed individual, and is defined by four elements: (1) a source and mechanism of chemical release to the environment; (2) an environmental transport medium for the released chemical; (3) a point of potential contact with the contaminated medium (i.e., an exposure point); and (4) an exposure route at the contact point. An exposure pathway is considered complete when all four elements are present; only complete exposure pathways are quantitatively evaluated in the risk assessment.

The contaminant source are the firing pads, the contaminated medium is the surface soil within the stream channel, and the exposure routes include incidental ingestion and dermal contact of soil under a non-intrusive industrial scenario. The inhalation exposure pathway is not evaluated because an inhalation reference dose for uranium is not available. Two exposure areas were evaluated by RESRAD; one includes the adjacent stream channel immediately surrounding the sample location (approximately 1 m^2), the other encompasses a larger total area (approximately 500 m^2). Because the firing pad and the surrounding area are not utilized every day for 8 hours/day, the exposure time and exposure frequency are estimated based on conversations with current site personnel. The exposure time is estimated to be no more than 2 hrs/day and the exposure frequency is estimated to be 22 days/year.

The exposure point concentration is the maximum detected concentration of uranium (316 mg/kg) in the stream channel. This concentration is the most conservative exposure and represents the worst case scenario.

To estimate dose, exposure point concentration of the COPC is combined with information describing the extent, frequency, and duration of exposure for each potential receptor of concern. The approaches used to quantify exposure are consistent with guidance provided by USEPA (1989, 1991, 1992a,b).

The quantification of exposure for the ingestion and dermal exposure pathways involves the estimation of an average daily dose, expressed as mg chemical/kg body weight per day (mg/kg-day). Dose can be defined as an exposure rate to a chemical determined over an exposure period per unit body weight, and is calculated similarly for ingestion and dermal absorption pathways. The average daily dose for a noncarcinogen is averaged over the duration of exposure, and following USEPA (1992a) guidance, is given the acronym ADD for average daily dose. The ADD is estimated using the exposure point concentration along with exposure parameters that specifically describe the exposure pathway. The ADDs for each pathway were derived by combining the selected exposure point concentration with exposure parameters that are quantitative estimates of the frequency, duration, and magnitude of exposure to various media (USEPA 1989, 1992a). The exposure parameters are either EPA default values or Laboratory site-specific default values for the exposure pathway of concern and are considered to be extremely conservative in nature.

The pathway-specific and radiological-specific doses from exposure to radionuclides are estimated by the Residual Radioactive (RESRAD) computer code version 5.61. The exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD code estimates the dose contributions of the exposure media by mathematical modeling of the soil data. RESRAD calculates the annual dose estimates for individual radionuclides using site-specific exposure point concentrations and exposure assumptions (Appendix E). The dose contribution of daughter products is included in the dose estimates for the primary radionuclides. The annual dose estimates derived from RESRAD, expressed in mrem/yr, are then compared to the radiation dose limits for the appropriate exposure scenario. The dose limit, as proposed in EPA's Radiation Site Cleanup Regulation, 40 CFR 196 (EPA 1993, 06-0119), is 30 mrem/yr for the current industrial scenario.

The intake equations and the exposure parameters used to calculate the ADDs for uranium are presented in Tables C-1, C-2 ,and C-3 of Appendix C. The calculated ADDs for noncarcinogenic

effects for each exposure pathway are presented in Tables 5.6.9-1 and 5.6.9-2. The RESRAD summary output files for uranium for the exposure scenario are provided in Appendix E.

5.6.9.3 Toxicity Assessment

The methodology used for classifying health effects from exposure to chemicals is recommended by USEPA (1986a,b, 1989, 1995, 1996). The health effects analysis considers chronic exposures with chronic toxicity criteria being obtained from USEPA's Integrated Risk Information System (IRIS) (USEPA 1996) and Health Effects Assessment Summary (HEAST) (USEPA 1995). These sources list the most recent toxicity values recommended by USEPA for use in human health risk assessments. Appendix C, Table C-4, presents a summary of the toxicity criteria (RfDs) used to calculate the risk estimates for uranium at this site as well as summaries of the toxicological profile for the COPC. Because toxicity criteria have not been specifically developed for the dermal route of exposure, oral toxicity criteria have been adjusted to assess this pathway. Oral toxicity criteria, which typically represent potential or administered doses, are modified to represent internal or absorbed doses (i.e., dermal dose estimates). The method for modifying toxicity criteria involves the determination of an absolute oral absorption factor for each chemical, which is then used to to decrease the RFD. Absolute oral absorption factors were obtained from the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles or, for those chemicals for which sufficient data are lacking, a default value of 1.0 was used (i.e., the oral toxicity criteria were not adjusted). The toxicological profile for uranium is presented in Appendix C.

The toxicity value used to evaluate chemicals exhibiting noncarcinogenic effects is the reference dose (RfD), which is expressed in units of dose (mg chemical/kg body weight-day), and is derived from either human or animal studies. These values are estimates of the daily exposure of the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are used characterize the potential for the occurrence of noncarcinogenic effects associated with exposure durations greater than seven years and are the toxicity values used in this risk assessment.

The RfDs are derived using uncertainty factors that reflect scientific judgment regarding the various types of data used to estimate this value. The RfDs are typically estimated from no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) in human or animal studies. The NOAELs or LOAELs are divided by one or more uncertainty factors, as appropriate, as well as modifying factors in some cases to take into account other incertainties in the toxicity database. The uncertainty factors, generally 10-fold factors, are intended to account for:

- The variation in sensitivity among members of the human population;
- the uncertainty in extrapolating animal data to humans;
- the uncertainty in extrapolating data obtained in a study that is less-than-lifetime exposure
- the uncertainty in using LOAEL data rather than NOAEL data; and
- the inability of any single study to adequately address all possible adverse effects in humans.

The net result is that RfDs are generally considered to be conservative estimates of the likelihood of adverse noncarcinogenic effects.

For radionuclides, the ratio of exposure to dose is expressed as a dose conversion factor (DCF). The DCFs used are default values provided in the RESRAD code and are listed in the summary output files in Appendix E. The output files contain DCFs for uranium as well as DCFs for important progeny. Additional information regarding DCFs is provided in the Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD (Yu et al. 1993, 1177). The annual dose limits for uranium for the exposure scenario are calculated by RESRAD 5.61 using scenario-specific parameters (See Appendix E). These parameters were selected to result in a reasonable maximum exposure for an individual. The annual dose limits are compared to the recommended target dose limit of 30 mrem/yr for a commercial/industrial exposure scenario (EPA 1993, 06-0119). The target dose limit satisfies the "as low as reasonably achievable" (ALARA) principle to ensure that radiation exposure is minimized.

5.6.9.4 Risk and Dose Characterization

Nonradiological Risk

The potential human health risks associated with the selected human exposure pathways are assessed by combining the calculated doses with the toxicity criteria. USEPA has developed guidelines for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals, and uses separate methodologies for estimating the risks from these two classes of compounds.

The potential risks for noncarcinogens were calculated by means of a hazard index technique as recommended by USEPA (1989). The ratio of the ADD to the reference dose (RfD) was derived for each chemical. Values of these ratios, called hazard quotients, that are greater than one are indicative of potential adverse health effects. The effects from simultaneous exposures to all COPCs were computed by summing the individual hazard quotients within each exposure pathway. This sum, termed the hazard index, serves the same function for the mixture as the hazard quotient does for the individual compound, i.e., hazard indices greater than one are indicative of potential adverse health effects.

For current land use conditions, potential risks associated with incidental ingestion, dermal contact, and inhalation of fugitive dust by on-site workers were quantified. Uranium was the COPC for which hazard indices were calculated. The quantitative risk estimates associated with the COPC are presented in Tables 5.6.9-1 and 5.6.9-2. The hazard quotients for the exposure pathways associated with the current land-use are presented in Table 5.6.9-3.

Individuals may be exposed to a combination of pathways at any given time and therefore the combined pathway risks for plausible multiple pathway exposures were calculated and presented in Table 5.6.9-3. The hazard index for the current land use scenario was 0.3, which is less than the target limit of 1.0.

TABLE 5.6.9-1
EXPOSURES AND RISKS ASSOCIATED WITH INCIDENTAL INGESTION OF SOIL BY LONG-TERM WORKERS FOR THE STREAM CHANNEL UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	RME	RME			RME
Uranium	316	2.7E-05	3E-03	Kidney	9E-03
Hazard Index					9E-03

TABLE 5.6.9-2
EXPOSURES AND RISKS ASSOCIATED WITH DERMAL CONTACT OF SOIL BY LONG-TERM WORKERS FOR THE STREAM CHANNEL UNDER CURRENT LAND USE CONDITIONS

Non-carcinogen	Exposure Point Concentration (mg/kg)	Average Daily Dose (mg/kg-day)	RFD (mg/kg-day)	Target Organ or Critical Effect	ADD:RfD Ratio
Inorganics	RME	RME			RME
Uranium	316	8.7E-06	3E-05	Kidney	0.3
Hazard Index					0.3

TABLE 5.6.9-3
SUMMARY OF ESTIMATED RISKS ASSOCIATED WITH EXPOSURES FROM THE STREAM CHANNEL

Receptor/Pathway	Noncancer Hazard Index
CURRENT LAND-USE CONDITIONS	
LONG-TERM WORKER	
Incidental Ingestion of Soil	0.009
Dermal Contact with Soil	0.3
Cumulative Risk	**0.3**

[a] N/A = not applicable because there are no inhalation RfDs.

Radiological Dose

The potential dose of the radionuclides associated with the selected human exposure pathways are assessed for each exposure scenario using RESRAD 5.61. Dose contributions by daughter products are included in the dose estimates for depleted uranium. The long-term worker scenario exposure pathways include external gamma irradiation, soil ingestion, inhalation of dust, and inhalation of radon gas. The RESRAD input parameters are provided in Appendix E. The exposure point concentration for both exposure areas is the maximum detected concentration of uranium in the stream channel converted from mg/kg to pCi/g by multiplying the concentration (316 mg/kg) by 0.4 to yield an exposure point of 126.4 pCi/g. The RESRAD outputs in Appendix E are for exposure to 1.0 pCi/g of depleted uranium and are not based on the exposure point concentration.

The annual total dose contributions for individual radionuclides and pathways for the current land-use scenario are presented in Table 5.6.9-4. The estimated annual dose range of 0.4 mrem/yr to 4.9 mrem/yr for the long-term worker is below the dose limit of 30 mrem/yr. The estimated dose limit is driven by the inhalation pathway for the 1 m^2 exposure area, which accounts for 75% of the total estimated dose, and by the external irradiation and inhalation pathways for the 500 m^2 exposure area, which accounts for 55.1% and 42.9% of the total estimated dose, respectively.

TABLE 5.6.9-4
ANNUAL DOSE CONTRIBUTION FOR INDIVIDUAL RADIONUCLIDES FOR THE CURRENT LAND-USE SCENARIO

Exposure Pathway	Uranium (mrem/yr)		Percent Contribution by Pathway	
	1.0 m^2	500 m^2	1.0 m^2	500 m^2
External irradiation	0.1	2.7	25%	55.1%
Inhalation of dust	0.3	2.1	75%	42.9%
Inhalation of radon gas	0.0	0.0	0.0%	0.0%
Ingestion of soil	0.00008	0.1	0.0%	2.0%
Total	0.4	4.9	Construction worker scenario total: 0.4 mrem/yr to 4.9 mrem/yr	

Uncertainties in the Human Health Risk Assessment

All risk assessments involve the use of assumptions, judgments, and incomplete data to varying degrees that contributes to the uncertainty of the final estimates of risk. Uncertainties result both from the use of assumptions or models in lieu of actual data and from the error inherent in the estimation of risk-related parameters, and may cause the risk to be overestimated or underestimated. Therefore, the results of the risk assessment should not be considered as an absolute estimate of the risk to the individuals potentially exposed to the chemicals.

Consideration of the uncertainties related to the various aspects of the risk assessment allows for a better interpretation of the results and an understanding of the potential adverse effects on

human health. In general, the primary sources of uncertainty are associated with site conditions (e.g., land use assumptions) ; toxicological data (e.g., toxicity criteria); and exposure assessment (e.g., exposure pathways and parameters).

Site Conditions

The likelihood is high that the site conditions used to estimate the exposure and risk under the industrial exposure scenario will remain the same. The firing sites at TA-39 are still active and there are no immediate plans for their being decommissioned. As a result, the entire area will remain under Laboratory control for now and the foreseeable future. Because no additional construction or excavation is planned for TA-39, the likelihood that the area will be disturbed is minimal. Therefore, potential for exposure to the COPCs at this site by the long-term workers is minimal.

Exposure Assessment

There is inherent uncertainty in the estimation of exposure. The estimation of exposure and risk is deterministic and is based on the assumption that a receptor will be exposed and, once exposed estimates the health hazard and/or risk. The probability of exposure is not accounted for in this approach. The primary areas of uncertainty involve the assumptions regarding exposure pathways, estimation of exposure points, and the exposure parameters.

The exposure pathways selected for evaluation in the risk assessment were based on potential and worst case exposures. For example, it was assumed that individuals would engage in regular activities under current land-use activities that would result in exposures to uranium. This assumption is conservative because it is more likely that the activity resulting in exposure would not occur.

The parameters used to describe the extent, frequency, and duration of exposure are associated with some degree of uncertainty. Actual risks for certain individuals within an exposed population may vary from those predicted depending upon their actual intake rates, nutritional status, or body weights. The exposure assumptions were selected to produce an upper-bound estimate of exposure in accordance with USEPA guidelines regarding potential exposures at a site. As a result, exposures and estimated potential risks for the majority of the evaluated receptors are likely to be overestimated.

Uncertainies associated with characterizing the frequency, duration, and activity-related variables for exposure of a human population to soil contaminants are similar for both radionuclides and nonradionuclides. However, model uncertainty for a complex code such as RESRAD, which has numerous submodels, is difficult to evaluate without empirical validation. Uncertainty is also associated with choice of exposure frequency and exposure area.

Toxicological Data

There is inherent uncertainty in the derivation of the toxicity criteria. The assessment of risks relied on toxicity criteria designed to protect sensitive subpopulations and are therefore conservative in nature and based on concepts and assumptions that bias an evaluation in the direction of overestimation of the associated risks. As noted in USEPA's Guidelines for Carcinogenic Risk Assessment (EPA 1986):

> There are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility. Human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns, and other cultural factors.

These uncertainties are compensated for by using upper-bound 95% upper confidence limits for cancer slope factors, and safety factors for reference doses. The assumptions used here provide a rough but plausible estimate of the upper limit of risk, i.e., it is not likely that the true risk would be much more than the estimated risk, but it could be considerably lower, even approaching zero.

The absence of dermal toxicity criteria necessitated the adjustment of oral toxicity values in order to evaluate the dermal exposure pathway. As previously mentioned, absolute oral absorption factors were used to modify the oral toxicity criteria. For those chemicals for which sufficient information is lacking, a default oral absorption factor of 1.0 was used. The risk estimates for the dermal pathway may therefore be over or underestimated depending on how closely these values reflect the difference between oral and dermal routes.

The likelihood is moderate that the risk is not greater than that calculated as a result of the exclusion of some chemicals in the risk assessment. Several noncarcinogens, copper, cyanide, mercury, and silver,were eliminated from the risk assessment based on their contributions to the noncarcinogenic MCE analysis. The concentrations of these chemicals, which are well below SALs (all were 1/3 or more of the SAL) would not significantly alter the noncarcinogenic hazardestimate. Similarly, thorium-228, thorium-230, and thorium-232 were eliminated from the risk assessment based on comparisons to the background ranges. The concentrations of these radinuclides would not significantly alter the radionuclide risk estimate.

The DCFs used in the evaluation of radionuclide doses are associated with assumptions that contribute to uncertainty in dose estimates. Separate DCFs exist for internal and external expsoure to radiation and do not evaluate the effects of radiation on children. Although external DCFs are applicable to both men and women, internal DCFs are based on radiation effects for an adult male. Gender differences that contribute to the uncertainty when applying internal DCFs to women include potential differences in sensitivity of reproductive organs and effects related to pregnancy and lactation.

5.6.10 Preliminary Ecological Assessment

In cooperation with the New Mexico Environment Department and EPA Region VI, the Laboratory ER Project is developing an approach to ecological risk assessment. Further ecological risk assessment at this site will be deferred until the site can be assessed as part of the ecological exposure unit methodology currently being developed.

5.6.11 Conclusions and Recommendations

References for Chapter 5.0 - Firing Sites

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TABLE B-1
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Firing Pads at PRSs 39-004(a) and 39-004(d)]

Request Number	Sample ID	Suite	Comments
1145	0239-95-0089, -0090, -0091, -0092	Inorganic	Antimony, and selenium in all samples had percent recoveries in the spike sample outside of established limits (75%-125%). Data are less than the estimated quantitation limit (EQL), are qualified as UJ, and are usable because the percent recoveries were >40% and the laboratory control sample (LCS) recoveries were acceptable so the analytes would be detected and quantified if present.
1166	0239-95-0104, -0107		Antimony, manganese, selenium, vanadium, and zinc in all samples had percent recoveries in the spike sample outside of established limits (75%-125%). Data <EQL are qualified as UJ; data >EQL are qualified as J-. The data are usable because the percent recoveries for manganese, selenium, vanadium, and zinc were >50% and the LCS recoveries were acceptable so the analytes would be detected and quantified if present. The detected values of manganese and vanadium were less than one-half the background UTLs, while detected zinc values were either well below the background UTL or slightly above the UTL but orders of magnitude below the SAL. Therefore, the bias resulting from the spike recoveries did not affect the data comparisons. The antimony data are qualified as R,PM because recovery was <30%. Further review of the data indicate that the R qualifier should be retained and the data not used in the screening assessment.
1170	0239-95-0093, -0096, -0099, -0100, -0101, -0103		Antimony, cadmium, chromium, manganese, selenium, silver, vanadium, and zinc in all samples had percent recoveries in the spike sample outside of established limits (75%-125%). Data <EQL are qualified as UJ; data >EQL are qualified as either J- or J+. The data are usable because the percent recoveries for antimony, cadmium, chromium, manganese, selenium, and vanadium were >35% and the LCS recoveries were acceptable so the analytes would be detected and quantified if present. The detected values of cadmium, chromium, and manganese were one-sixth to one-half the background UTLs so the bias did not affect the data comparisons. The data for silver and zinc are usable because the results are biased high.
1145	0239-95-0089, -0090, -0091, -0092	Inorganic	Lead is qualified as P in all samples due to the duplicate relative percent difference (RPD). Further review of the data indicates the analyte met EPA's control limits for soil [±35% RPD, ±2X Contract Required Quantitiation Limit (CRDL)] and should not be qualified.
1166	0239-95-0104, -0107		Aluminum, iron, lead, manganese, and zinc are qualified as P in all samples due to the duplicate RPDs Further review of the data indicates the analytes met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified.
1170	0239-95-0093, -0096, -0099, -0100, -0101, -0103		Aluminum, calcium, copper, iron, lead and zinc are qualified as P in all samples due to the duplicate RPDs. Further review of the data indicates that zinc met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified, while the aluminum, copper, and lead data should be qualified as UJ or J. The data are usable because the RPDs reflect soil heterogeneity and do not affect method precision. The calcium and iron RPDs are unacceptable and these data for these samples should be qualified as R and not used in the screening assessment.

TABLE B-1
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Firing Pads at PRSs 39-004(a) and 39-004(d)]
Continued

Request Number	Sample ID	Suite	Comments
1145	0239-95-0089, -0090, -0091, -0092	Inorganic	Cadmium, nickel, and potassium were detected in the laboratory blank. Sample results >EQL but <5X the blank value are qualified as U and are usable as nondetects.
1166	0239-95-0104, -0107		Cobalt, nickel, and potassium were detected in the laboratory blank. Sample results >EQL but <5X the blank value are qualified as U and are usable as nondetects due to blank contamination.
1170	0239-95-0093, -0096, -0099, -0100, -0101, -0103		Cobalt, nickel, potassium, and vanadium were detected in the laboratory blank. Sample results >EQL but <5X the blank value are qualified as U and are usable as nondetects due to blank contamination.
1171	0239-95-0093, -0096, -0099, -0100, -0101, -0103	HE	The LCS spikes were run with seven analytes not the entire suite and results were qualified as PM. The spikes include analytes that accurately predict the recovery of those analytes that are missing. Therefore, the data should not be qualified and are usable in the screening assessment.
			2,4-Dinitrotoluene had percent recovery in the LCS above the established upper limit (>120%) and are qualified as UJ. The data are usable because the results are biased high.
1147	0239-95-0089, -0090, -0091, -0092	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1168	0239-95-0104, -0107		Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1172	0239-95-0093, -0096, -0099, -0100, -0101, -0103		Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1168	0239-95-0104, -0107	Radionuclide	The detected total uranium data are incorrectly qualified as J because of the duplicate recovery being outside the 3-sigma error. The duplicate results did have a 3-sigma agreement using Sigma Overlap Excel Macro and are usable as reported.
1147	0239-95-0089, -0090, -0091, -0092	Radionuclide	The RPD for the uranium duplicate was >20 percent and, therefore, samples are qualified as J. The lack of precision was probably due to the soil matrix, so the samples are usable as reported.
1168	0239-95-0104, -0107	Radionuclide	Thorium-230 was detected in the method blank. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.

TABLE B-2
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Transects at PRSs 39-004(a)and 39-004(d)]

Request Number	Sample ID	Suite	Comments
1172	0239-95-0093, -0096, -0099, -0100, -0101, -0103	Radionuclide	Thorium-230 was detected in the method blank. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects due to blank contamination.
1170	0239-95-0129, -0130, -0131, -0133, -0134, -0135	Inorganic	Antimony, cadmium, chromium, manganese, selenium, silver, vanadium, and zinc in all samples had percent recoveries in the spike sample outside of established limits (75%-125%). Data <EQL are qualified as UJ; data >EQL are qualified as either J- or J+. The data are usable because the percent recoveries for antimony, cadmium, chromium, manganese, selenium, and vanadium were >35% and the LCS recoveries were acceptable so the analytes would be detected and quantified if present. The detected values of cadmium, chromium, and manganese were one-sixth to one-half the background UTLs so the bias did not affect the data comparisons. The data for silver and zinc are usable because the results are biased high.
1086	0239-95-0137, -0138, -0139, -0140, -0141, -0142, -0143, -0144	Inorganic	Antimony, selenium, copper, lead, and thallium had percent recoveries in the matrix spike below the established lower limit (<75%) and are qualified as J. Data are usable because the recoveries for antimony, copper, selenium, and thallium were >50%<75%. All the detected values are below their respective SAL or UTL so the bias does not affect the data comparison. The lead recovery was >200% so the data are usable because the results are biased high.
1188	0239-95-0145, -0146, -0147		Arsenic, manganese, and selenium had percent recoveries in the matrix spike below the established lower limit (<75%) and are qualified as J. Data are usable because the recoveries were >50%<75%. All the detected concentrations are below their respective SAL or UTL and the bias does not affect the data comparison.
1086	0239-95-0137, -0138, -0139, -0140, -0141, -0142, -0143, -0144	Inorganic	Aluminum is qualified as P in all samples due to the duplicate RPD. However, after a detailed review of the data, the analyte met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified.
1170	0239-95-0129, -0130, -0131, -0133, -0134, -0135		Aluminum, calcium, copper, iron, lead, and zinc are qualified as P in all samples due to the duplicate RPDs. Further review of the data indicates that zinc met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified, while the aluminum, copper, and lead data should be qualified as UJ or J. The data are usable because the RPDs reflect soil heterogeneity and do not affect method precision. The calcium and iron RPDs are unacceptable and should be qualified as R and not used in the screening assessment.
1086	0239-95-0137, -0138, -0139, -0140, -0141, -0142, -0143, -0144	Inorganic	Arsenic, beryllium, cadmium, chromium, cobalt, copper, nickel, potassium, sodium, and silver were detected in the laboratory blank at or below the method detection limits (MDLs). Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.

TABLE B-2
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Transects at PRSs 39-004(a)and 39-004(d)]
Continued

Request Number	Sample ID	Suite	Comments
1170	0239-95-0129, -0130, -0131, -0133, -0134, -0135	Inorganic	Cobalt, nickel, potassium, and vanadium were detected in the laboratory blank. Sample results >EQL but <5X the blank value are qualified as U and are usable as nondetects.
1188	0239-95-0145, -0146, -0147		Arsenic, cadmium, cobalt, copper, potassium, and sodium were detected in the laboratory blank at or below the MDLs. Sample concentrations are<5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1085	0239-95-0137, -0138, -0139,	SVOC	Two internal standards were outside acceptable limits for five samples. All samples were re-analyzed and one internal standard was outside acceptable limits. Therefore, the re-analysis is used in the data validation. Pyrene, butylbenzyl phthalate, 3,3'-dichlorobenzidine, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene are qualified as UJ in sample 0239-95-0138. Benzo(b)fluoranthene, benzo(a)pyrene, benzo(k)fluoranthene, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, di-n-buty phthalate, and indeno(1,2,3-cd)pyrene are qualified as UJ in samples 0239-95-0137RE, and 0239-95-0139RE. In general, the internal standard may be slightly out of control due to the soil matrix but the sensitivity and responsiveness of the instrument were not compromised; therefore, data usability is unaffected.
1169	0239-95-0135	SVOC	Surrogate recoveries for both the acid extractable and base/neutral fractions were below 10% in sample 0239-95-0135. Data are qualified as R,PM. Further review of the data indicated that the R qualifier should be retained and the data not used in the screening assessment.
1171	0239-95-0129, -0130, -0131, -0133, -0134, -0135	HE	The LCS spikes were run with seven analytes and not the entire suite and, therefore, the reviewer qualified all results as PM. The spikes include analytes that should accurately predict the recovery of those analytes that are missing. Therefore, the data should not be qualified and are usable in the screening assessment.
			2,4-Dinitrotoluene had percent recovery in the LCS outside of established limits and are qualified as UJ. The data are usable because the results are biased high.
1088	0239-95-0137, -0138, -0139, -0140, -0141, -0142, -0143, -0144	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.

TABLE B-2
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Transects at PRSs 39-004(a)and 39-004(d)]
Continued

Request Number	Sample ID	Suite	Comments
1172	0239-95-0129, -0130, -0131, -0133, -0134, -0135	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries becasue the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1191	0239-95-0145, -0146, -0147		Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1088	0239-95-0137, -0138, -0139, -0140, -0141, -0142, -0143, -0144	Radionuclide	Thorium-230 was detected in the method blank. Sample values are >5X the blank values, are not qualified, and are usable as detected values.
1172	0239-95-0129, -0130, -0131, -0133, -0134, -0135		Thorium-230 was detected in the method blank. Sample concentrations are <5X the blank values, values are qualified as U and are usable as nondetects due to blank contamination.
1191	0239-95-0145, -0146, -0147	Radionuclide	Total uranium had percent recovery in the matrix spike outside of acceptable limits and is qualified as J. The data are usable because the results are biased high.

TABLE B-3
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Firing Pad at PRS 39-004(b)]

Request Number	Sample ID	Suite	Comments
927	0239-95-0048, -0049, -0050, -0051, -0052, -0053, -0056	Inorganic	The 14-day holding time for cyanide was exceeded for all samples and the data originally validated with a PM qualifier. The holding time was not grossly exceeded (more than twice the holding time) so the results are re-qualified as UJ. The data are usable because the samples were refrigerated and stable enough to prevent marked degradation within 28 days.
927	0239-95-0048, -0049, -0050, -0051, -0052, -0053, -0056	Inorganic	Antimony and manganese had matrix spike recoveries outside of acceptable limits and are qualified as J. Data are usable because the recovery for antimony was >50%. The manganese data are usesable because the results are biased high. All detected antimony and manganese results are below their respective SALs or UTLs so the bias does not affect the data comparison.
927	0239-95-0048, -0049, -0050, -0051, -0052, -0053, -0056	Inorganic	Calcium, copper, lead and manganese are qualified as P in all samples due to duplicate RPDs. After a detailed review of the data, calcium, lead, and manganese met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified. Copper did not meet EPA's control limits and should be qualified as J. The copper data are usable because the RPD was not overly excessive so the method precision was reasonable.
927	0239-95-0048, -0049, -0050, -0051, -0052, -0053, -0056	Inorganic	Beryllium, cadmium, cobalt, copper, silver, and nickel were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
929	0239-95-0048, -0049, -0050, -0051, -0052, -0053, -0056	Radionuclide	Thorium-228, thorium-232, and plutonium-238 were not spiked into the LCS and are qualified as PM. Thorium-230 and plutonium-239 were spiked into the LCS and these spikes should predict the thorium-228, thorium-232, and plutonium-238 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
929	0239-95-0048, -0049, -0050, -0051, -0052, -0053, -0056	Radionuclide	Thorium-230 was detected in the method blank. Sample values are >5X the blank values, are not qualified, and are usable as detected values.

TABLE B-4
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Transects at PRS 39-004(b)]

Request Number	Sample ID	Suite	Comments
1145	0239-95-0070, -0071, -0072, -0073, -0074	Inorganic	Antimony and selenium in all samples had percent recoveries in the spike sample outside of established limits (75%-125%). Data <EQL are qualified as UJ and are usable because the percent recoveries were >40% and the LCS recoveries were acceptable so the analytes would be detected and quantified if present.
1188	0239-95-0075, -0079, -0080, -0081, -0083, -0085, -0087	Inorganic	Arsenic, manganese, and selenium had percent recoveries in the matrix spike below the established lower limit (<75%) and are qualified as J. Data are usable because the recoveries were >50%<75%. All the detected concentrations are below their respective SAL or UTL and the bias does not affect the data comparison.
1145	0239-95-0070, -0071, -0072, -0073, -0074	Inorganic	Lead is qualified as P in all samples due to the duplicate RPD. Further review of the data indicates the analyte met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified.
1145	0239-95-0070, -0071, -0072, -0073, -0074	Inorganic	Cadmium, nickel, and potassium were detected in the laboratory blank. Sample results >EQL but <5X the blank value are qualified as U and are usable as nondetects.
1188	0239-95-0075, -0079, -0080, -0081, -0083, -0085, -0087		Arsenic, cadmium, cobalt, copper, potassium, and sodium were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1191	0239-95-0075, -0079, -0080, -0081, -0083, -0085, -0087	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1191	0239-95-0075, -0079, -0080, -0081, -0083, -0085, -0087	Radionuclide	Total uranium had percent recovery in the matrix spike outside of established limits and is qualified as J. The data are usable because the results are biased high.
1191	0239-95-0081, -0083, -0085,	Radionuclide	The MDA americium-241 was less than the EQL in three samples and are qualified as U. All results are usable as nondetects.

TABLE B-5
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Firing Pad at PRS 39-004(e)]

Request Number	Sample ID	Suite	Comments
927	0239-95-0003, -0004, -0005, -0006, -0007	Inorganic	The 14-day holding time for cyanide was exceeded for all samples and the data originally validated with a PM qualifier. The holding time was not grossly exceeded (more than twice the holding time) so the results are re-qualified as UJ. The data are usable because the samples were refrigerated and stable enough to prevent marked degradation within 28 days.
927	0239-95-0003, -0004, -0005, -0006, -0007	Inorganic	Antimony and manganese had matrix spike recoveries below the established limit and are qualified as J. Data are usable because the recovery for antimony was >50%. The manganese data are usable because the results are biased high. All detected antimony and manganese results are below their respective SALs or UTLs so the bias does not affect the data comparison.
927	0239-95-0003, -0004, -0005, -0006, -0007	Inorganic	Calcium, copper, lead and manganese are qualified as P in all samples due to duplicate RPDs. After a detailed review of the data, calcium, lead, and manganese met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified. Copper did not meet EPA's control limits and should be qualified as J. The copper data are usable because the RPD was not overly excessive so the method precision was reasonable.
927	0239-95-0003, -0004, -0005, -0006, -0007	Inorganic	Beryllium, cadmium, cobalt, copper, silver, and nickel were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
929	0239-95-0003, -0004, -0005, -0006, -0007	Radionuclide	Thorium-228, thorium-232, and plutonium-238 were not spiked into the LCS and are qualified as PM. Thorium-230 and plutonium-239 were spiked into the LCS and these spikes should predict the thorium-228, thorium-232, and plutonium-238 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1043	0239-95-0023, -0024, -0025, -0026, -0027, -0028		Thorium-228 and thorium-232were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
929	0239-95-0003, -0004, -0005, -0006, -0007	Radionuclide	Thorium-230 was detected in the method blank. Sample values are greater than 5X the blank values, are not qualified, and are usable as detected values.
1043	0239-95-0023, -0024, -0025, -0026, -0027, -0028		Uranium was detected in the method blank. Sample values are >5X the blank values, are not qualified, and are usable as detected values.

TABLE B-6
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Transects at PRS 39-004(e)]

Request Number	Sample ID	Suite	Comments
1045	0239-95-0023, -0024, -0025, -0026	Inorganic	Manganese, lead, silver, and zinc had percent recoveries in the matrix spike below the established lower limit (<75%) for all samples and are qualified as J. Data are usable because the recoveries for lead and silver were >50%<75%. The manganese data are usable because the results are biased high. All detects are below their respective SAL or UTL so the bias does not affect the data comparison. The zinc recovery was <10% so the data are qualified as R and are not used in the screening assessment.
1063	0239-95-0031, -0032, -0033, -0034, -0035, -0036, -0037, -0038, -0202, -0203		Antimony, cadmium, chromium, copper, lead, and thallium percent recoveries in the matrix spike below the established limit (<75%) and are qualified as J. Data are usable because the recoveries for cadmium, chromium, and thallium were >50%<75%. All detected analytes are below their respective SAL or UTL so the bias does not affect the data comparison. Lead and copper recoveries were >125% and >200%, respectively, and are usable because the results are biased high The antimony recovery was <10%, data are qualified as R, and not used in the screening assessment.
1086	0239-95-0039, -0049, -0041, -0042, -0043, -0044, -0045		Antimony, selenium, copper, lead and thallium had percent recoveries in the matrix spike outside of established limits and are qualified as J. Data are usable because the recoveries for antimony, copper, selenium, and thallium were >50%<75%. All the detected values are below their respective SAL or UTL so the bias does not affect the data comparison. Lead recovery was >200% and data are usable because the results are biased high.
1188	0239-95-0028, -0046, -0047		Arsenic, manganese, and selenium had percent recoveries in the matrix spike below the established lower limit (<75%) and are qualified as J. Data are usable because the recoveries were >50%<75%. All detected concentrations are below the SALs or UTLs and the bias does not affect the data comparison.
1045	0239-95-0023, -0024, -0025, -0026	Inorganic	Aluminum, manganese, silver and zinc are qualified as P in all samples due to the duplicate RPD. However, after a detailed review of the data, aluminum, manganese and silver met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified. Zinc did not meet EPA's control limits and, therefore, should be qualified as J. However, the zinc data are already unusable due to the low matrix spike recovery.
1063	0239-95-0031, -0032, -0033, -0034, -0035, -0036, -0037, -0038, -0202, -0203		Cyanide, copper, lead and silver are qualified as P in all samples due to the duplicate RPD. However, after a detailed review of the data, lead and silver met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified. Cyanide and copper did not meet EPA's control limits and, therefore, should be qualified as UJ and J, respectively. The cyanide and copper data are usable because the RPDs were not overly excessive so the method precision was reasonable.
1086	0239-95-0039, -0049, -0041, -0042, -0043, -0044, -0045		Aluminum is qualified as P in all samples due to the duplicate RPD. However, after a detailed review of the data, the analyte met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified.

TABLE B-6
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Transects at PRS 39-004(e)]
Continued

Request Number	Sample ID	Suite	Comments
1045	0239-95-0023, -0024, -0025, -0026	Inorganic	Arsenic, chromium, nickel, potassium, and selenium were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1063	0239-95-0031, -0032, -0033, -0034, -0035, -0036, -0037, -0038, -0202, -0203		Arsenic was detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1086	0239-95-0039, -0049, -0041, -0042, -0043, -0044, -0045		Arsenic, beryllium, cadmium, chromium, cobalt, copper, nickel, potassium, sodium, and silver were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1188	0239-95-0029, -0046, -0047		Arsenic, cadmium, cobalt, copper, potassium, and sodium were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values, are qualified as U, and are usable as nondetects in the screening assessment due to blank contamination.
1044	0239-95-0023	SVOC	Di-n-butyl phthalate was detected in one sample at less than the EQL. The sample result has a high degree of uncertainty because the value cannot be accurately distinguished from instrument "noise" levels. As a result, the datum is usable as an estimated value, but should be used with caution in the screening assessment because it cannot be accurately quantified.
1085	0239-95-0039, -0049, -0041, -0042, -0043, -0044, -0045	SVOC	Two internal standards were outside acceptable limits for five samples. All samples were re-analyzed and one internal standard was outside acceptable limits. Therefore, the re-analysis is used in the data validation. Pyrene, butylbenzylphthalate, 3,3'-dichlorobenzidine, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene are qualified as UJ in sample 0239-95-040. Benzo(b)fluoranthene, benzo(a)pyrene, benzo(k)fluoranthene, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, di-n-butyl phthalate, and indeno(1,2,3-cd)pyrene are qualified as UJ in sample 0239-95-0042RE. In general, the internal standard may be slightly out of control due to the soil matrix but the sensitivity and responsiveness of the instrument were not compromised; data usability is unaffected.

TABLE B-6
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Transects at PRS 39-004(e)]
Continued

Request Number	Sample ID	Suite	Comments
1065	0239-95-0031, -0032, -0033, -0034, -0035, -0036, -0037, -0038, -0202, -0203	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1088	0239-95-0039, -0049, -0041, -0042, -0043, -0044, -0045		Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1065	0239-95-0031, -0032, -0033, -0034, -0035, -0036, -0037, -0038, -0202, -0203	Radionuclide	Uranium was detected in the method blank. Sample values are >5X the blank values and are considered valid. Data are qualified as U and are usable as detected values.
			Thorium-230 was detected in the method blank. Sample values are >5X the blank values and are considered valid. Data are qualified as U and are usable as detected values.
1088	0239-95-0039, -0049, -0041, -0042, -0043, -0044, -0045		Thorium-230 was detected in the method blank. Sample values are >5X the blank values and are considered valid. Data are qualified as U and are usable as detected values.

TABLE B-7
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Firing Pad at PRS 39-004(c)]

Request Number	Sample ID	Suite	Comments
927	0239-95-0148, -0149, -0150, -0151, -0152	Inorganic	The 14-day holding time for cyanide was exceeded for all samples and the data originally validated with a PM qualifier. The holding time was not grossly exceeded (more than twice the holding time) so the results are re-qualified as UJ. The data are usable because the samples were refrigerated and stable enough to prevent marked degradation within 28 days.
927	0239-95-0148, -0149, -0150, -0151, -0152	Inorganic	Antimony and manganese had matrix spike recoveries below the established limits (75-125%) and are qualified as J. Data are usable because the recovery for antimony was >50%. The manganese data are usable because the results are biased high. All detected antimony and manganese results are below their respective SALs or UTLs so the bias does not affect the data comparison.
1105	0239-95-0183, -0184, -0185, -0186, -0187, -0188, -0189, -0190		Antimony, chromium, selenium, vanadium, and zinc had matrix spike recoveries below the established limits (75-125%) and are qualified as UJ or J. Data are usable because the recoveries were >50% and the results are below their respective SALs or UTLs so the bias does not affect the data comparison.
927	0239-95-0148, -0149, -0150, -0151, -0152	Inorganic	Calcium, copper, lead and manganese are qualified as P in all samples due to duplicate RPDs. After a detailed review of the data, calcium, lead, and manganese met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified. Copper did not meet EPA's control limits and should be qualified as J. The copper data are usable because the RPD was not overly excessive so the method precision was reasonable.
927	0239-95-0148, -0149, -0150, -0151, -0152	Inorganic	Beryllium, cadmium, cobalt, copper, silver, and nickel were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
929	0239-95-0148, -0149, -0150, -0151, -0152	Radionuclide	Thorium-228, thorium-232, and plutonium-238 were not spiked into the LCS and are qualified as PM. Thorium-230 and plutonium-239 were spiked into the LCS and these spikes should predict the thorium-228, thorium-232, and plutonium-238 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
929	0239-95-0148, -0149, -0150, -0151, -0152	Radionuclide	Thorium-230 was detected in the method blank. Sample values are >5X the blank values, are not qualified, and are usable as detected values.

TABLE B-8
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Transects at PRS 39-004(c)]

Request Number	Sample ID	Suite	Comments
1188	0239-95-0174, -0175, -0176, -0181, -0191, -0192, -0194, -0195, -0196, -0197, -0198	Inorganic	Arsenic, manganese, and selenium had percent recoveries in the matrix spike below the established lower limit (<75%) and are qualified as J. Data are usable because the recoveries were >50%<75%. All the detected concentrations are below their respective SAL or UTL and the bias does not affect the data comparison.
1188	0239-95-0174, -0175, -0176, -0181, -0191, -0192, -0194, -0195, -0196, -0197, -0198	Inorganic	Arsenic, cadmium, cobalt, copper, potassium, and sodium were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1104	0239-95-0188	SVOC	All the internal standards for sample 0239-95-0188 were below established limits and all analytes are qualified as UJ,PM. The surrogates were within quality control criteria and, after a detailed review of the data, the data should be qualified as UJ and are usable as estimated nondetects.
1107	0239-95-0183, -0184, -0185, -0186, -0187, -0188, -0189, -0190	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recovery because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1191	0239-95-0174, -0175, -0176, -0181, -0191, -0192, -0194, -0195, -0196, -0197, -0198		Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1107	0239-95-0183, -0184, -0185, -0186, -0187, -0188, -0189, -0190	Radionuclide	Thorium-230 was detected in the method blank. Sample values are >5X the blank values, are not qualified, and are usable as detected values.
1107	0239-95-0183	Radionuclide	The gamma spec sample 0239-95-0183 was reanalyzed and the results changed due to background; therefore, the results of the reanalysis should be used in the screening assessment.
1107	0239-95-0183, -0184, -0185, -0186, -0187, -0188, -0189, -0190	Radionuclide	Total uranium matrix spike was not of the sample delivery group and the batch matrix spike was not included in the data package and were qualified PM. Data are qualified as J and are usable because the matrix spike from the other SDG was acceptable and all other QC samples were acceptable.
1191	0239-95-0174, -0175, -0176, -0181, -0191, -0192, -0194, -0195, -0196, -0197, -0198		Total uranium had percent recovery in the matrix spike outside of established limits and is qualified as J+. The data are usable because the results are biased high.

TABLE B-9
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Gas Gun Site PRS 39-008]

Request Number	Sample ID	Suite	Comments
1191	0239-95-0174, -0175, -0176, -0181, -0191, -0192	Radionuclide	The MDA americium-241 was less than the EQL in ten samples and are qualified as U. All results are usable as nondetects.
927	0239-95-0200, -0201	Inorganic	Antimony and manganese had matrix spike recoveries outside of established limits and are qualified as J. Data are usable because the recovery for antimony was >50%. The manganese data are usable because the results are biased high. All detected antimony and manganese results are below their respective SALs or UTLs so the bias does not affect the data comparison.
1266	0239-95-0215, -0216, -0219, -0221, -0222, -0223, -0225, -0227, -0228, -0230, -0231		Antimony, manganese, selenium, and silver had percent recoveries in the matrix spike outside of established limits and are qualified as J. Data are usable because the recoveries for antimony and silver were >50%<75%. All detected values are below their respective SAL or UTL so the bias does not affect the data comparison. The manganese recovery was greater than the control limit and the data are usable because the results are biased high. The selenium recovery was 0% and qualified as R,PM. Further review of the data indicated that the R qualifier should be retained and the selenium results are not used in the screening assessment.
927	0239-95-0200, -0201	Inorganic	Calcium, copper, lead and manganese are qualified as P in all samples due to duplicate RPDs. After a detailed review of the data, calcium, lead, and manganese met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified. Copper did not meet EPA's control limits and should be qualified as J. The copper data are usable because the RPD was not overly excessive so the method precision was reasonable.
1246	0239-95-0204, -0205, -0206, -0207, -0209, -0210, -0211, -0212, -0213, -0214		Aluminum is qualified as P in all samples due to the duplicate RPD. However, after a detailed review of the data, the analyte met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified.
1249	0239-95-0208		Aluminum is qualified as P in all samples due to the duplicate RPD. However, after a detailed review of the data, the analyte met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified.
1266	0239-95-0215, -0216, -0219, -0221, -0222, -0223, -0225, -0227, -0228, -0230, -0231		Chromium, iron, silver and zinc are qualified as P in all samples due to the duplicate RPD. However, after a detailed review of the data, the analytes met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified.
927	0239-95-0200, -0201	Inorganic	The 14-day holding time for cyanide was exceeded for all samples and the data originally validated with a PM qualifier. The holding time was not grossly exceeded (more than twice the holding time) so the results are re-qualified as UJ. The data are usable because the samples were refrigerated and stable enough to prevent marked degradation within 28 days.

TABLE B-9
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Gas Gun Site PRS 39-008]
Continued

Request Number	Sample ID	Suite	Comments
1246	0239-95-0204, -0205, -0206, -0207, -0209, -0210, -0211, -0212, -0213, -0214	Inorganic	The 14-day holding time for cyanide was exceeded by nine days for all samples and the data originally validated with a PM qualifier. The holding time was not grossly exceeded (more than twice the holding time) so the results are re-qualified as UJ. The data are usable as non-detects because the samples were refrigerated and stable enough to prevent marked degradation within 28 days.
1249	0239-95-0208		The 14-day holding time for cyanide was exceeded by eight days for all samples and the data originally validated with a PM qualifier. The holding time was not grossly exceeded (more than twice the holding time) so the results are re-qualified as UJ. The data are usable as non-detects because the samples were refrigerated and stable enough to prevent marked degradation within 28 days.
927	0239-95-0200, -0201	Inorganic	Beryllium, cadmium, cobalt, copper, silver, and nickel were detected in the laboratory blank at or below the MDLs. Sample concentrations are<5X the blank values. The values are qualified as U and are usable as nondetects n the screening assessment due to blank contamination.
1246	0239-95-0204, -0205, -0206, -0207, -0209, -0210, -0211, -0212, -0213, -0214		Beryllium, chromium, cobalt, copper, nickel, silver, sodium and vanadium were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1249	0239-95-0208		Antimony and sodium were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment.
1266	0239-95-0215, -0216, -0219, -0221, -0222, -0223, -0225, -0227, -0228, -0230, -0231		Chromium, cobalt, copper, and nickel were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1245	0239-95-0206	SVOC	Sample 0239-95-0206 had eight out of ten surrogates below 10 percent recovery and all data are qualified as R,PM. The re-extraction had good surrogate recovery but the sample was re-extracted outside holding times and the data are qualified as PM. The holding times were not grossly exceeded so the results for the re-extracted analysis should be re-qualified as UJ and are usable as nondetects.
	0239-95-0213		Sample 0239-95-0213 had ten out of ten surrogates less than the established limits but greater than ten percent and all results are qualified as UJ. The sample was re-extracted outside holding times with good surrogate recovery and results are qualified as PM. The results of the re-extracted analysis should be re-qualified as UJ and are usable because the holding times were not grossly exceeded.

TABLE B-9
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Gas Gun Site PRS 39-008]
Continued

Request Number	Sample ID	Suite	Comments
1264	0239-95-0215, -0216, -0219 -0221, -0222, -0223, -0225, -0227, -0228, -0230, -0231	SVOC	Di-n-butyl phthalate, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene are incorrectly qualified as UJ in samples 0239-95-0215, 0239-0216, 0239-95-0223, 0239-95-0225, 0239-95-0227, -239-95-0228, 0239-95-0230, and 0239-95-0231 because the internal standard recoveries were within established limits. These analytes are correctly qualified as UJ in samples 0239-95-0219 and -0219RE, 0239-95-0221 and -0221RE, and 0239-95-0222 and -0222RE.
1264	0239-95-0225, -0227, -0228, -0231	SVOC	Bis(2-ethylhexyl)phthalate was detected below the MDL in samples 0239-95-0225, 0239-95-0227, 0239-95-0228, and 0239-95-0231 and is qualified as U and data are usable as non-detects.
1265	0239-95-0215, -0216, -0219, -0221, -0222, -0223, -0225, -0227, -0228, -0230, -0231	HE	The LCS spikes were run with seven analytes and not the entire suite and, therefore, the reviewer qualified all results as PM. The spikes include analytes that should accurately predict the recovery of those analytes that are missing. Therefore, the data should not be qualified and are usable in the screening assessment.
929	0239-95-0200, -0201	Radionuclide	Thorium-228, thorium-232, and plutonium-238 were not spiked into the LCS and are qualified as PM. Thorium-230 and plutonium-239 were spiked into the LCS and these spikes should predict the thorium-228, thorium-232, and plutonium-238 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1247	0239-95-0204, -0205, -0206, -0207, -0209, -0210, -0211, -0212, -0213, -0214		Thorium-228 , thorium-232 and plutonium-238 were not spiked into the LCS and are qualified as PM. Thorium-230 and plutonium-239 were spiked into the LCS and the spike should predict the thorium-228, thorium-232 and plutonium-238 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1250	0239-95-0208		Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.

TABLE B-9
DATA QUALITY EVALUATION FOR TA-39 SAMPLES
[Gas Gun Site PRS 39-008]
Continued

Request Number	Sample ID	Suite	Comments
1267	0239-95-0215, -0216, -0219, -0221, -0222, -0223, -0225, -0227, -0228, -0230, -0231	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
929	0239-95-0200, -0201	Radionuclide	Thorium-230 was detected in the method blank. Sample values are >5X the blank values and are considered valid. Data are qualified as U and are usable as detected values.
1247	0239-95-0204, -0205, -0206, -0207, -0209, -0210, -0211, -0212, -0213, -0214	Radionuclide	Thorium-230 was detected in the method blank. Sample values are >5X the blank values and are considered valid. Data are qualified as U and are usable as detected values.
1250	0239-95-0208		Thorium-230 was detected in the method blank. Sample value is >5X the blank value and is considered valid. Datum is not qualified and is usable as a detected value.
1250	0239-95-0208	Radionuclide	The gamma spec duplicate was not analyzed so all associated results were qualified as PM. Sample was associated with the QC batch for SDG 1247 which had a gamma spec duplicate. Therefore, there is no need to qualify the data as PM; data should not be qualified.
1267	0239-95-0215	Radionuclide	The MDA was not reported for sample 0239-95-0215 and, therefore, gamma spec results are qualified as PM. The MDA for all samples was other samples with this batch are acceptable. Data are usable as reported.

TABLE B-10
DATA QUALITY EVALUATION FOR TA-39 1994 SAMPLES
[Stream Channel from Below Firing Sites to State Rd. 4]

Request / Batch Number	Sample ID	Suite	Comments
19666	AAB0589,0590, 0591,0592,0594, 0597,0599,0600, 0601,0602,0603, 0604,0605	Inorganic	Aluminum, chromium, and vanadium in all soil samples had percent recoveries in the blind QC sample below the established lower limit (<75%) and are qualified as UJ or J. Data are usable because the recoveries are >65% so the analytes would be detected and quantified if present. Detected values are more than a factor of two below the background UTLs.
19666	AAB0589,0590, 0591,0592,0594, 0597,0599,0600, 0601,0602,0603, 0604,0605	Inorganic	Mercury in all soil samples exceeded holding time. Results <DL are qualified as UJ (eight samples), results >DL qualified as J (five samples). Data are usable because samples were preserved and properly stored, degradation of material was minimized, and the holding time was not grossly exceeded.
			Total cyanide in all soil samples grossly exceeded holding time. All results were <DL and were qualified as R. Data are not used in the screening assessment.
19345	AAB0588,0593, 0596,0598	HE	The recommended 14-day extraction holding time was exceeded by 49 days and the 40-day analytical holding time for four soil samples was exceeded by 109 days. All data <EQL and qualified as UJ. Because the soil samples were kept frozen before extraction, the extraction holding time can be extended up to 8 weeks (and probably longer). Following extraction, the analytes are preserved and stored at 4°C to stop bacterial growth and prevent photodegradation. This process appears to stop decomposition of material for up to at least 71 days (or longer). Therefore, the usability of the data is probably not compromised because proper storage prevented degradation of material despite the extreme exceedance of the extraction and analytical holding times. However, the data should be used with caution in the screening assessment.
	AAB0595		The recommended 14-day extraction holding time was exceeded by 49 days and the 40-day analytical holding time for one soil sample was exceeded by 109 days and surrogate recovery was <50%. All of the data for this sample are <EQL and qualified as R because of the multiple QC problems. Data are not used in the screening assessment.
19369	AAB0589,0590, 0591,0592,0594, 0597,0599,0600, 0601,0602,0603, 0604,0605	HE	Nitrobenzene and 1,3,5-trinitrobenzene in all soil samples had percent recoveries in the blind QC below the established lower limit (<50%). Data are qualified as UJ and are usable because the recoveries were >20%<50% so the analytes would be detected and quantified if present.

TABLE B-11
DATA QUALITY EVALUATION FOR TA-39 1995 SAMPLES
[Stream Channel Segments Adjacent to PRSs 39-004(a) and 39-004(d)]

Request Number	Sample ID	Suite	Comments
19368	AAB0589,0590, 0591,0592,0594, 0597,0599,0600, 0601,0602,0603, 0604,0605	PCBs/ Pesticides	The quantitation value for p,p'-DDD in one soil sample from the analytical columns differed by >25%. Since the %D (percent difference) between the two quantitation columns was >25% indicating a false positive, the sample data for the detected target compound are qualified as J. Data are usable because DDT and DDE were detected in the sample indicating that presence of DDD is likely.
1127	0239-95-0110, -0111, -0112, -0113, -0114, -0115, -0116, -0117, -0118, -0119, -0120, -0121, -0122, -0123, -0124	Inorganic	Antimony, lead, and vanadium in all samples had percent recoveries in thematrix spike sample below the established limit (75-125%). Lead and vanadium data are qualified as J- because recoveries were between 30% and 75%, and the antimony data are qualified as R,PM because recovery was <30%. The lead and vanadium data are usable because the analytes were detected an order of magnitude below the SALs so the bias does not affect the data comparison. Antimony data are not usable because the analyte cannot be quantified.
1170	0239-95-0125, -0126, -0127, -0128	Inorganic	Antimony, cadmium, chromium, manganese, selenium, silver, vanadium, and zinc in all samples had percent recoveries in the spike sample outside of established limits (75%-125%). Data < EQL are qualified as UJ; data > EQL are qualified as either J- or J+. The data are usable because the percent recoveries for antimony, cadmium, chromium, manganese, selenium, and vanadium were >35% and the LCS recoveries were acceptable so the analytes would be detected and quantified if present. The detected values of cadmium, chromium, and manganese were one-sixth to one-half the background UTLs so the bias did not affect the data comparisons. The data for silver and zinc are usable because the results are biased high.
1127	0239-95-0110, -0111, -0112, -0113, -0114, -0115, -0116, -0117, -0118, -0119, -0120, -0121, -0122, -0123, -0124	Inorganic	Aluminum, lead, and manganese are qualified as P in all samples due to the duplicate RPDs. Further review of the data indicates that PRDs did not meet EPA's control limits for soil (±35% RPD, ±2X CRDL). The data should be qualified as J and are usable because the RPDs reflect soil heterogeneity and do not affect method precision.
1170	0239-95-0125, -0126, -0127, -0128	Inorganic	Aluminum, calcium, copper, iron, lead, and zinc are qualified as P in all samples due to the duplicate RPDs. Further review of the data indicates that zinc met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified, while the aluminum, copper, and lead data should be qualified as UJ or J. The data are usable because the RPDs reflect soil heterogeneity and do not affect method precision. The calcium and iron RPDs are unacceptable and these data for these samples should be qualified as R and not used in the screening assessment.
1170	0239-95-0125, -0126, -0127, -0128	Inorganic	Cobalt, nickel, potassium, and vanadium were detected in the laboratory blank. Sample results >EQL but <5X the blank value are qualified as U and are usable as nondetects.

TABLE B-11
DATA QUALITY EVALUATION FOR TA-39 1995 SAMPLES
[Stream Channel Segments Adjacent to PRSs 39-004(a) and 39-004(d)]
Continued

Request Number	Sample ID	Suite	Comments
1130	0239-95-0110, -0111, -0112, -0113, -0114, -0115, -0116, -0117, -0118, -0119, -0120, -0121, -0122, -0123, -0124	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1172	0239-95-0125, -0126, -0127, -0128		Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1130	0239-95-0110, -0111, -0112, -0113, -0114, -0115, -0116, -0117, -0118, -0119, -0120, -0121, -0122, -0123, -0124	Radionuclide	Thorium-230 and thorium-232 were detected in the method blank. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1172	0239-95-0125, -0126, -0127, -0128		Thorium-230 was detected in the method blank. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects due to blank contamination.

TABLE B-12
DATA QUALITY EVALUATION FOR TA-39 1995 SAMPLES
[Stream Channel Segment Adjacent to PRS 39-004(b)]

Request Number	Sample ID	Suite	Comments
976	0239-95-0008, -0009, -0010,	Inorganic	Samples 0239-95-008, 0239-95-009, and 0239-95-010 were originally not validated in this request. These samples have subsequently been validated in-house based on current baseline validation procedures.
976	0239-95-0008, -0009, -0010, -0011, -0012, -0013, -0014, -0015, -0016, -0017, -0018, -0019, -0020, -0021, -0022	Inorganic	The 14-day holding time for cyanide was exceeded for all samples by 26 days and data were originally qualified as P,PM. The holding time was not grossly exceeded so the data are re-qualified as UJ. The data are usable as estimated nondetects because the samples were refrigerated and stable enough to prevent marked degradation within 28 days.
976	0239-95-0008, -0009, -0010, -0011, -0012, -0013, -0014, -0015, -0016, -0017, -0018, -0019, -0020, -0021, -0022	Inorganic	Manganese, mercury, and selenium had percent recoveries in the spike sample below the established lower limit (<75%) for all samples. The results are qualified as J and are usable because the recoveries for manganese and mercury were >50%<75%. The selenium data are usable because the results are biased high. All detects are below their respective SAL or UTL so the bias does not affect the data comparison.
976	0239-95-0008, -0009, -0010, -0011, -0012, -0013, -0014, -0015, -0016, -0017, -0018, -0019, -0020, -0021, -0022	Inorganic	Aluminum, iron, and manganese were qualified P in all samples due to the duplicate RPDs. However, after a detailed review of the data, iron and manganese met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified. Aluminum did not meet EPA's control limits and, therefore, should be qualified as J. The aluminum data are usable because the RPD was not overly excessive so the method precision was reasonable.
975	0239-95-0022	SVOC	Sample 0239-95-0022 was diluted in order to accurately quantitate the concentration of bis(2-ethylhexyl)phthalate and, therefore, the second analysis should be used in the screening assessment.
974	0239-95-0008, -0009, -0010, -0011, -0012, -0013, -0014, -0015, -0016, -0017, -0018, -0019, -0020, -0021, -0022	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.

TABLE B-13
DATA QUALITY EVALUATION FOR TA-39 1995 SAMPLES
[Stream Channel Segment Adjacent to PRS 39-004(e)]

Request Number	Sample ID	Suite	Comments
974	0239-95-0008, -0009, -0010, -0011, -0012, -0013, -0014, -0015, -0016, -0017, -0018, -0019, -0020, -0021, -0022	Radionuclide	Thorium-230 was detected in the method blank. Sample concentrations are less than 5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination. The thorium-230 duplicate was outside quality control limits and is qualified as J. The sample data were previously qualified as U due to blank contamination but should be qualified as UJ and usable as estimated nondetects.
1045	0239-95-0059, -0060, -0061, -0062, -0063, -0064, -0065, -0066, -0067, -0068, -0069	Inorganic	Manganese, lead, silver, and zinc had percent recoveries in the matrix spike below the established lower limit (<75%) for all samples and are qualified as J or R. Data are usable because the recoveries for lead and silver were >50%<75%. The manganese data are usable because the results are biased high. All detects are below their respective SAL or UTL so the bias does not affect the data comparison. The zinc recovery was <10% so the data are qualified as R and are not used in the screening assessment.
1045	0239-95-0059, -0060, -0061, -0062, -0063, -0064, -0065, -0066, -0067, -0068, -0069	Inorganic	Aluminum, manganese, silver and zinc are qualified as P in all samples due to the duplicate RPD. However, after a detailed review of the data, aluminum, manganese and silver met EPA's control limits for soil (±35% RPD, ±2X CRDL) and, therefore, should not be qualified. Zinc did not meet EPA's control limits and, therefore, should be qualified as J. However, the zinc data are already unusable due to the low matrix spike recovery.
1045	0239-95-0059, -0060, -0061, -0062, -0063, -0064, -0065, -0066, -0067, -0068, -0069	Inorganic	Arsenic, chromium, nickel, potassium, and selenium were detected in the laboratory blank at or below the MDLs. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1044	0239-96-0063, -0064, -0065	SVOC	Di-n-butyl phthalate was detected in three samples at less than the EQL. The sample results have a high degree of uncertainty because the values cannot be accurately distinguished from instrument "noise" levels. As a result, the data are usable as estimated values, but should be used with caution in the screening assessment because they cannot be accurately quantified.
1043	0239-95-0059, -0060, -0061, -0062, -0063, -0064, -0065, -0066, -0067, -0068, -0069	Radionuclide	Thorium-230 was detected in the method blank. Sample values are <5X the blank values and are qualified as U. Data are usable as nondetects.

TABLE B-14
DATA QUALITY EVALUATION FOR TA-39 1995 SAMPLES
[Stream Channel Segment Adjacent to PRS 39-004(c)]

Request Number	Sample ID	Suite	Comments
1043	0239-95-0059, -0060, -0061, -0062, -0063, -0064, -0065, -0066, -0067, -0068, -0069	Radionuclide	Uranium was detected in the method blank. Sample values are >5X the blank values and are considered valid. Data are qualified as U and are usable as detected values.
1166	0239-95-0153, -0154, -0155, -0156, -0157, -0158, -0159, -0160, -0161, -0162, -0163, -0164, -0165, -0166, -0167, -0168, -0169, -0170, -0171, -0172, -0173	Inorganic	Antimony, manganese, selenium, vanadium, and zinc in all samples had percent recoveries in the spike sample outside of established limits (75%-125%). Data <EQL are qualified as UJ; data >EQL are qualified as J-. The data are usable because the percent recoveries for manganese, selenium, vanadium, and zinc were >50% and the LCS recoveries were acceptable so the analytes would be detected and quantified if present. The detected values of manganese and vanadium were more than one-half the background UTLs, while detected zinc values were either well below the background UTL or slightly above the UTL but orders of magnitude below the SAL. Therefore, the bias resulting from the spike recoveries did not affect the data comparisons. The antimony data are qualified as R,PM because recovery was <30%. Further review of the data indicate that the R qualifier should be retained and the data not used in the screening assessment.
1166	0239-95-0153, -0154, -0155, -0156, -0157, -0158, -0159, -0160, -0161, -0162, -0163, -0164, -0165, -0166, -0167, -0168, -0169, -0170, -0171, -0172, -0173	Inorganic	Aluminum, iron, lead, manganese, and zinc are qualified as P in all samples due to the duplicate RPDs. Further review of the data indicates the analytes met EPA's control limits for soil (±35% RPD, ±2X CRDL) and should not be qualified.
1166	0239-95-0153, -0154, -0155, -0156, -0157, -0158, -0159, -0160, -0161, -0162, -0163, -0164, -0165, -0166, -0167, -0168, -0169, -0170, -0171, -0172, -0173	Inorganic	Cobalt, nickel, and potassium were detected in the laboratory blank. Sample results >EQL but <5X the blank value are qualified as U and are usable as nondetects.

TABLE B-14
DATA QUALITY EVALUATION FOR TA-39 1995 SAMPLES
[Stream Channel Segment Adjacent to PRS 39-004(c)]
Continued

Request Number	Sample ID	Suite	Comments
1168	0239-95-0153, -0154, -0155, -0156, -0157, -0158, -0159, -0160, -0161, -0162, -0163, -0164, -0165, -0166, -0167, -0168, -0169, -0170, -0171, -0172, -0173	Radionuclide	Thorium-228 and thorium-232 were not spiked into the LCS and are qualified as PM. Thorium-230 was spiked into the LCS and the spike should predict the thorium-228 and thorium-232 recoveries because the chemistry is similar for the respective isotopes. Therefore, the data should be re-qualified as J and are usable.
1168	0239-95-0153, -0154, -0155, -0156, -0157, -0158, -0159, -0160, -0161, -0162, -0163, -0164, -0165, -0166, -0167, -0168, -0169, -0170, -0171, -0172, -0173	Radionuclide	Thorium-230 was detected in the method blank. Sample concentrations are <5X the blank values. The values are qualified as U and are usable as nondetects in the screening assessment due to blank contamination.
1168	0239-95-0161, -0162, -0163, -0164, -0165, -0166, -0167, -0168, -0169, -0170, -0171, -0172, -0173	Radionuclide	The detected total uranium data for thirteen samples are incorrectly qualified as J because of the duplicate recovery being outside the 3-sigma error. The duplicate results did have a 3-sigma agreement using Sigma Overlap Excel Macro and are usable as reported.

C.1 Toxicological Profiles for Firing Sites

Beryllium

Beryllium is not readily absorbed by any route of exposure. Less than one percent beryllium is absorbed through the gastrointestinal tract in laboratory animals (ATSDR 1991). Occupational exposure to beryllium results in bone, liver, and kidney depositions (EPA 1986). The most common clinical symptom caused by chronic beryllium exposure is granulomatous lung inflammation (IARC 1980, EPA 1986). Chronic skin lesions sometimes appear after a long latent period in conjunction with the pulmonary effects. Systemic effects from beryllium exposure may include right heart enlargement with accompanying cardiac failure, liver and spleen enlargement, cyanosis, digital clubbing, and kidney stone development (EPA 1986, Schroeder and Mitchner 1975). Beryllium has been shown to be carcinogenic in experimental animals resulting primarily in lung and/or bone tumors when given by injection, intratracheal administration, or inhalation (EPA 1986). Following lifetime exposure in drinking water, slight increases in the incidence of gross tumors of all sites combined were observed in rats (Schroeder and Mitchner 1975). Several epidemiological studies have suggested that occupational exposure to beryllium may result in an increased lung cancer risk although the data are inconclusive (EPA 1986, Wagoner et al. 1980).

EPA (1996) classified beryllium in Group B2 (Probable Human Carcinogen) based on increased incidences of lung cancer and osteosarcomas in animals. EPA (1996) calculated an inhalation cancer unit risk of 2.4×10^{-3} $(\mu g/m^3)^{-1}$ based on the relative risk for lung cancer, estimated from an epidemiological study by Wagoner et al. (1980). EPA (1996) established an oral cancer slope factor of 4.3 $(mg/kg/day)^{-1}$ based on the induction of gross tumors (all sites combined) in rats chronically administered beryllium sulfate in their drinking water (Schroeder and Mitchner 1975). EPA (1996) also developed an oral reference dose for beryllium of 5×10^{-3} mg/kg/day based on a study by Schroeder and Mitchner (1975) in which rats exposed to 0.54 mg/kg/day beryllium sulfate (the highest dose tested) in drinking water for a lifetime did not exhibit adverse effects. An uncertainty factor of 100 was used to develop the RfD.

Cadmium

Gastrointestinal absorption of cadmium in humans ranges from 5-6% (EPA 1985a). Based on a comprehensive model for inhaled cadmium, the deposition rate of particulate airborne cadmium is 5-50% (i.e., 5% of particles greater than 10 microns and up to 50% of particles less than 0.1 micron), and 50 -100% of the cadmium deposited was absorbed (Nordberg et al. 1985). Cadmium bioaccumulates in humans, particularly in the kidney and liver (EPA 1985a, b). Chronic oral or inhalation exposure of humans to cadmium has been associated with renal dysfunction, itai-itai disease (bone damage), hypertension, anemia, endocrine alterations, and immunosuppression. Renal toxicity occurs in humans chronically exposed to cadmium in food as lowest-observed-adverse-effect-level (LOAEL) of 0.0075 mg/kg/day (Shiwen et al. 1990). In laboratory animals, chronic oral exposure to cadmium results in increased blood pressure, hematological, and renal effects at LOAELs of 0.014 to 57 mg/kg/day (ATSDR 1991). Teratogenic and reproductive effects were reported in laboratory animals subchronically exposed to cadmium in drinking water at LOAELs between 0.04 and 40 mg/kg/day (ATSDR 1991). Epidemiological studies have demonstrated a strong association between inhalation exposure to cadmium and cancers of the lung, kidney, and prostate (EPA 1985b, Thun et al. 1985). In experimental animals, cadmium induces injection-site sarcomas and testicular tumors. When administered by inhalation, cadmium chloride is a potent pulmonary carcinogen in rats.

EPA (1996) classified cadmium as a Group B1 agent (Probable Human Carcinogen) by inhalation. This classification applies to agents for which there is limited evidence of carcinogenicity in humans from epidemiological studies. EPA (1996) derived an inhalation unit risk of 1.8×10^{-3} $(\mu g/m^3)^{-1}$ for cadmium based on epidemiological studies in which respiratory tract tumors were observed (Thun et al. 1985, EPA 1985b). Using renal toxicity as an endpoint, and a safety factor of 10, EPA (1996) derived two separate oral reference doses. The RfD associated with oral exposure to drinking water is 5×10^{-4} mg/kg/day, and is based upon the LOAEL of 0.005 mg/kg in

humans (EPA 1985b, Friberg et al. 1974). The RfD associated with exposure to cadmium in food is $1x10^{-3}$ mg/kg/day.

Chromium

Chromium exists in two states, as chromium (III) and as chromium (VI). Following exposure, absorption of chromium (III) has been reported to be 0.4%, while absorption of chromium (VI) has been observed to be as high as 10% (ATSDR 1991). However, chromium (VI) is rapidly reduced to chromium (III) after penetration of biological membranes and in the gastric environment (ATSDR 1991). Chromium is an essential micronutrient and is not toxic in trace quantities (EPA 1980b). Alterations in liver enzyme activities were noted in rats administered an oral dose of 13.5 mg chromium (VI)/kg/day for 20 days (Kumar et al. 1985). Rats subchronically administered higher concentrations of chromium (VI) (98 mg/kg/day) have exhibited adverse effects on renal function (Diaz-Mayans et al. 1986). No significant changes, however, were detected in the livers or kidneys of rats exposed to 2.7 mg/kg/day or 3.5 mg/kg/day chromium (III) or chromium (VI), respectively, in the drinking water for one year (MacKenzie et al. 1958, ATSDR 1991). Central nervous system effects including hypoactivity have been reported in rats exposed to subchronic levels of 98 mg/kg/day chromium (VI) in drinking water (Diaz-Mayans et al. 1986). Furthermore, epidemiological studies of worker populations have clearly established that inhaled chromium (VI) is a human carcinogen; the respiratory passages and the lungs are the target organs (Mancuso 1975, EPA 1984). Inhalation of chromium (III) or ingestion of chromium (III) or (VI) has not been associated with carcinogenicity in human or experimental animals (EPA 1984). Oral exposure of pregnant mice (gestational days 1 to 19) to 57 mg chromium (VI)/kg/day resu ted in embryolethal effects, reduced ossification and gross anomalies (Trivedt et al. 1989). Chromium (III) does not appear to cause fetotoxic or teratogenic effects in rats (ATSDR 1991).

EPA (1996) classified inhaled chromium (VI) in Group A (Human Carcinogen) by the inhalation route. Inhaled chromium (III) and ingested chromium (III) and (VI) have not been classified with respect to carcinogenicity (EPA 1996). EPA derived a chronic oral reference dose of $5x10^{-3}$ mg/kg/day for chromium (VI) based on a study by MacKenzie et al. (1958) in which no adverse effects were observed in rats exposed to 2.4 mg chromium (VI)/kg/day in drinking water for one year. A safety factor of 500 was used to derive the RfD. EPA (1996) developed an oral RfD of 1 mg/kg/day for chromium (III) based on a study in which rats were exposed to chromic oxide baked bread. No effects due to chromic oxide treatment were observed at any dose level (Ivankovic and Preussman 1975); however, hepatotoxicity was the effect of concern. An uncertainty factor of 1000 was used to calculate the RfD. For this assessment, total chromium was assumed to be chromium (III) based on historical information.

Cobalt

Cobalt is an essential trace element in human nutrition and is generally well absorbed following ingestion. Acute ingestion of large doses by humans produces gastrointestinal disurbances (vomiting and diarrhea) and a sensation of warmth. Signs of acute poisoning in animals fed cobalt salts consist of diarrhea, loss of appetite, paralysis of hind legs, cutaneous vasodilation, and reduced body temperature prior to death. Large doses produced anuria, while smaller doses resulted in albuminuria (Stokinger 1981). In animals, subchronic oral exposures result in disturbed conditioned reflexes and alterations in hematopoiesis (NRC 1977). In humans, chronic oral exposure to cobalt in high doses can cause goiter, decreased thyroid function, increased heart and respiratory rates, and blood lipid changes (Hammond and Beliles 1980). Chronic exposure to cobalt dust has been reported to produce respiratory disease in workers (Stokinger 1981). Cobalt salts included in a beer formulation at concentrations of 1.2 to 1.5 mg/liter were reported to be responsible for a number of deaths due to congestive heart failure (NRC 1977). Cobalt administered to labroatory rodents produced adverse teratogenic effects including craniofacial developmental abnormalities in mice (Leonard et al. 1984) and decreased body weight in rats (Shepard 1986). Cobalt has been reprted to cause sarcomas at the site of injection in rats (Gilman 1962, Heath 1960); however, the results of carcinogenesis studies performed by other routes of expsure have been negative.

EPA has not classified cobalt on the basis of carcinogenicity. A provisional oral RfD of $6x10^{-2}$ mg/kg/day was derived by EPA's Environmental Criteria and Assessment Office.

Copper

Copper is an essential element. A daily copper intake of 2 mg is considered to be adequate for normal health and nutrition; the minimum daily requirement is 10 mg/kg (EPA 1985). In humans, absorption of copper (as copper acetate) following oral exposure is approximately 60% (15 to 97% range) and is influenced by competition with other metals and the level of dietary protein and ascorbic acid in both humans and animals (EPA 1984). Adverse effects in humans resulting from acute oral exposure to copper at concentrations of 0.07 to 1.421 mg/kg/day as copper (II) include salivation, gastrointestinal irritation, nausea, vomiting, hemorrhagic gastritis, and diarrhea (ACGIH 1986, ATSDR 1991). Dermal or ocular exposure of humans to copper salts can produce irritation (ACGIH 19886). Acute inhalation of dusts or mists of copper salts in humans may produce irritation of the mucous membranes and pharynx, ulceration of the nasal septum, and metal fume fever (Gleason 1968). Limited data are available on the chronic toxicity of copper; however, chronic overexposure to copper in humans has been associated with anemia (ACGIH 1986) and local gastrointestinal irritation (EPA 1987). Humans ingesting copper in drinking water at 0.056 mg/kg/day for a year and a half reported abdominal pain and vomiting (Spitalny et al. 1984). Results of several animal bioassays suggest that copper compounds are not carcinogenic by oral administration; however, some copper compounds can induce injection-site tumors in mice (EPA 1985).

EPA (1995) reported the drinking water standard of 1.3 mg/liter as an oral reference dose for both chronic and subchronic exposure based on local gastrointestinal irritation (EPA 1987). Assuming a 70-kg adult ingests 2 liters of water per day, this concentration is equivalent to a dose of $3.7x10^{-2}$ mg/kg/day. However, EPA (1987) concluded toxicity data were inadequate for the calculation of a RfD for copper.

Lead

Absorption of lead from the gastrointestinal tract of adult humans is estimated at 6% to 45%. The extent and rate of gastrointestinal absorption area affected by fasting and the solubility of a particular lead salt in gastric acid (ATSDR 1991). In children, absorption from non-paint sources ranges from 30% to 50% (Hammond and Beliles 1980, EPA 1986). There are other interpretations of the data (Duggan 1983) that suggest this may be as high as 70%. For adult humans, the deposition rate of particulate airborne lead is 30% to 50%, and essentially all of the lead deposited is absorbed (EPA 1986, Morrow et al. 1980). Lead is stored in the body in the kidney, liver, and bone (EPA 1984). The major adverse effects in humans caused by lead include alterations in the hematopoietic and nervous systems. The toxic effects are generally related to the concentration of this metal in the blood. Blood concentration levels of over 80 mg/dL (decaliter or 10 liters) in children and over 100 mg/dL in sensitive adults can cause severe, irreversible brain damage, encephalopathy, and possible death. The Centers for Disease Control (CDC 1985) have used the value of 25 mg/dL as an acceptable level of blood lead. Recent information (EPA 1988), however, indicates that physiological and/or biochemical effects can occur even at lower levels. These include enzyme inhibition (16 mg/dL), elevated erythrocyte protoporphyrin (15 mg/dL), interference with Vitamin D metabolism, cognitive dysfunction in infants (10 to 15 mg/dL), electrophysiological dysfunction (6 mg/dL), and reduced childhood growth (4 mg/dL). Decreased fertility, fetotoxic effects, and skeletal malformations have been observed in experimental animals exposed to lead (EPA 1984). Chronic oral ingestion of certain lead salts (lead acetate, lead phosphate, and lead subacetate) has been associated in experimental animals with increased renal tumors. Doses of lead that induced kidney tumors were high and were beyond the lethal dose in humans (EPA 1985).

EPA (1996) classified certain lead salts in Group B2 (Probable Human Carcinogen), although no cancer slope factor was established. This category applies to those agents for which there is sufficient evidence of carcinogenicity in animals and inadequate evidence of carcinogenicity in humans. EPA (1996) considered it inappropriate to develop a reference dose for inorganic lead and lead compounds, since many of the health effects associated with lead intake (particularly

changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development) occur essentially without a threshold.

Mercury

In humans, inorganic mercury is absorbed following inhalation and oral exposure, however only 7% to 15% of administered inorganic mercury is absorbed following oral exposure (EPA 1984, Rahola et al. 1971, Task Group on Metal Accumulation 1973, ATSDR 1989). Organic mercury is almost completely absorbed from the gastrointestinal tract and is assumed to be well absorbed via inhalation in humans (EPA 1984). A primary target organ for inorganic mercury is the kidney. Acute and chronic exposures of humans to inorganic mercury compounds have been associated with anuria, polyuria, proteinuria, and renal lesions (Hammond and Beliles 1980). Chronic occupational exposure of workers to elemental mercury vapors (0.026 to 0.2 mg/m^3) has been associated with mental disturbances, tremors, and gingivitis (EPA 1984, ATSDR 1989). Rats chronically administered inorganic mercury (as mercuric acetate) in their diet for two years exhibited a dose-related increase in glomerular nephritis at concentrations as low as 1.27 mg/kg/day (Fitzhugh et al. 1950). The central nervous system is a major target for organic mercury compounds. Adverse effects in humans, resulting from subchronic and chronic oral exposures to organic mercury compounds, have included destruction of cortical cerebral neurons, damage to Purkinje cells, and lesions of the cerebellum. Clinical symptoms following exposure to organic mercury compounds have included paresthesia, loss of sensation in extremities, ataxia, and hearing and visual impairment (WHO 1976, ATSDR 1989). Adverse kidney effects are also prominent in animals following chronic ingestion of organic mercury (0.5 mg/kg phenyl mercuric acetate or 0.015 mg Hg/kg/day) (Fitzhugh et al. 1950). Embryotoxic and teratogenic effects, including malformations of the skeletal and genitourinary systems have been observed in animals exposed orally to organic mercury (EPA 1984). Both organic and inorganic compounds are reported to be genotoxic in eukaryotic systems (Leonard et al. 1984). There is evidence to suggest methylmercury chloride induces renal tumors, mostly adenocarcinomas, in two strains of male mice (ICR and B6C3F1) (Hirano et al. 1986, Mitsumori et al. 1981, 1990). However, monkeys, cats, and rats chronically administered methyl mercury in the diet did not develop an elevated tumor incidence (Ikeda et al. 1973, Charbonneau et al. 1976, Vershuuren et al. 1976). Furthermore, elevated cancer incidence has not been reported in humans who ingested methylmercury-contaminated fish in the Minamata area of Japan (Katsuna 1968), or in humans who ingested methylmercury fungicide-treated grain in Iraq and were followed for 13 years (Greenwood 1985).

EPA (1995) reported an oral reference dose for both chronic and subchronic exposures of $3x10^{-4}$ mg/kg/day for inorganic mercury based on several oral and parenteral studies in the Brown Norway rat, which observed kidney effects (Andres 1984, Druet et al. 1978, Bernaudin et al. 1981). An uncertainty factor of 1000 was used to derive the RfD. EPA (1995) also derived an inhalation reference concentration for inorganic mercury of $3x10^{-4}$ mg/m^3 for both chronic and subchronic exposures based on several human occupational studies in which neurotoxicity was observed (Fawer et al. 1983, Piikivi and Tolonen 1989, Piikivi and Hanninen 1989, Piikivi 1989). An uncertainty factor of 30 was used to derive the inhalation reference concentration. The RfD/RfC Workgroup verified both values and input into the IRIS database is pending. An oral RfD of $3x10^{-4}$ mg/kg-day for methyl mercury (organic) has been reported by EPA (1995) based on several studies reporting human poisonings (Clarkson et al. 1976, Nordberg and Strangert 1976, WHO 1976). An uncertainty factor of 10 was used to derive the RfD for methyl mercury.

Nickel

Nickel compounds can be absorbed following inhalation, ingestion, or dermal exposure. The amount absorbed depends on the dose administered and the chemical and physical form of the particular nickel compound (EPA 1986). The oral absorption of dietary nickel ranges from <1% to 4.3% in humans, which is much less than nickel sulfate given in the drinking water (27%) (ATSDR 1991). Studies in rats and dogs indicate that 1-10% of nickel (nickel, nickel sulfate hexahydrate, or nickel chloride) in the diet or by gavage is absorbed (ATSDR 1991). In humans, about 35% of inhaled nickel is absorbed into the blood from the respiratory tract, and the soluble compounds

(i.e., nickel chloride, nickel sulfate) are more readily absorbed in humans than the insoluble compounds (nickel oxide, nickel subsulfide) (ATSDR 1991). Several studies in humans indicate that nickel can penetrate the skin (55-77%); however, it could not be determined if the nickel had been absorbed into the bloodstream (Nosgaard 1955). Dermal exposure of humans to nickel produces allergic contact dermatitis (EPA 1986). Subchronic exposure to air concentrations as low as 0.025 mg/m^3 have produced mild immunological responses in rats (Spiegelberg et al. 1984). Chronic and subchronic oral exposure of experimental animals to nickel has been associated with reduced weight gain, degenerative lesions of the male reproductive tract, asthma, nasal septal perforations, pneumonitis, rhinitis, sinusitis, hyperglycemia, decreased prolactin levels, decreased iodine uptake, and vasoconstriction of the coronary vessels at concentrations as low as 0.7 mg/kg/day (ATSDR 1991). However, rats chronically exposed to nickel sulfate did not experience adverse effects to doses of 5 mg/kg/day in food (Ambrose et al. 1976). Teratogenic and fetotoxic effects have been observed in the offspring of exposed animals (EPA 1986). Inhalation exposure of rats to nickel subsulfide (0.7 mg/m^3) induced pulmonary tumors (Ottolenghi et al. 1974). Several nickel salts cause localized tumors when administered by subcutaneous injection or implantation. Epidemiological evidence indicates that inhalation of nickel refinery dust and nickel subsulfide is associated with cancers of the nasal cavity, lung, larynx, kidney, and prostate (EPA 1986).

Nickel refinery dust and nickel subsulfide are both categorized in Group A (Human Carcinogens) by inhalation (EPA 1996). This classification is based on an increased incidence of lung and nasal tumors observed in workers occupationally exposed to nickel refinery dust (EPA 1986). There is inadequate evidence for carcinogenicity of nickel refinery dust and nickel subsulfide by the oral route. These materials have inhalation cancer unit risks of 2.4×10^{-4} and 4.8×10^{-4} $(\mu g/m^3)^{-1}$, respectively (EPA 1996). EPA derived an oral reference dose for nickel soluble salts of 2×10^{-2} mg/kg/day for both chronic (EPA 1996) and subchronic (EPA 1995) exposures based on a study by Ambrose et al. (1976) in which rats administered 5 mg/kg/day nickel (as nickel sulfate) in the diet for 2 years did not experience decreased weight gain which was observed in animals administered 50 mg/kg/day. A safety factor of 300 was used to calculate the oral RfDs.

RDX

RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine: cyclonite) is completely absorbed following oral exposure (EPA 1988). No data are available regarding dermal absorption. Workers exposed to RDX via inhalation and gastrointestinal routes suffered central nervous system effects, including headaches, nausea, vomiting, amnesia, clonic/tonic convulsions, and unconsciousness (Gosslein et al. 1984; Kaplan 1965). These symptoms paralleled those previously reported in animal studies (Sunderman et al. 1944; Von Oettingen et al. 1949). However, a cross-sectional epidemiological study in a munitions plant did not identify any abnormalities in employees attributable to RDX exposure (Hathaway 1977). In subchronic feeding studies, mice experienced increased liver weights. Anemia was seen in male mice and rats, and female rats experienced increased liver weights (EPA 1988). Chronic oral exposure to RDX in rats and mice produced central nervous system effects, increased mortality, weight loss, anemia, hepatoxicity, renal toxicity, testicular degeneration, and inflammation of the prostate (Levine et a . 1983; EPA 1988). Decreased fertility, developmental effects, and embyrotoxicity were observed in rats that were fed RDX. In rabbits, RDX caused maternal toxicity and there was suggestive evidence for teratogenic effects ((EPA 1988). No conclusive evidence of carcinogenicity has been shown for RDX. RDX was not found to be carcinogenic in Fisher 344 rats (Levine et al. 1983) or Sprague-Dawley rats (Hart 1977) exposed to RDX in the diet for 2 years. However, Lish et al. (1984) reported a statistically significant increase in combined incidence of hepatocellular carcinomas and adenomas in female B6C3F1 mice fed RDX in the diet for 2 years.

EPA (1996) has classified RDX in Group C (Possible Human Carcinogen) and has developed an oral cancer slope factor of 0.11 $(mg/kg/day)^{-1}$. The potency factor is based on the increased incidence of combined hepatocellular carcinomas and adenomas in female mice receiving RDX in the diet for 2 years (Lish et al. 1984). EPA (1996) has derived a reference dose of $3x10^{-3}$ mg/kg/day based on a chronic study in which rats receiving RDX in the diet for 24 months at varying dosages experienced inflammation of the prostate (Levine et al. 1983). A LOAEL of 1.5 mg/kg/day was identified and an uncertainty factor of 100 was used to derive the RfD.

Thorium

No toxic effect of exposure to thorium have been documented, and the EPA has not developed an RfD for thorium. Therefore, the health hazard for thorium is associated with its potential radiocarcinogenic effects.

Natural thorium is present in the earth's crust as a primordial element and has been historically used as a medical imaging agent known as Thorotrast (25% colloidal solution of thorium dioxide). Thorotrast has been used extensively as an intravascular contrast agent that has resulted in the deposition of thorium in tissues and organs in the body. Once deposited, alpha particle emissions irradiate the tissues for long periods of time at low-rate doses. The data on human health effects of thorium exposure are base primarily on epidemiological studies of Thorotrast patients. A German study (van Kaick et al. 1978a and b, 1983, 1984, 1986) looked at patients that underwent intravascular injections of Thorotrast to enhance the imaging of cerebral and limb angiography. The results of the follow-up analysis indicated an excess of malignant cancers, most notably liver cancers and leukemias, among the patients relative to the controls. A Portuguese study (Abbatt 1973; da Motta et al. 1979; Horta et al. 1978), with a follow-up period of about 30 years, showed a significant excess of malignant cancer deaths (particularly liver malignancies) among patients compared to the control group. A Japanese study (Kato et al. 1979; Mori et al. 1979a and b, 1983, 1986) and a Danish study (Faber 1973, 1977, 1978, 1979, 1983, 1986) showed similar excess malignancies and deaths compared to the control groups. The excess liver cancers and leukemias were most notable in both studies. The American study (Falk et al. 1979) is a preliminary assessment of Thorotrast patients that indicates a liver cancer incidence that is reportedly increasing; further follow-up of these individuals is needed. Animal experimetnal evidence indicates that Thorocast induces cancers as a result of the radiation does delivered by the solution. Rabbits injected with Th-230 enriched Thorotrast revealed a shortened latency period associated with higher specific activity solutions (Faber 1973). A study of dose response and possible foreign body effects in rats (Wesch et al. 1973, 1983) demonstrated that the frequency of cancers follows a linear dependence with dose rate, but that varying the volume of

Thortrast administered did not correlate with the frequency of induction. However, the latent period was shortened by the increased volume of Thorotrast. In additional studies of rats injected with Zirconotrast (zirconium dioxide solution) enriched with Th-228, the number of induced cancers increased and the induced cancers were similar to those induced in humans by Thorotrast (Wesch 1986). The frequency of cancer induction in this study was dose-rate dependent and the Zirconotrast without Th-228 did not induce excess cancers.

The dose estimates for the thorium isotopes, thorium-228, thorium-230, and thorium-232, were derived using RESRAD 5.61. The dose estimates were based on the exposure scenarios, Laboratory parameters, and a dose limits of 15 mrem/yr and 30 mrem/yr.

Uranium

In general, uranium compounds are not easily absorbed across the human gastrointestinal tract. Soluble uranium compounds demonstrate the best absorption. Recent uranium metabolic models estimated absorption from the gastrointestinal tract to the blood to be 0.6% (Wrenn et al. 1987). Although human data concerning absorption by dermal exposure are sparse, water-soluble uranium compounds were not absorbed in significant quantities across the skin (Yuile 1973) and are not believed to pose a significant risk to humans by this exposure route. Approximately 70% of an intake of uranium has been estimated to be excreted by the kidneys within 24 hours of intake (Berlin and Rudell 1979). Uranium that is not excreted is store in the kidneys and bones. Exposure to uranium, a chemical toxicant, leads to nephritis of the kidneys. In an extensive chronic feeding study performed on laboratory animals (i.e., rats, rabbits, and dogs), renal damage was the observed effect (Maynard and Hodge 1949). Based on this study, the EPA has established the lowest uranium dose of 2.8 mg/kg/day as the lowest observed adverse effect level (LOAEL) (EPA 1991). This LOAEL was used to establish the RfD for uranium in lieu of a no observed adverse effect level (NOAEL). The RfD of 3 µg/kg/day has an uncertainty factor of 1000 because of intraspecies and interspecies variability in toxicological responses and for the use of the LOAEL rather than the NOAEL.

Uranium can induce cancer as a result of intake into the body through inhalation and ingestion pathways. The induction of cancer results from when organs and tissues are exposed to alpha particles emitted from decaying uranium atoms. Alpha particles are not an external hazard because they do not penetrate sensitive tissues from outside the body. The outer layers of skin stop the alpha particles before they can penetrate and damage inner-layered tissue. The type of uranium (i.e., natural, depleted, or enriched) under consideration is important because different types of uranium have different amounts of radioactivity per unit mass. The value of the specific activity of the uranium reflects the number of alpha particles emitted per unit mass, which has a direct impact on the magnitude of the radiological dose delivered after the uranium enters the body. However, convincing epidemiological evidence of uranium-induced radiocarcinogenic effects in humans is difficult to obtain. Available epidemiological evidence has come from studies involving workers in uranium mining and milling operations. However, past epidemiological studies have failed to conclusively demonstrate health effects from chronic exposure to uranium dust by uranium mine and mill workers. The most probable radiogenic effect is an increase in bone sarcomas. The likelihood of sarcomas from naturally occurring uranium is considered low and demonstrable only if a linear dose-response relationship is assumed (Mays et al. 1985); if a quadratic relationship exists there is virtually no effect expected.

In this assessment, the annual dose estimates for uranium for radiocarcinogenic risk were derived using RESRAD 5.61. The dose estimates were based on the exposure scenarios and Laboratory parameters, and compared to recommended dose limits of 15 mrem/yr and 30 mrem/yr.

Zinc

Zinc is absorbed in humans following oral exposure (approximately 20-30%) (ATSDR 1992); however, insufficient data are available to evaluate absorption following inhalation exposure (EPA 1984). Zinc is an essential trace element that is necessary for normal health and metabolism and therefore is nontoxic in trace quantities (Hammond and Beliles 1980). The National Research Council (NRC 1989) recommends a dietary allowance of 10-15 mg/day for adults. Exposure to zinc at concentrations that exceed recommended levels, however, has been associated with a variety of adverse effects. In humans, acute inhalation exposure to relatively high levels of zinc has been associated with gastrointestinal disturbances, dermatitis, and metal fume fever (ATSDR 1992). Eighteen healthy women given supplements of zinc gluconate (1 mg/kg/day) for 10 weeks developed slight alterations in blood chemistry (decreased enzyme levels) (Yadrick et al. 1989). Chronic oral exposure of humans to zinc (2 mg/kg/day) may cause decreased red blood cell counts (Hale et al. 1988). Experimental animals administered zinc in the diet (68-1110 mg/kg/day) for durations up to one year manifested blood, liver, renal, and reproductive effects (ATSDR 1992). An increased incidence of fetal resorption was noted in pregnant rats administered 200 mg/kg/day zinc (Schlicker and Cox 1968). In addition, increased pre-implantation loss was observed in rats fed the same concentration for 18 days (Pal and Pal 1987). There is no evidence that zinc is carcinogenic (ATSDR 1992).

EPA (1996) derived an oral reference dose of $3x10^{-1}$ mg/kg/day based on a human diet supplement study in which decreased blood enzyme activity (47% decrease in erythrocyte superoxide dismutase) was observed in adult females after 10 weeks of zinc exposure of 1 mg/kg-day (59.72 mg/day) (Yadrick et al. 1989). An uncertainty factor of 3 was applied to the LOAEL to derive the RfD.

C.2 Intake Equations and Exposure Parameters

TABLE C-1
EXPOSURE PARAMETERS FOR INHALATION OF VOCS OR FUGITIVE DUST
INDUSTRIAL AND CONSTRUCTION WORKER SCENARIOS

Intake (mg/kg-day) = (CA x IR x ET x EF x ED)/(BW x AT)	Assumptions			
	Industrial		Construction Worker	
Parameters	MLE	RME	MLE	RME
CA = Chemical Concentration in Ambient Air (mg/m^3)	Chemical-specific[a]	Chemical-specific[a]	Chemical-specific[b]	Chemical-specific[b]
IR = Inhalation Rate (m^3/hour)	0.83[c]	1.7[d]	1.3[e]	2.2[f]
ET = Exposure Time (hours/day)	2[g]	2[g]	8[h]	8[h]
EF = Exposure Frequency (days/year)	25[i]	22[j]	90[k]	250[j]
ED = Exposure Duration (years)	9[l]	25[m]	1[n]	1[n]
BW = Body Weight (kg)	70[o]	70[o]	70[o]	70[o]
AT = Averaging Time (period over which exposure is averaged - days)				
- Non-carcinogenic effects	3285[p]	9125[p]	365[p]	365[p]
- Carcinogenic effects	25550[q]	25550[q]	25550[q]	25550[q]

a. Concentrations in fugitive dust calculated from chemical concentrations in soil and particulate concentration in air of 0.09 mg/m^3 (EPG 1990, 0497).
b. Concentrations in fugitive dust calculated from chemical concentrations in soil and best professional judgment of particulate concentrations in air of 1 mg/m^3 for MLE and 5 mg/m^3 for RME.
c. Default value based on 20 m^3/day (EPA 1991, 0746).
d. Outdoor inhalation rate of 1.7 m^3/hr equal to 0.5 exposure time at light activity + 0.5 exposure time at moderate activity, adult male inhalation rate (inhalation rates at activity levels given in EPA 1989, 0304).
e. Recommended default values for outdoor workers (EPA 1995, 1304).
f. Outdoor inhalation rate of 1.7 m^3/hr equal to 0.5 exposure time at light activity + 0.25 exposure time at moderate activity + 0.25 exposure time at heavy activity, adult male inhalation rate (inhalation rates at activity levels given in EPA 1989, 0304).
g. Site-specific for the firing sites, approximately 2 hrs per day is spent at the site preparing and conducting tests based on conversations with site personnel.
h. Default value (EPA 1991, 0746).
i. Site-specific value, default is best professional judgment assuming 1/10 of 250 working days will be outdoors.
j. For the firing sites, approximately 22 days per year are spent at the site preparing and conducting tests based on conversations with site personnel.
k. Assumes 90 days/year for average construction job.
l. Assumes individual would change job with the same frequency as relocating to new area (e.g., every 9 years; EPA 1989, 0304).
m. Standard default value (EPA 1991, 0746).
n. Assumes construction worker is working on site for one year.
o. Standard default value (EPA 1991, 0746).
p. ED x 365 days/year.
q. 70 years x 365 days/year.

TABLE C-2
EXPOSURE PARAMETERS FOR INGESTION OF SOIL
INDUSTRIAL AND CONSTRUCTION WORKER SCENARIOS

Intake (mg/kg-day) = (CS x IR x CF x FI x EF x ED) / (BW x AT)	Assumptions			
	Industrial		Construction Worker	
Parameters	MLE	RME	MLE	RME
CS = Chemical Concentration in Soil (mg/kg)	Chemical-specific[a]	Chemical-specific[a]	Chemical-specific[a]	Chemical-specific[a]
IR = Ingestion Rate (mg soil/day)	50[b]	100[b]	480[c]	480[c]
CF = Conversion Factor (kg/mg)	1E-06	1E-06	1E-06	1E-06
FI = Fraction Ingested from Contaminated Source (unitless)	0.5[d]	1[d]	1[d]	1[a]
EF = Exposure Frequency (days/year)	25[e]	22[f]	90[g]	250[j]
ED = Exposure Duration (years)	9[h]	25[i]	1[i]	1[i]
BW = Body Weight (kg)	70[k]	70[k]	70[k]	70[k]
AT = Averaging Time (period over which exposure is averaged - days)				
- Non-carcinogenic effects	3285[l]	9125	365[l]	365[l]
- Carcinogenic effects	25550[m]	25550[m]	25550[m]	25550[m]

a. Mean and 95th UCL of mean concentrations used for MLE and RME calculations respectively.
b. Default values (EPA 1991, 0746).
c. Default value (EPA 1991, 0746). For evaluation of exposure to areas of surface and subsurface contamination as appropriate. Evaluation limited to contaminants in soils at depths of 12 ft or less. Rate of 480 mg/d for the construction worker based on EPA guidance (EPA 1991,0746), to account for substantial soil contact and potential ingestion of inhaled material that is not retained in the lungs.
d. Best professional judgment of soil consumption fractions from contaminated source.
e. Site-specific value, default is best professional judgment assuming 1/10 of 250 working days will be outdoors.
f. For the firing sites, approximately 22 days per year are spent at the site preparing and conducting tests based on conversations with site personnel.
g. Assumes 90 days/year for average construction job.
h. Assumes individual would change job with the same frequency as relocating to new area (e.g., every 9 years; EPA 1989, 0304).
i. Default value (EPA 1991, 0746).
j. Assumes construction worker is working onsite for one year. Standard default value (EPA 1991, 0746).
l. ED x 365 days/year.
m. 70 years x 365 days/year.

TABLE C-3
EXPOSURE PARAMETERS FOR DERMAL CONTACT WITH SOIL
INDUSTRIAL AND CONSTRUCTION WORKER SCENARIOS

Absorbed Dose (mg/kg-day) = (Cs x CF x SA x AF x ABS x EF x ED)/(BW x AT)	Assumptions			
	Industrial		Construction Worker	
Parameters	MLE	RME	MLE	RME
CS = Chemical Concentration in Soil (mg/kg)	Chemical-specific[a]	Chemical-specific[a]	Chemical-specific[a]	Chemical-specific[a]
CF = Conversion Factor (kg/mg)	1E-06	1E-06	1E-06	1E-06
SA = Skin Surface Area Available for Contact (cm^2/event)	2000[b]	3200[c]	2000[b]	3200[c]
AF = Soil to Skin Adherence Factor (mg/cm^2)	0.2[d]	1.0[e]	0.2[b]	1.0[d]
ABS = Absorption Factor (unitless)	Chemical-specific[e]	Chemical-specific[e]	Chemical-specific[e]	Chemical-specific[e]
EF = Exposure Frequency (days/year)	25[f]	22[g]	90[h]	250[g]
ED = Exposure Duration (years)	9[i]	25[j]	1[k]	1[k]
BW = Body Weight (kg)	70[l]	70[l]	70[l]	70[l]
AT = Averaging Time (period over which exposure is averaged - days)				
- Non-carcinogenic effects	3285[m]	9125[m]	365[m]	365[m]
- Carcinogenic effects	25550[n]	25550[n]	25550[n]	25550[n]

a. Mean and 95th UCL of mean concentrations used for MLE and RME calculations, respectively.
b. Assumes individual wears long sleeve shirt, pants, and shoes. The exposed skin surface area is limited to the head and hands (EPA 1992, 1012).
c. Assumes individual wears short sleeve shirt, pants, and shoes. The exposed skin surface area is limited to the head, forearms, and hands (SA for these body parts from EPA 1992, 1012).
d. Recommended default values (EPA 1992,1012).
e. Default values of 0.01 for inorganic chemicals and 0.1 for organic chemicals are recommended when chemical-specific values are unavailable (EPA 1995, 1307).
f. Site-specific value, default is best professional judgment assuming 1/10 of 250 working days will be outdoors.
g. For the firing sites, approximately 22 days per year are spent at the site preparing and conducting tests based on conversations with site personnel.
h. Assumes 90 days/year for average construction job.
i. Assumes individual would change job with the same frequency as relocating to new area (e.g., every 9 years; EPA 1989, 0304).
j. Default value (EPA 1991, 0746).
k. Assumes construction worker is working onsite for one year.
l. Standard default value (EPA 1991, 0746).
m. ED x 365 days/year.
n. 70 years x 365 days/year.

TABLE C-4
TOXICITY CRITERIA FOR THE NONRADIONUCLIDE COPCS FROM THE FIRING SITES AT TA-39

Chemical	Oral Reference Dose (mg/kg/day)	Oral Slope Factor $(mg/kg/day)^{-1}$	Oral Absorption Fraction (unitless)	Dermal Reference Dose (mg/kg/day)	Dermal Slope Factor $(mg/kg/day)^{-1}$	Inhalation Reference Dose (mg/kg/day)	Inhalation Slope Factor $(mg/kg/day)^{-1}$
Beryllium	5E-03(i)	4.3E+00(i)	0.01	5E-05(r)	4.3E+02(r)	Not Available	8.4E+00(i)
Cadmium	5E-04(i)	N/A	0.07	3.5E-05(r)	N/A	Not Available	6.3E+00(i)
Chromium (Cr III)	1E+00	N/A	0.004	4E-03(r)	N/A	Not Available	N/A
Chrysene	N/A	7.3E-03(e)	0.9	N/A	8.1E-03(r)	N/A	6.1E-03(e)
Cobalt	6E-02(e)	N/A	1.0	6E-02(r)	N/A	Not Available	N/A
Copper	4E-02(h)	N/A	0.97	3.7E-02(r)	N/A	Not Available	N/A
Lead	No toxicity criteria for lead have been derived; the preliminary remediation goal (PRG) for industrial scenarios (1000 mg/kg) obtained from USEPA Region VI is based on a pregnant female worker as the exposed individual.						
Nickel	2E-02(i)	N/A	0.1	2E-03(r)	N/A	Not Available	N/A
RDX	3E-03(i)	1.1E-01	1.0	3E-03(r)	1.1E-01	Not Available	Not Available
Uranium	3E-03(i)	N/A	1.0	3E-03(r)	N/A	Not Available	N/A
Zinc	3E-01(i)	N/A	0.8	2.4E-01(r)	N/A	Not Available	N/A

N/A = Not Applicable

Sources: (i) Integrated Risk Information System (IRIS); (h) Health Effects Assessment Summary Tables (HEAST); (e) Environmental Criteria and Assessment Office (ECAO); (r) criteria derived by multiplying the oral RfD or slope factor by the oral absorption fraction.

C-3. Lead Equations and Assumptions

The equations presented below are the basic equations obtained from EPA Region 6 for the calculation of adult lead cleanup levels for protection of the fetus in a pregnant female worker. The assumptions are the default parameters provided by EPA with the model and may be modified if site-specific information is available.

$$PbB_{GMtarget} = PbBo + (BKSF)\ [(IRs \times EFs \times AFs \times Cs) + (Ksd \times IRd \times EFs \times AFs \times Cd)]$$

$$PbB_{95thmaternal} = PbB_{GMtarget} \times GSDI^{1.645}$$

$$PbB_{95thfetal} = PbB_{95thmaternal} \times R$$

$PbB_{GMtarget}$ = geometric mean blood lead level;
$PbB_{95thfetal}$ = 95th percentile blood lead in fetus; recommended PbB95th fetal is 10 µg/dL;
$PbB_{95thmaternal}$ = 95th percentile maternal blood lead level;
R = mean ratio of fetal to maternal blood lead level; recommended value is 0.9;
GSDi = individual geometric standard deviation; a "typical" GSDi is 1.8;
PbBo = baseline blood lead value; default is 1.9;
BKSF = biokinetic slope factor; recommended is 0.4 µug/dL per µg/day;
IRs = soil ingestion rate; recommended is 0.025 g/day;
IRd = dust ingestion rate; recommended is 0.025 g/day;
Ksd = ratio of concentration in dust to that in soil; "typical" value is 0.7;
EFs = soil exposure frequency; default for industrial setting is 250 days/year;
EFd = dust exposure frequency; default for industrial setting is 250 days/year;
AFs = absolute absorption fraction of lead in soil; recommended value is 0.1;
AFd = absolute absorption fraction of lead dust; recommended value is 0.1;
Cs = concentration in soil;
Cd = concentration in dust.

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