2-1-2004

Justification for Class III Permit Modification February 2004 SWMU 231 Operable Unit 1309 Storm Drain System Outfall Site

Sandia National Laboratories/NM

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United States Department of Energy
under contract DE-AC04-94I85000.

SWMU 231
Storm Drain System Outfall

Environmental Restoration Project

Site History

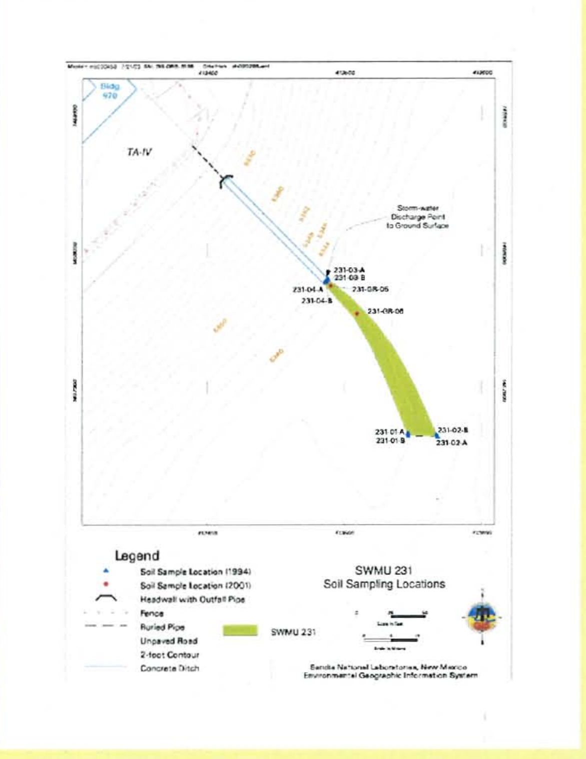
- SWMU 231 covers 0.04 acres of unpaved ground along the steep northern rim of Tijeras Arroyo. The site consists of a 140-foot long earthen ditch that occasionally receives storm water from a paved storage yard located on the east side of TA-IV Building 970. The storm water is directed to the site through buried piping and a concrete ditch. The outfall was built in the early 1980s. No chemical releases have occurred at the site.

Depth to Groundwater

- The perched aquifer (not a source of drinking water) is approximately 300 ft bgs. The regional aquifer is approximately 470 ft bgs.

Constituents of Concern

- The list of COCs includes chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, diesel fuel, and mineral oil. The list of COCs was conservatively based upon chemicals used at TA-IV.



Summary of Data Used for NFA Justification

- In 1994, the ground surface at SWMU 231 was surveyed for UXO/HE and radioactive materials; no anomalies were detected. Shallow soil samples were collected at the four corners of the site. The maximum sampling depth of the four samples was three ft bgs. The soil samples were analyzed for TAL metals, chromium-VI, TPH, VOCs, SVOCs, tritium, and gamma-emitting radionuclides. No VOC or SVOC contamination was detected in the soil samples. The reporting of four TPH detections ranging from 44 to 130 mg/kg is considered suspect because no VOCs (except acetone, a common laboratory contaminant) or SVOCs were detected. All of the metal and radionuclide values were below background values.

- In June 2001, two locations along the centerline of the ditch were sampled with a backhoe. The soil samples were collected at depths ranging from 0 to 5 ft bgs. The samples were analyzed for VOCs, SVOCs, TPH, TAL metals, chromium-VI, gamma-emitting radionuclides, gross alpha/beta, and tritium. The only VOC detected was acetone at 0.008 J mg/kg. Ten SVOCs were detected with bis(2-Ethylhexyl)phthalate having a maximum value of 0.0826 J mg/kg. TPH was not reported above the detection limit. Five metals were detected above background levels. The only radionuclide reported above background activity was U-235 at 0.228 pCi/g.

Recommended Future Land Use

- Industrial land use was established for this site.

Results of Risk Analysis

- Risk assessment results for the residential scenario are calculated per NMED risk assessment guidance in 2003 as presented in the "Supplemental Risk Document Supporting Class 3 Permit Modification Process" (SNL October 2003).

- Because COCs were present in concentrations or activities greater than background-screening levels or because constituents were present that did not have background-screening levels, it was necessary to perform a risk assessment for the site. The risk assessment analysis evaluated the potential for adverse health effects for the residential land-use scenario.

- The total HI was 0.39, which is below the NMED guideline of 1.

- The mean concentration of arsenic was below background and therefore was removed from the risk calculation.

- With the removal of arsenic, the total estimated excess cancer risk was reduced to 1E-6, which is below the NMED guideline of less than 1E-5.

- There are no calculated background activities for the Tijeras Arroyo area; however, background activities for the North Supergroup soils were used for comparison. Any detected radionuclides were considered in the calculation of human health residential land-use scenario incremental TEDE. For SWMU 231 the TEDE is 8.6E-2 mrem/yr for the radiological COC. The EPA's numerical guideline is 75 mrem/yr. Thus, the TEDE is below EPA's guideline.

- Using the SNL predictive ecological risk assessment methodology, the ecological risk for this SWMU is acceptable.

- In conclusion, human health and ecological risks are acceptable per NMED guidance.

Human Health Risk Assessment Values for SWMU 231 Nonradiological COCs

COC	Maximum Concentration/ UCL (mg/kg)	Residential Land Use Scenario (Maximum Concentrations)		Residential Land Use Scenario (UCL Concentrations)	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	5.7/**3.1**	0.26	1E-5	*	*
Barium	240	0.05	--	0.05	--
Beryllium	1.03	0.01	9E-10	0.01	9E-10
Cadmium	1.7	0.04	1E-9	0.04	1E-9
Chromium, total	17	0.00	--	0.00	--
Chromium VI	1.6	0.01	7E-9	0.01	7E-9
Mercury	0.0219	0.00	--	0.00	--
Selenium	0.5 61	0.00	--	0.00	--
Silver	0.25	0.00	--	0.00	--
Acetone	0.008 J	0.00	--	0.00	--
Benzo(a)anthracene	0.0397	0.00	6E-8	0.00	6E-8
Benzo(a)pyrene	0.0569	0.00	9E-7	0.00	9E-7
Benzo(b)fluoranthene	0.0621	0.00	1E-7	0.00	1E-7
Benzo(k)fluoranthene	0.0357	0.00	6E-9	0.00	6E-9
bis(2-Ethylhexyl) phthalate	0.0826 J	0.00	2E-9	0.00	2E-9
Chrysene	0.0566	0.00	9E-10	0.00	9E-10
Fluoranthene	0.0425	0.00	--	0.00	--
Indeno(1,2,3-c,d)pyrene	0.0467	0.00	8E-8	0.00	8E-8
Phenanthrene[c]	0.0198 J	0.02	--	0.02	--
Pyrene	0.0605	0.00	--	0.00	--
Total		**0.39**	**1E-5**	**0.13**	**1E-6**
NMED Guidance		**≤1**	**<1E-5**	**≤1**	**<1E-5**

* = UCL concentration was below background screening level. Therefore risk was not calculated.

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Justification for Class III Permit Modification

February 2004

SWMU 231
Operable Unit 1309
Storm Drain System Outfall Site

NFA Originally Submitted June 1995
NOD Submittal Oct. 1996
Second NOD Submittal Date Dec. 2002
Supplemental Risk Document Submitted Oct. 2003

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

NFA

PROPOSAL FOR NO FURTHER ACTION

Site 231, Storm Drain System Outfall Site
Operable Unit 1309

SANDIA NATIONAL LABORATORIES/NEW MEXICO

1. Introduction

1.1 ER Site Identification Number and Name

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Environmental Restoration (ER) Site 231, Storm Drain System Outfall Site, Operable Unit (OU) 1309. ER Site 231 is listed in the Hazardous and Solid Waste Amendment (HSWA) Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1992).

1.2 SNL/NM Risk-based NFA Process

This proposal for a determination of an NFA decision has been prepared using the criteria presented in Section 4.5.3 of the SNL/NM Program Implementation Plan (PIP) (SNL/NM February 1994). Specifically, this proposal will "contain information demonstrating that this SWMU has never contained constituents of concern that may pose a threat to human health or the environment" [as proposed in the Code of Federal Regulations (CFR), Section 40 Part 264.51(a) (2)] (EPA July 1990). The HSWA Module IV contains the same requirements for an NFA demonstration:

> Based on the results of the RFI [RCRA Facility Investigation] and other relevant information, the Permittee may submit an application to the Administrative Authority for a Class III permit modification under 40 CFR 270.42(c) to terminate the RFI/CMS [corrective measures study] process for a specific unit. This permit modification application must contain information demonstrating that there are no releases of hazardous waste including hazardous constituents from a particular SWMU at the facility that pose threats to human health and/or the environment, as well as additional information required in 40 CFR 270.42(c) (EPA August 1993).

For a risk-based proposal, an SWMU is eligible for an NFA determination if the NFA criterion established by the SNL/NM permit is met. This criterion, found in Section M.1 of the permit, is as follows: "[T]here are no releases of hazardous waste including hazardous constituents...that pose threats to human health and/or the environment..." This risk-base proposal contains information needed to make the NFA determination.

This proposal is using the technical approach which is the foundation for the SNL/NM corrective action process. The details of the SNL/NM technical approach are provided in Appendix C of the PIP. The first step in the technical approach is the data qualitative review step (the same step used to determine whether the SWMU is eligible for administrative NFA). Should significant uncertainties remain, the assessment of the SWMU continues within the SNL/NM technical approach.

At this site, sufficient data were not available to compare to established action levels or develop site-specific action levels. Background soil samples were collected and analyzed to develop upper tolerance limits (UTLs) for metals. Site-specific data were collected to compare to existing soil action levels (proposed Subpart S action levels) and UTLs. If site-specific concentrations exceeded the proposed Subpart S action levels or UTLs, then a risk assessment was performed. The site-specific concentrations were compared to the derived risk assessment action levels. Concentrations less than these action levels, either proposed Subpart S action levels, UTLs, or derived risk-based values, triggered this NFA proposal for Site 231.

1.3 Local Setting

SNL/NM occupies 2,829 acres of land owned by the Department of Energy (DOE), with an additional 14,920 acres of land provided by land-use permits with Kirtland Air Force Base (KAFB), the United States Forest Service, the State of New Mexico, and the Isleta Indian Reservation. SNL/NM has been involved in nuclear weapons research, component development, assembly, testing, and other nuclear activities since 1945.

ER Site 231 (Figure 1) is located on land owned by DOE. The outfall is located along the northern embankment of Tijeras Arroyo and is situated west of Building 970 in Technical Area (TA) IV.

Surficial deposits in the SNL/KAFB area lie within four geomorphic provinces, which in turn contain nine geomorphic subprovinces. Site 231 lies with in the Tijeras Arroyo subprovince. The Tijeras Arroyo subprovince is characterized by broad, west-sloping alluvial surfaces and the 50-meter-deep Tijeras Arroyo. The Tijeras Arroyo subprovince contains deposits derived from many sources, including granitic and sedimentary rocks of the Sandia Mountains, sedimentary and metamorphic rocks of the Manzanita Mountains, and sediments of the Upper Santa Fe Group.

2. History of the SWMU

2.1 Sources of Supporting Information

In support of the request for a risk-based with confirmatory sampling NFA decision for ER Site 231, a background study was conducted to collect available and relevant site information. Interviews were conducted with Sandia National Laboratories/New Mexico (SNL/NM) staff and contractors familiar with site operational history.

The following information sources were available for the use in the evaluation of ER Site 231:

- Confirmatory-sampling program conducted in September 1994
- Risk analysis for three metals and two radionuclides
- One surface radiation survey
- One unexploded ordnance/high explosives (UXO/HE) survey
- Interviews and personnel correspondence
- Historical aerial photographs spanning 40 years

2.2 *Previous Audits, Inspections, and Findings*

In November 1993, the Sandia ER staff recognized Site 231 as an SWMU. ER Site 231 was not listed as a potential release site based on the Comprehensive Environmental Assessment and Response Program (CEARP) interviews in 1985 (DOE September 1987). In addition, Site 231 was not included in the Environmental Protection Agency (EPA) RCRA Facility Assessment (RFA) in 1987 (EPA April 1987) and Site 231 was not included in the Hazard Ranking System (DOE September 1987).

2.3 *Historical Operations*

The outfall discharged industrial effluent and storm water from TA-IV (Figure 1). Currently, the outfall discharges only storm water. The specific constituents in the industrial effluent are not known. The possible discharge contaminants include chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, and other petroleum products. Mineral oil is also considered to be a potential soil contaminant because of a recent release (June 1994) of mineral oil at a similar outfall, Site 232.

3. Evaluation of Relevant Evidence

3.1 *Unit Characteristics*

The Storm Drain System Outfall is confined to the downstream natural drainage. All releases would be contained in this limited area.

3.2 *Operating Practices*

Based on interviews and personnel correspondence, the outfall discharged industrial effluent and storm water from approximately 1984 to 1991. Aerial photographs confirmed this time frame but provided no additional information.

3.3 *Presence or Absence of Visual Evidence*

The approximately 150-foot long outfall and the cement culvert are the only physical evidence of the outfall system. No discoloration of soils was observed during site reconnaissance and soil sampling activities.

3.4 *Results of Previous Sampling/Surveys*

In 1994, the site was visually surveyed for surface indications of UXO/HE. No UXO/HE were found (SNL/NM 1994a). Also in 1994, a surface radiation survey was conducted on the entire site using an Eberline ESP-2 portable scaler, with an Eberline SPA-8 (2 inch X 2 inch sodium iodide) detector. A 30-second integrated count was performed at each proposed sample location, while scanning the detector over an area approximately 2 feet in radius around the sample location. The alarm was set at 1.3 times the background count rate. No alarms occurred during the survey. No surface anomalies were detected (SNL/NM 1994b).

3.5 Assessment of Gaps in Information

No environmental sampling data existed for Site 231. If contamination was present, potential constituents of concern (metals, radioactive constituents, and organic constituents), would be expected at shallow depths. Metals and radioactive constituents generally adsorb on soil and precipitate rather than remaining soluble. If organic constituents were introduced in the drainage, they should be detectable in surface or shallow subsurface soils.

3.6 Confirmatory Sampling

A surface (0-6 inches deep) and shallow subsurface (6-36 inches deep) soil sampling program was developed and implemented in September 1994. The Confirmatory Sampling and Analysis Plan (SAP) can be found in Appendix A. Those soil sample results exceeding an action level are summarized in Table 1. A complete list of "hits" or detections and quality assurance (QA) results can be found in Appendix B.

For health and safety purposes, a photoionization detector, OVM, was used throughout the field program. The OVM measured no anomalous vapor concentrations.

Surface and shallow subsurface soil samples were collected at the most likely locations of contamination. Four samples were collected at the outfall and four samples were collected at the furthest extent of visible erosion and scour (Figure 1). Every sample was analyzed for target analyte list (TAL) metals[1], chromium^{+6}, and seven of eight samples were analyzed for total petroleum hydrocarbon (TPH). The four subsurface samples also were analyzed for volatile organic compounds (VOCs). Four samples were analyzed for semivolatile organic compounds (SVOCs). As a general check for radioactive constituents, two samples were analyzed for tritium, one sample was analyzed for isotopic uranium and plutonium, and four samples were screened with in-house gamma spectroscopy.

3.6.1 Background Samples for Metals and Radioactive Constituents

UTLs for background metals were calculated from analyses of 24 samples collected in the vicinity of the 11 sites discussed in the SAP (Appendix A). UTLs or background 95th percentiles for background radionuclides were calculated from samples collected throughout KAFB (IT 1994). A discussion of background calculations and supporting data and analyses are included in Appendices C and D.

3.6.2 Organic Compounds

No organic compounds were detected without qualification; acetone was detected in one of four samples but was below the reporting limit (qualified with a "J" in Table 1) and 2-butanone was detected in four of four samples but was qualified with a "J" and "B". None of these qualified detections indicate significant contamination. TPH was detected in four of the

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[1] Although the TAL metal analytes include calcium, magnesium, potassium, and sodium, these nontoxic, major cations are not included in the evaluation. They do not pose a significant environmental or human health risk regardless of concentration.

seven samples. Three of these four detections were at concentrations below 100 milligrams per kilogram (mg/kg). One TPH analysis (Sample 231-03-B) indicated a concentration of 130 mg/kg. The average of the four samples was 78 mg/kg. The TPH detections do not indicate significant contamination.

3.6.3 Metals

The maximum local background value for beryllium was 0.53 mg/kg. Beryllium was not detected above 0.53 mg/kg at Site 231. Mercury, selenium, and silver were not detected at Site 231. Chromium^{+6} was detected at one location (Sample 231-01-A) at a concentration of 1.6 mg/kg compared to the proposed Subpart S Action Level of 400 mg/kg. Background samples were not analyzed for chromium^{+6}. All other metal concentrations except one analysis for copper and five analyses for zinc were below UTLs. Sample 231-03-B had a copper concentration of 29 mg/kg, compared with a UTL of 13.6 mg/kg. No Subpart S Action Level has been proposed for copper. The five zinc concentrations above the UTL of 79 mg/kg ranged from 90 to 130 mg/kg. The proposed Subpart S Action Level for zinc is 20,000 mg/kg.

3.6.4 Radionuclides

Thallium was not detected at Site 231. Tritium, plutonium-239/240, and plutonium-238 were not detected above the minimum detectable activity (MDA). Uranium-238 was detected in one sample at an activity of 0.42 picocuries per gram (pCi/g), which is below the base-wide background 95th percentile of 1.1 pCi/g. Uranium-235/236 was detected in Sample 231-01-A at 0.39 pCi/g, in comparison to a base-wide background 95th percentile of 0.168 pCi/g. Uranium-234 was detected at an activity of 1.03 pCi/g in Sample 231-01-A. The base-wide background 95th percentile for uranium-234 is 1.0 pCi/g. The maximum activities for uranium-235/236 and uranium-234, based on six local background analyses, are 0.33 and 0.97 pCi/g, respectively.

3.6.5 Quality Assurance Results

As discussed in the Confirmatory Sampling and Analysis Plan (Appendix A), quality assurance samples, including field duplicates, trip blanks and rinsates, were collected as part of the 11 site sampling program. Analyses indicate that the field soil duplicates were comparable to the original soil sample results. The trip blanks and rinsates indicated no significant sampling contamination. QA results can be found in Appendix B. Level I and Level II data verification was conducted on all data, as described in the PIP (SNL/NM 1994).

3.7 Risk Analysis

To further evaluate the metals data for metals with concentrations greater than background UTLs, risk was analyzed for a combination of chromium^{+6}, copper, and zinc, assuming the maximum detected concentrations. To further evaluate the site data for radionuclides with activities above background UTLs, 95th percentiles, or those without background UTLs, a risk assessment was performed for the combination of uranium-234 and uranium-235/236, assuming the maximum detected activities.

The risk calculations were designed to produce conservatively large estimates of hazard index and radioactive dose to counter uncertainties in the soil data. This approach facilitates the following decision regarding future activities at Site 231:

- If the conservative estimates based on the soil data result in an unacceptable hazard index (greater than 1) or dose (greater than 10 mrem/year), further investigation and/or remediation will be needed; or

- If the hazard index and dose estimates are acceptable, the potential for health hazards at the site is extremely low, and further actions will not be needed.

Hazard indices and radionuclide doses were computed using methods and equations promulgated in proposed RCRA Subpart S documentation (USEPA 1990). Accordingly, all calculations were based on the assumption that receptor doses from both toxic metals and radionuclides result from ingestion of contaminated soil.

Calculation of hazard indices required values of oral reference doses (oral RfDs) for each of the metals. The RfD values for chromium^{+6} and zinc were taken from EPA's IRIS database (IRIS 1994). An estimated RfD for copper was computed using a maximum contaminant level (MCL) of 1.3 mg/l and assuming that a 70-kg person consumes 2 liters of water a day.

Similarly, calculation of radionuclide doses required values of dose conversion factors, which are used to convert radionuclide intakes (in units of pCi/year) into effective dose equivalents (in units of mrem/year). Published values of dose conversion factors (Gilbert et al., 1989) exist for uranium-234 and uranium-235/236.

To assure that the computed hazard indices and doses were conservatively large, only the maximum observed concentration of each constituent at a site was employed. To consider combined effects, a hazard index was calculated as the sum of the individual metal hazard quotients and a radiological dose was calculated as the sum of the individual doses.

Following proposed Subpart S methodology, the equation and parameter values used to calculate the summed hazard index for toxic metals were:

$$HI = \sum_i [HSR(i) \times S(i)] \qquad \textbf{(1)}$$

where:

HI	=	total hazard index (dimensionless),
HSR(I)	=	hazard index-to-soil concentration ratio for the ith metal (kg/mg)

$$= \frac{I \times A}{RfD(i) \times W} \times \frac{0.001\ g}{mg}$$

S(I)	=	soil concentration of the i^{th} metal (mg/kg),
I	=	soil ingestion rate = 0.2 g/day,
A	=	absorption factor (dimensionless) = 1,
W	=	body weight = 16 kg, and
RfD(I)	=	oral reference dose for the i^{th} metal (mg/kg-day).

Risk assessment guidance, prepared by the U.S. Environmental Protection Agency (EPA, 1989), recommends that the total hazard index be less than one in order for a site to be considered a non-threat to human health.

Following proposed Subpart S methodology, the equation and parameter values used to calculate the summed radioactive dose was:

$$DOSE = \sum_{i} [DSR(i) \times S(i)] \qquad (2)$$

where:

DOSE	=	total effective dose equivalent (mrem/yr);
DSR(I)	=	dose-to-soil concentration ratio for the i^{th} radionuclide (mrem/yr)/(pCi/g), = I X DCF(I);
S(I)	=	soil concentration of the i^{th} radionuclide (pCi/g);
I	=	soil ingestion rate = 0.2 g/day = 73 g/yr; and
DCF(I)	=	dose conversion factor for the i^{th} radionuclide (mrem/pCi).

The PIP stipulates that, for the purpose of computing media action levels, the total radioactive dose at a site should not be greater than 10 mrem/year (SNL/NM 1994), which corresponds to a cancer risk of less that 10^{-6} excess deaths.

The input and results of the risk calculations are presented in Tables 2 and 3. The summed hazard index for metals is less than one and the summed radioactive dose is less than 10 mrem/year. Therefore, the site is considered to be risk-free in terms of metals and radionuclide contamination.

3.8 Rationale for Pursuing a Risk-based NFA Decision

Surface soil and shallow subsurface soil samples were collected at the "head" of the outfall (where the flow leaves the concrete flume and spills into the natural drainage) and at the furthest extent of visible erosion/scour where the discharged effluent would have most likely settled. These two areas are the most likely areas for contamination. SNL/NM is proposing a risk-based NFA because representative soil samples from ER Site 231 have concentrations less than action levels; either proposed Subpart S action levels, background UTLs, background 95th percentiles, or derived risk-based values.

In addition

- A site visit in 1993 by ER personnel confirmed the presence of a confined natural drainage with no discoloration in the soils.

- In June 1994, a UXO/HE visual survey was conducted by KAFB Explosive Ordnance Division (EOD) and found no UXO/HE ordnance debris at Site 231 (SNL/NM 1994a).

- In September, 1994, as part of the surface soil sampling effort at Site 231, a surface radiation survey was conducted (SNL/NM 1994b). No surface anomalies were detected at Site 231.

4. Conclusion

Based upon the evidence cited above, ER Site 231 has no releases of hazardous waste or hazardous constituents that pose a threat to human health and/or the environment. Therefore, ER Site 231 is recommended for an NFA determination.

5. References

5.1 ER Site References

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5.2 Reference Documents

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5.3 Aerial Photographs

Ebert & Associates, Inc., November 1994. "Photo-Interpretation and Digital Mapping of ER Sites 7,16,45,228 from Sequential Historical Aerial Photographs."

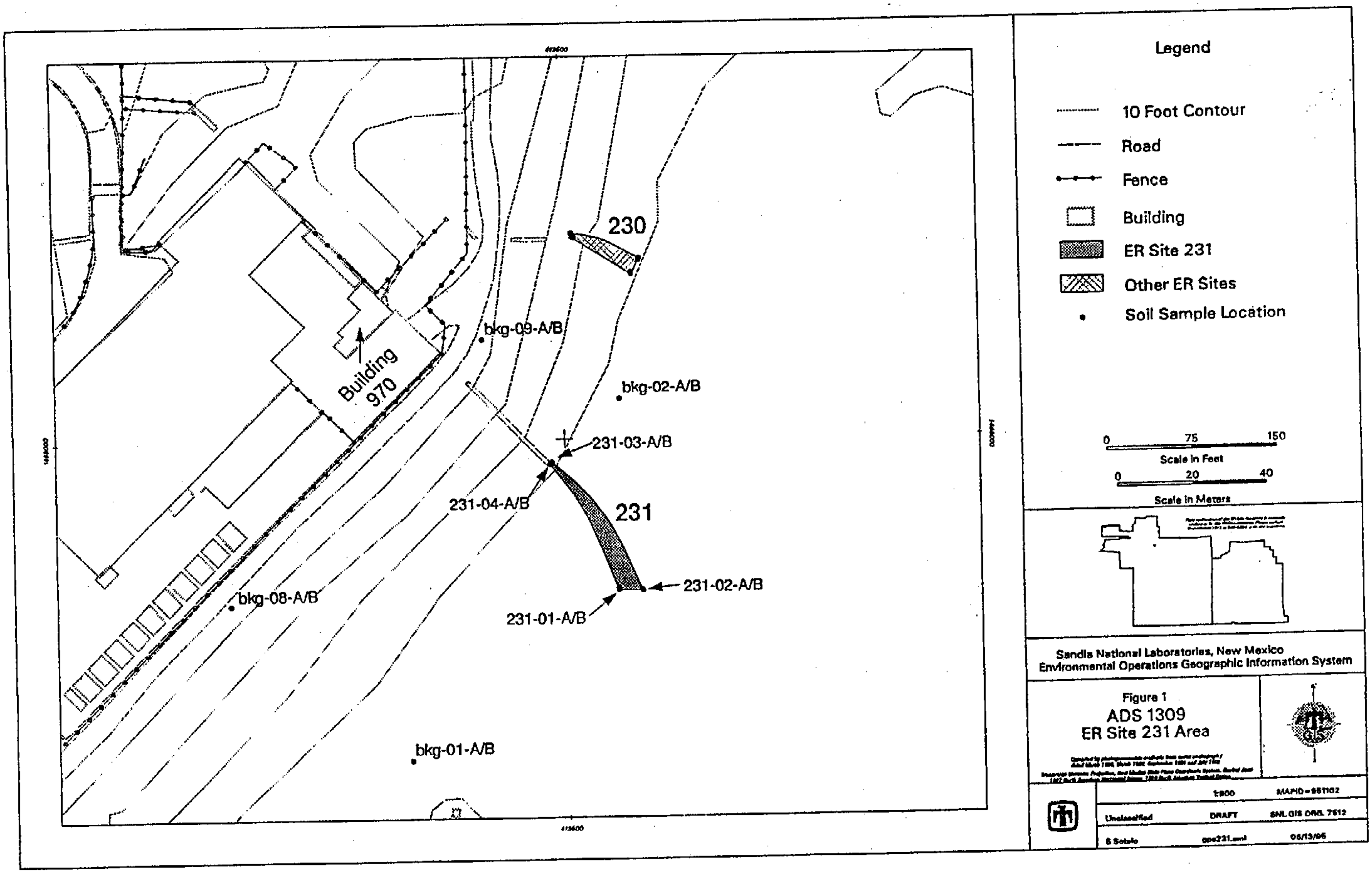

Figure 1. Storm Drain System Outfall Site 231.

Table 1. Site 231 - Results of Shallow Soil Sampling and Analysis

Sample Identifier	Analytical Method	Constituent	Concentration (mg/kg)	Qualifier(s)	Background (mg/kg)	Action Level (mg/kg)
231-03-B	VOCs (8240)	Acetone	0.008	J		
231-01-B	VOCs (8240)	2-butanone	0.004	JB		
231-02-B	VOCs (8240)	2-butanone	0.004	JB		
231-03-B	VOCs (8240)	2-butanone	0.005	JB		
231-04-B	VOCs (8240)	2-butanone	0.005	JB		
231-02-A	TPH (8015)	TPH	44			
231-03-B	TPH (8015)	TPH	130			
231-04-A	TPH (8015)	TPH	79			
231-04-B	TPH (8015)	TPH	59			
231-03-B	TAL Metals (6010)	Copper	29		13.6	1,451
231-01-B	TAL Metals (6010)	Zinc	130		79	20,000/6,506
231-02-B	TAL Metals (6010)	Zinc	110		79	20,000/6,506
231-03-A	TAL Metals (6010)	Zinc	90		79	20,000/6,506
231-04-A	TAL Metals (6010)	Zinc	100		79	20,000/6,506
231-04-B	TAL Metals (6010)	Zinc	100		79	20,000/6,506
231-01-A	Cr+6 (aqueous leaching)Chromium^{+6}	1.6			400/80	
231-01-A	Isotopic Uranium (HASL-300 4.5)	Uranium-235/236	0.39 Pci/g		0.33/0.168 pCi/g	146 pCi/g
231-01-A	Isotopic Uranium (HASL-300 4.5)	Uranium-234	1.03 pCi/g		0.97/1.0 pCi/g	386 pCi/g

Notes

A "J" qualifier means detected at a concentration below the laboratory reporting limit.

A "B" qualifier means detected in the associated blank sample.

For copper and zinc, background is the 95 percent upper tolerance level for the local background data.

For uranium-234 and uranium-235/236 the first background value is the maximum of six local background values; the second background value is the base-wide background 95th percentile.

The first action levels for zinc and chromium^{+6} are proposed Subpart S action levels.

The other action levels are calculated risk-based levels.

Was ND in trip blank 9/26/94

Table 2. Metal Risk Calculations for Site 231

Constituent	Concentration (mg/kg)	RfD(I) (mg/kg-day)	Individual HI	Source of RfD
Chromium VI	1.60E+00	5.00E-03	4.00E-03	IRIS
Copper	2.90E+01	3.70E-02	9.80E-03	Estimated from drinking water standard of 1.3 mg/l, 2 L/day ingestion rate, and 70 kg body weight.
Zinc	1.30E+02	3.00E-01	5.42E-03	IRIS
Summed HI			1.92E-02	

Table 3. Radionuclide Risk Calculations for Site 231

Constituent	Activity (pCi/g)	DCF(I) (mrem/pCi)	Individual Dose (mrem/year)	Source of DCF
Uranium-234	1.03E+00	2.60E-04	1.95E-02	Gilbert et al., 1989
Uranium-235/236	3.90E-01	2.50E-04	7.12E-03	Gilbert et al., 1989
Summed Dose			2.67E-02	

APPENDIX A

Appendix A
Confirmatory Sampling and Analysis Plan

SAMPLING AND ANALYSIS PLAN FOR ELEVEN SITES IN TIJERAS ARROYO OPERABLE UNIT SANDIA NATIONAL LABORATORIES/ NEW MEXICO

Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit

Introduction
The purpose of the sampling and analysis described in this plan is to determine the appropriate way to proceed toward closure of 11 (of the 17) sites in the Tijeras Arroyo Operable Unit. Based on the surface and shallow subsurface soil samples and analyses for the constituents of concern (COCs), one of three approaches will be pursued for each site:

1. A petition for "No Further Action" (NFA) will be produced for regulatory consideration;
2. A voluntary corrective measure (VCM) will be designed and implemented, hopefully followed by an NFA petition; or
3. The site assessment and eventual closure will follow the standard RFI/CMS path

Most of the sites covered by this Sampling and Analysis Plan (SAP) are outfalls from the storm water and sanitary sewer systems emanating from Sandia Technical Areas (TAs) I, II, and IV. The general sampling program for the outfalls will be to collect four samples at the head of the outfall, two samples of surface soil (0 to 6 inches deep) and two samples of shallow subsurface soil (18 to 36 inches deep) and four samples (two surface soil and two shallow subsurface soil) at the furthest extent of channel erosion and scour. The analytes for most of the samples are volatile organic compounds, semi-volatile organic compounds (BNAs), metals, chromium^{+6}, for samples where chromium is found in a metals analysis, total petroleum hydrocarbon (TPH), explosives, Total Kjeldahl Nitrogen (TKN), nitrate/nitrite, and Gamma Spectroscopy for radionuclides, isotopic uranium, isotopic plutonium, tritium, and chlorodiphenyls (PCBs).

Sampling Procedures and Volumes
Surface soil samples will be collected with a stainless steel scoopula or trowel and placed in a stainless steel bowl. After at least 1000 ml[1] of soil has been collected, the soil will be thoroughly mixed in the bowl and transferred to two or three 500-ml sample bottles with a stainless steel scoopula. Sample bottles will be labeled accordingly and the appropriate sample information (sample depth, collection date and time, etc.) will be documented on the chain-of custody (COC) after each sample is collected. Samples will then be packaged and cooled to 4 degrees Celsius.

Shallow subsurface soil samples (18-36 inches) will be collected with a 2-inch (minimum) hand auger. A soil sample is collected by turning the auger clockwise and advancing it into the ground until the bucket at the end of the auger (last 6-8 inches) is full of soil or refusal occurs. Several runs with the auger is anticipated in order to obtain the appropriate volume. A hand shovel may also be used to bypass large rocks in order to continue with the auger. The auger is then extruded counter-clockwise from the ground and the soil is removed from the auger and placed in a stainless steel bowl. After 1,125[2] ml of soil has been collected, the soil will be mixed in the bowl and transferred to two or three 500-ml sample bottles and one 125-ml sample bottle with a stainless steel scoopula. Sample bottles will be labeled accordingly and the appropriate sample information will be documented on the COC after each sample is collected. Samples will then be packaged and cooled to 4 degrees Celsius.

Waste Generation and Equipment Decontamination
Decontamination of sampling equipment will be done between each sample. Decontamination will include thoroughly washing the inside and outside of the sampling equipment with a spray of ALCONOX™ or LIQUINOX™ and water; rinsing with distilled,

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[1]The sample volume varies between 1,000 and 1,500 ml depending on the analyses for the sample.

[2]The sample volume varies between 1,125 and 1,625 ml depending on the analyses for the sample.

deionized water; and drying before reusing. No soil waste will be generated. The soil removed from the hand-auger holes, while collecting samples at a depth of 18 to 36 inches, will be return to the hole. The sampling tools, which are scoopulas/trowels, hand-augers, and shovels, will be decontaminated with water and ALCONOX™ after each use. The decon leachate will be stored in capped 1-gallon containers. One or two containers will be used for each site and two to four containers will be used for the background samples. The containers will be labeled as "IDW" and the site number identified on each container. All the containers will be stored at Site 232, a central location. The leachate waste will be disposed according to the analytical results of the soil samples collected at the site.

Site Descriptions

The sites that will be sampled are

- Site 46, Old Acid Waste Line Outfall;
- Site 50, Old Centrifuge Site;
- Site 77, Oil Surface Impoundment;
- Site 227, Bldg. 904 outfall;
- Site 229, Storm Drain System Outfall;
- Site 230, Storm Drain System Outfall;
- Site 231, Storm Drain System Outfall;
- Site 232, Storm Drain System Outfall;
- Site 233, Storm Drain System Outfall;
- Site 234, Storm Drain System Outfall; and
- Site 235, Storm Drain System Outfall.

The site locations are shown in Figure 1. A description of the site history, conditions, previous investigations, and sampling plans are described in the following sections.

Site 46: Acid Waste Line Outfall

The Old Acid Waste Line carried wastes from several buildings in TA I. The waste line begins as a north-south trending, 750-feet long open trench in a grassy field northwest of Building 981-1 in TA IV. No pipe opening is visible at the "head" of the trench. As the trench crosses the field, it turns to the southeast and continues to a non-engineered spillway at the edge of Tijeras Arroyo. The spillway lies on a bank (40 to 50 feet of relief) composed of compacted alluvial sediment. Historical aerial photographs show vegetation, presumably supported by the discharge, growing southeast of the spillway to the active arroyo channel (about 200 feet distance from the spillway). The site is not restricted and is easily accessible.

During use, discharged effluent averaged an estimated 130,000 gallons per day. Use of the line has been discontinued. The line received wastes from plating, etching, and photo processing operations, and cooling tower "blow down". Acids and metals are target contaminants. Chromic acid and ferric chloride are mentioned specifically in the site history, and ferric chloride was found in the soils during a limited sampling event. Various radionuclides, possibly including tritium, uranium, and plutonium were used in TA I.

Building 863 was a source of discharge to the Acid Line. The information sheet for ER Site 98 (Building 863, TCA Photochemical Release: Silver Catch Boxes) indicates the presence of trichloromethane, silver, and photo-processing chemicals with an ammonia-like odor. The waste solution from the silver recovery unit reportedly was discharged to the Old Acid Waste Line, which is the only specific information about chemical discharges.

The site has been visually surveyed for surface indications of unexploded ordnance and high explosives (UXO/HE). No UXO/HE were found. Also, a surface radiation survey was conducted on the entire site. No surface radiation anomalies were detected.

The sampling program includes four samples collected at the "head" of the site outfall (by the fire extinguisher training area west of TA IV) and four samples collected by the spillway into the Tijeras Arroyo drainage (Figure 1). Every sample will be analyzed for tritium, metals, chromium^{+6} (if chromium is detected), TKN, and nitrate/nitrite. Half the samples will also be analyzed for semi-volatiles and cyanide. Additionally, all the subsurface samples will be analyzed for volatiles. The analytes are listed in Table 1. A "4" on the table indicates that ALL the samples will be analyzed
for that specific analyte whereas a "2" on the table indicates half the samples will have additional analyses for the analyte listed.

Site 50: Old Centrifuge
Site 50, Old Centrifuge, was an outdoor, rocket propelled centrifuge that was used in the early 1950s to test units under G forces. The facility is located east of the TA II fence in a slight depression on top the escarpment northwest of Tijeras Arroyo. The concrete centrifuge pad has a diameter of 80 to 90 feet. The site has a 7-foot high wooden retaining wall on the north, east, and south sides. The west side is open. The centrifuge arm assembly, which has a 20-foot radius, is sitting outside the wall to the north and appears to be intact. Control wiring to the center axis of the centrifuge was suspended from a cable between two telephone poles on the north and south side of the pad. The control wiring went to a bunker located to the southwest over the escarpment. The bunker had a electrical transformer containing PCB. The electrical transformer has been removed. The pad was not stained and no spills or leaks were reported.

The centrifuge was rocket driven by two T40 6-KS-3000 or two Deacon 3.5DS-5700 solid rocket motors. The combustion byproducts produced by these rocket motors were carbon dioxide, carbon monoxide, water, hydrochloric acid, aluminum oxide, and possibly barium oxide. No other HE is known or suspected at the site. The rocket orientation would expel combustion byproducts towards the retaining wall and the opening to the west. The rocket propellant would be consumed in the rocket motor case. Under normal operating conditions, no unburned propellant would be released.

In 1987, a reconnaissance investigation at five potential contaminated sites, including the Old Centrifuge Site, was conducted by the ER Project. Samples were analyzed for uranium, TNT, HSL inorganics, TCLP constituents, and EP Toxicity constituents. Metals, including barium, were detected at concentrations well below regulatory action levels. Total uranium concentrations were typical of area background levels. TNT, pesticides, PCBs, herbicides, and semi-volatiles TCLP compounds were not detected.

Prior to sampling, the surface will be surveyed for radiation. If contamination exists, it is expected to be around the edge of the centrifuge pad at the surface, probably along the open west side. The constituents of concern are metals (specifically lead, beryllium, and barium), depleted uranium, and high explosives. Four surface samples and four subsurface samples will be collected. The sampling locations will be biased toward the west side of the site because that is the open side (Figure 1). All surface samples will be analyzed for all the COCs. One-half of the subsurface samples will be analyzed for uranium and high explosives. All four subsurface samples will be analyzed for metals.

Site 77: Oil Surface Impoundment
The Oil Surface Impoundment Site is outside the TA IV fence, southeast of Building 981-1. The surface impoundment, which was constructed in the 1970's, is used to catch waste water from accelerators. At the time of the RCRA facilities environmental survey, the impoundment was unlined. Since then the impoundment was drained. Soil samples were analyzed for PCBs and

solvents. Based on the analytical results, the impoundment was determined to be clean. Subsequently, the impoundment was lined with geotextile and is now regulated under Sandia's Surface Water Discharge Program.

This site will not require UXO/HE or radiation surface surveys. Minimal confirmation sampling and analysis is proposed to verify that the site is clean. Three surface and three shallow subsurface samples are proposed. The samples will be collected along the perimeter of the existing lined pond (Figure 1). All the samples will be analyzed for PCBs. The subsurface soil samples also will be analyzed for volatile organic compounds (Table 1).

Site 227: Bunker 904 Outfall
Site 227 is an inactive outfall from the septic system for Building 904 (ER Site 48) in TA II. The site starts where the discharge exits the septic tank piping system, approximately 100 feet northeast of the southernmost point of TA II. The extent of the area influenced by the discharge may include the bank of Tijeras Arroyo below the outfall and some area between the outfall and the main channel of Tijeras Arroyo. The site is along the eastern edge of ER Site 45.

Building 904, built in 1948, was used for weapons assembly, HE testing, photo processing, and various other testing. Sanitary wastes were discharged to a septic tank, and other wastes were discharged to the outfall.

Mineral oil is also being considered a potential soil contaminant at all outfalls along the Tijeras Arroyo due to a recent release (June 1994) of mineral oil at Outfall 232 and vague historical records.

Possible soil contaminants are explosives, radioactive materials from weapons processing, including tritium, uranium, and plutonium, solvents (acetone, methylene chloride, methyl ethyl ketone, carbon tetrachloride, toluene, xylene, hexane, alcohols), and inorganics (ammonium hydroxide, barium, cadmium, silver, chromium, titanium, cyanide).

Access to this site is along the TA II perimeter road. This site is within the TA II testing exclusion zone. The best days to sample are generally Friday, Saturday, and Sunday, when testing ceases. Bruce Berry (telephone 845-8018) must be contacted to gain permission and access to this site. Prior to sampling

1. tumbleweeds will be cleared from locations to be sampled and placed adjacent to the drainage;
2. these locations will be visually scanned for UXO/HE; and
3. these locations will be screened for surface radiation anomalies.

The proposed sampling program is to collect four surface soil samples and four shallow subsurface samples. Two surface and two subsurface samples will be collected at the outfall. The other two surface and two subsurface samples will be collected at the furthest visible channel erosion and scour (Figure 1). The analytes are listed in Table 1.

Sites 229 - 235: Storm Drain Systems Outfalls
These sites consist of the discharge areas at seven outfalls along the northern embankment of Tijeras Arroyo. The outfalls discharged industrial effluent and storm water from TAs I, II, and IV. Presently they only discharge storm water. The outfalls receive runoff from Site 96 (Storm Drain System) and other engineered drain systems within the three TAs. The sites are along approximately ¾ miles of the embankment.

The specific constituents in the industrial effluent at these sites are not known. The possible discharged contaminants include chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, and other petroleum products. To cover this array of possible contaminants, soil samples will be analyzed for volatiles (subsurface samples only), semi-volatiles, metals and chromium^{+6}, if chromium is found in the metals analysis.

Mineral oil is also being considered a potential soil contaminant at all outfalls along the Tijeras Arroyo due to a recent release (June '94) of mineral oil at Outfall 232 and vague historical records. Therefore, soil samples will also be analyzed for TPH.

At Sites 229 through 234, prior to sampling

1. tumbleweeds will be cleared from locations to be sampled and placed adjacent to the drainage;
2. these locations will be visually scanned for UXO/HE; and
3. these locations will be screened for surface radiation anomalies.

Site 229 is due east of the footings of the old guard tower and the south "corner" of the TA II fence. It discharges near the top of the embankment through the center of ER Site 45. Access to this site is along the TA II perimeter road. This site is within the TA II testing exclusion zone. The best days to sample are generally Friday, Saturday, and Sunday, when testing ceases. Bruce Berry (telephone 845-8018) must be contacted to gain permission and access to this site. Because this site discharges from TA II, various radionuclides, possibly including tritium, uranium, and plutonium are of concern. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 230 is west of Building 970 in TA IV. A drain pipe discharges into a bowl-shaped concrete structure adjacent to Building 970A. Flow from this structure is directed to a drain and flume located approximately 120 feet further west. The flume carries the flow to a discharge point slightly above the base of the arroyo embankment. Doug Bloomquist (845-7455) must be contacted to ensure that no laser testing is being performed in the area. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 231 is west of Building 970 in TA IV. A drain pipe discharges to a concrete flume near the top of the embankment. The flume carries the flow to a discharge point near the base of the slope. Doug Bloomquist (845-7455) must be contacted to ensure that no laser testing is being performed in the area..Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 232 consists of two outfalls. One outfall is south of Building 970A, east of the lined lagoon. A drain pipe discharges to a concrete flume near the top of the embankment. The flume carries the flow to at discharge point near the bottom of hillside. On June 1, 1994, about 150 to 350 gallons of mineral oil was spilled into this outfall through the storm water drain by building 986. The day after the spill the site was screened for radiation and UXO/HE. No surface radiation anomalies or UXO/HE were found. Also, four surface soil and four subsurface soil samples were collected. The samples were sent to Quintera Laboratory in Denver for analysis for organics, metals, chromium^{+6}, and gamma spec. Other than TPH from the mineral, no contaminants were detected. A Voluntary Corrective Measure was conducted in July and August to remove soil contaminated with mineral oil above 100 mg/kg of TPH.

The second outfall in Site 232 also is south of Building 970A, west of lined lagoon, and approximately 120 feet east of the other Site 232 outfall. Discharge occurs from a concrete structure opening near base of embankment. Access to the site is along the road outside the south side of TA IV. Four surface soil and four subsurface soil samples will be collected at this drainage Figure 1). The analytes are listed in Table 1.

Site 233 is south-southwest of Building 986. Near the top of an escarpment, a small metal drain pipe discharges to an open drain which directs flow within another pipe before discharging near the base of the hillslope. Access to the site is along the road outside the south side of TA IV. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 234 is southeast of Building 981I (Inflatable Building) and a lagoon impoundment (Site 77).

The site discharges into a steep-sided, deeply incised channel cut into the hillside. The drainage channel splits directly uphill of a tree. Access to the site is along the road outside the south side of TA IV. Both channels will be sampled. Six surface soil and six subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 235 is immediately downstream of a large concrete spillway on the northeast side of Pennsylvania and south of the Skeet Range, at the point where the road comes off the north bank of the arroyo and descends into the channel. The flow moves in a confined channel after dropping down the spillway. The site has been cleared for visible surface UXO/HE and screened for surface radiation with no anomalies detected. This channel is considerably larger than the other outfall sites. Six surface soil and six subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Background
Background soil concentrations for organic contaminants should be negligible. Background concentrations for total metals and radionuclides must be determined for comparison to concentrations found at the sites. Twelve locations have been identified to collect samples for background determination (Figure 1). At each of these sites, one sample will be collected at a depth of 0-6 inches and a second sample collected at 18-36 inches (Table 1).. In addition, the background study report prepared by International Technology Corporation (May 1994) will also be used to evaluate the data.

Quality Assurance
As shown in Table 1, quality assurance samples will include the following:

- Field "duplicates" on more than 10 percent of the samples. These samples will be collected adjacent to the original surface soil sample and in the same hole as the original subsurface soil sample;
- Field soil blanks for more than 10 percent of the VOC analyses. These sample will be obtained from Sample Management Office (SMO) and will contain no VOCs; and
- One rinsate blank. All rinsate will be composited in one container. A sample of the rinsate will be analyzed for all constituents. The disposal method for the rinsate will be determined by the analytical results on this sample.

Site	Site Name	Potential Contaminants	[illegible]e Soils															Subsurface Soils															
			Number of Samples	BNAs (8270)	TAL Metals (6010/7000)	Cr^{+6}* (aqueous leaching)	Cyanide (acid digestion)	TPH (8015)	Explosives Res (8330)	TKN (acid digestion)	NO_3/NO_2 (353.2)	Gamma Spec (In-House) 600 901.1	Gamma Spec (Off-site) 600 901.1	PCBs (8080)	Tritium (600 906.0)	Isotopic Plutonium (600 7-79-081)	Isotopic Uranium (HASL-300 4.5)	Number of Samples	VOCs (8240)	BNAs (8270)	TAL Metals (6010/7000)	Cr^{+6}* (aqueous leaching)	Cyanide (acid digestion)	TPH (8015)	Explosives Res (8330)	TKN (acid digestion)	NO_3/NO_2 (353.2)	Gamma Spec (In-House) 600 901.1	Gamma Spec (Off-site) 600 901	PCBs (8080)	Tritium (600 906.0)	Isotopic Plutonium (600 7-79-081)	Isotopic Uranium (HASL-300 4.5)
46	Old Acid Waste Line Outfall (Tijeras Arroyo)	Ferric chloride, chromic acid and other acids, ammonia, photo processing chemicals and other unknown chemicals	4	2	4	4	2			4	4	4	2		4	2	2	4	4	2	4	4	2			4	4	4			4	2	2
50	Old Centrifuge Site (TA-2)	Rocket propellant and residues	4		4				4			2			2	1	2	4			4				2						1		1
77	Oil Surface Impoundment	Solvents and PCBs	4											4				4	4											4			
227	Bldg. 904 outfall (TA-2)	High explosives, radioactive materials, nitrate, toluene, methanol, other solvents, carbon tetrachloride, ammonium hydroxide, barium, cadmium, silver, chromium, titanium, cyanide	4	2	4	4	2	2	2	4	4	4	2		4	2	2	4	4	2	4	4	2	4	2	4	4	4			4	2	2
229	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				4	2		4	2	2	4	4	2	4	4		4				4			4	2	2
230	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1	4	4	2	4	4		4				2					
231	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1	4	4	2	4	4		4				2					
232	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1	4	4	2	4	4		4				2					
233	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1	4	4	2	4	4		4				2					
234	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	6	3	6	6		6				2			2	1	1	6	6	3	6	6		6				2					
235	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1	4	4	2	4	4		4				2					
Na	Background		12		12							12			3	3	3	12			12							12			3	3	3
QA	Duplicates	Na		2	5	4	1	4	1	1	1		1	1			2		5	2	5	4	1	4	1	1	1			1			1
QA	Field Soil Blank	Na																	5														
QA	Rinsate	Na		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1												
	Totals		58	22	60	43	6	37	8	10	10	39	8	6	30	17	20	58	53	21	60	42	5	38	5	9	9	36		5	16	9	11
	Totals - Surface Plus Subsurface		116	43	120	85	11	75	13	19	19	75	8	11	46	26	31		53														

* Analyze for Cr^{+6} only if Cr is detected in metals analysis

APPENDIX B

Appendix B
Analytical Results

ACRONYMS FOR ANALYTICAL DATA

Organic/metals data for soil = mg/kg
Radionuclides data for soil = pCi/g

ND = Not detected

NS = Not significant

MDA = Maximum Detectable Activity

J = Detected at a concentration below the laboratory reporting limit

B = Detected in the associated blank sample

Site 231 Soil Results

Sample Identifier	Aluminium	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury
231-01-A	2000	4	2	90	ND	0.9	25000	2.4	2.7	5.4	4900	6.3	1800	180	ND
231-01-B	3800	7.1	1	240	0.3	1.2	25000	3.7	3.5	6.9	7000	7.6	2700	230	ND
231-02-A	2900	5.7	1	120	ND	0.8	24000	3.2	2.8	5.8	5400	6.7	2300	200	ND
231-02-B	4500	7.7	1	200	0.3	1.5	22000	7.9	4.1	7.7	9900	8.6	3200	250	ND
231-03-A	6200	11	2	200	0.4	1.5	37000	6	4.7	10	9800	9.5	4200	280	ND
231-03-B	2600	5.6	2	120	ND	1	33000	3.4	3.3	29	4800	6.4	2200	150	ND
231-04-A	5400	9.5	6	210	0.3	1.7	42000	5.8	4.9	13	8900	10	3800	230	ND
231-04-B	2700	6	2	220	ND	0.8	78000	3.4	2.6	7.6	4400	5.5	2700	160	ND

Sample Identifier	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Cr^{+6}	Tritium	Plutonium 239/240	Plutonium 238	Uranium-238	Uranium-235/236	Uranium-234
231-01-A	3.1	1700	ND	ND	ND	ND	8.9	50	1.6	<0.035	<0.008	<0.011	0.42	0.4	1
231-01-B	5.2	2000	ND	ND	740	ND	11	130	ND						
231-02-A	3.9	1900	ND	ND	330	ND	8.9	75	ND						
231-02-B	8.7	2600	ND	ND	550	ND	17	110	ND						
231-03-A	6.9	2500	ND	ND	380	ND	16	90	ND						
231-03-B	3.9	870	ND	ND	ND	ND	9.7	55	ND						
231-04-A	6.5	1900	ND	ND	460	ND	15	100	ND	<0.014					
231-04-B	3.2	720	ND	ND	550	ND	10	100	ND						

Concentrations in mg/kg
Activities in pCi/g
Sample Identifier XX-XX-A - surface soil samples
Sample Identifier XX-XX-B - subsurface soil samples

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Quality Assurance Results for Organic Constituents

Sample Identifier	Sample Type	2-Butanone	2-Hexanone	4-Methyl-2-pentanone	Acetone	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Di-n-octyl phthalate	Fluoranthene	Methylene Chloride	Phenanthrene	Pyrene	Styrene	total-Xylenes	TPH
227-01-A	original										0.066 J		0.055 J	0.040 J			
227-01-A	duplicate										0.038 J		0.051 J				
227-01-B	original	0.007 J		0.001 J													
227-01-B	duplicate	0.006 J			0.006 J												
227-04-B	original	0.004 J															
227-04-B	duplicate	0.005 J															
229-01-A	original					0.071 J	0.050 J	0.16 J	0.11 J		0.23 J		0.17 J	0.19 J			ND
229-01-A	duplicate					0.006 J	0.092 J	0.16 J	0.12 J		0.20 J		0.18 J	0.28 J			81
229-02-B	original	0.006 J															
229-02-B	duplicate	0.006 J															
229-03-B	original	0.006 J															
229-03-B	duplicate	0.006 J															
230-04-B	original	0.003 JB								0.16 J							
230-04-B	duplicate																
235-02-B	original	0.006 JB															
235-02-B	duplicate	0.004 JB															
Site 227	trip blank	0.010 B	0.003 J	0.002 J	0.019												
Site 229	trip blank	0.009 JB			0.015												
Site 230	trip blank	0.004 JB										0.003 J					
Site 232	trip blank	0.007 JB															
Site 234	trip blank	0.007 JB			0.015										0.001 J		
Site 235	rinsate	0.005 JB			0.010											0.001 J	ND

Quality Assurance Results for Inorganic and Radiological Constituents

Sample Identifier	Sample Type	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Vanadium	Zinc
227-02-A	original	5800	9.3	5.9	180	ND	2.1	6.6	4.1	7.8	13000	7.5	160	ND	5.4	27	51
227-02-A	duplicate	6500	11	1.4	150	0.25	2.5	6.4	4.1	13	14000	9.1	170	ND	5.9	28	51
227-03-B	original	5100	8.8	0.92	140	ND	2.1	5.9	4.5	11	13000	7.5	200	ND	5.4	25	48
227-03-B	duplicate	6400	9.9	5.6	140	0.25	2.9	7.4	4.6	10	16000	8.9	230	ND	5.9	33	50
229-04-A	original	8100	13	5.7	150	0.32	2.3	8.0	4.2	7.9	13000	12	210	ND	6.3	24	55
229-04-A	duplicate	7700	12	1.5	140	0.30	2.2	8.0	4.2	7.7	12000	11	190	ND	6.2	24	52
230-04-B	original	1500	3.3	1.6	130	ND	0.61	2.3	ND	18	3500	4.2	110	ND	3.0	9.1	82
230-04-B	duplicate	2400	4.9	1.7	140	ND	0.68	3.1	2.5	15	4500	4.1	120	ND	3.4	9.7	71
235-01-A	original	3600	6.2	5.1	150	ND	2.7	6.0	8.4	6.6	20000	7.6	210	ND	4.5	36	66
235-01-A	duplicate	3000	5.3	1.3	160	ND	1.6	4.2	5.7	6.5	12000	9.4	180	ND	4.4	22	66
50-01-B	original	3100	6.5	2.1	110	0.25	1.3	4.1	3.9	6.2	7600	6.6	130	ND	4.5	17	18
50-01-B	duplicate	3900	7.5	2.0	110	0.26	1.3	4.3	4.0	5.7	8800	5.9	150	ND	4.2	18	21
50-02-A	original	5800	12	4.2	220	0.38	1.6	5.2	4.3	12	6700	25	210	ND	7.1	11	69
50-02-A	duplicate	7000	14	6.4	280	0.55	2.2	8.3	6.1	17	9000	35	290	0.04	9.4	18	61
Bkg-05-A	original	6400	13	5.7	210	0.53	1.8	6.1	6.6	14	10000	16	330	ND	8.9	22	37
Bkg-05-A	duplicate	5900	12	7.6	190	0.50	1.7	6.0	6.3	14	10000	16	320	ND	8.7	24	36
Site 235	rinsate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Sample Identifier	Sample Type	TKN	NO_3/NO_2	Potassium 40	Lead 212	Lead 214	Plutonium 239/240	Uranium 238	Uranium 235/236	Uranium 234
227-02-A	original	400	2.7							
227-02-A	duplicate	320	9.3							
227-03-A	original						0.004	0.4	0.15	0.61
227-03-A	duplicate							0.67	0.023	0.67
227-03-B	original							0.72	0.11	0.72
227-03-B	original	220	ND							
227-03-B	duplicate			27.8	0.71	0.7				
227-03-B	duplicate	190	1.4							
229-01-A	original						0.007	0.45	0.17	0.67
229-01-A	duplicate							0.73	0.034	0.6
229-03-B	original							0.45	0.058	0.45
229-03-B	duplicate							0.99	0.06	1

<u>Notes on Quality Assurance Data</u>

Explosive residues were not detected in Site 50 duplicate sample

Hexavalent chromium was not detected in five duplicates and one decon rinsate

Cyanide was not detected in two duplicates and one decon rinsate

PCBs were not detected in one Site 77 duplicate sample

Tritium and Plutonium-238 were not detected in four duplicate samples

Selenium, silver, and thallium were not detected in any quality assurance samples

APPENDIX C

Appendix C
Background Calculations for Metals and Radionuclides

Appendix C. Background Calculations for Metals and Radionuclides

To evaluate metals data, 24 background samples were collected for metals analyses.[4] Distribution analyses was performed first by constructing histograms. The histograms indicated a parametric distribution. Outliers were screened in a two-step process as described in the base wide background report (IT 1994). The first step is to perform an "a priori" screening for very high values relative to the rest of the data set. This is qualitatively performed by visually examining a column of sorted values. Maximum values that are a factor of 3 or 4 times higher than their nearest neighbor are removed from the data set during this step. None of the anomalous values were deleted by the "a priori" process.

The second step, from EPA, 1989, determines whether an observation that appears extreme fits the data distribution. A statistical parameter, T_n is calculated:

$$T_n = (X_n - X_a)/S$$

where:

X_n = questionable observation;

X_a = sample arithmetic mean; and

S = sample standard deviation

T_n is compared to a table of one-sided critical values for the appropriate significance level (upper 5 percent) and sample size from a table provided in EPA 1989. Extreme concentrations for barium, calcium, chromium, copper and nickel were identified as outliers and were excluded from the data set. These anomalous values may have resulted from laboratory or sampling error.

Probability plots were then replotted to determine whether the data fit normal or lognormal populations. These plots are shown in Appendix D. The UTL[5] was calculated for data sets that fit a normal or lognormal distribution. Data sets are provided in Appendix D. As recommended by EPA, a tolerance coefficient value of 95 percent was used (EPA 1989). Most metals background data fit lognormal distributions. Iron and zinc data fit normal distributions. UTLs were not calculated for mercury, selenium, and silver because mercury and selenium were not detected and silver was detected only once in the 24 background samples. The beryllium background data did not fit a normal or lognormal distribution. The maximum value in a data set is commonly taken as the UTL in a non-parametric setting (Guttman, 1970). The maximum background beryllium concentration was 0.53 mg/kg.

Base-wide background UTLs for radionuclides were established by International Technology (IT) Corporation to compare and evaluate radionuclide data (IT, 1994). A table is provided in Appendix

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[2]These data are referred to as local background data. The data collected throughout Kirtland Air Force Base (KAFB), with most of the data collected within SNL/NM technical areas, are called base-wide background data (IT 1994).

[3]UTL = x + K•S, where:

UTL = Upper tolerance limit;

x = Sample arithmetic mean (for normal distribution), sample geometric mean (for lognormal distribution);

S = Sample standard deviation; and

K = One-sided normal tolerance factor (95 percent for these evaluations).

D with radionuclide background data and the corresponding UTLs. The maximum activity from the six local background samples for isotopic plutonium and isotopic uranium was used as an additional method to evaluate the data. Also, in-house gamma spectroscopy was performed on all 24 background samples and indicated low levels of radioactivity but no significant contamination.

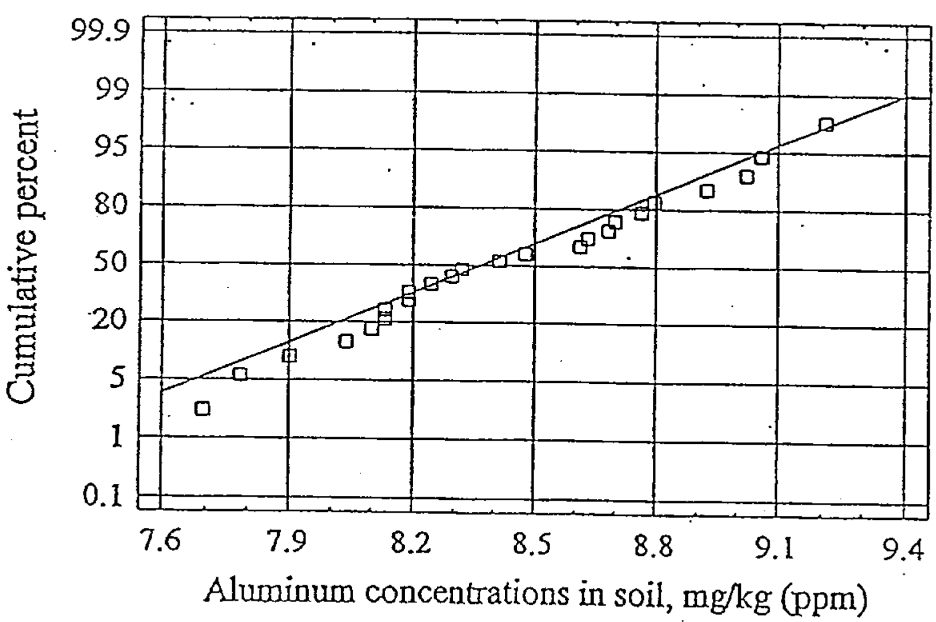
APPENDIX D

Appendix D
Probability Plots, Local Background UTL Calculations, and Base-Wide Background UTLs for Radionuclides

Summary Statistics for log(Aluminum)

```
Count = 24
Average = 8.42942
Median = 8.36529
Mode =
Geometric mean = 8.41976
Variance = 0.170246
Standard deviation = 0.412609
Standard error = 0.0842235
Minimum = 7.69621
Maximum = 9.21034
Range = 1.51413
Lower quartile = 8.13153
Upper quartile = 8.73178
Interquartile range = 0.600253
Skewness = 0.132255
Stnd. skewness = 0.26451
Kurtosis = -0.792361
Stnd. kurtosis = -0.792361
Coeff. of variation = 4.89487
Sum = 202.306
```

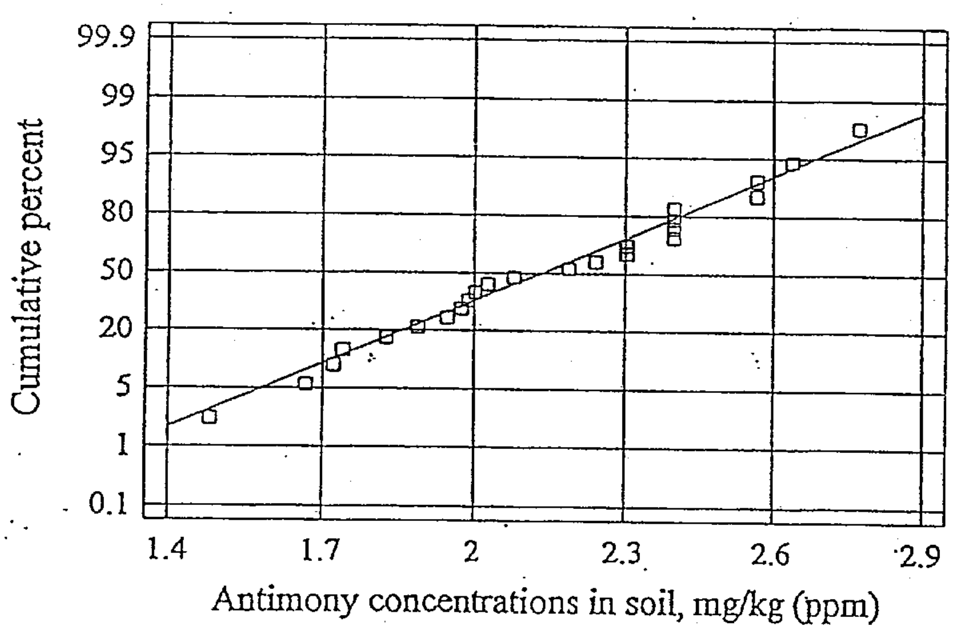
Lognormal Probability Plot for Aluminum



Statistics for log(Antimony)

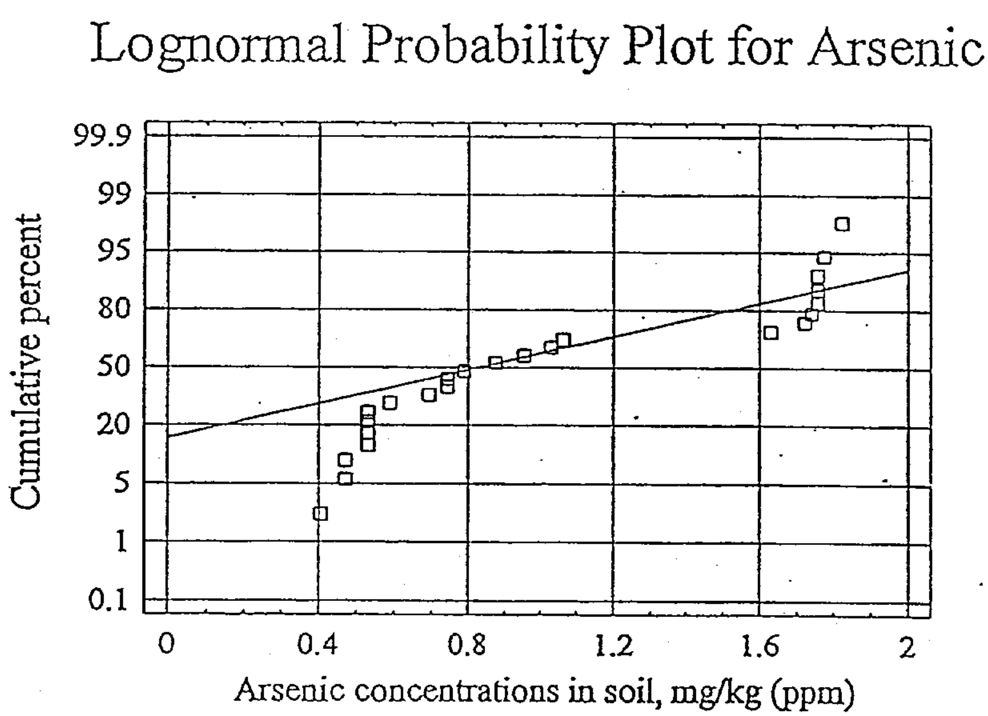
```
24
= 2.14609
lian = 2.13275
le = 2.3979
metric mean = 2.12004
iance = 0.113831
ndard deviation = 0.337389
ndard error = 0.0688692
imum = 1.4816
imum = 2.77259
ge = 1.29098
er quartile = 1.91649
er quartile = 2.3979
erquartile range = 0.481405
wness = -0.040772
d. skewness = -0.0815441
tosis = -0.744171
d. kurtosis = -0.744171
ff. of variation = 15.7211
= 51.5062
```

Lognormal Probability Plot for Antimony



ımmary Statistics for Log(Arsenic)

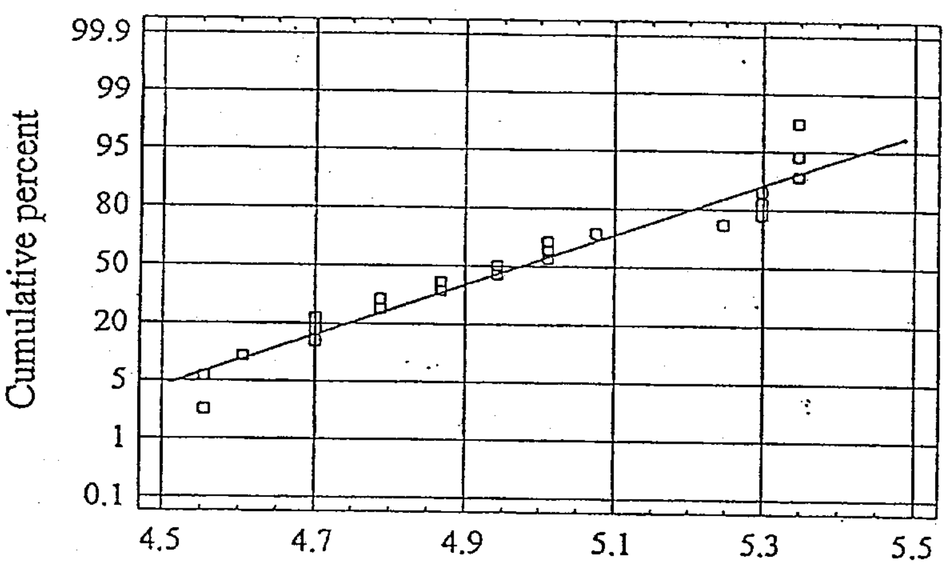
ount = 24
verage = 1.038
edian = 0.831963
ode =
eometric mean = 0.908119
ariance = 0.291153
tandard deviation = 0.539586
tandard error = 0.110143
nimum = 0.405465
aximum = 1.82455
ange = 1.41908
ower quartile = 0.530628
pper quartile = 1.73162
nterquartile range = 1.20099
kewness = 0.463036
nd. skewness = 0.926071
urtosis = -1.58507
nd. kurtosis = -1.58507
oeff. of variation = 51.983
um = 24.9121



Statistics for log(Barium)

23
= 4.96948
ian = 4.94164
e = 5.34711
metric mean = 4.96236
iance = 0.0740602
ndard deviation = 0.27214
ndard error = 0.0567451
imum = 4.55388
imum = 5.34711
ge = 0.793231
er quartile = 4.70048
er quartile = 5.29832
erquartile range = 0.597837
wness = 0.0653415
l. skewness = 0.127931
tosis = -1.30542
l. kurtosis = -1.27794
f. of variation = 5.47622
= 114.298

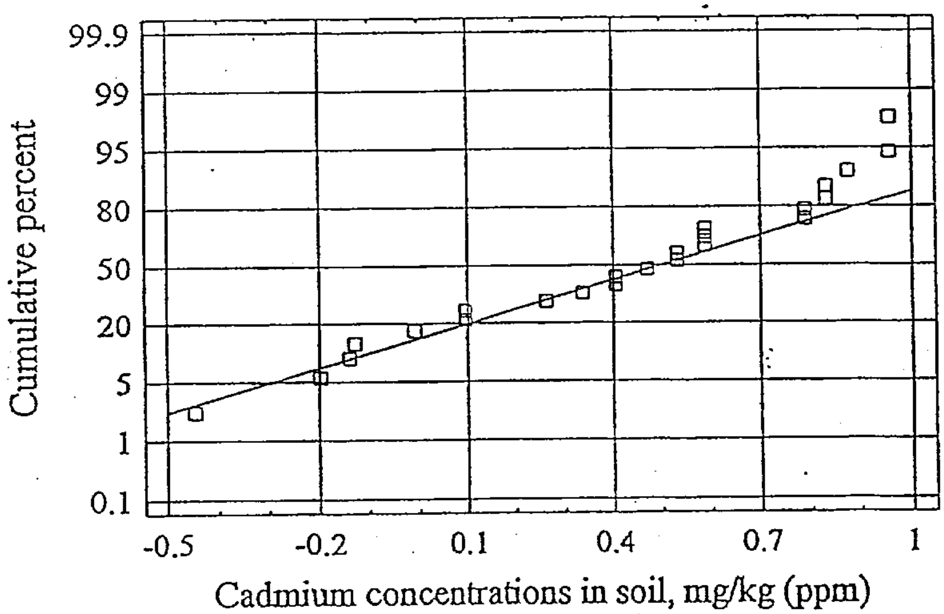
Lognormal Probability Plot for Barium



ımmary Statistics for log(Cadmium)

```
ount = 24
erage = 0.416764
dian = 0.500316
ode =
ometric mean =
riance = 0.159937
andard deviation = 0.399922
andard error = 0.0816337
nimum = -0.446287
ximum = 0.955511
nge = 1.4018
wer quartile = 0.0953102
per quartile = 0.788457
terquartile range = 0.693147
ewness = -0.506707
nd. skewness = -1.01341
rtosis = -0.674504
nd. kurtosis = -0.674504
eff. of variation = 95.9587
m = 10.0023
```

Lognormal Probability Plot for Cadmium

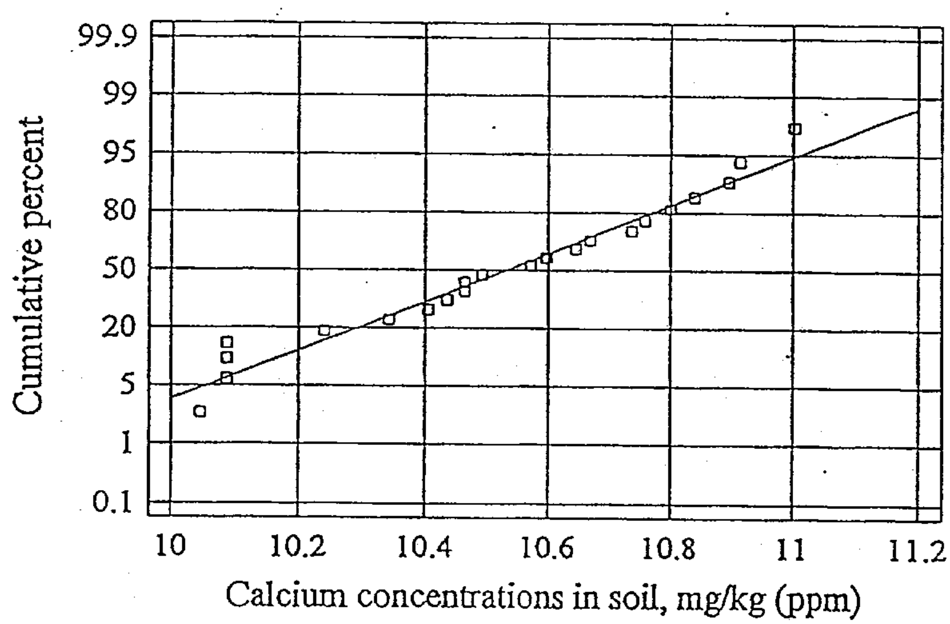


32

Statistics for log(Calcium)

23
)= 10.5579
ed. = 10.5713
xde = 10.0858
eometric mean = 10.5532
iriance = 0.10513
tandard deviation = 0.324237
tandard error = 0.0676081
nimum = 10.0432
ximum = 11.2645
inge = 1.22121
wer quartile = 10.3417
per quartile = 10.7996
terquartile range = 0.457833
ewness = 0.109797
nd. skewness = 0.214971
rtosis = -0.415646
nd. kurtosis = -0.406895
eff. of variation = 3.07103
m = 242.832

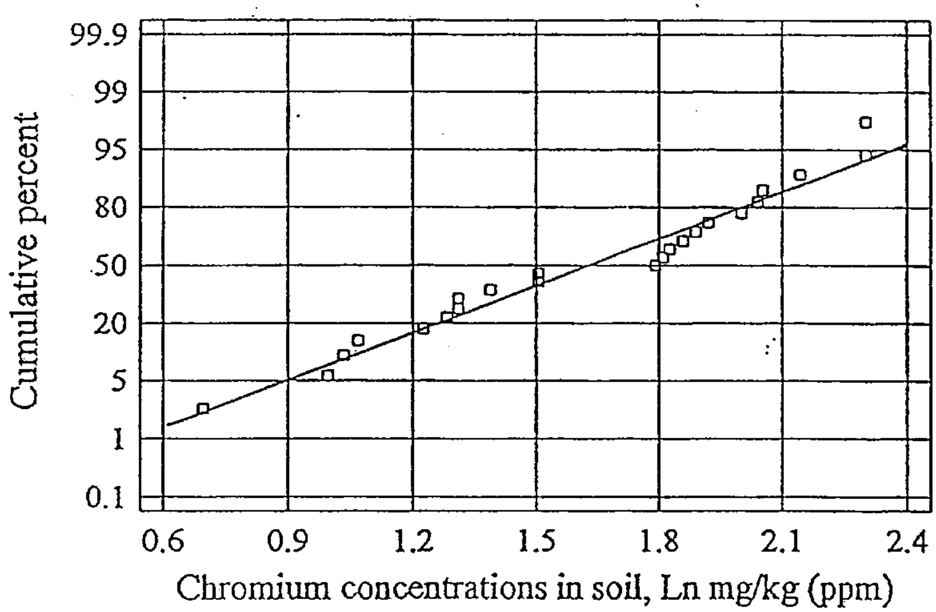
Lognormal Probability Plot for Calcium



ımmary Statistics for log(Chromium)

```
ount = 23
/erage = 1.61841
edian = 1.79176
ode =
eometric mean = 1.55042
ariance = 0.204195
tandard deviation = 0.451879
tandard error = 0.0942233
inimum = 0.693147
aximum = 2.30259
ange = 1.60944
ower quartile = 1.28093
pper quartile = 2.00148
nterquartile range = 0.720546
kewness = -0.274151
tnd. skewness = -0.536757
urtosis = -0.905395
tnd. kurtosis = -0.886332
oeff. of variation = 27.9211
um = 37.2235
```

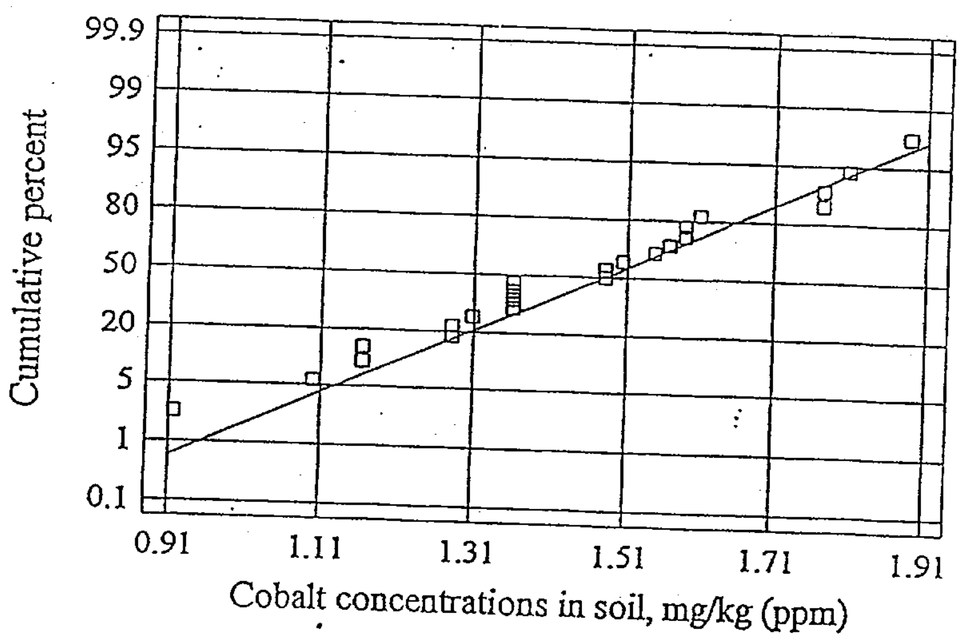
Lognormal Probability Plot for Chromium



y Statistics for log(Cobalt)

n = 24
e = 1.29969
an = 1.42129
ode =
eometric mean =
riance = 0.574775
tandard deviation = 0.758139
tandard error = 0.154754
nimum = -2.07944
ximum = 1.88707
nge = 3.96651
wer quartile = 1.28093
per quartile = 1.58924
terquartile range = 0.308301
ewness = -4.13299
nd. skewness = -8.26598
rtosis = 18.9091
nd. kurtosis = 18.9091
eff. of variation = 58.3324
m = 31.1925

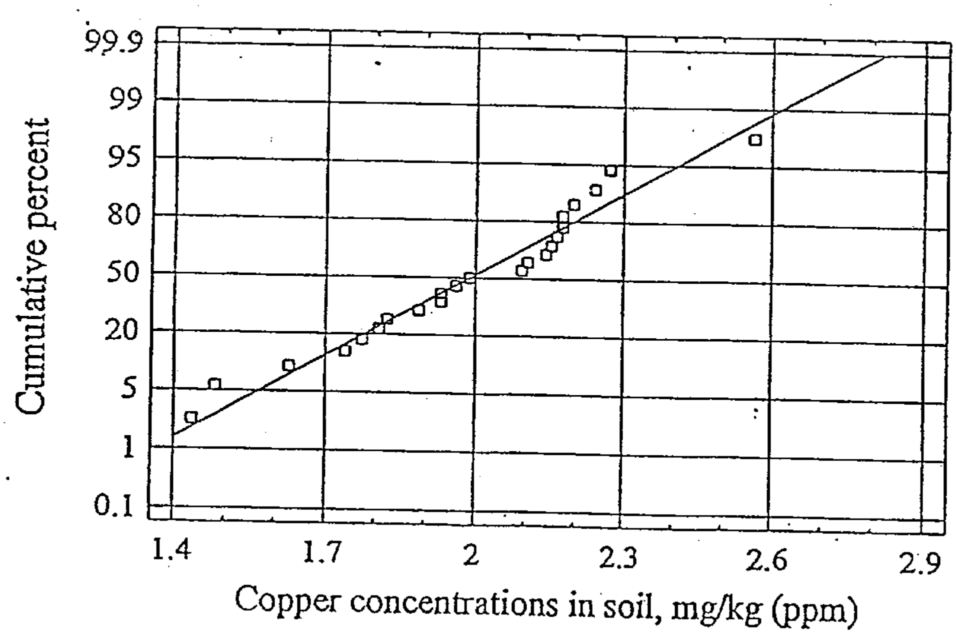
Lognormal Probability Plot for Cobalt



```
Summary Statistics for log(Copper)

Count = 23
Average = 1.98556
Median = 1.98787
Mode =
Geometric mean = 1.96762
Variance = 0.0713494
Standard deviation = 0.267113
Standard error = 0.0556969
Minimum = 1.43508
Maximum = 2.56495
Range = 1.12986
Lower quartile = 1.80829
Upper quartile = 2.17475
Interquartile range = 0.366463
Skewness = -0.263077
Stnd. skewness = -0.515077
Kurtosis = 0.18883
Stnd. kurtosis = 0.184854
Coeff. of variation = 13.4528
Sum = 45.6679
```

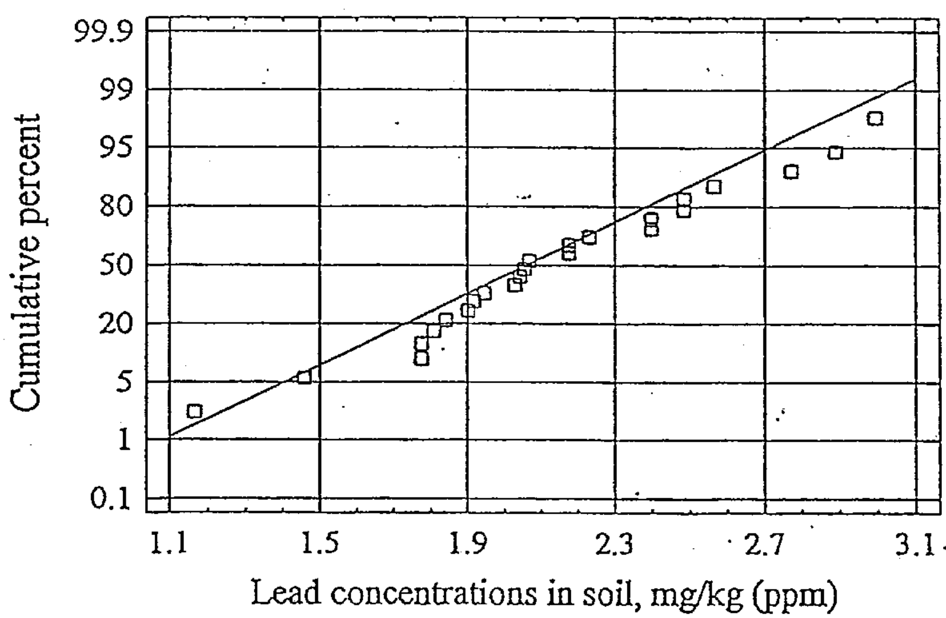
Lognormal Probability Plot for Copper



ummary Statistics for log(Lead)

24
e = 2.13936
= 2.06049
ode =
eometric mean = 2.09509
ariance = 0.107882
tandard deviation = 0.433454
tandard error = 0.0884784
inimum = 1.16315
aximum = 2.99573
ange = 1.83258
ower quartile = 1.87133
pper quartile = 2.4414
nterquartile range = 0.570072
kewness = 0.0350174
tnd. skewness = 0.0700348
urtosis = 0.200156
tnd. kurtosis = 0.200156
oeff. of variation = 20.261
um = 51.3446

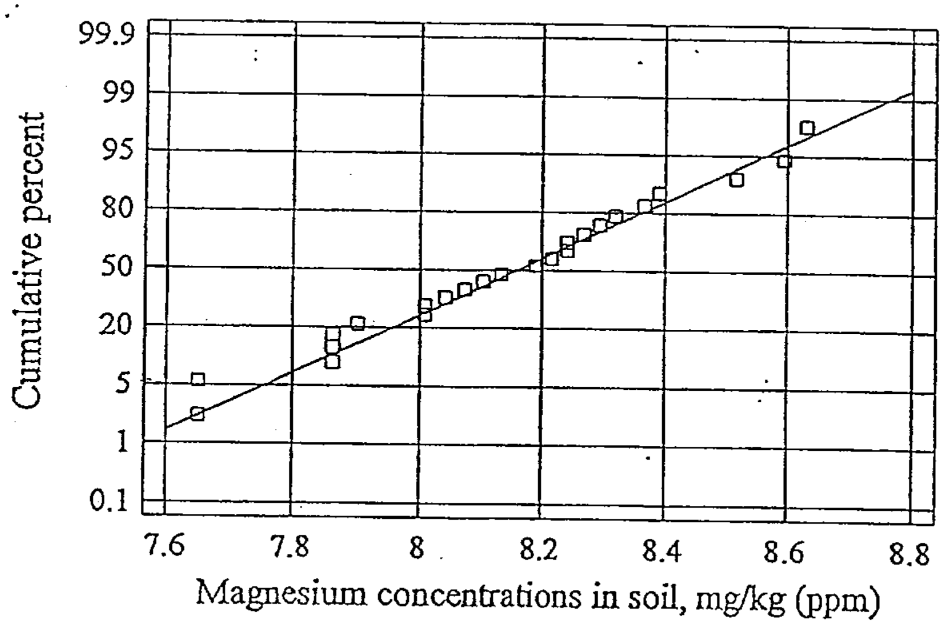
Lognormal Probability Plot for Lead



Summary Statistics for log(Magnesium)

Count = 24
Average = 8.14232
Median = 8.16011
Mode =
Geometric mean = 8.13815
Variance = 0.0706013
Standard deviation = 0.265709
Standard error = 0.0542376
Minimum = 7.64969
Maximum = 8.63052
Range = 0.980829
Lower quartile = 7.95369
Upper quartile = 8.3064
Interquartile range = 0.352709
Skewness = -0.0600481
Stnd. skewness = -0.120096
Kurtosis = -0.414246
Stnd. kurtosis = -0.414246
Coeff. of variation = 3.26331
Sum = 195.416

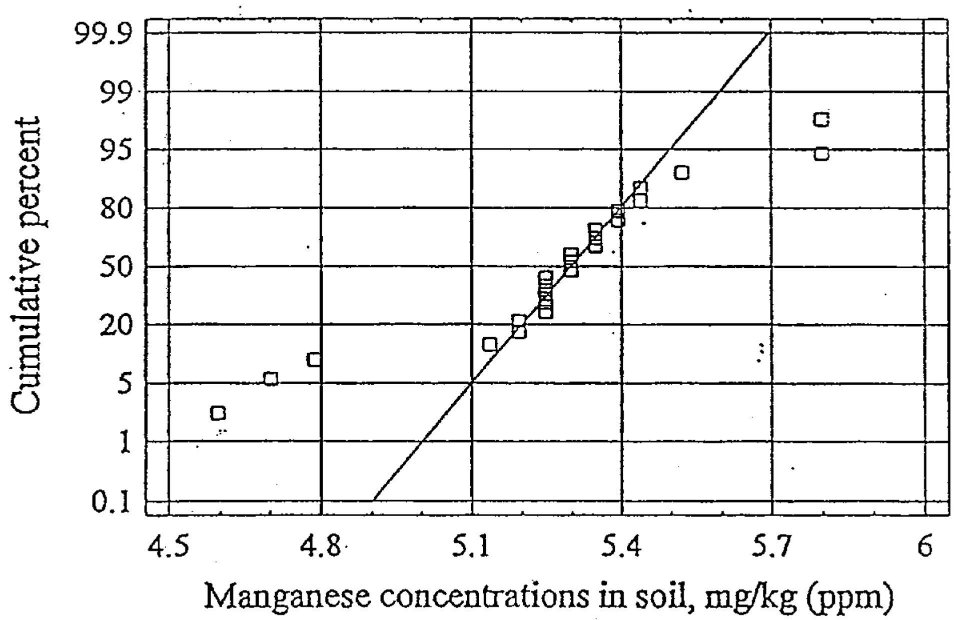
Lognormal Probability Plot for Magnesium



```
nm  Statistics for log(Manganese)

    24
  e = 5.2733
  n = 5.29832
de =
ometric mean = 5.2661
riance = 0.0771874
andard deviation = 0.277826
andard error = 0.056711
nimum = 4.59512
ximum = 5.79909
nge = 1.20397
wer quartile = 5.21999
per quartile = 5.39363
terquartile range = 0.173637
ewness = -0.660387
nd. skewness = -1.32077
rtosis = 1.62566
nd. kurtosis = 1.62566
eff. of variation = 5.26854
m = 126.559
```

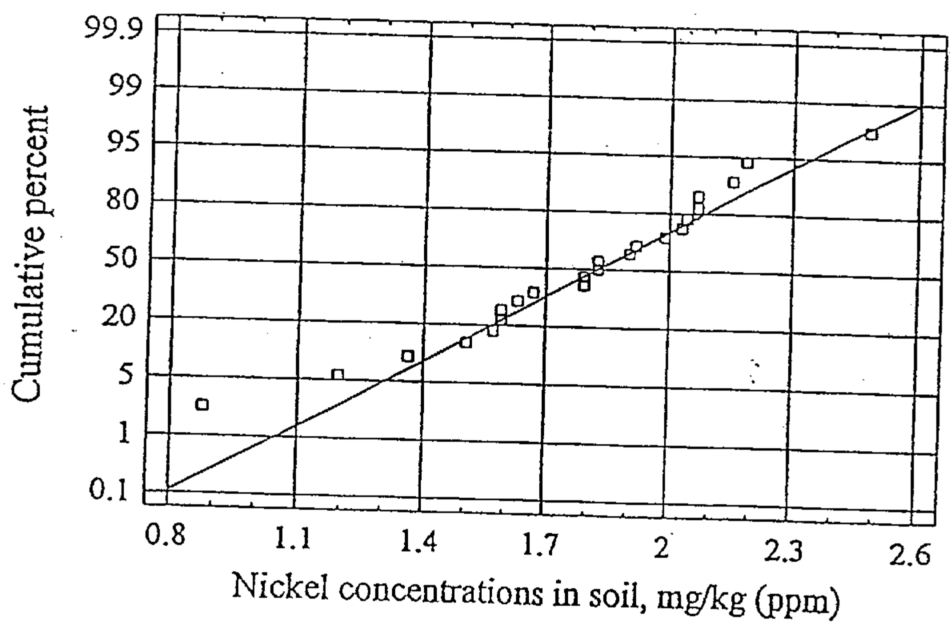
Lognormal Probability Plot for Manganese



Summary Statistics for log(Nickel)

Count = 23
Average = 1.78451
Median = 1.82455
Mode =
Geometric mean = 1.74596
Variance = 0.1246
Standard deviation = 0.352987
Standard error = 0.0736029
Minimum = 0.875469
Maximum = 2.48491
Range = 1.60944
Lower quartile = 1.58924
Upper quartile = 2.04122
Interquartile range = 0.451985
Skewness = -0.609856
Stnd. skewness = -1.19403
Kurtosis = 0.992502
Stnd. kurtosis = 0.971605
Coeff. of variation = 19.7806
Sum = 41.0438

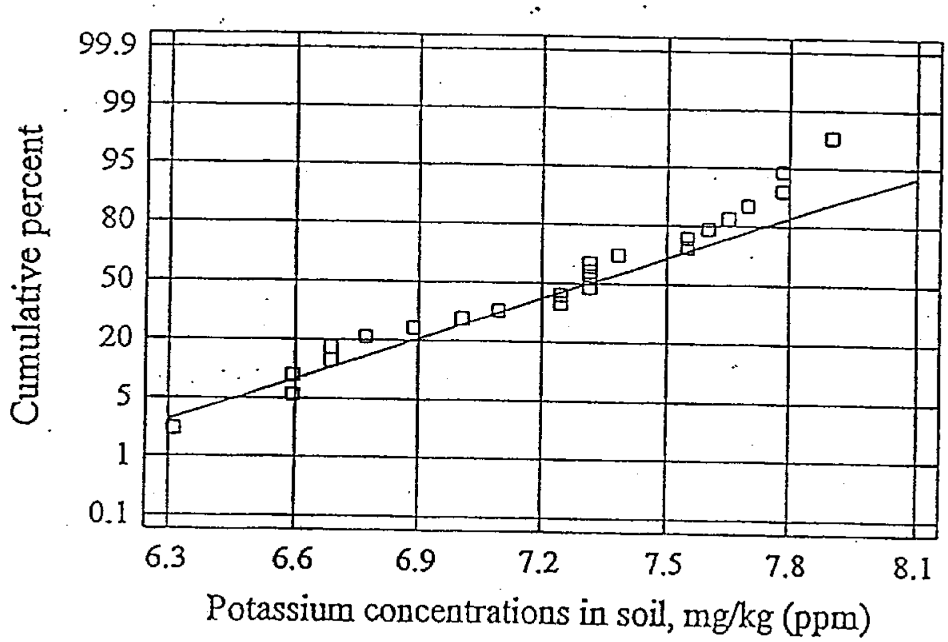
Lognormal Probability Plot for Nickel



```
u   y Statistics for log(Potassium)

      = 24
ve      )= 7.21062
3a       = 7.31322
ode = 7.31322
eometric mean = 7.20542
ariance = 0.195599
tandard deviation = 0.442265
tandard error = 0.0902771
nimum = 6.30992
ximum = 7.90101
nge = 1.59109
wer quartile = 6.82802
per quartile = 7.57526
terquartile range = 0.747233
ewness = -0.373735
nd. skewness = -0.74747
rtosis = -0.83864
nd. kurtosis = -0.83864
eff. of variation = 6.12673
m = 173.247
```

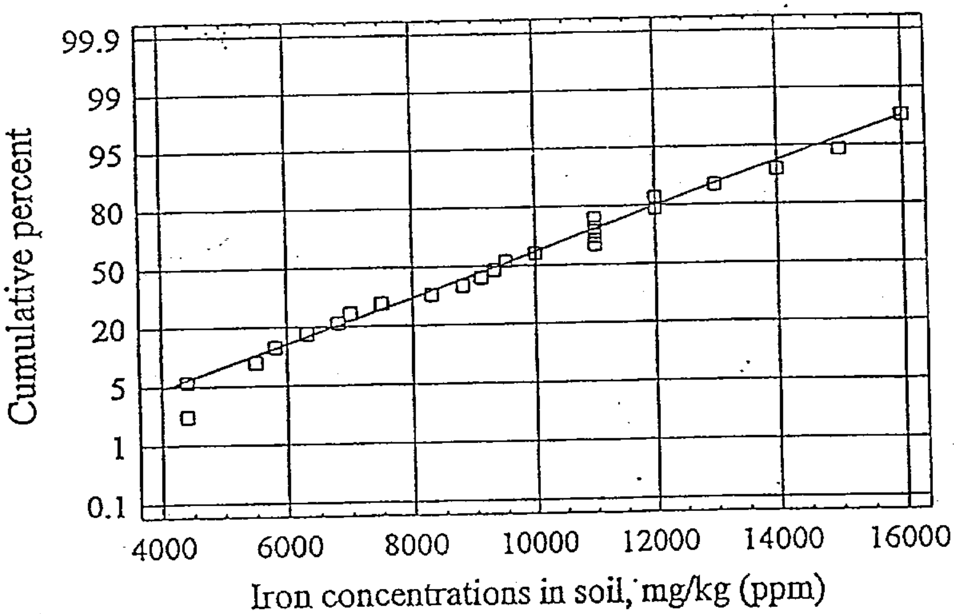
Lognormal Probability Plot for Potassium



Summary Statistics for Iron

Count = 24
Average = 9529.17
Median = 9400.0
Mode = 11000.0
Geometric mean = 8977.5
Variance = 1.0363E7
Standard deviation = 3219.17
Standard error = 657.109
Minimum = 4400.0
Maximum = 16000.0
Range = 11600.0
Lower quartile = 6900.0
Upper quartile = 11500.0
Interquartile range = 4600.0
Skewness = 0.20025
Stnd. skewness = 0.400499
Kurtosis = -0.620589
Stnd. kurtosis = -0.620589
Coeff. of variation = 33.7822
Sum = 228700.0

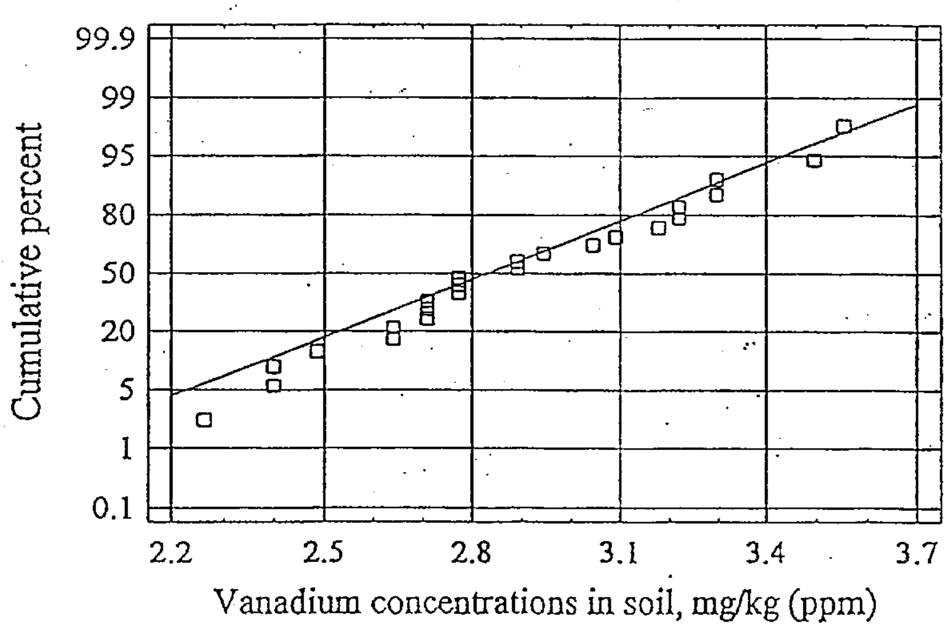
Normal Probability Plot for Iron



```
na Statistics for log(Vanadium)

  24
  = 2.89094
  = 2.83148
e =
metric mean = 2.87064
iance = 0.122444
ndard deviation = 0.34992
ndard error = 0.0714271
imum = 2.26176
imum = 3.55535
ge = 1.29358
er quartile = 2.67355
er quartile = 3.19846
erquartile range = 0.524911
wness = 0.158415
d. skewness = 0.316831
tosis = -0.688491
d. kurtosis = -0.688491
ff. of variation = 12.104
 = 69.3826
```

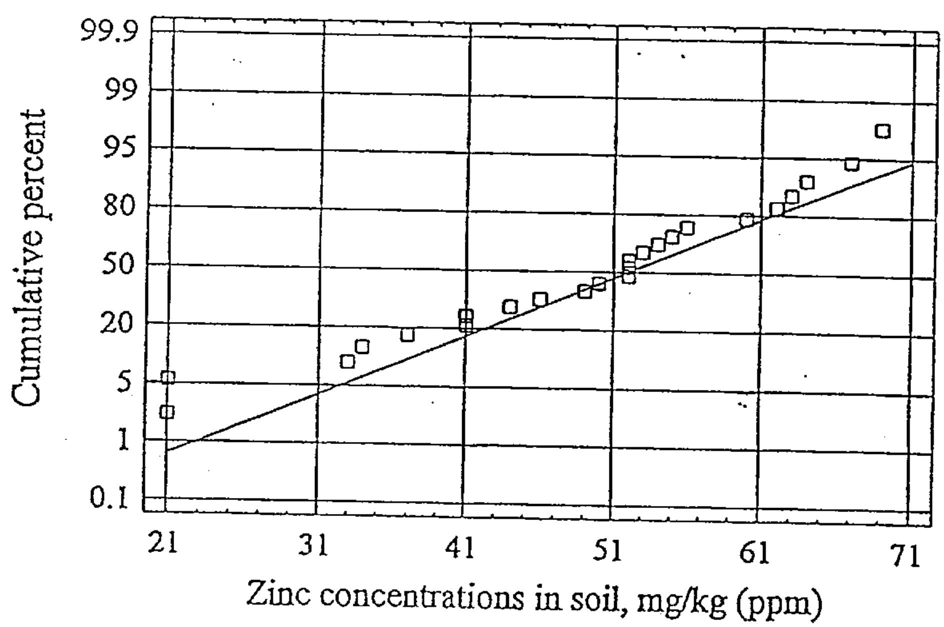
Lognormal Probability Plot for Vanadium



Summary Statistics for Zinc

Count = 24
Average = 49.0
Median = 52.0
Mode = 52.0
Geometric mean = 46.9434
Variance = 171.478
Standard deviation = 13.095
Standard error = 2.673
Minimum = 21.0
Maximum = 69.0
Range = 48.0
Lower quartile = 41.0
Upper quartile = 58.0
Interquartile range = 17.0
Skewness = -0.633044
Stnd. skewness = -1.26609
Kurtosis = -0.0224531
Stnd. kurtosis = -0.0224531
Coeff. of variation = 26.7244
Sum = 1176.0

Normal Probability Plot for Zinc



Local Background Soil Results

Sample Identifier	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury
Bkg-01-A	2700	6	2	110	ND	0.9	23000	3	3	6	5800	6	2100	190	ND
Bkg-01-B	4100	8	2	130	0.3	1.5	24000	5	4	7	8800	7	3100	230	ND
Bkg-02-A	2400	4	2	110	ND	0.8	35000	2	3	4	4400	3	2100	99	ND
Bkg-02-B	3400	7	2	130	ND	1	31000	3	3	6	6300	8	2700	210	ND
Bkg-03-A	4800	9	5	110	0.4	1.8	36000	6	5	9	11000	9	3700	210	ND
Bkg-03-B	6000	10	2	95	0.4	1.8	28000	7	5	9	11000	9	4400	250	ND
Bkg-04-A	4000	7	2	120	0.3	2.3	24000	9	4	13	9300	8	3000	190	ND
Bkg-04-B	3300	6	2	120	ND	1.4	24000	4	4	7	8300	6	2600	210	ND
Bkg-05-A	6400	13	6	210	0.5	1.8	78000	6	7	14	10000	16	5600	330	ND
Bkg-05-B	5500	10	6	140	0.5	1.7	33000	6	6	9	11000	11	3900	330	ND
Bkg-06-A	4500	9	6	150	0.3	1.5	46000	19	4	8	9100	8	3800	190	ND
Bkg-06-B	3800	8	2	150	0.3	1.1	51000	4	4	7	6800	7	3400	200	ND
Bkg-07-A	3100	6	2	95	0.3	1.1	34000.	4	4	6	7000	12	2600	170	ND
Bkg-07-B	3600	7	3	100	0.3	1.3	39000	4	4	6	7500	7	3000	180	ND
Bkg-08-A	2200	5	6	160	ND	0.6	54000	3	ND	4	4400	4	2600	110	ND
Bkg-08-B	3600	7	3	190	ND	1.6	60000	5	4	7	9500	6	4100	180	ND
Bkg-09-A	5900	11	6	210	0.4	1.7	49000	6	5	7	11000	8	5400	230	ND
Bkg-09-B	3400	7	3	210	0.3	0.9	82000	3	3	5	5500	6	3800	120	ND
Bkg-10-A	7500	11	2	140	0.3	2.3	42000	8	5	8	13000	12	3200	190	ND
Bkg-10-B	6600	11	6	150	0.3	2.6	35000	7	4	10	14000	11	3300	200	ND
Bkg-11-A	8300	13	2	200	0.4	2.2	43000	8	5	9	12000	18	3600	190	ND
Bkg-11-B	10000	16	2	200	0.5	2.4	40000	10	6	9	16000	20	4000	220	ND
Bkg-12-A	5600	11	2	200	0.3	2.2	55000	7	5	9	12000	9	4300	200	ND
Bkg-12-B	8600	14	6	290	0.4	2.6	47000	10	6	9	15000	13	5000	220	ND

Concentrations in mg/kg
Activities in pCi/g
Sample Identifier XX-XX-A - surface soil samples
Sample Identifier XX-XX-B - subsurface soil samples

Local Background Soil Results

Sample Identifier	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Tritium	Plutonium 239/24	Plutonium 238	Uranium-238	Uranium-235/236	Uranium-234
Bkg-01-A	4	1500	ND	ND	ND	ND	11	50						
Bkg-01-B	6	2000	ND	ND	ND	ND	16	63						
Bkg-02-A	2	730	ND	ND	ND	ND	9.6	41						
Bkg-02-B	5	1600	ND	ND	ND	ND	11	53						
Bkg-03-A	7	1500	ND	ND	ND	ND	19	56						
Bkg-03-B	9	1200	ND	ND	480	ND	15	62						
Bkg-04-A	12	1900	ND	1	ND	ND	18	55	<0.010	<0.009	<0.011	0.8	0.28	1
Bkg-04-B	5	1400	ND	ND	ND	ND	16	52	<0.022	<0.008	<0.009	0.3	0.02	0.3
Bkg-05-A	9	2700	ND	ND	ND	ND	22	37						
Bkg-05-B	8	1400	ND	ND	ND	ND	18	34						
Bkg-06-A	13	1500	ND	ND	ND	ND	16	52						
Bkg-06-B	6	800	ND	ND	420	ND	14	54						
Bkg-07-A	5	870	ND	ND	ND	ND	15	21						
Bkg-07-B	5	800	ND	ND	380	ND	15	21						
Bkg-08-A	3	730	ND	ND	ND	ND	12	33						
Bkg-08-B	5	980	ND	ND	430	ND	21	67						
Bkg-09-A	8	1100	ND	ND	280	ND	24	41						
Bkg-09-B	5	550	ND	ND	640	ND	14	44						
Bkg-10-A	6	2400	ND	ND	ND	ND	27	52						
Bkg-10-B	7	2200	ND	ND	ND	ND	27	49						
Bkg-11-A	7	2100	ND	ND	280	ND	25	60	<0.023	<0.007	<0.017		0.03	0.5
Bkg-11-B	8	2400	ND	ND	290	ND	35	64	<0.024	<0.012	<0.018		0.03	0.6
Bkg-12-A	6	1500	ND	ND	ND	ND	25	46	<0.084	<0.030	<0.017		0.17	0.8
Bkg-12-B	8	1900	ND	ND	620	ND	33	69	<0.023	0.035	0.038	0.6	0.33	0.9

Concentrations in mg/kg
Activities in pCi/g
Sample Identifier XX-XX-A - surface soil samples
Sample Identifier XX-XX-B - subsurface soil samples

Normal Parameters for Tijeras Arroyo Local Metal Background Data

Statistical Parameter	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Vanadium	Zinc
median	4300	8.5	2	140	2	6	4.2	7.3	9400	7.9	200	6.2	17	52
geometric mean	4579.9	8.6	3	144	2	5	3.7	7.3	8977.5	8.5	195	6	18	47
maximum	10000	16	6	210	3	10	6.6	13	16000	20	330	12	35	69
minimum	2200	4.4	2	95	1	2	0.1	4.2	4400	3.2	99	2.4	9.6	21
arithmetic average	4970.8	9	3	149	2	5.5	4.2	7.5	9529.2	9.3	202	6.3	19	49
standard deviation	2095.4	3	2	40.5	1	2.3	1.3	2	3219.2	4.2	53.6	2.1	6.9	13
normal tolerance	2.309	2.3	2	2.33	2	2.3	2.3	2.3	2.309	2.3	2.31	2.3	2.3	2.3
UTL	4927.4	16	7	244	3	11	7.3	12	16962	19	326	11	35	79

Lognormal Parameters for Tijeras Arroyo Local Metal Background Data

Statistical Parameter	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Vanadium	Zinc
arithmetic average	8.4294	2.2	1	4.97	0	1.6	1.3	2	9.1025	2.1	5.27	1.8	2.9	3.8
standard deviation	0.4126	0.3	1	0.27	0	0.5	0.8	0.3	0.3631	0.4	0.28	0.4	0.3	0.3
normal tolerance	2.309	2.3	2	2.33	2	2.3	2.3	2.3	2.309	2.3	2.31	2.3	2.3	2.3
UTL	9.3821	2.9	2	5.6	1	2.7	3.1	2.6	9.941	3.1	5.91	2.6	3.7	4.6
e^{UTL}	11874	19	10	271	4	14	21	14	20764	23	370	14	40	98

ifficient data for mercury, selenium, silver, and thallium to calculate statistics
concentrations in mg/kg

Summary of Background Concentrations for Radionuclides in Soil

Analyte	Original Number of Samples	Number of Detects	Number of Rejected Samples	Distribution Type	Range (pCi/g)	n[a]	Geometric Mean (pCi/g)	Median (pCi/g)	95th Upper Tolerance Limit (pCi/g)	95th Percentile (pCi/g)
Cesium-137	802	561	26	–	–	–	–	–	–	–
(Surface)	–	–	–	Nonparametric	0.004–10.1	604	0.200	0.2495	–	0.92
(Subsurface)	–	–	–	Unknown[c]	<detection limit (<0.0686)	172	<detection limit (<0.0686)	<detection limit (<0.0686)	–	<detection limit (<0.0686)
Bismuth-212	324	17	307	Nonparametric	0.414–2.7	17	1.1055	1.0	–	2.7
Bismuth-214	340	321	19	Nonparametric	0.27–1.4	321	0.648	0.6	–	0.8
Cobalt-60	321	11	74	Unknown	<detection limit (<0.0418)	247	<detection limit (<0.0418)	<detection limit (<0.0418)		<detection limit (<0.0418)
Lead-210[b]	338	40	292	Nonparametric	0.3–12.0	46	2.26838	2.835	–	6.8
Lead-212[b]	323	233	90	Lognormal	0.1–1.4	233	0.49689	0.5	1.0795	–
Lead-214[b]	249	241	9	Lognormal	0.29–1.13	240	0.549	0.56	0.90	–
Potassium-40	722	720	4	Normal	0.192–31.0	718	15.889	16.4	25.34	–
Radium-224	24	24	0	Nonparametric	0.43–0.97	24	0.6747	0.655	–	0.968
Radium-226	368	53	314	Lognormal	0.5–2.09	54	0.713	0.590	1.94	–
Radium-228	24	24	0	Nonparametric	0.45–1.05	24	0.695	0.630	–	1.05
Radon	0	0	0	Unknown	–	0	–	–	–	–
Strontium-90	54	45	9	Nonparametric	0.032–1.85	45	0.2528	0.2883	–	0.765
Thorium-232	136	136	0	Lognormal	0.23–1.20	136	0.7971	0.810	1.258	–
Thorium-234	365	52	330	Lognormal	0.324–3.0	35	0.7796	0.71	2.89	–
Tritium	0	0	0	Unknown	–	0	–	–	–	–
Uranium-234	4	4	0	Nonparametric	0.8–1.0	4	0.897	0.9	–	1.0
Uranium-235	95	21	75	Nonparametric	0.05–0.18	20	0.1198	0.1235	–	0.168
Uranium-238	223	206	17	Nonparametric	0.0033–2.065	206	0.506	0.763	–	1.1

[a]Sample size.
[b]These constituents are not listed as COC in Table 2-2 for this media.
[c]Constituents of concern are of unknown distribution type because data are either below the limit of detection, unusable, or nonexistent.

(IT, 1994)

NOD

Department of Energy
Field Office, Albuquerque
Kirtland Area Office
P.O. Box 5400
Albuquerque, New Mexico 87115

OCT 17 1996

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Benito Garcia, Bureau Chief
New Mexico Environment Department
Hazardous and Radioactive Materials Bureau
2044 Galisteo Street
P.O. Box 26110
Santa Fe, NM 87505-2100

Dear Mr. Garcia:

Enclosed are two copies of the Sandia National Laboratories, New Mexico/Department of Energy (SNL/NM/DOE) response to the New Mexico Environment Department (NMED) technical comments on the 23 No Further Action (NFA) proposals submitted to NMED in June of 1995.

If you have any questions, please contact John Gould at (505) 845-6089, or Mark Jackson at (505) 845-6288.

Sincerely,

Michael J. Zamorski
Acting Area Manager

Enclosure

cc w/enclosure:
T. Trujillo, AL, ERD
W. Cox, SNL, MS 1147
N. Weber, NMED-AIP
R. Kern, NMED-AIP
D. Neleigh, EPA, Region 6 (2 copies)

cc w/o enclosure:
B. Oms, KAO-AIP
E. Krauss, SNL, MS 0141
B. Hoditschek, NMED
S. Dinwiddie, NMED

OCT 21 1996

RESPONSES TO NMED TECHNICAL COMMENTS ON NO FURTHER ACTION PROPOSALS DATED JUNE 1995

GENERAL TECHNICAL COMMENTS

1. **Please provide a Table of Contents so that the individual sites and their order of discussion can be more readily tracked.**

   Response: A Table of Contents is provided with each No Further Action Proposal submission sent to the regulators.

2. **Information sources are listed for individual proposals within the section Sources of Supporting Information. Although the information sources might be useful for evaluation of the proposals, it is generally difficult to match the information source the referenced document. Information sources should be referenced.**

   Response: Citations in text to the references cited will be provided in future NFA proposals submissions and resubmissions.

3. **The background soil sampling results should be submitted for NMED review.**

   Response: A Site-Wide statistical study for determining the background concentrations of metals and radionuclides in soil and water at Sandia National Laboratories/New Mexico and Kirtland Air Force Base has been recently completed and submitted to NMED in March 1996 (IT, 1996). These new background values were used to replace values provided for specific NFA proposals in this response.

4. **Concerns exist over the sampling of the "septic system" solid waste management units (SWMUs). NMED believes the soil borings for drywells, seepage pits, or drain fields are inadequate. The proposal states that soil borings/samples were taken near the units (within 10 feet), but not underneath them. A sampling plan must be established to investigate underneath the seepage pits, drywells, or drain fields. Also, samples taken underneath the septic pipes/drain pipes need to be taken deeper than 3 feet.**

   Response: See Response to Site-Specific Technical Comment #1 below.

15. Site 231, OU 1309, Storm Drain Outfall Site

a. Comments a, b, d, and e for Site 230 are pertinent to Site 231. [a] NMED understands that Site 230 received industrial effluent and storm water from Technical Area 4 from 1984 to 1991. Currently, the outfall discharges only storm water. The rate and volume of discharge are unknown. Potential contaminants of concern at Site 233 include metals, VOCs, and SVOCs. NMED is concerned that no specifics are provided as to the kinds and quantities of wastes managed via outfall discharges. Waste generation records and process knowledge might be used to better suggest what kinds and quantities of contaminants may have been released to the environment. [b] A maximum sampling depth of 6 to 36 inches may be inadequate to detect any contaminants of concern. Additionally, please explain why samples were potentially composited over as much as 30 inches? Why are actual sample depths not reported? [d] Method detection limits are not provided in Table 1 and Appendix B. [e] How was industrial effluent introduced into the drainage system that connected to the outfall. Are there pipes connected to the drainage system and/or outfall? Please provide construction plans (preferably "as built") of the entire drainage system.

Response: SNL/NM has compiled additional historical and process data to reduce the misunderstanding that has previously surrounded ER Site 231 (Attachment C). This outfall has only received storm water from TA-IV. No industrial waste streams has ever entered the outfall. Waste generation records are not relevant for ER Site 231 because the outfall receives storm water. The purpose of the outfall system is to mitigate soil erosion on the steep slope east of TA-IV. No process or waste waters flow into the outfall; such fluids are directed to the sanitary sewer system or two evaporative lagoons (Attachment C). Discharges of storm water at SNL/NM are monitored by a Storm Water Program that follows NPDES guidance. Discharge of storm water from the outfall only occurs several days per year.

In the June 1995 NFA Proposal, the potential COCs were considered to be chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, diesel fuel, and mineral oil. This list of COCs was conservatively based upon chemicals used at TA-IV. However, no releases are known to have occurred in the area that drains to the ER Site 231 outfall. Likewise, no stained soil or stressed vegetation has been documented at the site. Additional historical, regulatory compliance, and process information for TA-IV has been recently gathered and is discussed in Attachment C.

Since about 1984, the ER Site 231 outfall has received storm water from the eastern portion of TA-IV. The ER Site 231 boundary contains a 3- to 22-ft wide, unpaved area that surrounds the headwall and the 110-ft long concrete drainage ditch (Figures 1 and 2). A single catch basin on the east side of TA-IV collects storm water from a paved storage yard that contains wooden and metallic test articles. The catch basin is plumbed to a headwall that contains the outfall pipe (Figure 3 - SNL/NM Engineering Sheet UAD-G13).

SNL/NM believes that the sampling interval was appropriate at the ER Site 231 outfall. Soil samples were collected at the headwall and associated drainage ditch where the potential for contamination was greatest. SNL/NM believes that some trace of contamination would be found in the surface or shallow subsurface soils if a significant deeper problem existed. The analytical methodology incorporated part-per-billion detection limits (Attachment A). Soil samples were composited for sampling simplicity due to the homogeneous nature of the soil. Each shallow sample was composited using soil from a depth interval of 0 - 6 inches. The samples shown in Table 4 with identification numbers that end in an "A" represent "shallow" soil (0 - 6 inches) samples. The mention of the subsurface-soil sampling interval being 6 - 36 inches is misleading. The subsurface-soil sampling interval was either 6 - 30 inches or 6 - 36 inches, depending of the analytes of interest. For convenience sake, the sampling interval for all subsurface-soil samples was standardized on the sample collection logs as 6 - 36 inches. The samples shown in Table 4 with identification numbers that end in an end in a "B" represent these "subsurface" samples. The sampling procedures are discussed in greater detail in Appendix A of the June 1995 *Proposal for NFA - Site 231.*

Method detection limits are listed in Attachment A of this response.

b. Soil/sediment samples should be collected from boreholes drilled along the alignment of the outfall and analyzed for constituents determined from process knowledge and waste disposal records.

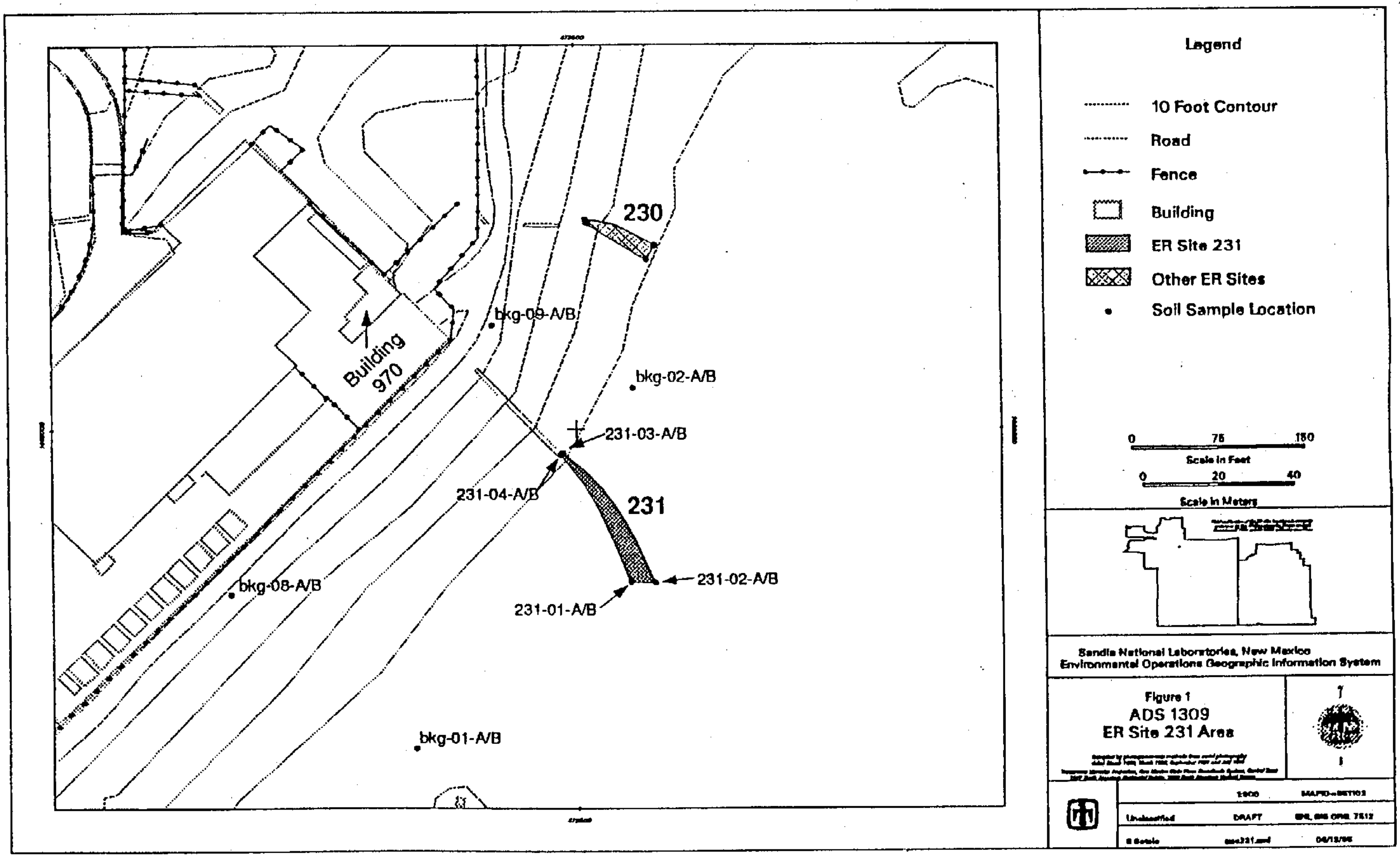


Figure 1
ADS 1309
ER Site 231 Area

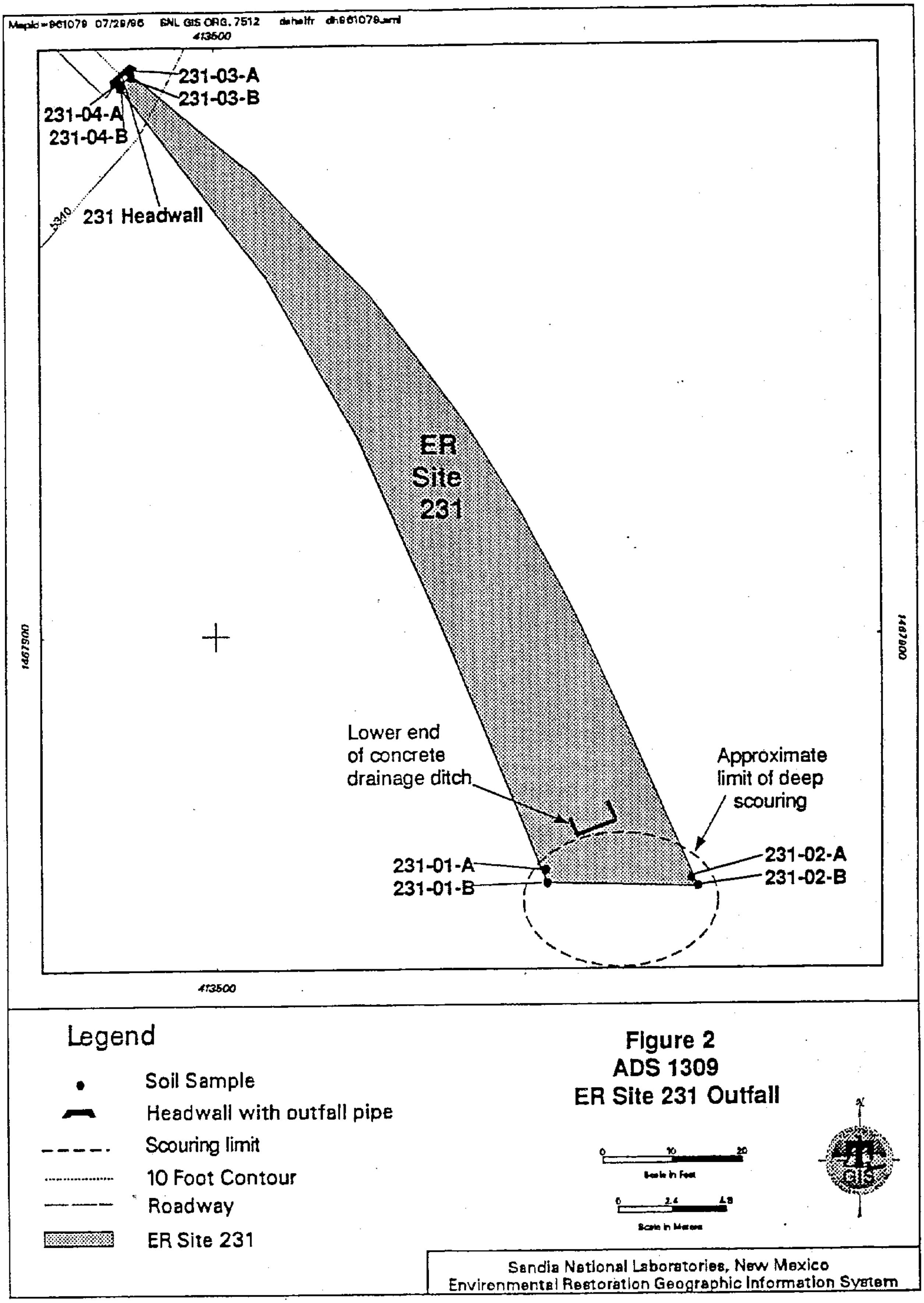


Figure 2
ADS 1309
ER Site 231 Outfall

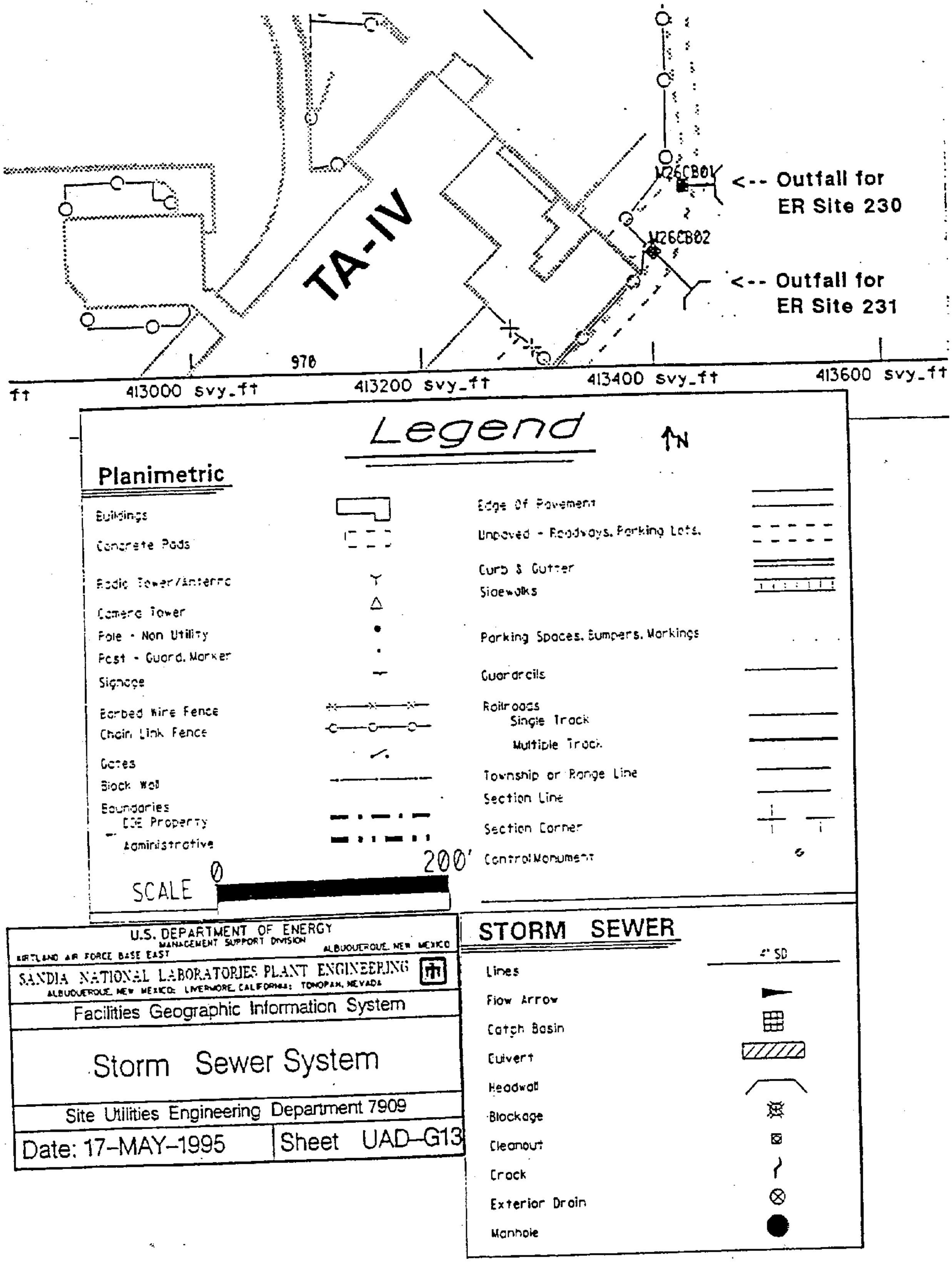


Figure 3. TA-IV storm-water system at ER Site 231. [Excerpt of SNL/NM Engineering Sheet UAD-G13; the ER site labels were added by the SNL/NM ER Project.]

Response: For five reasons, SNL/NM does not agree that additional soil sampling is necessary. (1) No releases have occurred in the area that drains to the outfall. (2) The outfall is constructed of reinforced concrete and has no stains. (3) The slope of the ditch is so great, about 30 degrees, that storm water is unlikely to have ever flowed over the sides (alignment) of the 110-ft long, concrete ditch. (4) No scouring of soil is evident along the sides (alignment) of the ditch. (5) No contaminants are present in the soil at the base of the ditch. SNL/NM believes that the lack of significant shallow soil contamination at the most likely release site is sufficient for a NFA decision.

c. Comment e for Site 227 is pertinent to Site 231. [NMED has some concerns regarding the sampling performed at these SWMUs. Since these SWMUs have been releasing waste water for at least 15 years, NMED is concerned that no evidence of contamination was found in the soil or other media. NMED believes that the following additional work should be performed:]

c-1. A soil gas survey should be performed near the outfall areas/drainage channel.

Response: The outfall has only received storm water, not waste water. The lack of contamination is not surprising because no chemical releases have occurred in the area that drains to the outfall.

Soil-vapor (gas) samples were not collected because the location of the outfall was visible and the storm water is not suspected to contain VOCs (Figure 2). As a cost-effective field-screening tool, SNL/NM has used soil-vapor sampling at other ER sites where the locations of release sites are not well known or the sampling area is large. SNL/NM believes that the quantitative analytical data for the soil samples is more useful than qualitative soil-vapor data.

c-2. Deeper soil samples (minimum 20 ft.) should be collected in the outfall areas/drainage channel. Locations may be based upon the soil gas survey results.

Response: SNL/NM asserts that the eight soil samples were appropriately located (Figure 2). Four soil samples (231-01-A, 231-01-B, 231-02-A, 231-02-B) were collected at the headwall; two of the samples were collected on each side and about one ft downstream of the outfall pipe. An additional four samples (231-03-A, 231-03-B, 231-04-A, and 231-04-B) were collected at the furthest extent of visible erosion and scour. The tail of the ditch is approximate 10 ft lower in elevation than the outfall. All soil samples were collected at depths ranging from of 0 to 36 inches.

c-3. Additional samples should be collected at the outfall areas/drainage areas that received the waste. NMED questions whether the soil sampling locations originally chosen actually received wastes.

Response: SNL/NM asserts that the soil samples were appropriately located at the ER Site 231 outfall (Figure 2). Four soil samples were collected at the headwall; two of the samples were collected on each side and about one ft downstream of the outfall pipe. An additional four samples were collected at the furthest extent of visible erosion and scour.

The analytical results that were previously presented in the June 1995 *Proposal for NFA - Site 231* as Table 1 and Appendix B have been reorganized in this NOD response. The following section discusses the concentrations and potential risks of contaminants in soil at ER Site 231.

d. RECOMMENDATION: Based upon site concerns, including the lack of adequate sampling and inadequate information about the quantities of discharges and system construction, NMED considers that NFA is not currently appropriate for Site 231. Additionally, if any possible contamination from TA-2 might have entered the Site 231 drainage system, then soils sampling/analysis should also include nitrates, explosives, and radionuclides.

Response: No storm water or waste water from TA-II has discharged into the ER Site 231 outfall. Soil samples have been collected and analyzed for all relevant COCs associated with TA-IV. SNL/NM believes that the lack of significant shallow soil contamination at the most likely release site is sufficient for a NFA decision. The discussion immediately below reemphasizes the position that no additional sampling is necessary.

SNL/NM Analytical Data Summary for ER Site 231

Introduction

Since the submission of the June 1995 *Proposal for NFA - Site 231,* three significant approaches have been employed by the SNL/NM ER Project for evaluating the potential impact of contaminants upon human health. First, a site-wide (the KAFB and SNL/NM area) statistical study has been recently completed for determining the background concentrations of metals and radionuclides in soil and water (IT, 1996). These new background values are listed in Attachment I and have been through a more rigorous statistical analysis and therefore replace the values that were used in the June 1995 NFA proposals. Second, the Tijeras Arroyo background values in Attachment I have been recalculated using U.S. EPA guidance (EPA, 1989; EPA, 1992a; EPA, 1992b). Third, a standardized risk-assessment approach has been implemented by SNL/NM with U.S. EPA Region VI acceptance. These three approaches and the screening of regulatory standards have been incorporated in the ER Site 231 risk assessment that is presented in Attachment I. Elevated metals and other non-radioactive constituents were evaluated using U.S. EPA guidance (EPA, 1989; EPA, 1991). Radionuclides that exceeded background were evaluated using DOE guidance and the RESRAD computer code for residual radioactive material (ORNL, 1994).

Background Concentrations

As part of the site-wide study, background concentrations were calculated for both the surface and subsurface soils of the North Super Group, which is defined as soils present in TA-I, TA-II, TA-IV, the northern rim of Tijeras Arroyo, and the northeastern portion of KAFB (IT, 1996). The depth of six inches was used for defining surface soil from subsurface soil. Two background concentrations are therefore listed for most of the metals and radionuclides in Tables 5 and 6. The background concentrations consist of either Upper Tolerance Limits (UTLs) or 95th Percentiles. An UTL was calculated for those COCs with normal or lognormal distributions; the 95th percentile was calculated for those COCs with nonparametric distributions.

Quality Assurance / Quality Control

The analytical results that were previously presented in the June 1995 *Proposal for NFA - Site 231* as Table 1 and Appendix B have been reorganized in this NOD response to incorporate the three new approaches. To prevent confusion, the reorganized analytical data are presented herein as Tables 4, 5, and 6. The tables present the maximum concentrations for each detected analyte. The tables present the maximum concentrations for each detected analyte as reported by the two, CLP-certified, offsite analytical laboratories (the Quanterra Environmental Services - St. Louis Laboratory and the ENCOTEC - Ann Arbor laboratory). The actual laboratory reports are available for review at the ER Project Records Center in Building 6584.

Attachment A lists the analytical methods and detection limits that were used in the Tijeras Arroyo OU sampling program. Quality Assurance (QA) samples, including field duplicates, trip blanks and rinsate samples, also were collected as

Table 4. All reported concentrations of VOCs and SVOCs in ER Site 231 soil samples.

Sample Identifier[1]	Analyte	Type	Detection Limit (mg/kg, ppm)	Reported Concentration (mg/kg, ppm)	Qualifier
231-03-B	Acetone	VOC[2]	0.010	0.008	J[3]
231-01-B	2-butanone	VOC	0.010	0.004	B[4]J
231-02-B	2-butanone	VOC	0.010	0.004	BJ
231-03-B	2-butanone	VOC	0.010	0.005	BJ
231-04-B	2-butanone	VOC	0.010	0.005	BJ

[1]Sample identifier: First set of numbers denotes ER Site, second set of numbers denotes sample location, letter designator denotes sample depth (A denotes sample depth of 0 - 6 inches; B denotes sample depth of 6 - 30 or 6 - 36 inches).
[2]VOC = Volatile organic compound (EPA Method 8240).
[3]J = Qualifier denotes that the analyte was reported at below the laboratory detection limit.
[4]B = Qualifier denotes that the analyte was measured in the associated blank sample.

Table 5. Comparison of maximum concentrations in ER Site 231 soil versus Proposed Subpart S action levels and background UTLs and 95th Percentiles for North Super Group surface and subsurface soils.

Analyte	Maximum concentration in ER Site 231 soil (mg/kg, ppm)	Proposed Subpart S and Lead action levels (mg/kg, ppm) (EPA, 1990;EPA, 1994)	Surface soil UTL (mg/kg, ppm) (IT, 1996)	Surface soil 95th Percentile (mg/kg, ppm) (IT, 1996)	Subsurface soil UTL (mg/kg, ppm) (IT, 1996)	Subsurface soil 95th Percentile (mg/kg, ppm) (IT, 1996)
Metals						
Aluminum (Al)	6,200.0	n.s.[1]	n.c.[2]	n.c.	n.c.	n.c.
Antinomy (Sb)	11.0	30.0	n.a.[3]	3.9	n.a.	3.9
Arsenic (As)	6.0	80.0	n.a.	5.6	n.a.	4.4
Barium (Ba)	240.0	4,000.0	n.a.	200.0	n.a.	336.0
Beryllium (Be)	0.4	0.2	n.a.	0.8	n.a.	0.8
Cadmium (Cd)	1.7	40.0	n.a.	1.6	n.a.	0.9
Calcium (Ca)	78,000.0	n.s.	n.c.	n.c.	n.c.	n.c.
Chromium (Cr)-total	5.9	n.s.	n.a.	17.3	n.a.	12.8
Chromium-VI (Cr+6)	1.6	400.0	n.c.	n.c.	n.c.	n.c.
Cobalt (Co)	4.9	n.s.	n.a.	7.1	n.a.	8.8
Copper (Cu)	29.0	n.s.	n.a.	25.5	n.a.	88.2
Iron (Fe)	9,900.0	n.s.	n.c.	n.c.	n.c.	n.c.
Lead (Pb)	11.0	400.0.	68.0	n.a.	n.a.	11.2
Magnesium (Mg)	4,200.0	n.s.	n.c.	n.c.	n.c.	n.c.
Manganese (Mn)	280.0	n.s.	n.c.	n.c.	n.c.	n.c.
Mercury (Hg)	<0.04	20.0	n.a.	0.31	n.a.	<0.1
Nickel (Ni)	8.7	2,000.0	n.a.	25.4	n.a.	25.4
Potassium (K)	2,600.0	n.s.	n.c.	n.c.	n.c.	n.c.
Selenium (Se)	<0.25	n.s.	n.a.	<1.0	n.a.	<1.0
Silver (Ag)	<0.5	200.0	n.a.	2.0	n.a.	<1.0
Sodium (Na)	740.0	n.s.	n.c.	n.c.	n.c.	n.c.
Thallium (Tl)	<0.50	n.s.	n.a.	<1.1	n.a.	<1.1
Vanadium (V)	16.0	n.s.	47.2	n.a.	n.a.	42.8
Zinc (Zn)	130.0	n.s.	n.a.	82.4	n.a.	82.4
Miscellaneous						
TPH	130.0	n.s.	n.c.	n.c.	n.c.	n.c.

[1] n.s. = not specified.
[2] n.c. = not calculated. The analyte is not a COC for SNL or KAFB (IT, 1996).
[3] n.a. = not applicable. The UTL is provided for those COCs with normal or lognormal distributions; the 95th percentile is provided for those COCs with nonparametric distributions.

Table 6. Comparison of all reported maximum radionuclide activities in ER Site 231 soil versus background UTLs and 95th Percentiles for SNL North Area Group surface and subsurface soils.

Radionuclide	Maximum activity in ER Site 231 soil (pCi/g)	Surface soil UTL (pCi/g) (IT, 1996)	Surface soil 95th Percentile (pCi/g) (IT, 1996)	Subsurface soil UTL (pCi/g) (IT, 1996)	Subsurface soil 95th Percentile (pCi/g) (IT, 1996)
Plutonium-238	<0.011	n.c.[1]	n.c.	n.c.	n.c.
Plutonium-239/240	<0.008	n.c.	n.c.	n.c.	n.c.
Tritium	<0.035	n.c.	n.c.	n.c.	n.c.
Uranium-234	1.03	1.6	n.a.	1.6	n.a.
Uranium-235/236	0.39	n.a.	0.18	n.a.	0.18
Uranium-238	0.42	n.a.	1.3	n.a.	1.3

[1]n.c. = not calculated. The analyte is not a COC at SNL or KAFB (IT, 1996).
[2]n.a. = not applicable. The UTL is provided for those COCs with normal or lognormal distributions; the 95th percentile is provided for those COCs with nonparametric distributions.

part of the Tijeras Arroyo OU site-sampling program. The QA results demonstrated the effectiveness of the decontamination procedures (Appendix B - June 1995 *Proposal for NFA - Site 231*). Eleven QA-field duplicates were collected for the soil samples (Attachment B). Relative percent difference (RPD) values were calculated for the metals, nitrate/nitrite, and radionuclides. The lack of detectable VOCs, SVOCs, and HE compounds did not allow RPDs to be calculated for those compounds. Of the 111 detectable metal and nitrate/nitrite concentrations, 85% of the RPDs were below the EPA-recommended target of 35%. Fifteen percent of the remaining RPDs were above the 35% target and probably are a function of the soil heterogeneity rather than a systematic error in sampling or analytical procedures. Of the nine detectable radionuclide activities, six were above the EPA-recommended target of 35%. However, the use of RPDs to evaluate the radionuclides values does not appear to be realistic because the activities were less than one pCi/g. Such low activities are well below background and are reported with relatively large 2-sigma errors. For example, U-235/236 was reported at 0.023 pCi/g with a 2-sigma error of 0.018 pCi/g. With a 95% confidence interval, the U-235/236 activity is in the range of 0.005 to 0.041 pCi/g and could therefore actually be below the minimum detectable activity (MDA) of 0.009 pCi/g. Soil heterogeneity could also account for the range of RPD values for the radionuclides. To conclude, the RPD values indicate that both the metal, nitrate/nitrite, and radionuclide analyses are of sufficient precision for preparing this NOD response.

Table 4 is the most detailed table and contains the maximum concentrations as well as all reported concentrations, including 'J' and 'B' values, for VOCs and SVOCs. Table 5 compares the maximum concentrations of metals, cyanide, and nitrate/nitrite (NO2+NO3) in ER Site 231 soil versus the Proposed Subpart S action levels (EPA, 1990) and the newly available background values (IT, 1996). Table 6 compares the maximum radionuclide activities in ER Site 231 soil versus the background UTLs and 95th Percentiles.

No VOC or SVOC contamination was detected in the ER Site 231 soil samples. Two organic compounds were reported with qualification. The 2-butanone concentrations ranged from 0.004 to 0.005 mg/kg (ppm). However, all the reported concentrations had both 'J' and 'B' qualifiers as being below the laboratory reporting limit, and being detected in the associated blank sample, respectively. The acetone concentration of 0.008 mg/kg (ppm) was a 'J' value. Both 2-butanone and acetone are common laboratory contaminants (Bleyler, 1988). The reporting of four TPH detections at concentrations ranging from 44 to 130 mg/kg (ppm) is considered suspect because no VOCs or SVOCs were detected.

ATTACHMENT C

ATTACHMENT C

RELEVANT ENVIRONMENTAL ASPECTS OF TA-IV

Attachment C -
Relevant Environmental Aspects of TA-IV

Since submittal of the Tijeras Arroyo Operable Unit NFA Proposals in June 1995, SNL has collected additional historical, regulatory compliance, and process information for Technical Area IV (TA-IV). In April 1996, the *Environmental Assessment for Operation, Upgrades, and Modifications in SNL/NM Technical Area IV* was submitted to various agencies (SNL/NM, 1996). SNL Organization 9300, the Applied Physics, Engineering, and Testing Center, operates TA-IV. With research operation beginning in 1980, TA-IV is the newest SNL technical area and has always operated using modern environmental, safety, and health procedures and considerations. Approximately 750 people work at the 83 acre facility. The principal mission for TA-IV is the research, development, and testing of pulsed power technology. Other activities include computer science, flight dynamics, satellite processing, and robotics. Major facilities include the SATURN x-ray facility, the High Energy Radiation Megavolt Electron Source-III (HERMES-III) gamma-ray facility, and the Particle Beam Fusion Accelerator-II (PBFA-II). Other smaller facilities include the Rocket Systems and Flight Dynamic Laboratory, the Payload and Satellite Processing Facility, the parallel Computing Science Laboratory, the Robotics Laboratory, and seven small accelerators.

Biological resources were evaluated before the construction of various TA-IV buildings was begun. An *Environmental Assessment for Operation, Upgrades, and Modifications in SNL/NM Technical Area IV* be was submitted to various agencies in 1996 (SNL/NM, 1996). This evaluation of biological resources at TA-IV is relevant for ten of the ER Sites (sites 46, 50, 77, 227, 229, 230, 231, 233, 234, and 235). These ten sites are located along the northern rim of Tijeras Arroyo in the vicinity of TA-I, TA-II, TA-IV, Pennsylvania Avenue, a Skeet Range, KAFB Landfill 8, and the Albuquerque International Airport. No undisturbed natural habitat remains in the vicinity of TA-IV. Vegetation is limited to scattered ruderal plants and a row of ornamental ash trees. Sufficient food, water, and cover are not available to support wildlife. No federally-listed endangered or threatened species (plants or animals) or state-listed endangered wildlife species (Group 1 or Group 2) are known to occur within the vicinity of TA-IV, based on two biological surveys performed by IT Corporation in 1995 for the SNL/NM Environmental Restoration Project (IT, 1995). No natural lakes or wetlands are present and all drainage flows are intermittent, occurring during periods of precipitation. The Environmental Assessment report concluded that additional building construction would have no impact on biological resources.

Air monitoring is routinely conducted at TA-IV when the various accelerators are operating. The HERMES-III, PBFA-II, and SABRE accelerators generate short-lived nitrogen-13 and oxygen-15 radioactive air emissions but are in amounts million of times smaller than Clear Air Act standards (SNL/NM, 1995c). The half-lives for nitrogen-13 and oxygen-15 are 10 minutes and 2 minutes, respectively. The SATURN accelerator has historically released tritium, but the dose was at such a low level that the source was exempted from the National Emission Standards for Hazardous Air Pollutants (NESHAP) permit requirement.

No ER sites are located within TA-IV. Likewise, no septic tanks have been used at TA-IV. However, 21 aboveground and underground storage tanks (USTs) have been used, primarily for storing dielectric oil. Only above storage tanks (ASTs) are still in use at TA-IV. These 20 tanks store dielectric oil, acid, caustic, and deionized water. No USTs are currently registered with the NMED. A fuel-oil UST (970-1) was removed in 1994; no soil contamination was present.

The Storm Water Program in the SNL/NM Compliance and Generator Interface Department is responsible for measuring and reporting storm-water quality associated with storm-water outfalls located across SNL/NM. The storm-water results are reported annually in the Site Environmental Report (SNL/NM, 1995c). In accordance with National Pollutant Discharge Elimination System (NPDES) requirements, SNL/NM submitted an *Application For Permit to Discharge Stormwater - Discharges Associated with Industrial Activity* to U.S. EPA Region VI in 1992 (SNL/NM, 1992). Due to workload constraints, the U.S. EPA has not acted on the permit. In 1996, SNL/NM will submit a multi-sector permit to the U.S. EPA for their approval with State of New Mexico review and concurrence.

The Storm Drain System Outfall known as ER Site 235 is located about 500 ft southwest of TA-IV on the northern rim of Tijeras Arroyo near the Pennsylvania Avenue bridge. The site consists of a flood-control channel that extends for about 1,500 ft below a concrete baffle chute (energy dissipator). A storm-water monitoring station is located at the upper end of the baffle chute and is designated as Outfall 5 in the NPDES application (SNL, 1992). Sporadic storm water from the northeastern part of Kirtland Air Force Base (KAFB), including SNL Technical Areas I and IV, flows through the baffle chute and the channel before reaching Tijeras Arroyo. The outfall drains approximately 475 acres of which 65% is an impervious surface (SNL, 1996). Figures in the NOD response for ER Site 235 show the watershed. The SNL/NM Storm Water Program collected water samples from Outfall 5 on July 23, 1992, August 6, 1992, and May 25, 1994. Composite and grab samples were analyzed for total metals, general inorganics, and various other parameters. Since the NPDES application has not been reviewed by the U.S. EPA, the water samples have been compared to the most stringent standards available (Federal drinking water standards). Except for manganese and coliform, the quality of the storm water was better than the Federal standards (Tables C-1 and C-2). Manganese was reported at 0.13 mg/L (ppm) which is slightly above the Secondary Maximum Contaminant Level (SMCL) of 0.05 mg/L (ppm). However, the metal analyses were total values, not the dissolved values which are typically compared to drinking water standards. The presence of coliform at 2,000 colonies per 100 mL of water most likely reflects transient wildlife. Water samples were not collected in 1993 or 1995 because of insufficient precipitation.

In the June 1995 NFA Proposal, the SNL/NM ER project considered the potential COCs in soil at ER Site 235 to be: chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, diesel fuel, and mineral oil. Both radiation and unexploded ordnance (UXO) field surveys have been conducted at ER Site 235; no anomalies were detected.

No stained soil or stressed vegetation has been documented at the site. The SNL/NM ER project collected soil samples along the drainage ditch in the Fall of 1994; the results are discussed in the NOD Response.

Five other outfalls (ER Sites 230, 231, 232, 233, and 234) are located along the steep, Tijeras Arroyo northern rim at the eastern and southern edges of TA-IV. The purpose of the TA-IV outfalls is to reduce the amount of soil erosion caused by storm water. Discharge of storm water only occurs several days per year. During the period of April 7 to December 31, 1995, an automatic flow meter recorded storm-water flows on ten different days. Engineering drawings for the TA-IV storm-water and sanitary-sewer systems are presented in the NOD responses for ER Sites 230, 231, 233, and 234. No process or waste waters flow into the outfalls. Such fluids are directed to the sanitary sewer system or two evaporative lagoons.

The five TA-IV outfalls were added to the ER site list in 1993. However, only one of the sites has been involved in the spill or release of a Reportable Quantity (SNL, 1995b). The sole incident occurred in 1994 when mineral oil was spilled at ER Site 232. The contaminated soil was subsequently removed for off-site disposal. A NFA proposal for ER Site 232 will be submitted to NMED in late 1996.

In the June 1995 NFA Proposals, the SNL/NM ER project considered the potential COCs in soil at ER Sites 230, 231, 233, and 234 to be: chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, diesel fuel, petroleum products, and mineral oil. Both radiation and unexploded ordnance (UXO) field surveys have been conducted at each site; no anomalies were detected. No stained soil or stressed vegetation has been documented at any of the sites. The SNL/NM ER project collected soil samples at each site in the Fall of 1994; the results are discussed in the respective NOD Responses.

Outfall 6 is a catch basin that is located about 50 ft upslope of ER Site 233. According to NPDES guidance, only one of the TA-IV outfalls requires monitoring because all the TA-IV outfalls receive storm water from similar sources (Fink, 1996). Due to infrequent precipitation and the lack of an automatic sampler, only two water samples (July 31 and September 15, 1992) have been collected at Outfall 6. Except for manganese and coliform, the quality of storm water was better than the Federal standards for drinking water (Table C-3). Manganese was reported at 0.24 mg/L (ppm) which is slightly above the Secondary Maximum Contaminant Level (SMCL) of 0.05 mg/L (ppm). However, the metal analyses were total values, not the dissolved values which are typically compared to drinking water standards. The presence of coliform at 4,000 colonies per 100 mL of water most likely reflects transient wildlife.

Two evaporative lagoons (impoundments) are located at TA-IV and both serve similar functions. The primary purpose of the two lagoons is to store surface-water runoff from precipitation that collects in the sumps of the outdoor transformer-oil tank farm spill-containment areas (SNL/NM, 1995b). Both lagoons are lined with synthetic geotextile membranes. Surface-water runoff is pumped to the lagoons by manually operated sump pumps. If visible oil is present in the sumps, a manually operated skimmer is used to transfer the skimmed oil to an oil storage tank. Lagoon #1 (ER Site 77) is located to the south of TA-IV and also receives non-routine water and transformer oil spills from floor trenches in Buildings 981 and 983. The capacity of Lagoon #1 is 137,000 gallons. Lagoon #2 is located in the eastern section of TA-IV and also receives non-routine water and transformer oil spills from floor trenches in Building 970. The capacity of Lagoon #2 is 127,000 gallons.

Operation of the two lagoons is the responsibility of SNL/NM Organization 9300 with oversight by the Water Quality Program in SNL/NM Organization 7500. The lagoons are regulated by NMED under 'Surface Water Discharge Plan 530' (DP-530). The Water Quality Program conducts semiannual inspections that include the measurement of the water levels and the collection of water samples. To date, water has not overflowed onto the ground surface. The water is analyzed for major ions, total dissolved solids (TDS), volatile organics, and extractable organics. Water quality results have not necessitated the pumping of the water for off-site disposal. NMED inspected the surface impoundments twice during 1995; no deficiencies were noted. The SNL/NM Water Quality Program submits a lagoon-monitoring report to NMED on a semiannual basis. The report includes water level measurements and analytical data.

References

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Sandia National Laboratories / New Mexico (1995a), *Technical Area I (ADS 1302) RCRA Facility Investigation Work Plan,* February 1995, Plate 5-11: ER Site 226, Acid Waste Line, Southern Section Showing Breaks Identified By Camera Survey And Proposed Sampling Locations.

Sandia National Laboratories / New Mexico (1995b), *State of New Mexico Environmental Department Discharge DP-530 Lagoon Discharge Report,* Sandia National Laboratories, New Mexico.

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Table C-1. Comparison of Federal drinking water standards to maximum concentrations present in storm-water samples collected at NPDES Outfall 5 (ER Site 235) on July 23 and August 6, 1992 (SNL/NM, 1992).

Analyte	Maximum concentration of flow-weighted composite samples, mg/L (ppm)	Lowest MCL, MCLG, or SMCL, mg/L (ppm)	EPA method
Arsenic, total	0.0059	0.050	206.2
Barium, total	0.22	2.0	200.7
Cadmium, total	<0.0050	0.005	213.2
Chromium, total	<0.010	0.1	218.2
Copper, total	0.034	1.0	200.7
Lead, total	0.014	0.015	239.2
Manganese, total	0.13	0.05	200.7
Mercury, total	<0.00020	0.002	245.1
Nickel, total	<0.040	0.1	200.7
Selenium, total	<0.0050	0.05	270.2
Silver, total	<0.010	0.1	200.7
Zinc, total	0.18	5.0	200.7
BOD	11.0	n.s.	405.1
COD	87.9	n.s.	410.0
Cyanide	<0.010	n.s.	335.2
Fluoride	0.21	2.0	340.2
Gross Alpha	0±20 pCi/L	0 pCi/L	900.0/7110B
Gross Beta	10±20 pCi/L	0 mrem	900.0/7110B
HPLC Explosives	<0.032	0.0032	8330
Nitrate + Nitrite	0.76	10.0	353.2
Oil and Grease	<1.0	n.s.	413
Orthophosphate	0.18	n.s.	614
PCBs	<0.005	0.005	8080
Phenolics	0.016	n.s.	8040
Phosphorous as P	0.24	n.s.	365.3
Residual Chlorine	<0.20	n.s.	330
SVOCs	<0.085	0.085	8270
TDS	146.0	250.0	160.1
TKN	1.4	n.s.	351
Total Coliform	2,000 cl/100mL	0 cl/100mL	9230
TSS	221.0	n.s.	160.2
Volatile Organics	<0.005	n.s.	8240

Table C-2. Comparison of Federal drinking water standards to concentrations of total metals and general inorganics in storm-water samples collected at NPDES Outfall 5 (ER Site 235) on May 25, 1994.

Analyte	Composite sample concentration, mg/L (ppm)	Grab sample concentration, mg/L (ppm)	Lowest MCL, MCLG, or SMCL, mg/L (ppm)	EPA method
Antimony, total	<0.060	<0.060	0.006	200.7
Arsenic, total	0.0033	<0.010	0.050	206.2
Beryllium, total	<0.0020	<0.0020	0.004	200.7
Cadmium, total	0.00076	0.0010	0.005	213.2
Chromium, total	0.0031	0.0044	0.1	218.2
Copper, total	0.0078	0.014	1.0	200.7
Lead, total	0.014	0.026	0.015	239.2
Mercury, total	<0.00020	<0.00020	0.002	245.1
Nickel, total	<0.040	<0.040	0.1	200.7
Selenium, total	<0.0050	<0.0050	0.05	270.2
Silver, total	<0.010	<0.010	0.1	200.7
Zinc, total	0.066	0.17	5.0	200.7
Alkalinity, total	57.2	46.2	n.s.	310.1
Ammonia as N	0.14	0.18	n.s.	350.1
Chloride	1.9	2.5	250.0	300.0
Fluoride	0.20	0.17	2.0	340.2
Nitrate + Nitrite	0.33	0.33	10.0	353.2
Phosphorous as P	0.25	0.36	n.s.	365.3
Sulfate	4.9	4.2	250.0	300.0
TDS	202.0	106.0	500.0	160.1
TSS	255.0	310.0	n.s.	160.2

All water analyses performed by the Quanterra Environmental Services, Inc. laboratory.
BOD = Biochemical Oxygen Demand
cl/mL = colonies per 100 milliliter of water
COD = Chemical Oxygen Demand
Drinking Water Standards: MCL = Maximum Contaminant Level; MCLG = Maximum Contaminant Level Goal; SMCL = Secondary Maximum Contaminant Level, (EPA, 1996). The lead value is an action level.
HPLC = High Performance Liquid Chromatography
mg/L = milligrams per liter = parts per million (ppm)
mrem = millirem
n.s. = not specified (U.S. EPA, 1996)
pCi/L = picocuries per liter
PCBs = Polychlorinated Biphenyls
TDS = Total Dissolved Solids
TKN = Total Kjedahl Nitrogen
TSS = Total Suspended Solids
VOCs = Volatile Organic Compounds. The reported concentrations of VOCs (2-hexanone at 0.011 mg/L (ppm), 2-butanone at 0.046 mg/L (ppm), and acetone at 0.0723 and 0.110 mg/L (ppm) are considered suspect because all three VOCs are common laboratory contaminants (Bleyler, 1988).

Table C-3. Comparison of Federal drinking water standards to maximum concentrations present in storm-water samples collected at NPDES Outfall 6 (catch basin above ER Site 233) on July 31 and September 15, 1992 (SNL/NM, 1992).

Analyte	Maximum concentration of flow-weighted composite samples, mg/L (ppm)	Lowest MCL, MCLG, or SMCL, mg/L (ppm)	EPA method
Arsenic, total	<0.0050	0.050	206.2
Barium, total	0.099	2.0	200.7
Cadmium, total	<0.0050	0.005	213.2
Chromium, total	<0.010	0.1	218.2
Copper, total	0.025	1.0	200.7
Lead, total	0.0067	0.015	239.2
Manganese, total	0.24	0.05	200.7
Mercury, total	<0.00080	0.002	245.1
Nickel, total	<0.040	0.1	200.7
Selenium, total	<0.010	0.05	270.2
Silver, total	<0.010	0.1	200.7
Zinc, total	0.20	5.0	200.7
BOD	62.8	n.s.	405.1
COD	422.0	n.s.	410.0
Cyanide	<0.010	n.s.	335.2
Fluoride	0.17	2.0	340.2
Gross Alpha	1±6 pCi/L	0 pCi/L	900.0/7110B
Gross Beta	10±3 pCi/L	0 mrem	900.0/7110B
HPLC Explosives	<0.0032	0.0032	8330
Nitrate + Nitrite	2.7	10.0	353.2
Oil and Grease	3.2	n.s.	413
Orthophosphate	<0.050	n.s.	614
PCBs	<0.005	0.005	8080
Phenolics	0.048	n.s.	8040
Phosphorous as P	0.060	n.s.	365.3
Residual Chlorine	1.9	n.s.	330
SVOCs	<0.085	0.085	8270
TDS	440.0	250.0	160.1
TKN	5.8	n.s.	351
Total Coliform	4,000 cl/100mL	0 cl/100mL	9230
TSS	56.0	n.s.	160.2
Volatile Organics	<0.005	n.s.	8240

ATTACHMENT I

ATTACHMENT I

ER SITE 231 RISK ASSESSMENT ANALYSIS

ATTACHMENT I - ER SITE 231: RISK ASSESSMENT ANALYSIS

I. Site Description and History

The Storm Drain System Outfall known as ER Site 231 is located about 100 ft east of TA-IV on the northern rim of Tijeras Arroyo. The ER Site 231 boundary contains a 3- to 22-ft wide, unpaved area that surrounds the headwall and a 110-ft long concrete drainage ditch. Since the mid-1980s, storm water from a paved area of TA-IV has flowed into a single catch basin which is plumbed to a headwall with an outfall pipe. The catch basin collects storm water from a storage yard that contains wooden and metallic test articles. The purpose of the outfall system is to mitigate soil erosion on the steep slope east of TA-IV. No process or waste waters flow into the outfall; such fluids are directed to the sanitary sewer system or two evaporative lagoons. Potential constituents of concern (COCs) in soil at the outfall include chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, diesel fuel, and mineral oil. However, the COCs are solely based upon potential contaminants; no releases are known to have occurred in the area that drains to the ER Site 231 outfall. The list of COCs was conservatively based upon chemicals used at TA-IV. Both radiation and unexploded ordnance (UXO) field surveys have been conducted; no anomalies were detected. No stained soil or stressed vegetation has been documented at the site. Discharges of storm water at SNL/NM are monitored by a Storm Water Program that follows Federal and State regulatory requirements. Discharge of storm water from the outfall only occurs a few days per year.

II. Risk Assessment Analysis

Risk assessment of a site includes a number of steps which culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed in this section include:

Step 1.	Site data are described which provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations.
Step 4.	Data are described on the potential toxicity and cancer effects from exposure to the COCs and subsequent intake.
Step 5.	Potential toxicity effects (specified as a Hazard Index), cancer risks and radiation doses are calculated.

Step 6.	These values are compared with standards established by the USEPA and USDOE to determine if further evaluation, and potential site clean-up, is required.
Step 7.	Discussion of uncertainties in the previous steps.

II.1 Step 1. Site Data

Site history and site field characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration values of those COCs across the site are described in section SNL/NM Analytical Data Summary of the ER Site 231 NOD response. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment per USEPA 1989a. Both radioactive and nonradioactive COCs are evaluated. The nonradioactive chemicals are metals and organics.

II.2 Step 2. Pathway Identification

This site has been designated with a future land-use scenario of industrial (Attachment M). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion. The inhalation pathway for both chemicals and radionuclides is included because of the potential to inhale dust. Direct gamma exposure is also included in the radioactive contamination risk assessment. A groundwater pathway was not considered because no soil contamination was present in the sampling interval of 0 to 3 ft and the depth to groundwater is approximately 300 ft. Because of the lack of perennial surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered to not be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate.

PATHWAY IDENTIFICATION

Chemical Constituents	**Radionuclide Constituents**
Soil Ingestion	Soil Ingestion
Inhalation (Dust)	Inhalation (Dust and volatiles)
	Direct Gamma

II.3 Steps 3-5. Calculation of Hazard Indices and Cancer Risks

Steps 3 through 5 are discussed in this section. These steps include the discussion of the tiered approach in eliminating potential COCs from further consideration in the risk assessment process and the calculation of intakes from all identified exposure pathways, the discussion of the toxicity information, and the calculation of the hazard indices and cancer risks.

The risks from the COCs at ER Site 231 were evaluated using a tiered approach. First, the maximum concentrations of COCs for chemical constituents, were compared to Tijeras Arroyo background screening levels using 95th UTLs or percentile values. If a maximum concentration of a particular COC exceeded the Tijeras Arroyo specific background screening level or if the COC was a radioactive constituent, then the COC was compared to the SNL/NM Site-Wide background screening level (IT, 1996). The Site-Wide UTL chosen for comparison was the minimum value when comparing surface and subsurface UTL values. This procedure was implemented to ensure use of the most conservative value during the comparison process and due to uncertainties associated with some sample depths. The maximum concentration of each COC was used in order to also provide a conservative estimate of the associated risk. Those COCs that were below the background screening level were not considered in further risk assessment analyses.

Second, the remaining maximum concentrations were compared with action levels calculated using methods and equations promulgated in the proposed RCRA Subpart S (40 CFR Part 264, 1990) and Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989a) documentation. Accordingly, all calculations were based on the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface or near-surface, this assumption is considered valid. If there are 10 or fewer COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than 10 COCs, the proposed Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using Reasonable Maximum Exposure (RME) methods and equations promulgated in RAGS (USEPA, 1989a). The combined effects of all COCs in the soils that were above background concentration values were calculated. For toxic compounds, this was accomplished by summing the individual hazard quotients for each metal into a total Hazard Index. This Hazard Index is compared to the recommended standard of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended risk range of 10^{-4} to 10^{-6}. For the radioactive COCs, the cumulative dose was calculated and the corresponding excess cancer risk estimated.

II.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 231 COCs are listed in Table 1; radioactive COCs are listed in Table 2. Both tables show the 95th percentile or UTL background levels (IT, 1996). A background level for chromium VI was not available. Background levels for plutonium and tritium are not applicable because these radionuclides do not occur naturally, or due to fallout, at levels greater than typical detection limits of common laboratory instrumentation. Background concentrations have been recalculated for the Tijeras Arroyo background locations that were used in the June 1995 NFA proposals. The recalculated Tijeras Arroyo values were prepared using a more rigorous statistical approach according to USEPA guidance (USEPA, 1989b, 1992a, and 1992b). The Tijeras Arroyo background locations were not differentiated on the basis of depth because of the homogenous nature of the soil and the limited sampling depth of 0 to 36 inches. As part of the IT (1996) site-wide study, background concentrations were calculated for both the surface (0-6 inch depth) and subsurface (>6 inch depth) soils of the North Super Group, which is defined as soils present in TA-I, TA-II, TA-IV, the northern rim of Tijeras Arroyo, and the northeastern portion of KAFB. The Site-Wide background levels have not yet been approved by the USEPA or the NMED but are the result of a comprehensive study of joint Sandia and U.S. Air Force data from the Kirtland Air Force Base (KAFB). The report was submitted for regulatory review in early 1996. The values shown in Table 1 and Table 2 supersede the background values described in an interim background study report (IT, 1994). Several compounds have maximum measured values greater than background screening levels. Those compounds are retained for further analysis. Because organic compounds do not have calculated background values, this screening step was skipped, and all organics are carried into the risk assessment analyses.

Table 1. Nonradioactive Analytes at ER Site 231 and Comparison to the Background Screening Values.

Analytes	Maximum concentration (mg/kg)	Recalculated 95th % or UTL Level (mg/kg) for Tijeras Arroyo OU Background Locations	Is maximum COC concentration less than or equal to the applicable Tijeras Arroyo background screening level?	Site-Wide 95th % or UTL Level (mg/kg) for North Super Group Soils (IT, 1996)	Is maximum COC concentration less than background screening value?
Aluminum	6,200	11,874	Yes		
Antimony	11.0	18.6	Yes		
Arsenic	6.0	5.9	No	4.4	No
Barium	240.0	298	Yes		
Beryllium	0.4	0.58	Yes		
Cadmium	1.7	3.0	Yes		
Chromium-total	5.9	17.6	Yes		
Chromium VI	1.6	NC	No	NC	No
Cobalt	4.9	7.3	Yes		
Copper	29.0	14.7	No	25.5	No
Lead	11.0	23.1	Yes		
Manganese	280.0	330	Yes		
Mercury	<0.04	NC	No	<0.1	No
Nickel	8.7	14.8	Yes		
Selenium	<0.25	NC	No	<1.0	No
Silver	<0.5	NC	No	<1.0	No
Thallium	<0.50	NC	No	<1.1	No
Vanadium	16.0	40.4	Yes		
Zinc	130.0	79.2	No	82.4	No

NC - not calculated

Table 2. Radioactive Analytes at ER Site 231 and Comparison to the Background Screening Values.

Analytes	Maximum concentration (pCi/g)	Site-Wide 95th % or UTL Level (pCi/g)	Is maximum COC concentration non-detect or less than background screening value?
Pu-238	ND	NC	Yes
Pu-239/240	ND	NC	Yes
Tritium	ND	NC	Yes
U-234	1.03	1.6	Yes
U-235/236	0.39	0.18	No
U-238	0.42	1.3	Yes

NC - not calculated
ND - radionuclide not detected above minimum detectable activity

As part of the tiered approach to risk assessment, only those COCs that have values above the background screening level values are included in the next tier of risk assessment analyses. Also included in the next tier of analyses are COCs that do not have background screening values. Table 3 shows the inorganic COCs that were greater than the background screening value and organic COCs that do not have background screening values. The table also shows the proposed Subpart S action level for the contaminants. The table compares the maximum concentration values to 1/10 of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the USEPA (USEPA, 1996a). This is the second screening process in the tiered risk assessment approach. One nonradioactive compound had a concentration value greater than 1/10 of the proposed Subpart S action level. Copper and thallium do not have proposed Subpart S action levels. Because of these three compounds, the site fails the proposed Subpart S screening criteria and a Hazard Index value and cancer risk value must be calculated for the nine nonradioactive contaminants.

Radioactive contaminants do not have pre-determined action levels analogous to the proposed Subpart S and therefore this step in the screening process is not performed for radionuclides.

Table 3. Comparison of ER Site 231 COC Concentrations to Proposed Subpart S Action Levels.

COC name	Maximum concentration (mg/kg)	Proposed Subpart S Action Level (mg/kg)	Is individual contaminant less than 0.1 Action Level?
Arsenic	6.0	0.5	No
Chromium VI	1.6	400	Yes
Copper	29.0	NC	No
Mercury	<0.04	20	Yes
Selenium	<0.25	400	Yes
Silver	<0.5	400	Yes
Thallium	<0.50	NC	No
Zinc	130	20,000	Yes
Acetone	0.008J	8,000	Yes

NC - not calculated

II.3.2 Identification of Toxicological Parameters

Tables 4 and 5 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs.

Table 4. Toxicological Parameter Values for Nonradioactive COCs

COC name	RfD_o (mg/kg-d)	RfD_{inh} (mg/kg-d)	Confidence	SF_o (kg-d/mg)	SF_{inh} (kg-d/mg)	Cancer Class^
Arsenic	0.0003	--	M	1.5	15	A
Chromium VI	0.005	--	L	--	42	A
Copper	0.04	--	Est.	--	--	--
Mercury	0.0003	0.000086	--	--	--	D
Selenium	0.005	--	--	--	--	D
Silver	0.005	--	--	--	--	D
Thallium	--	--	--	--	--	D
Zinc	0.3	--	M	--	--	D
Acetone	0.1	9	L	--	--	D

RfD_o - oral chronic reference dose in mg/kg-day
RfD_{inh} - inhalation chronic reference dose in mg/kg-day
SF_o - oral slope factor in $(mg/kg\text{-}day)^{-1}$
SF_{inh} - inhalation slope factor in $(mg/kg\text{-}day)^{-1}$
^ EPA weight-of-evidence classification system for carcinogenicity

A - human carcinogen
B1 - probable human carcinogen. Limited human data are available
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen
D - not classifiable as to human carcinogencity
E - evidence of noncarcinogenicity for humans

L - low
M - medium
Est. - estimated
-- information not available

Table 5. Toxicological Parameter Values for Radioactive COCs

COC name	SF_e (m^2/pCi-yr)	SF_o (1/pCi)	SF_{inh} (1/pCi)	Cancer Class ^
U-235/236	1.16E-11	4.7E-11	1.3E-8	A

SF_e - external exposure slope factor (risk/yr per pCi/m^2)
SF_o - oral (ingestion) slope factor (risk/pCi)
SF_{inh} - inhalation slope factor (risk/pCi)
^ EPA weight-of-evidence classification system for carcinogenicity
A - human carcinogen
B1 - probable human carcinogen. Limited human data are available
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen
D - not classifiable as to human carcinogencity
E - evidence of noncarcinogenicity for humans

II.3.3 Exposure Assessment and Risk Characterization

Section II.3.3.1 describes the exposure assessment for this risk assessment. Section II.3.3.2 provides the risk characterization including the Hazard Index value and the excess cancer risk for both industrial and residential land-uses.

II.3.3.1 Exposure Assessment

Attachment M shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and Excess Cancer Risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based on RAGS (USEPA, 1989a). The parameters are based on information from RAGS (USEPA, 1989a) as well as other EPA guidance documents and reflect the RME approach advocated by RAGS.

Although the designated land-use scenario is industrial for this site, the risk values for a residential land-use scenario are also presented. These residential risk values are presented to show the potential to risk to human health even under the more restrictive land-use scenario.

II.3.3.2 Risk characterization

Table 6 shows the that for the nonradioactive COCs, the Hazard Index value is 0.02 and the excess cancer risk is 4 X 10^{-6} for the assumed industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradioactive COCs.

Table 6. Risk Assessment Values for ER Site 231 Nonradioactive COCs.

COC Name	Maximum concentration (mg/kg)	Industrial Land-use Scenario		Residential Land-use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	6.0	0.02	4E-6	0.07	1E-5
Chromium VI	1.6	0.00	4E-9	0.00	6E-9
Copper	29.0	0.00	--	0.00	--
Mercury	<0.04	0.00	--	0.00	--
Selenium	<0.25	0.00	--	0.00	--
Silver	<0.5	0.00	--	0.00	--
Thallium	<0.50	0.00	--	0.00	--
Zinc	130	0.00	--	0.00	--
Acetone	0.008J	0.00	--	0.00	--
TOTAL		**0.02**	4E-6	**0.07**	**1E-5**

NC - not calculated
NA - not applicable
-- information not available

For the residential land-use scenario, the Hazard Index value increases to 0.07 and the excess cancer risk is 1 X 10^{-5}. The numbers presented included exposure from soil ingestion and dust inhalation. Although USEPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, NM to be eroded and, subsequently, for dust to be present even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Attachment M).

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. Table 7 shows the total effective dose equivalent (TEDE) for both an industrial (0.7 mrem/yr) and residential (0.7 mrem/yr) land-use. In accordance with proposed EPA guidance, the standard being utilized is an excess TEDE of 15 mrem/yr (40 CFR Part 196, 1994), corresponding to an excess cancer risk of approximately 3 x 10^{-4}; the calculated dose values for ER Site 231 for both industrial and residential land-uses are well below that standard. The average radiation exposure due to natural sources (radon, internal radiation, cosmic radiation, and terrestrial radiation) in the U.S. is approximately 295 mrem/yr total effective dose (NCRP, 1987), with approximately 198 mrem/yr due to radon, 40 mrem/yr due to internal radiation (mainly K-40), 29 mrem/yr due to cosmic radiation and 28 mrem/yr due to terrestrial caused radiation. The value of 295 mrem/yr corresponds to an estimated cancer risk of 6×10^{-3}.

For a perspective on the estimated risk associated with background levels of radionuclides and to emphasize the conservativeness associated with RAGS RME risk and dose calculations, the excess cancer risk from background concentrations of radionuclides for relevant exposure pathways has also been estimated using RAGS methodologies. For an industrial or residential land-use scenario, using the 95th percentile or UTL values of radionuclides present in the background soil, the excess cancer risk from soil ingestion is calculated as 4×10^{-4}. The excess cancer risk for the inhalation pathway (i.e., inhalation of radon gas) is calculated as 0.1.

Table 7 shows not only the dose but also the estimated excess cancer risk as 2×10^{-5} for an industrial land-use and a value of 2×10^{-5} for a residential land-use. The excess cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (USEPA, 1989a).

Table 7. Risk Assessment Values for ER Site 231 Radioactive COCs.

COC Name	Max. Conc. (pCi/g)	Total Effective Dose Equivalent for Industrial Land-use (mrem/yr)	Total Effective Dose Equivalent for Residential Land-use (mrem/yr)	Excess Cancer Risk for Industrial Land-use	Excess Cancer Risk for Residential Land-use
U-235/236	0.39	0.7	0.7	2E-5	2E-5
TOTAL		**0.7**	**0.7**	**2E-5**	**2E-5**

II.4 <u>Step 6. Comparison of Risk Values to Numerical Standards.</u>

The risk assessment analyses considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario, which is the designated land-use scenario for this site, and also a residential land-use scenario.

For the industrial land-use scenario, the Hazard Index calculated is 0.02; this is much less than the numerical standard of 1 suggested in RAGS (1989a). The excess cancer risk is estimated at 4×10^{-6}. In RAGS, the USEPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical standard; the value calculated for this site is in the low-end of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the Hazard Index risk assessment values are significantly less than the established numerical standard and the excess cancer risk is in the low-end of the suggested acceptable risk range.

For the radioactive components of the industrial land-use scenario, the calculated dose is 0.7 mrem/yr, which is significantly less than the numerical standard of 15 mrem/yr suggested in the draft EPA guidance. The excess cancer risk estimate is 2×10^{-5}, which is significantly less than the excess cancer risk from naturally occurring radioactive sources.

For the residential land-use scenario, the calculated Hazard Index is 0.07, which is again significantly less than the numerical guidance. The excess cancer risk is estimated at 1×10^{-5}; this value is in the middle of the suggested acceptable risk range. The dose from the radioactive components is 0.7 mrem/yr, which is significantly less than the numerical guidance. The associated cancer risk is 2×10^{-5}, slightly higher than for the industrial land-use scenario but still significantly below background calculated risk values.

II.5 Uncertainty Discussion

The conclusion from the risk assessment analysis is that the potential effects on human health are small compared to established numerical standards when considering an industrial land-use scenario. Although the maximum arsenic concentration (6.0 mg/kg) exceeds the calculated UTL, it is within the range of arsenic concentration values measured in the Site-Wide background study and may be part of background. Therefore, this risk assessment is conservative as arsenic is a significant contributor to both the Hazard Index and the excess cancer risk. The uncertainty in this conclusion is considered to be small. Because of the location and history of the site, there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs were used to provide conservative results. Because the COCs are found in the surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis. Table 4 shows the confidence in the toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (EPA, 1996b) and Integrated Risk Information System (IRIS) (EPA, 1988, 1994) data bases. The constituents without toxicological parameters have low concentrations and are judged to be insignificant contributors to the overall risk. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis. The overall uncertainty in all of the steps in the risk assessment process is therefore considered to be not significant with respect to the conclusion reached.

III. Summary

The Storm Drain System Outfall, ER Site 231, had relatively minor contamination consisting of some inorganic, organic, and radioactive compounds. Although the maximum arsenic concentration (6.0 mg/kg) exceeds the calculated UTL, it is within the range of arsenic concentration values measured in the Site-Wide background study and may be part of background. In addition, based on historical records, arsenic is not considered to be a potential COC. Therefore, this risk assessment is conservative as arsenic is a significant contributor to both the Hazard Index and the excess cancer risk. Because of the location of the site on Kirtland AFB, the designated land-use scenario and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust inhalation for chemical constituents and soil ingestion, dust inhalation, and direct gamma exposure for radionuclides. Using conservative assumptions and employing a RME approach to the risk assessment, the calculations show that for the industrial land-use scenario the Hazard Index (0.02) is significantly less than the USEPA standard of 1. The estimated cancer risk (4×10^{-6}) is in the low-end of the suggested acceptable risk range. The calculations show that for the residential land-use scenario the Hazard Index (0.07) is also significantly less than the USEPA standard of 1. The estimated cancer risk (1×10^{-5}) is in the middle of the suggested acceptable risk range. The dose and corresponding cancer risk from the radioactive components are much less than EPA guidance values; the estimated dose is 0.7 mrem/yr for both the industrial and residential land-use scenarios. This value is much less than the numerical guidance of 15 mrem/yr in draft EPA guidance. The corresponding estimated cancer risk value is 2×10^{-5} for the two land-use scenarios. This value is also much less than risk values calculated due to naturally occurring radiation.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. We therefore conclude that this site does not have significant potential to affect human health under either an industrial or a residential land-use scenario.

The ecological risk for this site has not been estimated at this time. Site-Wide ecological risk analyses are being conducted and the relevant analyses for this site will be presented when available.

IV. References

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ATTACHMENT M

ATTACHMENT M

SNL ER PROJECT EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Sandia National Laboratories Environmental Restoration Program

EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

BACKGROUND

Sandia National Laboratories (SNL) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration project site. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM ER sites have similar types of contamination and physical settings, SNL believes that the risk assessment analyses at these sites will be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all Environmental Restoration (ER) sites exist within the boundaries of the Kirtland AFB. Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/ER draft Environmental Assessment (DOE, 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM ER sites. At this time, all SNL/NM ER sites have been tentatively designated for either industrial or recreational future land use.

Based on this and other related information, the SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index and risk values. EPA (EPA, 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;
- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products;
- Ingestion of contaminated surface water while swimming;
- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soil;

- Inhalation of airborne compounds (vapor phase or particulate), and;
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based on the location of the sites and the characteristics of the surface of the sites, we have evaluated these potential exposure routes to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM ER sites, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the computer code RESRAD manual (ANL, 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes; these are therefore not included. SNL/NM ER has therefore excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM ER site:

- Ingestion of contaminated fish and shell fish;
- Ingestion of contaminated fruits and vegetables;
- Ingestion of contaminated meat, eggs, and dairy products; and
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For future risk assessments, the exposure routes that will be considered are:

- Ingestion of contaminated drinking water;
- Ingestion of contaminated soil;
- Inhalation of airborne compounds (vapor phase or particulate).
- Dermal contact with chemicals in water;
- Dermal contact with chemicals in soils; and
- External exposure to penetrating radiation from ground surfaces with photon-emitting radionuclides.

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All six of the above routes will, however, be considered. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund: Volume 1 (EPA, 1989a and 1991). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for an industrial scenario, based on EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants.

Chemicals

Ingestion of Chemicals in Drinking Water:

Scenario: A person ingests tap water and beverages made from tap water. All tap water consumed is assumed to come from an on-site drinking well. In accordance with EPA guidance, the default parameter values used reflect a residential exposure.

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

CW = chemical concentration in water (mg/L)
IR = ingestion rate (L water/d);
EF = exposure frequency (d/yr);
ED = exposure duration (yr);
BW = body weight (kg);
AT = averaging time (d)

Parameter	Units	Point Value	Justification
CW	mg/L	site-specific	
IR	L/d	2	Exposure Factors Handbook (EPA, 1989b); reasonable worst-case value
EF	d/yr	350	Exposure Factors Handbook (EPA, 1989b) and RAGS, Vol 1, Part B (EPA, 1991), reasonable worst-case value
ED	yr	30	Exposure Factors Handbook (EPA, 1989b) and RAGS, Vol 1, Part B (EPA, 1991), reasonable worst-case value
BW	kg	70	Exposure Factors Handbook (EPA, 1989b); conservative estimate
AT	d	 10950 25500	RAGS (EPA, 1989a); ED x 365 d/y for noncarcinogenic effects; 70 yr x 365 d/y for carcinogenic effects.

Ingestion of Chemicals in Soil:
Scenario: A worker engages in a combination of indoor and outdoor activities for 8 hours per day with inadvertent ingestion of soil from a layer of soil on the inside surfaces of the fingers and thumb from outdoor activities or inadvertent ingestion of soil from handling of food or cigarettes. An EPA suggested average value of 100 mg/d is used for the ingestion rate.

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times (10^{-6}\ kg/mg) \times EF \times FI \times ED}{BW \times AT}$$

CS = chemical concentration in soil (mg/kg);
IR = ingestion rate (mg soil/d);
FI = fraction ingested (default to 1);
EF = exposure frequency (d/yr);
ED = exposure duration (yr);
BW = body weight (kg);
AT = averaging time (d).

Parameter	Units	Point Value	Justification
CS	mg/kg	site-specific	
IR	mg/d	100	Exposure Factors Handbook (EPA, 1989b), RAGS (EPA, 1989a); conservative estimate
EF	d/yr	250	Reasonable worst-case value for worker; RAGS (EPA, 1989a)
FI	--	1	Worst-case value
ED	yr	30	Reasonable worst-case value for worker
BW	kg	70	Exposure Factors Handbook (EPA, 1989b); conservative estimate
AT	d	 10950 25500	RAGS (EPA, 1989a); ED x 365 d/y for noncarcinogenic effects; 70 yr x 365 d/y for carcinogenic effects.

Inhalation of Airborne (vapor phase or particulate) Chemicals:
Scenario: A worker is engaged in activities (indoors or outdoors) and inhales contaminant vapors present in the air or is exposed to contaminant particulates present in the air.

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

CA = chemical concentration in air (mg/m^3);
IR = inhalation rate (m^3/h);
ET = exposure time (h/d);
EF = exposure frequency (d/yr);
ED = exposure duration (yr);
BW = body weight (kg);
AT = averaging time (d).

Parameter	Units	Point Value	Justification
CA	mg/m^3	site-specific	
IR	m^3/h	2.5	Exposure Factors Handbook (EPA, 1989b); reasonable worst-case value
EF	d/yr	250	Reasonable worst-case value for worker
ET	h/d	8	Reasonable worst-case value
ED	yr	30	Reasonable worst-case value for worker
BW	kg	70	Exposure Factors Handbook (EPA, 1989b); conservative estimate
AT	d	 10950 25500	RAGS (EPA, 1989a); ED x 365 d/y for noncarcinogenic effects; 70 yr x 365 d/y for carcinogenic effects.

The chemical concentration in air can be either measured or calculated based on the concentration of contaminants in the soil. If field measurements are not available, vapor-phase concentrations can be determined using a volatilization factor (VF) to define the relationship between the concentration of contaminant in soil and the volatilized contaminants in air. Likewise, chemical concentrations based on particulates can be determined using a particulate emission factor (PEF) to define the relationship between the contaminant concentration in soil with the concentration of respirable particles in air due to fugitive dust emissions. The volatilization factor was established as part of the Hwang and Falco (1986) model developed by EPA's Exposure Assessment group. The particulate emission factor is derived by Cowherd (1985), applicable to a typical hazardous waste site where the surface contamination provides a relatively continuous and constant potential for emission over an extended period of time. The equations for calculating VFs and PEFs can be found in EPA (EPA, 1991). Alternative methods for calculating these factors are also available. These alternative methods can be discussed with EPA/NMED staff for use in risk assessments if they can be shown to be technically consistent or superior to current published guidance.

Dermal Contact with Chemicals in Water:

Scenario: A worker is in contact with contaminants in water, primarily through hygienic activities as hand washing or showering.

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CW \times SA \times 10^4\ cm^2/m^2 \times PC \times ET \times EF \times ED \times 1\ L/10^3\ cm^3}{BW \times AT}$$

CW = chemical concentration in water (mg/L);
SA = skin surface area for contact (m^2);
PC = chemical specific dermal permeability constant (cm/h);
ET = exposure time (h/d);
EF = exposure frequency (d/yr);
ED = exposure duration (yr);
BW = body weight (kg);
AT = averaging time (d)

Parameter	Units	Point Value	Justification
CW	mg/L	site-specific	
SA	m^2	2	Exposure Factors Handbook (EPA, 1989b); {represents total body exposure); reasonable worst-case value
PC	cm/h	chemical specific	see e.g., Dermal Exposure Assessment (EPA, 1992)
EF	d/yr	250	Reasonable worst-case value for worker
ET	h/d	0.25	Dermal Exposure Assessment (EPA, 1992); reasonable worst case value
ED	yr	30	Reasonable worst-case value for worker
BW	kg	70	Exposure Factors Handbook (EPA, 1989b); conservative estimate
AT	d	 10950 25500	RAGS (EPA, 1989a); ED x 365 d/y for noncarcinogenic effects; 70 yr x 365 d/y for carcinogenic effects.

Dermal Contact with Soil:

Scenario: A worker is in contact with contaminants in soil for an exposure duration determined through discussions with EPA/NMED staff. A worker gets exposure to the head, hands, forearms and lower legs.

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times (10^{-6}\ kg/mg) \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

CS = chemical concentration in soil (mg/kg);
SA = skin surface area for contact (m^2);
AF = soil to skin adherence factor (mg/cm^2);
ABS = absorption factor (unitless);
EF = exposure frequency (d/yr);
ED = exposure duration (yr);
BW = body weight (kg);
AT = averaging time (d).

Parameter	Units	Point Value	Justification
CS	mg/kg	site-specific	
SA	m^2	0.53	Dermal Exposure Assessment (EPA, 1992); {accounts for adult exposure to head, hands, forearms, and lower legs); reasonable worst-case value
AF	mg/cm^2	1.0	Dermal Exposure Assessment (EPA, 1992); reasonable worst-case value
ABS	--		
EF	d/yr	250	Reasonable worst-case value for worker
ET	h/d	TBD	To be determined based on discussions with NMED staff.
ED	yr	30	Reasonable worst-case value for worker
BW	kg	70	Exposure Factors Handbook (EPA, 1989b); conservative estimate
AT	d	 10950 25500	RAGS (EPA, 1989a); ED x 365 d/y for noncarcinogenic effects; 70 yr x 365 d/y for carcinogenic effects.

EPA (EPA, 1992) recognizes that dermal contact exposure remains the least well understood of the major exposure routes. Chemical-specific data are often not available and dose-response relationships specific to dermal contact are not available. EPA (EPA, 1992) provides guidance on assessment of dermal exposure, including determination of permeability coefficients and other related parameters.

In addition to the equations presented above for absorbed dose via steady-state dermal exposure, EPA (EPA, 1992) presents methods for calculation of absorbed doses for unsteady-state exposure; these methods generally produce lower estimates of absorbed dose. The document also presents a screening process for determining if site-specific calculations of dermal exposure are necessary, assuming that dermal exposure is deemed a potentially valid route of contaminant exposure. In general, SNL/NM ER will use the latest guidance available from EPA on dermal exposure. This is an area where discussions with EPA/NMED staff on appropriate assumptions and parameter values is essential. Discussions with EPA/NMED staff are also necessary to determine when this exposure route should be invoked.

Radionuclides

Radionuclide Carcinogenic Effects from Water: Residential

Scenario: A worker drinks radioactively-contaminated water and inhales vapor from the water.

$$\text{Total risk} = (C_{rw} \times SF_o \times IR_w \times EF \times ED) + (C_{rw} \times SF_i \times IR_{air} \times K \times EF \times ED)$$

C_{rw} = radionuclide concentration in water (pCi/L)
SF_i = inhalation slope factor (risk/pCi)
SF_o = oral (ingestion) slope factor (risk/pCi)
EF = exposure frequency (d/y)
ED = exposure duration (y)
IR_{air} = indoor inhalation rate (m^3/d)
IR_w = water ingestion rate (L/d)
K = volatilization factor (unitless)

Parameter	Units	Point Value	Justification
C_{rw}	pCi/L	site-specific	
SF_i	risk/pCi	radionuclide-specific	
SF_o	risk/pCi	radionuclide-specific	
EF	d/y	350	RAGS (EPA, 1989a)
ED	y	30	Reasonable worst-case estimate.
IR_{air}	m^3/d	15	RAGS (EPA, 1989a)
IR_w	L/d	2	Reasonable worst-case estimate.
K	unitless	0.5	RAGS (EPA, 1989a)

Radionuclide Carcinogenic Effects from Soil: Industrial

Scenario: A worker inadvertently ingests soil, inhales vapor and particulates from soil and is externally exposed to penetrating radiation ground surfaces contaminated with photon-emitting radionuclides.

$$\text{Total risk} = C_{rs} \times ED \times [(SF_o \times 10^{-3} g/mg \times EF \times IR_{soil}) + (SF_i \times 10^3 g/kg \times EF \times IR_{air} / VF) + (SF_i \times 10^3 g/kg \times EF \times IR_{air} / PEF) + (SF_e \times 10^3 g/kg \times D \times SD \times (1-S_e) \times T_e)]$$

C_{rs} = radionuclide concentration (pCi/g)
SF_i = inhalation slope factor (risk/pCi)
SF_o = oral (ingestion) slope factor (risk/pCi)
SF_e = external exposure slope factor (risk/y per pCi/m^2)
EF = exposure frequency (d/y)
ED = exposure duration (y)
IR_{air} = inhalation rate (m^3/d)

IR_{soil} = soil ingestion rate (mg/d)
VF = soil-to-air volatilization factor (m^3/kg)
PEF = particulate emission factor (m^3/kg)
D = depth of radionuclides in soil (m)
SD = soil density (kg/m^3)
S_e = gamma shielding factor (unitless)
T_e = gamma exposure factor (unitless)

Parameter	Units	Point Value	Justification
C_r	pCi/g	site-specific	
SF_i	risk/pCi	radionuclide-specific	
SF_o	risk/pCi	radionuclide-specific	
SF_e	risk/y per pCi/m^2	radionuclide-specific	
EF	d/y	250	RAGS (EPA, 1989a)
ED	y	30	Reasonable worst-case estimate.
IR_{air}	m^3/d	20	RAGS (EPA, 1989a)
IR_{soil}	mg/d	100	Reasonable worst-case estimate.
VF	m^3/kg	nuclide-specific	
PEF	m^3/kg	1.32×10^9	Region VI guidance.
D	m	0.1	RAGS (EPA, 1989a)
SD	kg/m^3	1430	RAGS (EPA, 1989a)
S_e	unitless	0.2	RAGS (EPA, 1989a)
T_e	unitless	1	RAGS (EPA, 1989a)

Summary for an Industrial Land-Use Scenario

SNL proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial future land-use scenario. The parameter values are based on EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Summary for an Residential Land-Use Scenario

Sandia may choose to evaluate some sites using a residential land-use scenario in order to provide an indication of the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on Sandia ER sites. For a risk assessment evaluating a residential land-use scenario, Sandia will use parameter values as documented in the Risk Assessment Guidance for Superfund (RAGS, 1989a). That EPA guidance document provides detailed discussion on the appropriate values to use for all of the potential exposure pathways.

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ATTACHMENT N

ATTACHMENT N

REFERENCES FOR TIJERAS ARROYO OU NOD RESPONSES

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NOD

Sandia National Laboratories
Albuquerque, New Mexico
December 2002

Environmental Restoration Project
Tijeras Arroyo Operable Unit 1309
Responses to NMED Notices of Deficiency for
Solid Waste Management Units 230, 231, 232, 233, and 234
No Further Action Proposals
Dated June 1995 (2nd Round) and
August 1997 (8th Round)

INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is submitting this Notice of Deficiency (NOD) Response for the Technical Area (TA)-IV storm-water outfalls (Solid Waste Management Units [SWMUs] 230, 231, 232, 233, and 234). These five sites are managed as part of the Tijeras Arroyo Operable Unit (TJAOU) 1309. The proposals for no further action (NFA) for SWMUs 230, 231, 233, and 234 were previously submitted in 1995 (SNL/NM June 1995). The NFA proposal for SWMU 232 was submitted in 1997 (SNL/NM August 1997). This response addresses both the most recent NOD (NMED October 1999) for the five sites (SWMUs 230, 231, 232, 233, and 234) and the previous Request for Supplemental Information (RSI) (Dinwiddie January 1999) that contained specific comments (1 through 5) regarding SWMU 232.

The NOD (NMED October 1999) included comments relating to a number of SWMUs at SNL/NM. Five comments (1, 2, 4, 5, 8) in Enclosure B of this NOD (NMED October 1999) addressed SWMUs 230, 231, 232, 233, and 234. This document presents the SNL/NM response to these comments. Incorporated into the response are the confirmatory sampling requirements that were identified by SNL/NM Environmental Restoration (ER) TJAOU staff and the New Mexico Environment Department (NMED) Hazardous and Radioactive Materials Bureau (HRMB) (now known as the Hazardous Waste Bureau) in a meeting held on November 17, 1999. The outcome of the meeting was NMED's request for additional confirmatory soil sampling at SWMUs 230 through 234. A Field Implementation Plan (FIP) was subsequently developed for these five SWMUs (SNL/NM May 2001) that describes the confirmatory sampling and analysis requirements and provides historical information for the outfalls. The FIP, provided as Attachment A, was used to guide the confirmatory sampling that was conducted in June 2001.

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LIST OF ATTACHMENTS

Attachment	Title
A	Field Implementation Plan—Tijeras Arroyo Outfalls
B	SWMU 230 Risk Screening Assessment Report
C	SWMU 231 Risk Screening Assessment Report
D	SWMU 232-1 Risk Screening Assessment Report
E	SWMU 232-2 Risk Screening Assessment Report
F	SWMU 233 Risk Screening Assessment Report
G	SWMU 234 Risk Screening Assessment Report
H	Data Validation Reports for SWMU 230
I	Data Validation Reports for SWMU 231
J	Data Validation Reports for SWMU 232-1
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L	Data Validation Reports for SWMU 233
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TIJERAS ARROYO OPERABLE UNIT 1309
RESPONSES TO NMED NOTICES OF DEFICIENCY
FOR NFA PROPOSALS

RESPONSES TO ENCLOSURE B, OCTOBER 1999 NOTICE OF DEFICIENCY—PROPOSED ADDITIONAL SITE CHARACTERIZATION WORK, NFA PROPOSALS, JUNE 1995 (2nd Round)

The NMED comments (NMED October 1999) relevant to the TA-IV storm-water outfalls (SWMUs 230, 231, 232, 233, and 234) are presented below in bold text. The SNL/NM response follows each comment.

ER Sites 46, 232, 233, 234, 227, 229, 230, and 231 (OU 1309 Outfalls)

The outfalls at ER Sites 46 and 227 are of the most concern to the HRMB; the others, which are storm drain outfalls, are clustered near ER sites 46 and 227. More specifically, ER Sites 229, 230, and 231 are grouped near ER Site 227; whereas, ER Sites 232, 233, and 234 are located near ER Site 46. Additional site characterization work proposed includes:

1. **Locate each outfall accurately.**

   Response: Figure 1 accurately depicts the locations of each TA-IV storm-water outfall (SWMUs 230, 231, 232-1, 232-2, 233, and 234). The outfalls are located along the southern boundary of TA-IV and the steep northern rim of Tijeras Arroyo. Figure 2 is an SNL/NM Facilities Engineering drawing depicting the various utilities that are located at the southern part of TA-IV. Storm water drains to the sites via buried pipes that are connected to either concrete ditches or concrete drop structures. The SWMUs consist of earthen ditches that start at the discharge point of each concrete feature. SWMUs 230, 231, 232-1, 232-2, and 233 currently receive storm water from TA-IV. SWMU 234 previously received storm water from TA-IV, but is now inactive.

   As shown on Figure 2, SNL/NM Facilities Engineering has assigned a structure number ('struc. no.') to each outfall. For example, structure number 58 corresponds to SWMU 230. Structure numbers 59 and 60A correspond to SWMUs 231 and 232-1, respectively. Structure number 60 corresponds to SWMU 232-2. A structure number is not assigned to SWMU 234 because the concrete features were removed in the early 1990s when piping from the Building 981 area was diverted to SWMU 233 (structure number 62).

2. **Collect and analyze soil samples at the points of surface discharge and along the drainage channels. Analytical results of previous sampling will be used, to the extent possible, to meet this requirement.**

   Response: In June 2001, SNL/NM collected the soil samples, requested by NMED at the November 17, 1999, meeting, at the points of surface discharge and along the earthen channels. At all of the SWMUs (230 through 234), soil samples were collected at lateral distances of 5 and 30 feet downslope of the storm-water discharge point; the sampling depths for these lateral locations began at 0 and 5 feet below ground surface (bgs). Additional surface (0 to 1 foot bgs) soil samples were collected at SWMUs 230, 232-2, and 233. Figures 3 through 8 depict the sampling locations at SWMUs 230 through 234.

Table 1 lists the number of samples that have been collected at each site. Table 2 lists the soil samples for each SWMU. Sampling was conducted in 1994, 1995, and 2001. The soil samples were analyzed by both on-site and off-site laboratories (Tables 3 through 109). Sampling and analysis details are presented in the Risk Screening Assessment Reports for each site (Attachments B through G).

4. **Collect shallow subsurface soil samples at each storm drain outfall (two boreholes at each location at maximum depths of 5 ft). The soil samples will be analyzed for radionuclides, metals, volatile organic compounds, semi-volatile organic compounds, and high explosives.**

Response: In 2001, SNL/NM collected shallow subsurface samples at two locations at each of the storm-drain outfalls (SWMUs 230, 231, 232, 233, and 234). A third soil sample was collected at SWMUs 230, 232-2, and 233 (Table 2). The samples were collected in accordance with guidance received at the November 17, 1999, meeting between SNL/NM ER TJAOU staff and the NMED HRMB. The surface soil (0 to 0.5 foot bgs) and 1-foot-bgs soil samples were collected with a hand trowel. Because of the uneven terrain and large cobbles that serve as erosion control below the storm-water outfalls, a backhoe was used to collect the 5-foot-bgs soil samples. NMED verbally approved use of the backhoe before the sampling was conducted (Copland April 2001).

The soil samples from each site were analyzed for radionuclides (gamma spectroscopy, tritium, and gross alpha/beta), Resource Conservation and Recovery Act (RCRA) metals, chromium-VI, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and total petroleum hydrocarbons (TPH) using U.S. Environmental Protection Agency (EPA) methods (EPA November 1986). The need for analyzing the soil samples for high explosive (HE) compounds was discounted after informing NMED that the TA-IV storm-water outfalls have never received any type of TA-II water (storm, septic, or waste) (SNL/NM May 2001), as previously assumed by NMED. HE compounds are not a contaminant of concern (COC) for any of the TA-IV storm-water outfalls (SWMUs 230, 231, 232, 233, and 234).

5. **Collect a surface soil sample upstream of the drop inlet at ER Site 230. The soil sample will be analyzed for radionuclides, metals, volatile organic compounds, semi-volatile organic compounds, and high explosives.**

Response: A surface soil (0 to 0.5 feet bgs) sample (230-GR-05-0.5) was collected upstream of the drop inlet next to the chain-link fence and analyzed for radionuclides (gamma spectroscopy, tritium, and gross alpha/beta), RCRA metals, chromium-VI, VOCs, SVOCs, and TPH using EPA methods (EPA November 1986). The need for analyzing the soil samples for HE compounds was discounted after informing NMED that the TA-IV storm-water outfalls have never received any type of TA-II water (storm, waste, or septic) (SNL/NM May 2001), as previously assumed by NMED. HE compounds are not a COC for any of the TA-IV storm-water outfalls (SWMUs 230, 231, 232, 233, and 234).

8. **Revise and resubmit the data tables in the NFA proposals for each site, meeting the standards achieved in the 12th Round NFA proposals.**

Response: Analytical data tables from the NFA proposals (SNL/NM June 1995; SNL/NM August 1997) have been revised using the 12th Round format. In addition to the soil samples that were collected in 1994 and 1995 for the NFA proposals, samples also were collected in 2001. Table 2 lists the soil samples for each SWMU. Table 1 lists the corresponding analytical data tables (Tables 3 through 109). The soil samples were analyzed using EPA methods (EPA November 1986) for VOCs, SVOCs, TPH, metals (RCRA metals and chromium-VI), and radionuclides (gamma spectroscopy, tritium, and gross alpha/beta). All detectable concentrations are presented in the tables. In those cases in which no detectable concentrations were reported for a particular analytical suite, a table listing the detection limits is presented. Analytical laboratories are noted on each data table.

Risk assessments (human health and ecological) have been prepared for each SWMU (230 through 234) using all the available sampling results. The risk assessment results, as well as the sampling techniques and analytical methods, are presented in the Risk Screening Assessment Reports for each site (Attachments B through G). The Data Validation Reports for each site are included in Attachments H through M.

RESPONSES TO SPECIFIC COMMENTS, JANUARY 1999 REQUEST FOR SUPPLEMENTAL INFORMATION—NFA PROPOSALS, AUGUST 1997 (8th Round)

The NMED specific comments from the RSI (Dinwiddie January 1999) relevant to SWMU 232 are presented below in bold text. The SNL/NM response follows each comment. None of the other TA-IV storm-water outfalls (SWMUs 230, 231, 233, 234) were discussed in the January 1999 RSI correspondence.

ER Site 232 is not appropriate for NFA petition.

1. **Section 3.2.10 – The site-specific background concentrations have not been approved by the HRMB.**

   Response: The attached risk assessments do not use the SWMU 232 site-specific background concentrations. Instead, the appropriate NMED-approved background values, as defined by Dinwiddie (September 1997), are used.

2. **Table 3-4 – With regard to outfall 232-2, please provide the "DOE OB/NMED data" for VOCs and SVOCs. DOE/SNL did not analyze soil samples for these constituents.**

   Response: The NMED Oversight Bureau (OB) data is contained in Attachment N and was generated by NMED's contract laboratory, Analytical Technologies, Inc. As mentioned in the SWMU 232 NFA Proposal (SNL/NM August 1997), no VOCs or SVOCs were detected in the three soil samples that were collected by the NMED OB. The soil samples were collected from the excavation where soil contaminated with mineral oil had been removed during the SWMU 232-2 Voluntary Corrective Measure.

3. **Table 3-7 – DOE/SNL must provide a complete list of all VOCs and SVOCs analyzed for and their MDLs [method detection limits].**

   Response: The MDLs for each VOC and SVOC are listed in the revised tables (Tables 41, 43, 52, 54, 65, and 67).

4. **Site characterization at ER Site 232-1 is not adequate. Surface and shallow subsurface soil samples should be collected at two locations near the center of the area shown in Figure 3-2. The soil samples should be analyzed for VOCs, SVOCs, and TPH.**

   Response: The confirmatory soil samples were collected in 2001 by SNL/NM to satisfy this comment. At the direction of Mr. Will Moats (NMED OB), soil samples were collected at lateral distances of 5 and 30 feet downslope of the storm-water discharge point. The samples were analyzed for VOCs, SVOCs, and TPH. The analytical results are discussed above in the response to Comments 4 and 8 of Enclosure B of the October 1999 NOD.

5. **At Outfall 232-1, contaminated soil with concentrations of TPH > 100 mg/kg [milligrams/kilogram] should be remediated.**

Response: Recent guidance from NMED suggests that the remediation of soil containing TPH in excess of 100 parts per million (ppm) (mg/kg) is a moot issue for SWMU 232-1. Both the July 18, 2000, letter from the NMED Hazardous Waste Bureau and its accompanying Position Paper (*Use of TPH Test Results for Site Characterization*) (Bearzi July 2000) endorse the August 13, 1993, guidelines from the New Mexico Oil Conservation Division (OCD) (OCD August 1993). The OCD *Guidelines for Remediation of Leaks, Spills, and Releases* set forth ranking criteria for oil spills. SWMU 232-1 scores a ranking criteria of zero (0) because the depth to groundwater is greater than 100 feet and no perennial surface-water bodies, water-supply wells, or other water sources are located nearby. Accordingly, the TPH action level for the site should be 5,000 ppm above background. The maximum TPH concentration reported for the 1994 SWMU 232-2 soil samples was 860 ppm. The confirmatory soil samples collected in 2001 did not contain any TPH concentrations above the 0.45 ppm detection limit. Therefore, SNL/NM does not plan to conduct any remediation work at SWMU 232-2.

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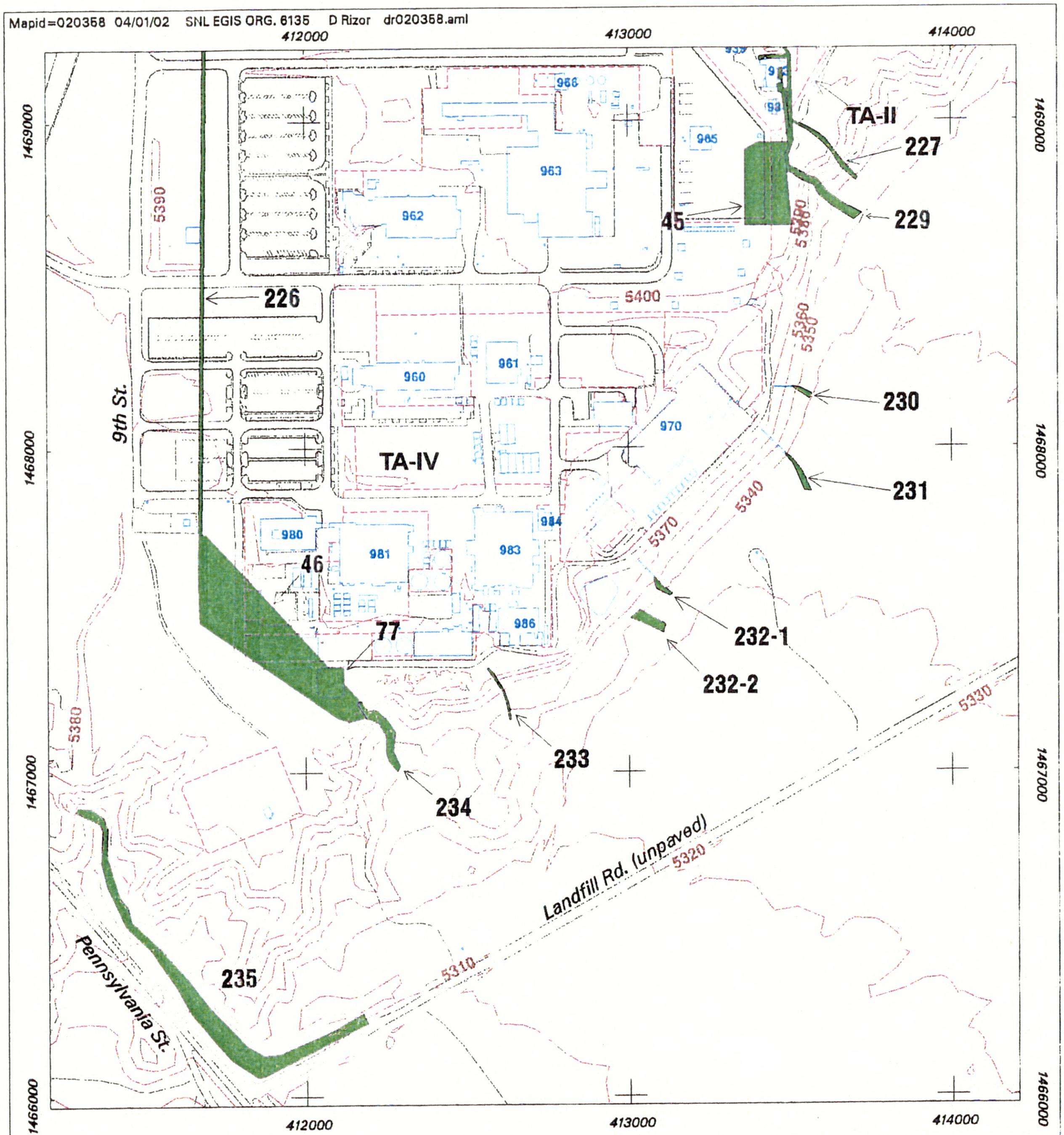
FIGURES



Legend

Road

10 Foot Contour

Fence

Building

SWMU

Figure 1
TA-IV Storm-Water Outfalls (SWMUs 230, 231 232, 233 and 234)

0 250 500
Scale in Feet

0 60 120
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

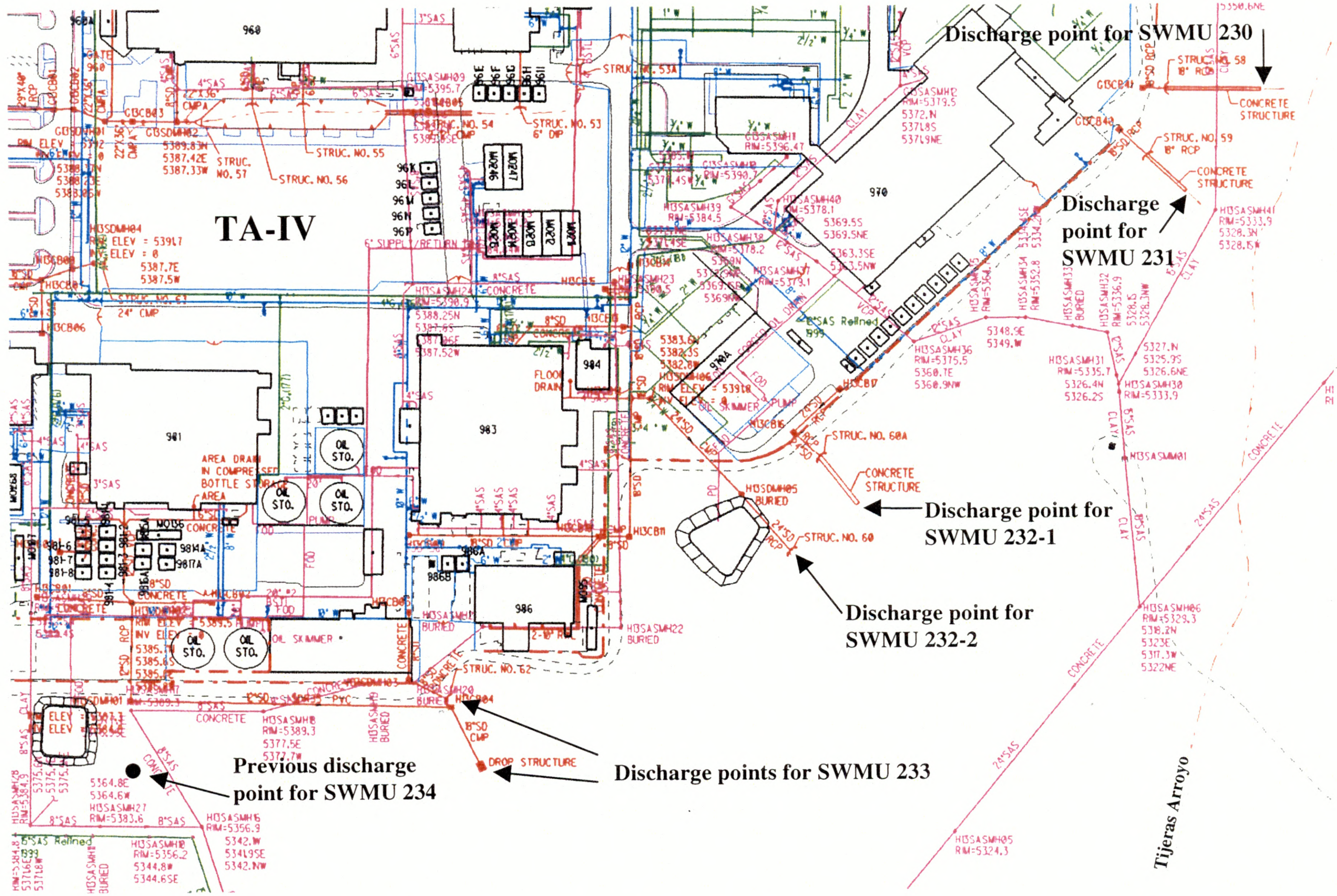
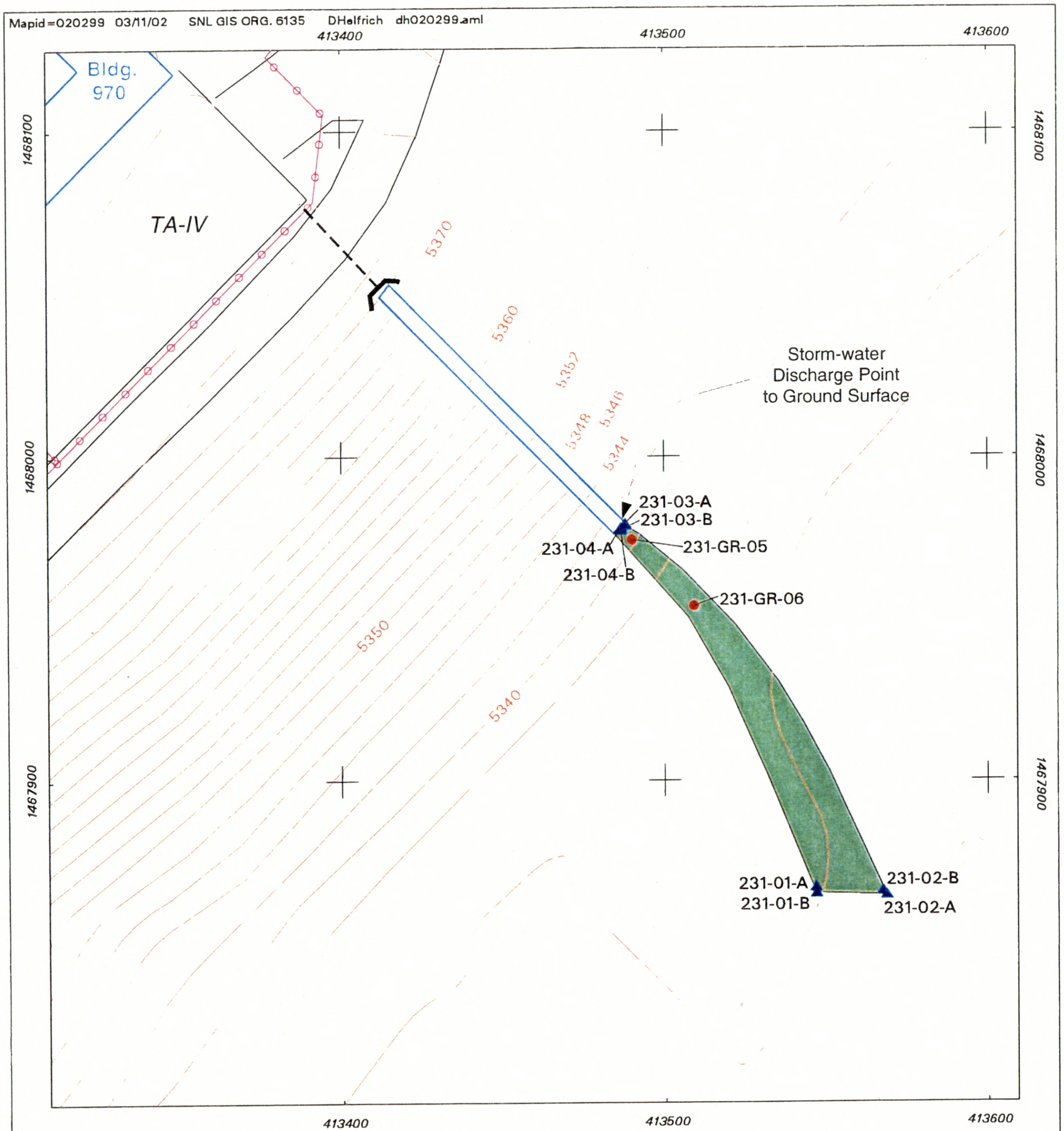


Figure 2. SNL/NM Facilities Engineering drawing for various utilities located on the south side of TA-IV. (Orange items are storm-drain features. Magenta lines are sanitary-sewer lines. Blue lines are potable-water lines. Green lines are natural gas lines and cathodic protection systems. Black lines are buildings and roads. Bold text with arrows added by the ER Project.)



Legend

- Soil Sample Location (1994)
- Soil Sample Location (2001)
- Headwall with Outfall Pipe
- Fence
- Buried Pipe
- Unpaved Road
- 2-foot Contour
- Concrete Ditch
- SWMU 231

Figure 4
Sampling Locations for SWMU 231

0 25 50
Scale in Feet

0 6 12
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

TABLES

Table 1
Number of Confirmatory Soil-Sampling Locations and Corresponding Analytical Data Tables for the TA-IV Storm-Water Outfalls for SWMUs 230, 231, 232-1, 232-2, 233, and 234

SWMU	Locations Sampled in 1994	Locations Sampled in 1995	Locations Sampled in 2001	Total Sampling Locations	Corresponding Analytical Data Tables
230	8	--	3	11	3–21
231	8	--	2	10	22–40
232-1	8	5	3	16	41–60
232-2	41	--	2	43	61–74
233	8	--	3	11	75–92
234	6[a]	--	2	8	93–109

[a]Another six locations (see Table 2) are not included in this tally for SWMU 234 because the corresponding six samples were not collected where storm water had drained.
SWMU = Solid Waste Management Unit.
TA = Technical Area.
-- = Information not available.

Table 2
Soil Samples Collected at SWMUs 230, 231, 232-1, 232-2, 233, and 234

SWMU	Sample ID	Beginning Depth (ft bgs)
230	1994 sampling	
	230-01-A	0.0
	230-01-B	0.5
	230-02-A	0.0
	230-02-B	0.5
	230-03-A	0.0
	230-03-B	0.5
	230-04-A	0.0
	230-04-B	0.5
	2001 sampling	
	230-GR-05-0.0-S	0.0
	230-GR-06-0.0-S	0.0
	230-GR-06-0.0-DU	0.0
	230-GR-06-5.0-S	5.0
	230-GR-07-5.0-S	5.0
231	1994 sampling	
	231-01-A	0.0
	231-01-B	0.5
	231-02-A	0.0
	231-02-B	0.5
	231-03-A	0.0
	231-03-B	0.5
	231-04-A	0.0
	231-04-B	0.5
	2001 sampling	
	231-GR-05-0.0-S	0.0
	231-GR-05-0.0-DU	0.0
	231-GR-05-5.0-S	5.0
	231-GR-06-5.0-S	5.0
232-1	1994 sampling	
	232-1-01-A	0.0
	232-1-01-B	0.5
	232-1-02-A	0.0
	232-1-02-B	0.5
	232-1-03-A	0.0
	232-1-03-B	0.5
	232-1-04-A	0.0
	232-1-04-B	0.5
	1995 sampling	
	232-1-BH1-5-S-1	5.0
	232-1-BH1-10-S-1	10.0
	232-1-BH1-10-SD-1	10.0
	232-1-BH1-10-SO-1	10.0
	232-1-BH2-5-S-1	5.0
	232-1-BH2-10-S-1	10.0
	232-1-BH3-5-S-1	5.0
	232-1-BH3-10-S-1	10.0
	232-1-BH4-6-S-1	6.0
	232-1-BH4-10-S-1	10.0
	232-1-BH5-5-S-1	5.0
	232-1-BH5-10-S-1	10.0
	2001 sampling	
	232-1-GR-05-0.0-S	0.0
	232-1-GR-05-0.0-DU	0.0
	232-1-GR-06-5.0-S	5.0
	232-1-GR-07-5.0-S	5.0

Refer to footnotes at end of table.

Table 2 (Continued)
Soil Samples Collected at SWMUs 230, 231, 232-1, 232-2, 233, and 234

SWMU	Sample ID	Beginning Depth (ft bgs)
232-2	1994 sampling	
	015861	1[a]
	015862	1[a]
	015863	5[a]
	015864	5[a]
	015865	5[a]
	015866	5[a]
	015867	5[a]
	015868	5[a]
	015869	5[a]
	015870	5[a]
	015871	5[a]
	015872	1[a]
	015873	9
	015874	9
	015875	9
	015876	9
	015877	9
	015878	9
	015879	9
	015880	5[a]
	015881	5[a]
	015882	5[a]
	015883	5[a]
	015884	5[a]
	015885	10
	015886	6.5
	015887	9
	015888	6.5
	015889	6
	015890	1
	015891	10
	015892	7
	015893	4
	015894	10.5
	015895	9.5
	015896	3.5
	017817	1
	017818	8
	NMED-232-east	10
	NMED-232-west	6
	NMED-undisturbed	9
	2001 sampling	
	232-2-GR-01-0.0-S	0.0
	232-2-GR-01-0.0-DU	0.0
	232-2-GR-01-5.0-S	5.0
	232-2-GR-01-10.0-S	10.0
	232-2-GR-02-5.0-S	5.0
	232-2-GR-02-7.0-DU	7.0

Refer to footnotes at end of table.

Table 22
Summary of SWMU 231 Confirmatory Soil Sampling
VOC Analytical Results—Detections Only
September 1994
(Off-Site Laboratory)[a]

Sample Attributes			VOCs (EPA Method 8240[b]) (mg/kg)
Record Number[c]	ER Sample ID	Sample Depth (ft)	Acetone
813	SITE 231-01-B	0.5–3	ND (0.01)
813	SITE 231-02-B	0.5–3	ND (0.01)
813	SITE 231-03-B	0.5–3	**0.008 J**
813	SITE 231-04-B	0.5–3	ND (0.01)

Note: Values in **bold** represent detected analytes.
[a]Environmental Control Technology Corporation Laboratory (ENCOTEC).
[b]EPA November 1986.
[c]Analysis request/chain-of-custody record.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J = Estimated value. See Data Validation report (Attachment I).
mg/kg = Milligram(s) per kilogram.
ND ( ) = Not detected above the method detection limit, shown in parentheses.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compounds.

Table 23
Summary of SWMU 231 Confirmatory Soil Sampling
VOC Analytical Detection Limits
September 1994
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit (mg/kg)
1,1,1-Trichloroethane	0.005
1,1,2,2-Tetrachloroethane	0.005
1,1,2-Trichloroethane	0.005
1,1-Dichloroethane	0.005
1,1-Dichloroethene	0.005
1,2-Dichloroethane	0.005
1,2-Dichloroethene	0.005
1,2-Dichloropropane	0.005
2-Butanone	0.01
2-Chloroethyl vinyl ether	0.01
2-Hexanone	0.01
4-methyl-2-Pentanone	0.01
Acetone	0.01
Benzene	0.005
Bromodichloromethane	0.005
Bromoform	0.005
Bromomethane	0.01
Carbon disulfide	0.005
Carbon tetrachloride	0.005
Chlorobenzene	0.005
Chloroethane	0.01
Chloroform	0.005
Chloromethane	0.01
Dibromochloromethane	0.005
Ethyl benzene	0.005
Methylene chloride	0.005
Styrene	0.005
Tetrachloroethene	0.005
Toluene	0.005
Trichloroethene	0.005
Vinyl acetate	0.01
Vinyl chloride	0.01
Xylene	0.005
cis-1,3-Dichloropropene	0.005
trans-1,3-Dichloropropene	0.005

[a]Environmental Control Technology Corporation Laboratory (ENCOTEC).
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compound.

Table 24
Summary of SWMU 231 Confirmatory Soil Sampling
SVOC Analytical Detection Limits
September 1994
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit (mg/kg)
1,2,4-Trichlorobenzene	0.33
1,2-Dichlorobenzene	0.33
1,3-Dichlorobenzene	0.33
1,4-Dichlorobenzene	0.33
2,2'-Dichlorodiisopropyl ether	0.33
2,4,5-Trichlorophenol	0.33
2,4,6-Trichlorophenol	0.33
2,4-Dichlorphenol	0.33
2,4-Dimethylphenol	0.33
2,4-Dinitrophenol	1.67
2,4-Dinitrotoluene	0.33
2,6-Dinitrotoluene	0.33
2-Chloronaphthalene	0.33
2-Chlorophenol	0.33
2-Methylnaphthalene	0.33
2-Nitroaniline	1.67
2-Nitrophenol	0.33
3,3'-Dichlorobenzidine	0.67
3-Nitroaniline	1.67
4-Bromophenyl phenyl ether	0.33
4-Chloro-3-methylphenol	0.33
4-Chlorobenzenamine	0.33
4-Chlorophenyl phenyl ether	0.33
4-Methylphenol	0.33
4-Nitroaniline	1.67
4-Nitrophenol	1.67
Acenaphthene	0.33
Acenaphthylene	0.33
Anthracene	0.33
Benzidine	2.66
Benzo(a)anthracene	0.33
Benzo(a)pyrene	0.33
Benzo(b)fluoranthene	0.33
Benzo(ghi)perylene	0.33
Benzo(k)fluoranthene	0.33
Benzoic acid	1.67
Benzyl alcohol	0.33
Butylbenzyl phthalate	0.33
Chrysene	0.33
Di-n-butyl phthalate	0.33
Di-n-octyl phthalate	0.33
Dibenz(a,h)anthracene	0.33
Dibenzofuran	0.33
Diethylphthalate	0.33
Dimethylphthalate	0.33

Refer to footnotes at end of table.

Table 24 (Concluded)
Summary of SWMU 231 Confirmatory Soil Sampling
SVOC Analytical Detection Limits
September 1994
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit (mg/kg)
Dinitro-o-cresol	1.67
Fluoranthene	0.33
Fluorene	0.33
Hexachlorobenzene	0.33
Hexachlorobutadiene	0.33
Hexachlorocyclopentadiene	0.33
Hexachloroethane	0.33
Indeno(1,2,3-c,d)pyrene	0.33
Isophorone	0.33
Naphthalene	0.33
Nitro-benzene	0.33
Pentachlorophenol	1.67
Phenanthrene	0.33
Phenol	0.33
Pyrene	0.33
bis(2-Chloroethoxy)methane	0.33
bis(2-Chloroethyl)ether	0.33
bis(2-Ethylhexyl)phthalate	0.33
n-Nitrosodiphenylamine	0.33
n-Nitrosodipropylamine	0.33
o-Cresol	0.33

[a]Environmental Control Technology Corporation Laboratory (ENCOTEC).
mg/kg = Milligram(s) per kilogram.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.

Table 25
Summary of SWMU 231 Confirmatory Soil Sampling
Total Petroleum Hydrocarbon Compounds Analytical Results—Detections Only
September 1994
(Off-Site Laboratory)[a]

Sample Attributes			TPH (EPA Method 418.1[b]) (mg/kg)
Record Number[c]	ER Sample ID	Sample Depth (ft)	
813	SITE 231-01-A	0–0.5	ND (40)
813	SITE 231-02-A	0–0.5	**44**
813	SITE 232-02-B	0.5–3	ND (40)
813	SITE 232-03-A	0–0.5	ND (40)
813	SITE 231-03-B	0.5–3	**130**
813	SITE 231-04-A	0–0.5	**79**
813	SITE 231-04-B	0.5–3	**59**

Note: Values in **bold** represent detected analytes.
[a]Environmental Control Technology Corporation Laboratory (ENCOTEC).
[b]EPA November 1986.
[c]Analysis request/chain-of-custody record.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
mg/kg = Milligram(s) per kilogram.
ND ( ) = Not detected above the method detection limit, shown in parentheses.
SWMU = Solid Waste Management Unit.
TPH = Total petroleum hydrocarbons.

Table 26
Summary of SWMU 231 Confirmatory Soil Sampling
Petroleum Analytical Detection Limits
September 1994
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit (mg/kg)
Total petroleum hydrocarbon	40

[a]Environmental Control Technology Corporation Laboratory (ENCOTEC).
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.

Table 27
Summary of SWMU 231 Confirmatory Soil Sampling
Metals Analytical Results
September 1994
(Off-Site Laboratory)[a]

Sample Attributes			Metals (EPA Methods 6010/6020/7196/7471/7741[b]) (mg/kg)				
Record Number[c]	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium
813	SITE 231-01-A	0–0.5	1.7	90	ND (0.25)	0.88	2.4
813	SITE 231-01-B	0.5–3	1.3	**240**	0.27	**1.2**	3.7
813	SITE 231-02-A	0–0.5	1.2	120	ND (0.25)	0.78	3.2
813	SITE 231-02-B	0.5–3	1.2	**200**	0.27	**1.5**	7.9
813	SITE 231-03-A	0–0.5	2.4	200	0.4	**1.5**	6
813	SITE 231-03-B	0.5–3	2	120	ND (0.25)	**1**	3.4
813	SITE 231-04-A	0–0.5	**5.7**	210	0.32	**1.7**	5.8
813	SITE 231-04-B	0.5–3	2.1	**220**	ND (0.25)	0.84	3.4
Background concentration (surface soil 0–0.5 ft)			NC	281	0.8	<1	21.8
Background concentration (subsurface soil >0.5 ft)			4.4	200	0.8	0.9	16.2

Refer to footnotes at end of table.

Table 27 (Concluded)
Summary of SWMU 231 Confirmatory Soil Sampling
Metals Analytical Results
September 1994
(Off-Site Laboratory)[a]

Sample Attributes			Metals (EPA Methods 6010/6020/7196/7471/7741[b]) (mg/kg)				
Record Number[c]	ER Sample ID	Sample Depth (ft)	Chromium (VI)	Lead	Mercury	Selenium	Silver
813	SITE 231-01-A	0–0.5	1.6	6.3	ND (0.04)	ND (0.25)	ND (0.5)
813	SITE 231-01-B	0.5–3	ND (0.2)	7.6	ND (0.04)	ND (0.25)	ND (0.5)
813	SITE 231-02-A	0–0.5	ND (1)	6.7	ND (0.04)	ND (0.25)	ND (0.5)
813	SITE 231-02-B	0.5–3	ND (0.2)	8.6	ND (0.04)	ND (0.25)	ND (0.5)
813	SITE 231-03-A	0–0.5	ND (0.1)	9.5	ND (0.04)	ND (0.25)	ND (0.5)
813	SITE 231-03-B	0.5–3	ND (0.1)	6.4	ND (0.04)	ND (0.25)	ND (0.5)
813	SITE 231-04-A	0–0.5	ND (0.1)	10	ND (0.04)	ND (0.25)	ND (0.5)
813	SITE 231-04-B	0.5–3	ND (0.1)	5.5	ND (0.04)	ND (0.25)	ND (0.5)
Background concentration (surface soil 0–0.5 ft)			NC	39	<0.25	<1	<1
Background concentration (subsurface soil >0.5 ft)			NC	11.2	<0.1	<1	<1

Note: Values in **bold** indicate concentrations greater than background.
[a]Environmental Control Technology Corporation Laboratory (ENCOTEC).
[b]EPA November 1986.
[c]Analysis request/chain-of-custody record.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
mg/kg = Milligram(s) per kilogram.
NC = Not calculated by Dinwiddie (September 1997).
ND ( ) = Not detected above the method detection limit, shown in parentheses.
SWMU = Solid Waste Management Unit.

Table 28
Summary of SWMU 231 Confirmatory Soil Sampling
Metals Analytical Detection Limits
September 1994
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit (mg/kg)
Arsenic	0.5–5
Barium	10
Beryllium	0.25
Cadmium	0.25
Chromium	1
Chromium (VI)	0.1–1
Lead	2
Mercury	0.04
Selenium	0.25
Silver	0.5

[a]Environmental Control Technology Corporation Laboratory (ENCOTEC).
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.

Table 29
Summary of SWMU 231 Confirmatory Soil Sampling
Gamma Spectroscopy Analytical Results
September 1994
(Off-Site Laboratory)[a]

Sample Attributes			Activity (pCi/g)									
			Plutonium-238		Plutonium-239/240		Uranium-234		Uranium-235/236		Uranium-238	
Record Number[b]	ER Sample ID	Sample Depth (ft)	Result	Error[c]	Result	Error[c]	Result	Error[c]	Result	Error[c]	Result	Error[c]
0814	231-01-A	0–0.5	ND (0.011)	--	ND (0.004)	--	1.03	0.18	0.39	0.1	0.42	0.11
Background concentration			NC	--	NC	--	NC	--	NC	--	NC	--

[a]Enseco/Quanterra Laboratory.
[b]Analysis request/chain-of-custody record.
[c]Two standard deviations about the mean detected activity.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NA = Not applicable. Background concentration not available.
NC = Not calculated by Dinwiddie (September 1997).
ND ( ) = Not detected above the minimum detectable activity, shown in parentheses.
pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 30
Summary of SWMU 231 Confirmatory Soil Sampling
Tritium Analytical Results
September 1994
(Off-Site Laboratory)[a]

Sample Attributes			Activity (pCi/g)	
			Tritium	
Record Number[b]	ER Sample ID	Sample Depth (ft)	Result	Error[c]
0814	231-01-A	0–0.5	ND (0.001)	--
0814	231-04-A	0–0.5	ND (0.014)	--
Background concentration[d]			0.021	--

[a]Enseco/Quanterra Laboratory.
[b]Analysis request/chain-of-custody record.
[c]Two standard deviations about the mean detected activity.
[d]The tritium background value of 0.021 pCi/g was calculated from the Tharp (February 1999) tritium background value of 420 pCi/L. The pCi/L value was converted to the pCi/g value using the assumption of 5 percent soil moisture and a soil density of 1 g/cubic centimeter.

ER = Environmental Restoration.
ft = Foot (feet).
g = Gram(s).
ID = Identification.
L = Liter.
ND ( ) = Not detected above the minimum detectable activity, shown in parentheses.
pCi = Picocurie(s).
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 31
Summary of SWMU 231 Confirmatory Soil Sampling
VOC Analytical Results—Detections Only
June 2001
(Off-Site Laboratory)[a]

Sample Attributes			VOCs (EPA Method 8260[b]) (µg/kg)
Record Number[c]	ER Sample ID	Sample Depth (ft)	Acetone
604308	TJAOU-231-GR-05-0.0-S	0.0	ND (1)
604308	TJAOU-231-GR-05-0.0-DU	0.0	ND (1)
604308	TJAOU-231-GR-05-5.0-S	5.0	**3.8 J (4.9)**
604308	TJAOU-231-GR-06-5.0-S	5.0	ND (1)
Quality Assurance/Quality Control Sample (µg/L)			
604308	TJAOU-231-GR-TB1	NA	ND (0.82)

Note: Values in **bold** represent detected analytes.
[a]General Engineering Laboratories, Inc. (GEL).
[b]EPA November 1986.
[c]Analysis request/chain-of-custody record.
DU = Duplicate sample.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = Estimated value less than the laboratory reporting limit, shown in parentheses. See Data Validation Report (Attachment I).
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the method detection limit, shown in parentheses.
OU = Operable Unit.
S = Soil sample.
SWMU = Solid Waste Management Unit.
TB = Trip blank.
TJA = Tijeras Arroyo.
VOC = Volatile organic compound.

Table 32
Summary of SWMU 231 Confirmatory Soil Sampling
VOC Analytical Detection Limits
June 2001
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit for Soil Samples (µg/kg)	Method Detection Limit for Aqueous Samples (µg/L)
1,1,1-Trichloroethane	0.29	0.18
1,1,2,2-Tetrachloroethane	0.3	0.15
1,1,2-Trichloroethane	0.36	0.11
1,1-Dichloroethane	0.41	0.07
1,1-Dichloroethene	0.262	0.28
1,2-Dichloroethane	0.27	0.14
1,2-Dichloropropane	0.32	0.16
2-Butanone	0.76	0.81
2-Hexanone	0.94	0.79
4-methyl-2-Pentanone	1.34	0.7
Acetone	1	0.82
Benzene	0.39	0.14
Bromodichloromethane	0.35	0.15
Bromoform	0.36	0.1
Bromomethane	0.31	0.24
Carbon disulfide	0.62	0.9
Carbon tetrachloride	0.26	0.16
Chlorobenzene	0.4	0.2
Chloroethane	0.28	0.32
Chloroform	0.47	0.17
Chloromethane	0.35	0.21
Dibromochloromethane	0.41	0.16
Ethyl benzene	0.35	0.15
Methylene chloride	0.44	0.63
Styrene	0.32	0.15
Tetrachloroethene	0.4	0.21
Toluene	0.5	0.22
Trichloroethene	0.72	0.16
Vinyl acetate	0.77	0.44
Vinyl chloride	0.3	0.26
Xylene	1.05	0.44
cis-1,2-Dichloroethene	0.41	0.18
cis-1,3-Dichloropropene	0.28	0.18
trans-1,2-Dichloroethene	0.37	0.31
trans-1,3-Dichloropropene	0.24	0.17

[a]General Engineering Laboratories, Inc. (GEL).
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compound.

Table 33
Summary of SWMU 231 Confirmatory Soil Sampling
SVOC Analytical Results—Detections Only
June 2001
(Off-Site Laboratory)[a]

Sample Attributes			SVOCs (EPA Method 8270[b]) (µg/kg)				
Record Number[c]	ER Sample ID	Sample Depth (ft)	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene
604308	TJAOU-231-GR-05-0.0-S	0.0	ND (5.99)	ND (2)	ND (2.33)	ND (5)	ND (6.33)
604308	TJAOU-231-GR-05-0.0-DU	0.0	**39.7**	**56.9**	**62.1**	**35.7**	**56.6**
604308	TJAOU-231-GR-05-5.0-S	5.0	ND (5.99)	ND (2)	ND (2.33)	ND (5)	ND (6.33)
604308	TJAOU-231-GR-06-5.0-S	5.0	ND (5.99)	ND (2)	ND (2.33)	ND (5)	ND (6.33)

Sample Attributes			SVOCs (EPA Method 8270[b]) (µg/kg)				
Record Number[c]	ER Sample ID	Sample Depth (ft)	Fluoranthene	Indeno(1,2,3-c,d) pyrene	Phenanthrene	Pyrene	bis(2-Ethylhexyl) phthalate
604308	TJAOU-231-GR-05-0.0-S	0.0	ND (3.33)	ND (6.66)	ND (4)	ND (8.66)	ND (6.99)
604308	TJAOU-231-GR-05-0.0-DU	0.0	**42.5**	**46.7**	**19.8 J (33.3)**	**60.5**	**82.6 J**
604308	TJAOU-231-GR-05-5.0-S	5.0	ND (3.33)	ND (6.66)	ND (4)	ND (8.66)	ND (6.99)
604308	TJAOU-231-GR-06-5.0-S	5.0	ND (3.33)	ND (6.66)	ND (4)	ND (8.66)	ND (6.99)

Note: Values in **bold** represent detected analytes.
[a]General Engineering Laboratories, Inc. (GEL).
[b]EPA November 1986.
[c]Analysis request/chain-of-custody record.

DU = Duplicate sample.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = Estimated value. See Data Validation report (Attachment I).
J ( ) = Estimated value less than the laboratory reporting limit, shown in parentheses. See Data Validation Report (Attachment I).
µg/kg = Microgram(s) per kilogram.
ND ( ) = Not detected above the method detection limit, shown in parentheses.
OU = Operable Unit.
S = Soil sample.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
TJA = Tijeras Arroyo.

Table 34
Summary of SWMU 231 Confirmatory Soil Sampling
SVOC Analytical Detection Limits
June 2001
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit for Soil Samples (µg/kg)	Method Detection Limit for Aqueous Samples (µg/L)
1,2,4-Trichlorobenzene	4.66	1.52
1,2-Dichlorobenzene	4.33	1.63
1,3-Dichlorobenzene	3.33	1.51
1,4-Dichlorobenzene	5.99	1.83
2,4,5-Trichlorophenol	42.3	1.18
2,4,6-Trichlorophenol	24.6	1.12
2,4-Dichlorophenol	7.99	1.28
2,4-Dimethylphenol	71.9	1.29
2,4-Dinitrophenol	15	1.36
2,4-Dinitrotoluene	5	0.97
2,6-Dinitrotoluene	3	1.09
2-Chloronaphthalene	3.66	0.13
2-Chlorophenol	5	1.24
2-Methylnaphthalene	4	0.15
2-Nitroaniline	80.9	2.09
2-Nitrophenol	46.3	1.33
3,3'-Dichlorobenzidine	143	1.1
3-Nitroaniline	86.6	1.31
4-Bromophenyl phenyl ether	4.66	1.14
4-Chloro-3-methylphenol	36.6	1.39
4-Chlorobenzenamine	58.9	2.5
4-Chlorophenyl phenyl ether	3.33	1.18
4-Methylphenol	5.66	1.07
4-Nitroaniline	83.9	1.55
4-Nitrophenol	21	0.18
Acenaphthene	4	0.07
Acenaphthylene	3.66	0.1
Anthracene	4.66	0.13
Benzo(a)anthracene	5.99	0.1
Benzo(a)pyrene	2	0.13
Benzo(b)fluoranthene	2.33	0.13
Benzo(ghi)perylene	5	0.08
Benzo(k)fluoranthene	5	0.23
Butylbenzyl phthalate	12.7	1.82
Carbazole	5	1.26
Chrysene	6.33	0.12
Di-n-butyl phthalate	20.6	1.82
Di-n-octyl phthalate	8.99	2.12
Dibenz(a,h)anthracene	2.66	0.1
Dibenzofuran	2.66	0.99
Diethylphthalate	19.6	1.23
Dimethylphthalate	11.7	1.11
Dinitro-o-cresol	16	0.97
Diphenyl amine	15.7	1.02

Refer to footnotes at end of table.

Table 34 (Concluded)
Summary of SWMU 231 Confirmatory Soil Sampling
SVOC Analytical Detection Limits
June 2001
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit for Soil Samples (µg/kg)	Method Detection Limit for Aqueous Samples (µg/L)
Fluoranthene	3.33	0.12
Fluorene	3	0.12
Hexachlorobenzene	4.66	0.76
Hexachlorobutadiene	6.66	1.76
Hexachlorocyclopentadiene	33	1.1
Hexachloroethane	4.33	1.7
Indeno(1,2,3-c,d)pyrene	6.66	0.1
Isophorone	2.33	1.12
Naphthalene	3.33	0.12
Nitro-benzene	36.6	1.42
Pentachlorophenol	60.9	1.58
Phenanthrene	4	0.12
Phenol	3.66	0.84
Pyrene	8.66	0.14
bis(2-Chloroethoxy)methane	5.99	1.39
bis(2-Chloroethyl)ether	6.66	1.4
bis(2-Ethylhexyl)phthalate	6.99	0.04
bis-Chloroisopropyl ether	37.1	1.32
n-Nitrosodipropylamine	33	1.32
o-Cresol	47.6	1.26

[a]General Engineering Laboratories, Inc. (GEL).
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.

Table 35
Summary of SWMU 231 Confirmatory Soil Sampling
Petroleum Analytical Detection Limits
June 2001
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit for Soil Samples (µg/kg)	Method Detection Limit for Aqueous Samples (µg/L)
Diesel range organics	450	3.37
Gasoline range organics	9.61	26.7

[a]General Engineering Laboratories, Inc. (GEL).
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
SWMU = Solid Waste Unit.

Table 36
Summary of SWMU 231 Confirmatory Soil Sampling
Metals Analytical Results
June 2001
(Off-Site Laboratory)[a]

Sample Attributes			Metals (EPA Methods 3005/3050/7196/7470/7471[b]) (mg/kg)				
Record Number[c]	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium
604308	TJAOU-231-GR-05-0.0-S	0.0	3.06	125	**0.829**	0.0282 J (0.463)	12.3
604308	TJAOU-231-GR-05-0.0-DU	0.0	2.51	129	**0.881**	0.0355 J (0.49)	14.1
604308	TJAOU-231-GR-05-5.0-S	5.0	2.72	132	**1.03**	0.0819 J (0.485)	**17**
604308	TJAOU-231-GR-06-5.0-S	5.0	2.6	126	**0.961**	0.0623 J (0.495)	16.1
Background concentration[d] (surface/subsurface)[e]			NC/4.4	281/200	0.8/0.8	<1/0.9	21.8/16.2

Sample Attributes			Metals (EPA Methods 3005/3050/7196/7470/7471[b]) (mg/kg)				
Record Number[c]	ER Sample ID	Sample Depth (ft)	Chromium (VI)	Lead	Mercury	Selenium	Silver
604308	TJAOU-231-GR-05-0.0-S	0.0	ND (0.07 J)	7.87	0.0114	0.493	ND (0.0578)
604308	TJAOU-231-GR-05-0.0-DU	0.0	ND (0.07 J)	6.49	0.0219	ND (0.135)	ND (0.0578)
604308	TJAOU-231-GR-05-5.0-S	5.0	ND (0.07 J)	7.53	ND (0.00455)	0.399 J (0.485)	ND (0.0578)
604308	TJAOU-231-GR-06-5.0-S	5.0	ND (0.07 J)	7.38	ND (0.00455)	0.561	ND (0.0578)
Background concentration[d] (surface/subsurface)[e]			NC/NC	39/11.2	<0.25/<0.1	<1/<1	<1/<1

Note: Values in **bold** indicate concentrations greater than background.
[a]General Engineering Laboratories, Inc. (GEL).
[b]EPA November 1986.
[c]Analysis request/chain-of-custody record.
[d]Dinwiddie September 1997.
[e]Surface samples defined as 0 to 6 inches; subsurface samples are greater than 6 inches.

DU = Duplicate sample.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = Estimated value less than the laboratory reporting limit, shown in parentheses. See Data Validation Report (Attachment I).
mg/kg = Milligram(s) per kilogram.
NC = Not calculated by Dinwiddie (September 1997).
ND ( ) = Not detected above the method detection limit, shown in parentheses.
ND (#J) = Not detected, uncertainty in the detection limit, shown in parentheses. See Data Validation Report (Attachment I).
OU = Operable Unit.
S = Soil sample.
SWMU = Solid Waste Management Unit.
TJA = Tijeras Arroyo.

Table 37
Summary of SWMU 231 Confirmatory Soil Sampling
Metals Analytical Detection Limits
June 2001
(Off-Site Laboratory)[a]

Analyte	Method Detection Limit for Soil Samples (mg/kg)	Method Detection Limit for Aqueous Samples (mg/L)
Aluminum	1.07	0.0343
Antimony	0.237	0.0038
Arsenic	0.137	0.00457
Barium	0.0148	0.00021
Beryllium	0.00767	0.0002
Cadmium	0.013	0.00025
Calcium	1.94	0.0375
Chromium	0.218	0.00078
Chromium (VI)	0.07	0.005
Cobalt	0.0545	0.0003
Copper	0.0251	0.00267
Iron	1.96	0.0206
Lead	0.17	0.00344
Magnesium	0.308	0.00449
Manganese	0.0239	0.00294
Mercury	0.00455	0.00007
Nickel	0.0995	0.00074
Potassium	0.866	0.00707
Selenium	0.135	0.00309
Silver	0.0578	0.0002
Sodium	1.25	0.00813
Thallium	0.472	0.00413
Vanadium	0.0594	0.00109
Zinc	0.13	0.00281

[a]General Engineering Laboratories, Inc. (GEL).
mg/kg = Milligram(s) per kilogram.
mg/L = Milligrams(s) per liter.
SWMU = Solid Waste Management Unit.

Table 38
Summary of SWMU 231 Confirmatory Soil Sampling
Gamma Spectroscopy Analytical Results
June 2001
(On-Site and Off-Site Laboratories)

Sample Attributes			Activity (pCi/g)							
Record Number[a]	ER Sample ID	Sample Depth (ft)	Cesium-137		Thorium-232		Uranium-235		Uranium-238	
			Result	Error[b]	Result	Error[b]	Result	Error[b]	Result	Error[b]
Samples Analyzed at RPSD Laboratory										
604307	TJAOU-231-GR-05-0.0-S	0.0	ND (0.036)	--	0.622	0.305	0.145	ND (0.183)	ND (0.784)	--
604307	TJAOU-231-GR-05-0.0-DU	0.0	0.0213	0.0132	0.614	0.294	ND (0.19)	--	ND (0.676)	--
604307	TJAOU-231-GR-05-5.0-S	5.0	ND (0.0261)	--	0.997	0.465	0.0938	0.162	0.947	0.293
604307	TJAOU-231-GR-06-5.0-S	5.0	ND (0.036)	--	0.781	0.393	0.138	0.198	ND (0.862)	--
Samples Analyzed at GEL										
604308	TJAOU-231-GR-05-0.0-S	0.0	0.0311	0.0233	0.672	0.0884	ND (0.147)	--	ND (0.904)	--
604308	TJAOU-231-GR-05-0.0-DU	0.0	ND (0.0269)	--	0.871	0.108	**0.228**	0.149	ND (1.35)	--
604308	TJAOU-231-GR-05-5.0-S	5.0	ND (0.0282)	--	1.03	0.128	ND (0.177)	--	ND (1.03)	--
604308	TJAOU-231-GR-06-5.0-S	5.0	ND (0.0397)	--	0.926	0.131	ND (0.186)	--	1.02	0.486
Background concentration[c] (surface/subsurface)[d]			0.908/NC	NA	NC/NC	--	NC/NC	--	NC/NC	--

Note: Values in **bold** indicate concentrations greater than background.
[a]Analysis request/chain-of-custody record.
[b]Two standard deviations about the mean detected activity.
[c]Dinwiddie September 1997.
[d]Surface samples defined as 0 to 6 inches; subsurface samples are greater than 6 inches.

DU = Duplicate sample.
ER = Environmental Restoration.
ft = Foot (feet).
GEL = General Engineering Laboratories, Inc.
GR = Grab sample.
ID = Identification.
NA = Not applicable.
NC = Not calculated by Dinwiddie (September 1997).
ND ( ) = Not detected above the minimum detectable activity, shown in parentheses.
OU = Operable Unit.
pCi/g = Picocurie(s) per gram.
RPSD = Radiation Protection Sample Diagnostics.
S = Soil sample.
SWMU = Solid Waste Management Unit.
TJA = Tijeras Arroyo.
-- = Information not available.

Table 39
Summary of SWMU 231 Confirmatory Soil Sampling
Tritium Analytical Results
June 2001
(Off-Site Laboratory)[a]

Sample Attributes			Activity (pCi/g)	
			Tritium	
Record Number[b]	ER Sample ID	Sample Depth (ft)	Result	Error[c]
604308	TJAOU-231-GR-05-0.0-S	0.0	ND (0.007)	--
604308	TJAOU-231-GR-05-0.0-DU	0.0	ND (0.007)	--
604308	TJAOU-231-GR-05-5.0-S	5.0	ND (0.007)	--
604308	TJAOU-231-GR-06-5.0-S	5.0	ND (0.007)	--
Background concentration[d]			0.021	NA

[a]General Engineering Laboratories, Inc. (GEL).
[b]Analysis request/chain-of-custody record.
[c]Two standard deviations about the mean detected activity.
[d]The tritium background value of 0.021 pCi/g was calculated from the Tharp (February 1999) tritium background value of 420 pCi/L. The pCi/L value was converted to the pCi/g value using the assumption of 5 percent soil moisture and a soil density of 1 g/cubic centimeter.
DU = Duplicate sample.
EB = Equipment blank.
ER = Environmental Restoration.
ft = Foot (feet).
g = Gram(s).
GR = Grab sample.
ID = Identification.
L = Liter.
NA = Not applicable.
ND ( ) = Not detected above the minimum detectable activity, shown in parentheses.
OU = Operable Unit.
pCi = Picocurie(s).
S = Soil sample.
SWMU = Solid Waste Management Unit.
TJA = Tijeras Arroyo.
-- = Information not available.

Table 40
Summary of SWMU 231 Confirmatory Soil Sampling
Gross Alpha and Beta Analysis
June 2001
(Off-Site Laboratory)[a]

Sample Attributes			Activity (pCi/g)			
			Gross Alpha		Gross Beta	
Record Number[b]	ER Sample ID	Sample Depth (ft)	Result	Error[c]	Result	Error[c]
604308	TJAOU-231-GR-05-0.0-S	0.0	**6.52**	4.39	**23**	4.25
604308	TJAOU-231-GR-05-0.0-DU	0.0	**4.24**	3.8	**17.6**	3.92
604308	TJAOU-231-GR-05-5.0-S	5.0	**13.9**	7.12	**16.3**	4.13
604308	TJAOU-231-GR-06-5.0-S	5.0	**17.4**	7.17	**20.8**	4.27

Note: Values in **bold** represent detected analytes. Background concentrations not available.
[a]General Engineering Laboratories, Inc. (GEL).
[b]Analysis request/chain-of-custody record.
[c]Two standard deviations about the mean detected activity.
DU = Duplicate sample.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
OU = Operable Unit.
pCi/g = Picocurie(s) per gram.
S = Soil sample.
SWMU = Solid Waste Management Unit.
TJA = Tijeras Arroyo.

ATTACHMENT A

ATTACHMENT A

Field Implementation Plan—Tijeras Arroyo Outfalls

FIELD IMPLEMENTATION PLAN - TIJERAS ARROYO OUTFALLS - 2001, A SAMPLING ODYSSEY

Plan Authorization and Implementation

Prepared by John R. Copland Date 31 May 2001
John Copland, 6133
Assistant Task Leader, Tijeras Arroyo Operable Unit

Reviewed by Sue Collins Date 31 May 2001
Sue Collins, 6133
Task Leader, Tijeras Arroyo Operable Unit

Approved by Dwight J. Stockham Date 5/31/01
Dwight Stockham, 6133
Department Manager, ER Technical Areas & Miscellaneous Sites

1.0 INTRODUCTION

This Field Implementation Plan (FIP) describes the confirmatory-soil sampling that will be conducted in the summer of 2001 at six of the Tijeras Arroyo Operable Unit (TJAOU) outfalls (Environmental Restoration [ER] Sites 230, 231, 232-1, 232-2, 233, and 234). These sites are managed by Sandia National Laboratories/New Mexico (SNL/NM) and are located on Kirtland Air Force Base (KAFB) along the northern rim of Tijeras Arroyo (Figure 1).

1.1 Project Information

Task Description Collect soil samples at TJAOU outfalls
Department 6133 ERMO Case No. 7225.02.02.10 ERFO Case No. 7225.02.03.01
Work Plan Title not applicable Field Team Leader John Copland
Scheduled Start of Sampling June 11, 2001 Estimated Completion July 1, 2001

1.2 Site Information

Technical Area OU 1309, Tijeras Arroyo Site(s) 230, 231, 232-1, 232-2 233, 234

1.3 Description of Sites

ER Sites 230, 231, 232-1, 232-2, 233, and 234 were designed to handle storm water from TA-IV (Table 1). One of the TA-IV outfalls, ER Site 234, is inactive. The outfalls are discussed in more detail in Section 2.

Table 1. Details for outfalls located near TA-IV.

ER Site	Type of water disposed of	Period of Use	Area (Acres)
230	Storm water from TA-IV	Early 1980s to present	0.02
231	Storm water from TA-IV	Early 1980s to present	0.04
232-1	Storm water from TA-IV	Early 1980s to present	0.01
232-2	Storm water from TA-IV	Early 1980s to present	0.02
233	Storm water from TA-IV	Early 1980s to present	0.03
234	Storm water from TA-IV	About 1979 to early 1990s	0.15

1.4 Physical Setting

The sites are located along the steep northern rim of Tijeras Arroyo and on the nearly flat floodplain between the Pennsylvania Avenue bridge and Powerline Road. However, none of the sites are located within the 100-year Tijeras Arroyo floodplain. The sites are not fenced; however, the sites are infrequently visited by non-ER Project personnel. Tijeras Arroyo is the most significant surface-water drainage feature on KAFB. The watershed for Tijeras Arroyo includes Tijeras Canyon and various storm-water channels in southeast Albuquerque. The arroyo eventually drains into the Rio Grande, approximately eight miles west of the Pennsylvania Avenue bridge.

The annual precipitation for the area, as measured at the Albuquerque International Sunport, is 8.1 inches (NOAA, 1990). No springs or perennial surface water bodies are located within four miles of the site. The vicinity of each site is unpaved. During most storm events, precipitation quickly infiltrates the soil. However, virtually all of the moisture undergoes evapotranspiration. Estimates of evapotranspiration for the KAFB area range from 95 to 99 percent of the annual rainfall (SNL/NM, 1998). Except for a few puddles, water does not pond at the sites even after heavy rainfall.

Groundwater monitoring for the area is conducted as part of the Tijeras Arroyo Groundwater (TAG) Investigation. Two water-bearing zones, the shallow water-bearing zone and the regional aquifer, underlie the area. The shallow water-bearing zone is not used for water supply. Ten shallow monitor wells are located in the vicinity of the site. The depth to the shallow water-bearing zone ranges across the area from about 280 to 330 ft below ground surface (bgs). Six regional-aquifer monitor wells are located in the vicinity. The depth to the regional aquifer ranges from approximately 450 to 500 ft bgs. Both the City of Albuquerque and KAFB utilize the regional aquifer for water supply. The nearest water-supply well is KAFB-4, which is located approximately 0.9. miles west of ER Site 234. KAFB-1 is the nearest downgradient water-supply well and is located approximately 1.4 miles northwest of ER Site 234.

For purposes of defining the background levels of metals and radionuclides, soil at the site has been included as part of the North Supergroup. More formally, the soil has been identified as the Bluepoint-Kokan Association (SNL/NM, 1998). The Bluepoint-Kokan Association consists of the Bluepoint loamy fine sand, which is developed on slopes of 5 to 15 percent, and the Kokan gravelly sand on slopes of 15 to 40 percent. These soils are slightly calcareous and mildly to moderately alkaline. Runoff potential ranges from slow to very rapid with water permeability being moderate to very rapid. The hazard of water erosion is slight to severe. The Bluepoint-Kokan Association is underlain by the upper unit of the Santa Fe Group. The upper Santa Fe Group consists of coarse- to fine-grained fluvial deposits from the ancestral Rio Grande that intertongue with coarse-grained alluvial fan/piedmont veneer facies, which extend westward from the Sandia and Manzanita Mountains. The upper Santa Fe unit is approximately 1,200 ft thick in the vicinity of the site (SNL/NM, 1998).

The land-use setting for the surrounding area is industrial. The area was originally desert grassland habitat, but has been highly disturbed by SNL/NM (IT Corporation, 1995). The site is principally vegetated by ruderal species such as Russian thistle (tumbleweed). Grasslands are the dominant plant community and include species such as blue and black grama and western cheatgrass. The indigenous wildlife includes reptiles, birds, and small mammals. However, wildlife use is limited by the degree of disturbance and proximity to operational facilities. The area was surveyed for sensitive species in 1994; no threatened or endangered species, or any other species of concern, have been identified in the area. No riparian or wetland habitats are present within four miles of the outfalls.

2.0 RESULTS OF PREVIOUS INVESTIGATIONS

Soil sampling, with varying degrees of practicality, has been conducted at each of the sites. All of the previous sampling results have been documented in various No Further Action (NFA) Proposals, Notice Of Deficiency (NOD) Responses, and a Request for Supplemental Information (RSI) Response (Table 2).

Table 2. List of documents for ER Sites 230, 231, 232-1, 232-2, 233, 234, and 235.

ER Site	SNL/NM Documents Sent to NMED	Records Center Barcode (Shears) #
230	NFA Proposal – Batch 2 – June 1995 NOD Response – October 1996 NOD Response – December 1999	50556 53440 198016
231	NFA Proposal – Batch 2– June 1995 NOD Response – October 1996 NOD Response – December 1999	50556 53440 198016
232-1	NFA Proposal – Batch 8 – August 1997 RSI Response – September 1999 NOD Response – December 1999	12262 165846 198016
232-2	NFA Proposal – Batch 8 – August 1997 RSI Response – September 1999 NOD Response – December 1999	12262 165846 198016
233	NFA Proposal – Batch 2 – June 1995 NOD Response – October 1996 NOD Response – December 1999	50556 53440 198016
234	NFA Proposal – Batch 2 – June 1995 NOD Response – October 1996 NOD Response – December 1999	50556 53440 198016
235	NFA Proposal – Batch 2 – June 1995 NOD Response – October 1996 NOD Response – December 1999	50556 53440 198016

Relevant details from the documents are summarized below for each of the outfalls. Recent findings and new clarifications also are discussed below.

2.1 Site History for the Storm-Water Outfalls

A redundancy in environmental compliance applies to the outfalls. Besides being listed as ER sites, the outfalls are also addressed by the National Pollutant Discharge Elimination System (NPDES) process in the SNL/NM Storm Water Program. Except for a mineral-oil spill at ER Site 232-2 in June of 1994, no other spills or releases of hazardous or radioactive materials have occurred at the outfalls. The mineral-oil spill was remediated in 1994. No stained soil or discolored outfall components have been seen since November 1995 when John Copland and Sue Collins began working on the sites. None of the sites have been on the radioactive materials management area (RMMA) list. However, ER Site 232-2 was informally tracked as a RMMA from June 1994 until November 1999.

The outfalls were constructed in various stages as buildings and parking lots were built at TA-IV. The sites are located on the steep northern rim of the arroyo where slopes range from about 20 to 40 degrees. The five ER sites along the south and southeast sides of TA-IV have a total of six outfalls. ER Site 232 is unique with two outfalls. Three of the six outfalls were constructed with concrete ditches that serve to minimize soil erosion on those rare days when precipitation falls at TA-IV. The concrete ditches at ER Sites 230, 231, and 232-1 range in length from about 55 to

70 ft. The depth and width of the concrete ditches are typically about two and four ft, respectively.

The TA-IV outfalls are shown on Photographs 1 to 18. Photograph 2 is an example of how the sites are marked with ER signs that are quite visible from the unpaved perimeter road on the south side of TA-IV. More ER signs are located on the Tijeras Arroyo floodplain. It is important to note that most of the ER signs do not accurately mark the site boundaries. All of these sites are, or have been, storm-water discharge points for TA-IV. The storm water comes from the TA-IV parking lots and roof drains. With research operations beginning in 1980, TA-IV is the newest SNL/NM technical area and has operated using modern environmental, safety, and health procedures. As such, TA-IV has had a minimal impact on the environment.

The first significant environmental work at began at the storm-water outfalls in 1994. Early that year, a visual inspection for UXO/HE material was conducted by KAFB Explosive Ordnance Disposal (EOD). No UXO/HE was observed. Also during 1994, Rust Geotech, Inc. conducted a gamma-radiation survey of the sites; no radioactive anomalies were found.

The uppermost boundary of each site is set at the point where storm water occasionally discharges on to the bare ground surface. At half of the outfalls, this boundary is at the lower end of the concrete ditch. At the other half of the outfalls, the uppermost boundary is set at the end of the outfall pipe. The lowermost boundary of each site was set in 1994, presumably at the farthest extent of soil erosion. As a result, each site is elongate. The sites vary in length from 70 to 280 ft, while the widths range from 5 to 35 ft.

Over the years, the long trench-like concrete components have had various names: flumes, concrete-drainage ditches, culverts, and channels. For simplicity, the term 'concrete ditches' has been used in this FIP and the attached figures. The term 'headwall' refers to the concrete component in which the outfall pipe is located.

In 1994, the *Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit* outlined the initial sampling for ER Sites 230 through 235 (SNL/NM, 1994). This *SNL/NM* sampling and analysis plan (SAP) will be known in this FIP as the *11-Sites SAP*, which in my opinion was poorly designed and executed. Except for ER Site 232-2, all of the outfall sites were sampled using the *11-Sites SAP* in September 1994. The soil samples were collected with a hand auger or trowel. Samples were collected from either 0-6 inches or 6-36 inches below ground surface (bgs). The shallow (0-6 inches) samples have an 'A' in the sample identifier. For example, the last (sixth) soil sample from ER Site 234 was identified as 234-06-A and was collected from a depth of 0 to 6 inches bgs. The 6-36 inches sample was identified as 234-06-B. The A and B samples were sometimes collected within just a few lateral inches of each other. Therefore, some older figures simplify the locations by combining the A and B samples into for example 234-06-A/B.

Figures 2 through 7 depict the 1994 soil-sampling locations. In September 2000, two locations per site were GPS'd as a verification check. The sample locations were found to be accurate in the EGIS database. However, some of the outfall components were found to be inaccurate on some of the old NOD figures. Figures 2 through 7 now accurately depict the outfall components.

In 1994, the TJAOU also collected background soil samples using the *11-Sites SAP*. Unique background values were subsequently calculated and used in the June 1995 NFA proposals for ER Sites 230, 231, 233, 234, and 235. However, these background values have been superseded by the NMED's approved background values that are used in the 1996 and 1999 NOD Responses.

Soil samples for the *11-Sites SAP* were analyzed for VOCs, SVOCs, total petroleum hydrocarbons (TPH), TAL metals, HE compounds, tritium, gamma-emitting radionuclides, and nitrate/nitrite. The samples were analyzed by Quanterra/Enseco and SNL/NM's Radiological Sample Diagnostic (Amir's) laboratory.

No significant contamination was identified at ER Sites 230, 231, 233, and 234. However, various problems such as the lack of sufficient quality assurance/quality control (QA/QC) samples nearly negated the usefulness of the analytical data. The failure to collect soil samples from the center line of the drainage ditches also has proven troublesome for NMED; they have not looked favorably at sample locations that are at the corners of the site boundaries instead of in-line with the concrete ditches and outfall pipes.

In their last NOD (October 13, 1999) concerning ER Sites 230 through 235, NMED requested that the analytical data for the 1994 sampling be formatted in the style of the 12th Batch NFA Proposals. This format was subsequently used in the ER Site 235 NOD Response, which NMED used as the basis for granting the site NFA status on March 27, 2000. Reformatting the remainder of the 1994 analytical data will be tedious because the data are not in ERDMS. However, hard copies for each site are on file in the Records Center. Besides reviewing the files for ER Sites 230 through 234, the ER Site 235 files and the October 1996 NOD Response will need to be reviewed in order to find all of the QA/QC samples. Except for the soil samples that were collected for the mineral-oil release, the samples at ER Sites 230 through 235 were collected during a one-week period in 1994. Unfortunately, some of the 1994 QA/QC samples such as the equipment blanks were collected on only one day. In the October 1996 NOD Response, some of the QA/QC results were inferred to be representative for the entire week during which ER Sites 230 through 235 had been sampled.

Unique features for each of the storm-water outfalls are discussed below in more detail.

2.1.1 Site History for ER Site 230

ER Site 230 consists of a 65-ft long earthen ditch (Photograph 1). The adjacent outfall components consist of a galvanized storm-water grate, buried 18-inch diameter concrete pipe, and a 55-ft long concrete ditch (Photographs 2 and 3). In 1994, four soil samples (230-01-A/B through 230-04-A/B) were collected down slope of the concrete ditch.

2.1.2 Site History for ER Site 231

ER Site 231 consists of a 140-ft long earthen ditch. The adjacent outfall components consist of a headwall with an 18-inch diameter concrete pipe that drains into 105-ft long concrete ditch

(Photographs 4 and 5). In 1994, four soil samples (231-01-A/B through 231-04-A/B) were collected down slope of the concrete ditch.

2.1.3 Site History for ER Site 232-1

ER Site 232-1 consists of a 70-ft long earthen ditch, the upper part of which is shown in Photograph 6. The adjacent outfall components consist of a headwall with a 24-inch diameter concrete pipe that drains into a 70-ft long concrete ditch and then the earthen ditch (Photograph 7). Two soil sampling investigations were conducted at ER Site 232-1. The first investigation in 1994 collected eight soil samples (232-01-A/B, 232-02-A/B, 232-03-A/B, and 232-04-A/B) to a maximum depth of 3 ft bgs. The soil samples contained total petroleum hydrocarbons (TPH) concentrations that ranged from non-detect [<50 mg/kg (ppm)] to a maximum of 860 ppm. A second investigation was subsequently implemented in 1995 to define the extent of TPH in soil. Samples were collected at depths of 5, 6, and/or 10 ft from five GeoProbe boreholes (BH-1, BH-2, BH-3, BH-4, and BH-5) which were placed at the same four sample locations as the first investigation and one additional location farther down slope (Figure 4). The 13 soil samples from the second investigation contained TPH concentrations that ranged from 6 to 32 ppm. The first and second investigations indicate that soil containing TPH concentrations above 100 ppm was limited to the immediate vicinity of the southern end of the concrete ditch at a depth of 3 ft or less. No SVOCs or VOCs such as benzene, toluene, ethylbenzene, or xylenes (BTEX) were detected in the soil samples.

In the RSI of September 1999, NMED requested the excavation of soil at ER Site 232-1 that contained greater than 100 ppm TPH. This overly conservative request was based upon surface-water concerns. A review of the 1994 sample results suggest that the volume of soil to be removed was just a couple of cubic yards. Unfortunately, depth measurements hung on the concrete ditch were not taken during the 1994 sampling. The issue of whether or not much soil erosion has occurred there has been a concern for ER Site 232-1. However, an aerial photograph shows that the ground surface was not graded to intercept the end of the concrete ditch (Photograph 8). Construction in the early 1980s left a significant drop-off of about five ft. Therefore, only a minor amount of soil erosion has occurred at ER Site 232-1. No oily stains have been observed on the concrete ditch or the nearby soil.

As mentioned above, NMED's RSI of September 1999 requested more soil sampling and the excavation of soil that contained TPH in excess of 100 ppm. However, recent guidance from NMED suggests that the excavation requirement is a moot issue. The July 18, 2000 letter from the NMED Hazardous Waste Bureau and the accompanying Position Paper (*Use of TPH Test Results for Site Characterization*) both endorse the August 13, 1993 guidelines from the New Mexico Oil Conservation Division (OCD). The OCD *Guidelines for Remediation of Leaks, Spills, and Releases* sets forth a ranking criteria for oil spills. ER Site 232-1 scores a ranking criteria of zero (0) because the depth to water is greater than 100 ft and no perennial surface-water bodies, water-supply wells, or other water sources are located nearby. Accordingly, the TPH action level for the site should be 5,000 ppm above background. Hopefully, NMED will issue a final decision supporting the use of the OCD guidelines.

2.1.4 Site History for ER Site 232-2

Prior to September 1996, some old records have confused the numbering for ER Sites 232-1 and 232-2. The numbering was standardized in the October 1996 NOD Response. The northern outfall discharges at ER Site 232-1, whereas the southern outfall discharges at ER Site 232-2. Uniquely, the *11-Sites SAP* was not used for Site 232-2 because of the mineral oil spill.

ER Site 232-2 consists of a 90-ft long earthen ditch (Photograph 9). The adjacent outfall components consist of a headwall with a 24-inch diameter concrete pipe that drains on to a five-ft long concrete slab and then the earthen ditch. No concrete ditch was installed at the site (Photograph 10). In June 1994, SNL/NM implemented a Voluntary Corrective Measure (VCM) to remediate the mineral oil spill at ER Site 232-2. Approximately 150 to 300 gallons of mineral oil had discharged from the outfall in June 1994. The mineral oil was HERMES oil, a petroleum-based oil that did not contain polychlorinated biphenyls (PCBs). The resulting oil stain on the ground surface down slope of the outfall was about 50-ft long with a width that varied from about 3 to 5 ft. The VCM involved excavation of oil-contaminated soil and confirmatory-soil sampling.

The VCM was conducted in July through November of 1994 to remove soil contaminated with mineral oil above the overly conservative cleanup goal of 100 ppm TPH. The contaminated soil was removed with a backhoe. The meager amount of field notes were summarized in the ER Site 232 NFA Proposal. The resulting trench began at the concrete slab and proceeded southeastward for about 75 ft. The average depth of the trench was about 5 ft. Near the concrete slab, the trench was excavated to a depth of about 9 ft. The southern end of the trench varied in depth from about 4 to 10 ft. The final width of the trench varied from about 15 to 30 ft. The total amount of excavated soil was approximately 429 cubic yards.

The sampling nomenclature for outfall 232-2 was an awkward set of 'blind' numbers (015861 through 015896, 017817, and 017818). A total of 101 samples and splits were collected and analyzed. Unfortunately, most of the sampling locations were apparently not documented. The 12 documented sampling locations are shown on Figure 5. Despite numerous tries, I have not been able to find a field log book for the VCM activities. Figure 5 depicts all the soil-sampling locations that I could find in the meager ER Site 232 notes.

Five VCM methods were used to verify that the cleanup goal was reached: visual observation of oil-stained soil; the use of a Hanby immunoassay kit; real-time monitoring with a FID; analyses of soil samples by ERCL; and analyses of soil samples by two off-site laboratories (Analytical Technologies, Inc. [ATI], and Enseco-Quanterra). As an additional verification check, SNL/NM and NMED collected 12 confirmatory soil samples along the trench in August, September, October 1994 (Figure 5). The SNL/NM samples (015887 through 015896) were analyzed for TPH and TAL metals by the Enseco-Quanterra laboratory. The maximum TPH concentration was 31.6 ppm. The three NMED split-soil samples were analyzed by their laboratory in Santa Fe; no VOCs or SVOCs were detected.

Based on the analyses of the verification samples, all of the mineral-oil contamination greater than the 100 ppm cleanup goal was successfully excavated. In addition, no significant concentrations of metals, VOCs, or SVOCs were present in soil. At the conclusion of the VCM field activities, the drainage below the outfall was backfilled with clean soil and the original grade was re-established. The excavated soil was disposed of off-site after being characterized as a non-regulated substance, i.e., not a Resource Conservation and Recovery Act (RCRA) hazardous waste or a radioactive waste. The soil was shipped to the United States Pollution Control Inc. - Grassy Mountain facility at Clive, Utah.

2.1.5 Site History for ER Site 233

ER Site 233 is a 175-ft long site that is unique with its two discharge points. The first discharge point is located next to the unpaved TA-IV perimeter road between the headwall/outfall pipe and the storm-water grate (Photograph 11). Storm water flows across bare ground at the first discharge point and then into the storm-water grate that is connected to an additional 75-ft long segment of buried piping. This piping terminates at a drop structure from which the storm water discharges for a second time on to the ground surface; this time into a earthen ditch (Photographs 12 and 13). In 1994, four soil samples (233-01-A/B through 233-04-A/B) were collected at ER Site 233 (Figure 11).

2.1.6 Site History for ER Site 234

ER Site 234 consists of a 270-ft long earthen ditch (Photograph 14). No outfall components are currently present at the site (Photograph 15). Before being removed in the early 1990s, the ER Site 234 outfall consisted of a steel pipe and possibly a headwall. No concrete ditch was used. In the early 1990s, the southernmost 90 ft of the outfall pipe was removed and storm water was re-directed through a buried pipe to the ER Site 233 outfall.

In September 2000, research of historical aerial photographs and engineering drawings revealed that the boundary for ER Site 234 was incorrect. The northern end of the site is now set where storm water had discharged from the outfall pipe. The southern end of the site remains where it was set in 1994 at the southern limit of soil erosion. A unrelated sewer manhole and a small electrical vault are located near the southern end of the site.

The soil-sample results also were recently re-evaluated. Of the six sampling locations (234-01-A/B through 234-06-A/B) that were used in 1994, only three locations (234-01-A/B, 234-05-A/B, and 234-06-A/B) are within the revised site boundary and potentially useful for site characterization. However, the sampling depth for sample 234-01-A/B was probably too shallow at a mere three ft bgs to have penetrated through the layer of backfill soil that remained after the removal of the outfall pipe. As such, sample 234-01-A/B may not have contained native soil from beneath or downstream of the outfall pipe. Samples 234-05-A/B and 234-06-A/B maybe useful for characterizing the southern end of the site. However, these two sample may contain some residual contaminants from the waste water that discharged from the outfall ditches. The other three sample locations (234-02-A/B, 234-03-A/B, and 234-04-A/B) were collected at useless locations where outfall pipes had been erroneously suspected in 1994.

One peculiar aspect of ER Site 234 is that TA-IV storm water was directed to the confluence area for the three ER Site 46 outfall ditches (OD-1, OD-2, and OD-3), where acid-waste water had discharged from 1948 to 1973. A review of historical aerial photography was used in August 2000 to re-evaluate the boundary for ER Site 46 (Photograph 16). Photograph 17 shows the surviving 60 ft segments for outfall ditches OD-1 and OD-2 at adjacent ER Site 46. In August 2000, steel-rebar markers with orange-square caps were placed at each end of the surviving segments. Because of TA-IV construction and installation/removal of the outfall pipe for ER Site 234, no field evidence for outfall ditch OD-3 remains. In August 2000, a steel-rebar marker was placed at the northern end of ER Site 234 outfall pipe where the was previously located; this location was GPS'd and verified to be where soil sample 234-01-A/B was collected in 1994 (Photograph 18).

2.2 Constituents of Concern

In the June 1995 No Further Action (NFA) Proposals, the COCs for ER Sites 230, 231, 233, and 234 were considered to be chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, diesel fuel, and mineral oil. This list of COCs was conservatively based upon chemicals used at TA-IV. The analytes of VOCs, SVOCs, RCRA metals, and chromium-VI are indicative of the COCs. However no chemical releases are known to have occurred in the area that drains to these sites.

The August 1997 NFA Proposal for ER Site 232 was not consistent with the other four storm-water outfalls. For consistency sake, the above-listed COCs will hereafter be applied to ER Sites 232-1 and 232-2.

3.0 EVALUATION OF PREVIOUS INVESTIGATIONS

Analytical results from the 1994 soil sampling at ER Sites 230, 231, 232-1, 232-2, 233, and 234 did not identify any significant contamination. The oil spill of non-hazardous mineral oil at ER Site 232-2 has been remediated. No releases of chemical or radioactive materials have occurred at any of the storm-water outfalls.

4.0 PLANNED ACTIVITIES

The following sections describe the activities planned for the outfalls.

4.1 Overview

Soil samples will be collected at six ER sites. The samples will be collected by personnel from the Environmental Restoration Field Office (ERFO). Hand tools and a backhoe will be used to collect the samples.

The sampling at ER Sites 230, 231, 232-1, 232-2, 233, and 234 will follow-up on the 1994 shallow-soil sampling. Unfortunately, the 1994 samples were not collected from the centerline of the storm-water ditches. More sampling details are discussed in Section 4.3.2.

4.2 Permitting, Approval, and Notification Requirements

The ER Field Work Checklist has been completed for this FIP. In accordance with the National Environmental Policy Act (NEPA), a review of the potential impacts of this project has already been undertaken, and clearance to proceed has been granted (Bleakly, 2001). Even though part of the sites are located adjacent to the Tijeras Arroyo floodplain, a U.S. Army Corps of Engineers permit is not required for collecting the samples with the backhoe. This exception is inferred from the correspondence (Fink, 1998; Manger, 1998) that supported the heavy-equipment work at nearby ER Site 228A.

4.3 Planned Sampling Activities

The planned sample locations for ER Sites 230-234 are listed in Table 3 and are shown on Figures 2 through 7. Sampling design is based upon several documents (Table 2) and various meetings. The most important meeting occurred on 17 November 1999 with SNL/NM representatives (Sue Collins, John Copland, and Bob Galloway) talking with NMED staff (Will Moats and Roger Kennett). Findings of the meeting were subsequently incorporated into the last formal document (the NOD Response of December 1999). This FIP also expands upon Mr. Moat's expectations, some of which may not be totally evident in our various NOD Responses or the Request for Supplemental Information (RSI) Response. In typical fashion, NMED has not formally responded to the 2001 sampling as proposed in the December 1999 NOD Response because Sue Collins verbally committed during the November meeting to fulfill all of Mr. Moat's expectations.

Depending upon NMED's site-specific requests, either two or three locations will be sampled per site (Table 3). The first location at each site will be located approximately five ft directly down slope of where storm water has discharged on to the bare ground surface. The second location will be located 30 ft farther down the center line of the drainage ditch from the first sampling location. NMED requested that these '5 ft from outfall' and '35 ft from outfall' locations be sampled at depths of 5 and/or 10 ft, bgs (Table 3). For both ER Sites 230 and 233, NMED also requested locations next to the storm-water grates.

To ensure that no sampling issues are unresolved at the waste-water outfalls, the TJAOU has decided to collect additional surface-soil (0-1 ft bgs) samples at each of the '5' locations. Because of a recent revision to the boundary for ER Site 234, The TJAOU has determined that the sampling for that site needs to be slightly modified from the December 1999 NOD Response. As shown on Figure 7, the two 2001 sample locations for ER Site 234 reflect the September 2000 revision of the site boundary.

A total of 29 soil samples will be collected at the outfalls. To prevent confusion, the 2001 sample numbers will start where the 1994 sample numbers stopped. The 2001 sample locations will have slightly different sampling nomenclature than the 1994 samples because the ER Project standardized the sampling nomenclature in April 1995. For example, the next soil sample for ER Site 234 with be at the seventh location and will be identified as TJAOU-234-GR-07-S-5.

Table 3. Proposed 2001 Soil Samples for ER Sites 230, 231, 232-1, 232-2, 233, and 234.

ER Site	Sample Number	Depth (ft, bgs)	Sample location/comment
230	TJAOU-230-GR-05	0-1	Storm water grate near TA-IV fence
	TJAOU-230-GR-06	0-1	5 ft from lower end of concrete ditch
	TJAOU-230-GR-06-DU	dupe	--
	TJAOU-230-GR-06	5-6	5 ft from lower end of concrete ditch
	TJAOU-230-GR-07	5-6	35 ft from lower end of concrete ditch
231	TJAOU-231-GR-05	0-1	5 ft from lower end of concrete ditch
	TJAOU-231-GR-05-DU	dupe	--
	TJAOU-231-GR-05	5-6	5 ft from lower end of concrete ditch
	TJAOU-231-GR-06	5-6	35 ft from lower end of concrete ditch
232-1	TJAOU-232-1-GR-05	0-1	Underneath the lower end of concrete ditch
	TJAOU-232-1-GR-05-DU	dupe	--
	TJAOU-232-1-GR-06	5-6	5 ft from lower end of concrete ditch
	TJAOU-232-1-GR-07	5-6	35 ft from lower end of concrete ditch
232-2	TJAOU-232-2-GR-1	0-1	5 ft from outfall-pipe concrete slab
	TJAOU-232-2-GR-1-DU	dupe	--
	TJAOU-232-2-GR-1	5-6	5 ft from outfall-pipe concrete slab
	TJAOU-232-2-GR-1	10-11	5 ft from outfall-pipe concrete slab
	TJAOU-232-2-GR-2	5-6	35 ft from outfall-pipe concrete slab
	TJAOU-232-2-GR-2	10-11	35 ft from outfall-pipe concrete slab
233	TJAOU-233-GR-05	0-1	by storm-water grate at upper end of site
	TJAOU-233-GR-05-DU	dupe	--
	TJAOU-233-GR-05	5-6	by storm-water grate at upper end of site
	TJAOU-233-GR-06	0-1	5 ft from drop structure
	TJAOU-233-GR-06	5-6	5 ft from drop structure
	TJAOU-233-GR-07	5-6	35 ft from drop structure
234	TJAOU-234-GR-07	0-1	Upper end of site at rebar marker
	TJAOU-234-GR-07-DU	dupe	--
	TJAOU-234-GR-07	5-6	Upper end of site at rebar marker
	TJAOU-234-GR-08	5-6	35 ft from upper rebar marker
Total = 29	--	--	--

4.3.3 Conducting Buried-Utility Surveys

SNL/NM Facilities Engineering staff will perform line-spotting services and will locate the buried utilities at each of the seven sites. Dig/Penetration permits have been obtained from both SNL/NM and KAFB. Figure 8 shows a utilities coverage from the Facilities Engineering CAD system.

4.3.4 Implementing Waste-Management Procedures

No regulated waste will be generated.

4.3.5 Collecting Confirmatory-Soil Samples

The sampling procedures are listed in Table 4. Soil samples will be collected using either grab, hand-auger, and/or backhoe techniques. The use of a backhoe to collect soil samples at the outfalls was endorsed by Mr. Moats during a 27 April 2001 meeting with John Copland (logbook ER-050). Soil will be quickly transferred from the backhoe bucket to the sample containers.

Samples will be immediately labeled and placed in a cooler and stored at 4°C. Because none of sites are RMMAs, a RCT will not need to frisk and swipe the sample containers. Samples will be delivered to the Sample Management Office (SMO) for processing and shipment to the appropriate analytical laboratory. A completed Analysis Request and Chain-of-Custody form (ARCOC) will accompany each shipment.

Table 4. Applicable Operating Procedures for Sampling Activities.

Procedure #	Procedure Title
FOP 94-01	Safety Meetings, Inspections, and Pre-Entry Briefings
FOP 94-25	Documentation of Field Activities
FOP 94-26	General Equipment Decontamination
FOP 94-34	Field Sample Management and Custody
FOP 94-54	Surface Sediment/Soil Sampling
FOP 94-68	Field Change Control
FOP 94-69	Personnel Decontamination (Level D, C, and B Protection)

4.3.6 Decontamination of Sampling Equipment

No significant contamination is present at the six sites. To ensure that sample integrity is maintained, the sampling equipment will be decontaminated after each sample is collected (FOP 94-26). The decontamination will typically utilize dry-decontamination techniques such as scraping with a wire brush and wiping with paper towels. If used, decontamination water will be discharged directly to the ground surface without being sampled, provided that there is reason to believe that the sampling equipment has not brought up contamination not already existing on the ground surface. Discharges of decontamination water to the ground surface will be less than 50 gallons per week and less than 5 gallons per hour. Water will not be discharged in areas prone to erosion. Water will not be discharged in an area that will be sampled later. Decontamination water may be placed in open-top drums or left on a temporary pad for evaporation.

4.3.8 Final Grading

The backhoe work will have a small impact. After the sampling is completed at a particular site, the site will be returned to the pre-sampling topography. None of the alignments for the storm-water channels will be altered. Because the disturbed areas will each be less that 0.75 acres, no Topsoil Disturbance Permit is needed.

4.3.9 Final Report

Upon completion of the soil-sampling work and evaluation of the analytical data, NOD/RSI Responses will be prepared and subsequently submitted to NMED for regulatory review. After validation, the analytical results will be summarized using the format style of the 12th Batch or later NFA Proposals. Human-health/ecological risk assessments will be prepared for each site.

5.0 TEAM ORGANIZATION

Management:

Department 6133 Manager	Dwight Stockham	Organization	6133
OU 1309 Task Leader	Sue Collins	Organization	6133
OU 1309 Assistant Task Leader	John Copland	Organization	6133

Sampling:

Field Team Leader	John Copland	Organization	6133
ERFO Coordinator	Tony Roybal	Organization	6135

Analytical:

Sample Management Office Doug Salmi Organization 6133
Analytical Laboratories: General Engineering Laboratory and RPSD

6.0 HEALTH AND SAFETY

- Health and Safety Plan: Level D, use HASP for ER Site 228B – Centrifuge Dump Site, January 2000, per Change Directive 1309-2001-3.
- Notifications and Communications with adjacent facilities: TA-IV HERMES III Linear Accelerator (operator Roy Guttierrez, 845-7226). Outdoor testing may require the sampling effort to be briefly delayed during the HERMES III shots which are vented to the northeast of Building 970.

7.0 SAMPLE COLLECTION

Sample Media: X Environmental n/a Waste Matrix Type Soil

8.0 ANALYTICAL REQUIREMENTS

The analytes for the soil sampling are based upon the COCs discussed above as well as additional COCs that NMED has traditionally expected for SNL/NM. The COCs for each site are listed below.

- ER Site 230: VOCs, SVOCs, TPH, TAL metals, chromium-VI, tritium, gamma-emitting radionuclides, gross alpha/beta
- ER Site 231: VOCs, SVOCs, TPH, TAL metals, chromium-VI, tritium, gamma-emitting radionuclides, gross alpha/beta
- ER Site 232-1: VOCs, SVOCs, TPH, TAL metals, chromium-VI, tritium, gamma-emitting radionuclides, gross alpha/beta
- ER Site 232-2: PCBs, VOCs, SVOCs, TPH, TAL metals, chromium-VI, tritium, gamma-emitting radionuclides, gross alpha/beta
- ER Site 233: VOCs, SVOCs, TPH, TAL metals, chromium-VI, tritium, gamma-emitting radionuclides, gross alpha/beta
- ER Site 234: VOCs, SVOCs, TPH, TAL metals, chromium-VI, tritium, gamma-emitting radionuclides, gross alpha/beta

The soil samples will be analyzed using the analytical methods listed in Table 5. The detection limit for each COC will be lower than the respective HRMB background value and risk-assessment level. A bottle order has already been submitted to SMO.

Table 5. Analytical Methods for Confirmatory Soil Samples.

Analyte	Analytical Method
TAL metals	EPA 6010/7471
Cr-VI	EPA 7196
VOCs	EPA 8260
SVOCs	EPA 8270
TPH	EPA Method 8015-modified
PCBs	EPA 8080
Gross alpha/beta	EPA Method 900.0
Tritium	HASL 300
Gamma-emitting radionuclides	HASL 300

9.0 QUALITY CONTROL

For each site, the QA/QC samples shall consist of one soil duplicate (DU) and one aqueous equipment blank (EB) for each of the analytes. This rate will slightly exceed the 5% frequency typically used in ER's verification sampling. Trip (aqueous) blanks will accompany the soil samples for VOC analyses.

As necessary, additional QA/QC results such as matrix spike/matrix spike duplicate (MS/MSD) will be requested. The ratios for collecting/preparing other QA/QC samples are specified in Table 6.

Table 6. Collection/preparation Ratios for QA/QC Samples.

Field		Laboratory	
X Duplicate samples	10% of soil samples	X LCS	5% or 1 per batch
X Equipment Blank	1 per day	X MS	5% or 1 per batch
X Trip Blank - VOCs	1 per shipment	X MSD	5% or 1 per batch
Other		X Method blank	1 per analytical batch
		X Surrogate spike	all GC/MS samples

10.0 DATA VALIDATION

Analytical reports will be reviewed with the most current data-validation procedure suitable for the risk-assessment process.

11.0 SAMPLE NOMENCLATURE

The "ER Sample ID" nomenclature in Table 7 will be used to identify the samples. A block of 'random SMO numbers' for "Sample No. – Fraction" will be obtained from the automated phone number 284-5514.

Table 7. ER Sample ID nomenclature.

Operable Unit		Site		Location Category		Location Number		Sample depth (ft)	-	Sampling Media
AAAAA				NNN		AAA		NNNN.N	-	AAA
3 to 5 digits				2 to 3 digits		3 digits		5 digits	-	1 to 3 digits
Example										
Tijeras Arroyo		230		Grab		05		2 to 2.5		soil
Nomenclature										
TJAOU	-	230	-	GR	-	05	-	2	-	S

12.0 MAPPING

After the sampling is complete, sample locations will be mapped using Global Positioning System equipment. This will ensure that the locations are accurately mapped and the location data are archived.

13.0 REFERENCES

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Sandia National Laboratories / New Mexico (1995), *Proposal for No Further Action - Site 233, Operable Unit 1309*, in 'Proposals for No Further Action - Environmental Restoration Project,' SNL/NM Environmental Restoration Project, Albuquerque, NM, June 1995.

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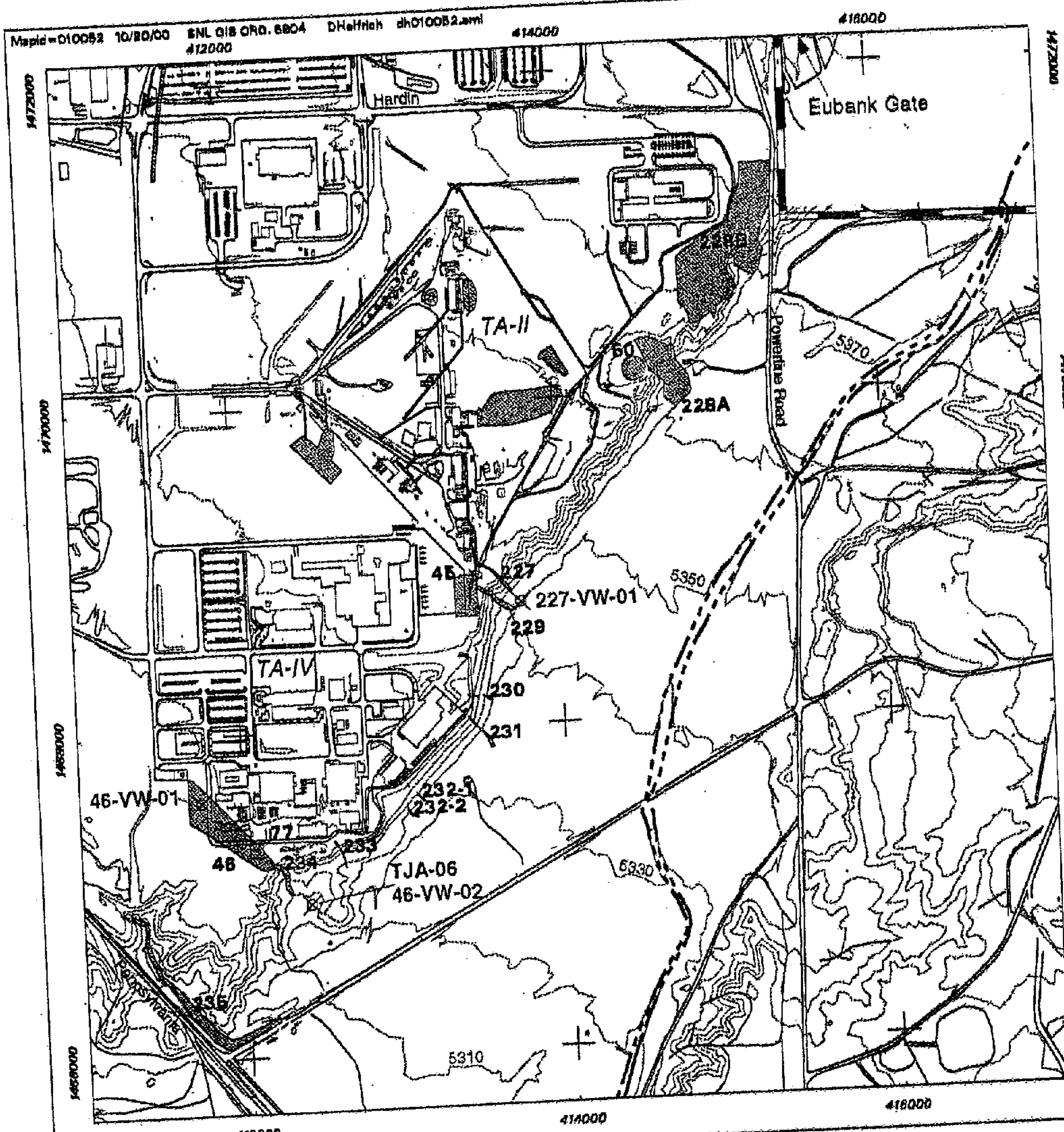
Sandia National Laboratories / New Mexico (1999a) *Field logbook #ER-050*, page 62, December 20, 1999.

Sandia National Laboratories / New Mexico (2001) *Field logbook #ER-050*, page 126, April 27, 2001.



Legend

- Proposed Monitor Well
- Road
- 10 Foot Contour
- Tijeras Arroyo Channel
- KAFB Boundary
- Building
- ER Site

Figure 1
ER Sites 46 & 229
Proposed Locations for Groundwater & Soil Vapor Monitor Wells

0 500 1000
Scale in Feet

0 120 240
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

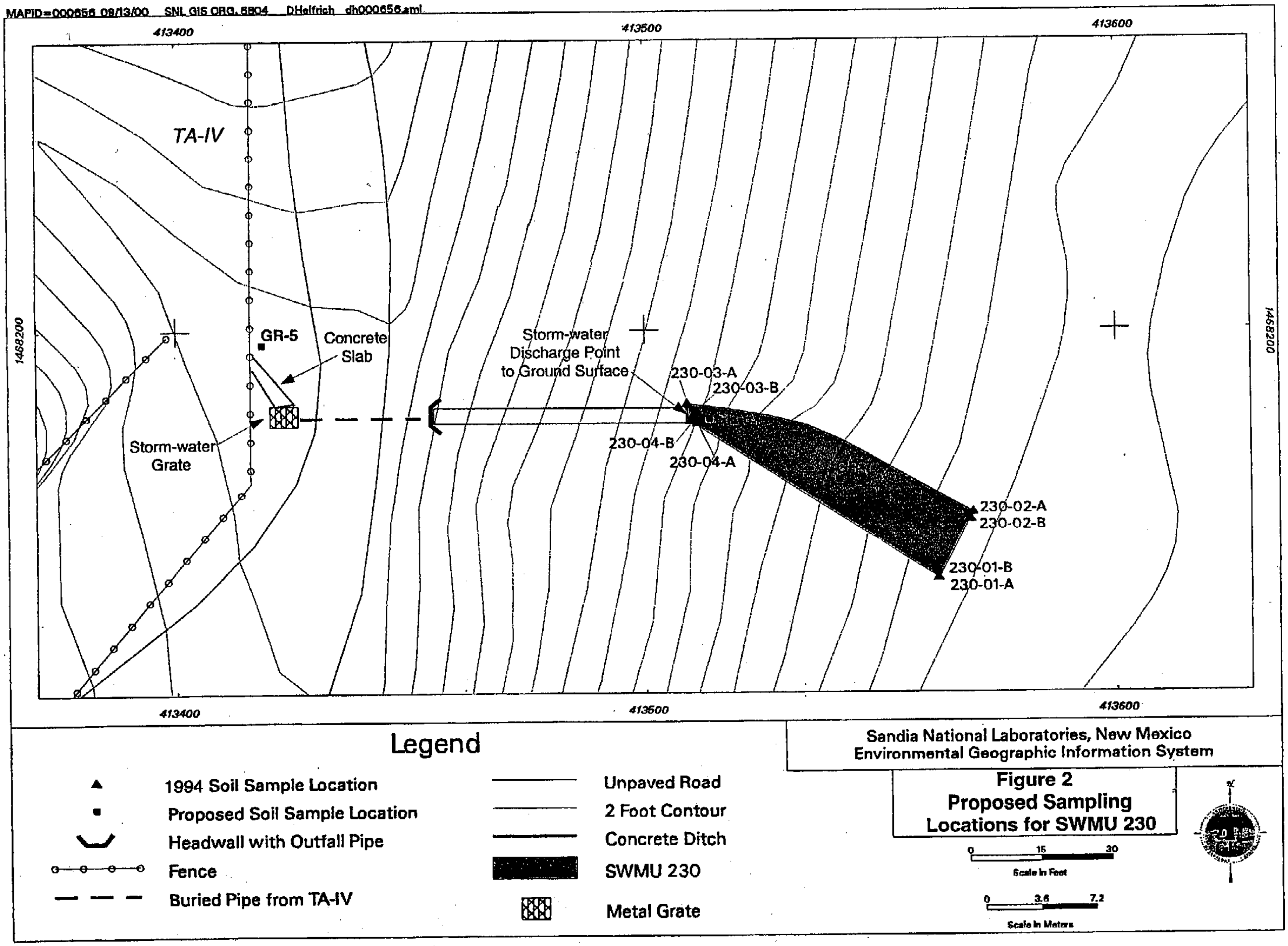
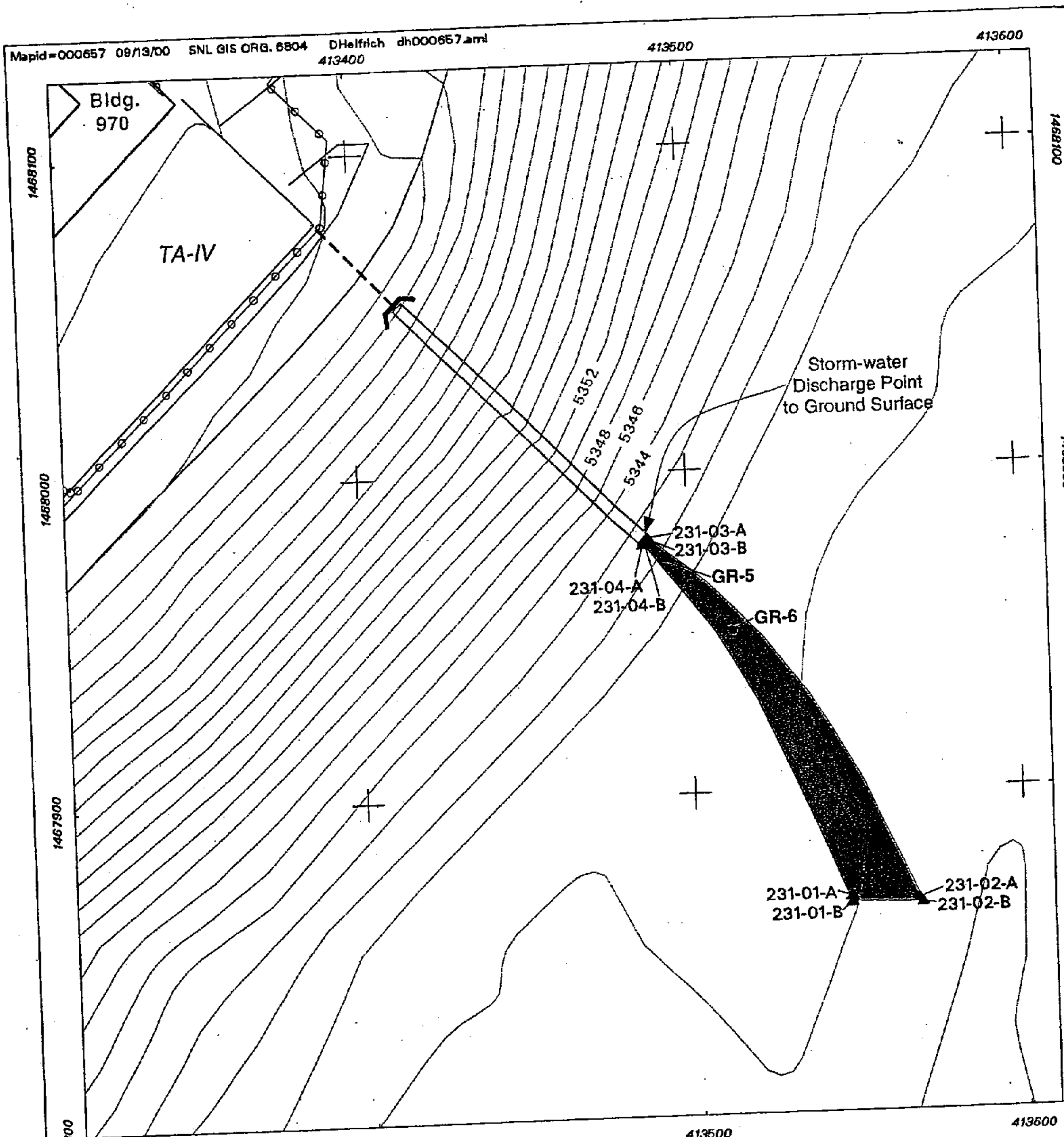


Figure 2
Proposed Sampling Locations for SWMU 230



Legend

- 1994 Soil Sample Location
- Proposed Soil Sample Location
- Headwall with Outfall Pipe
- Buried Pipe from TA-IV
- Fence
- Unpaved Road
- 2 Foot Contour
- Concrete Ditch
- SWMU 231

Figure 3
Proposed Sampling Locations for SWMU 231

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

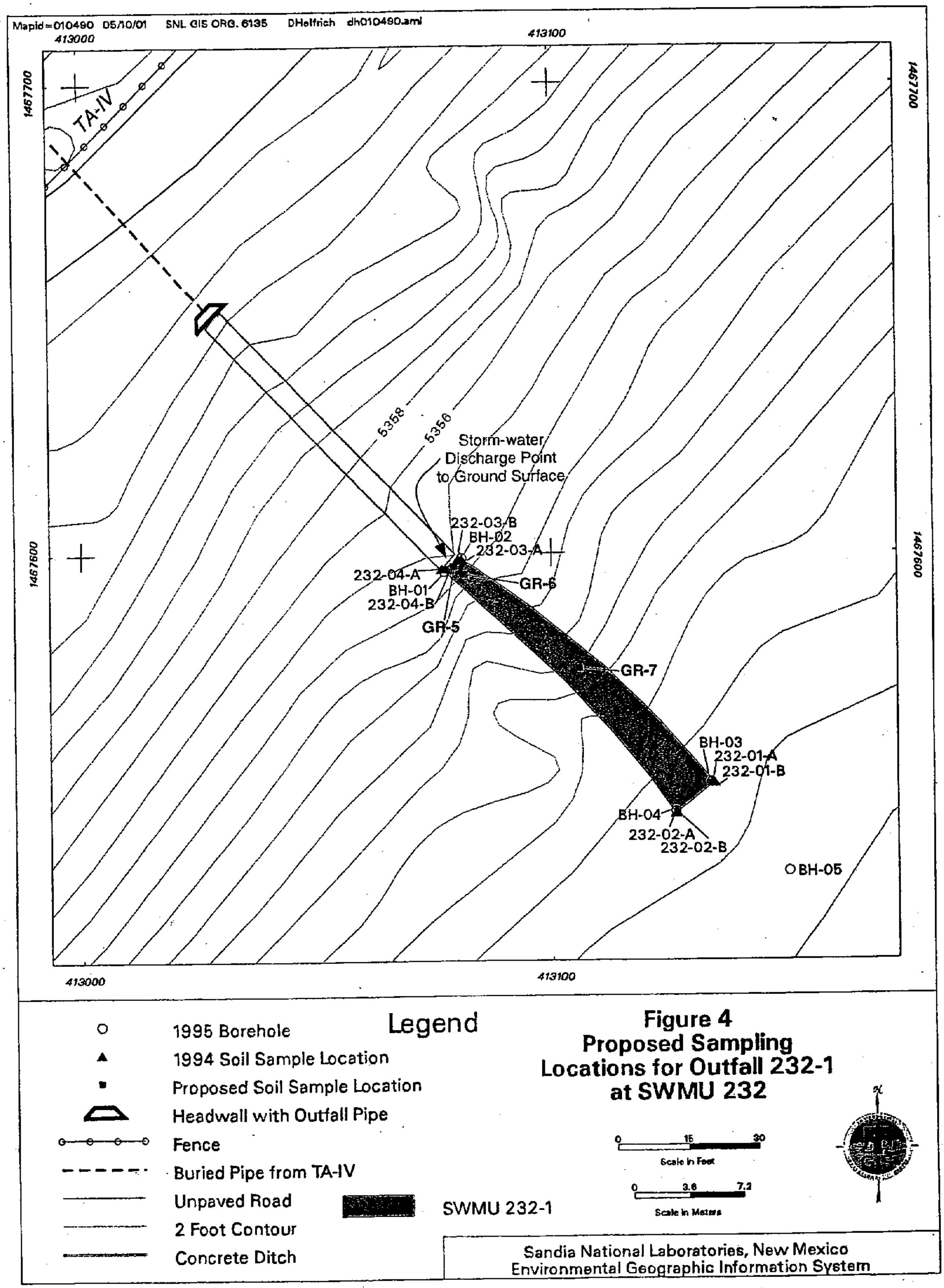


Figure 4
Proposed Sampling Locations for Outfall 232-1 at SWMU 232

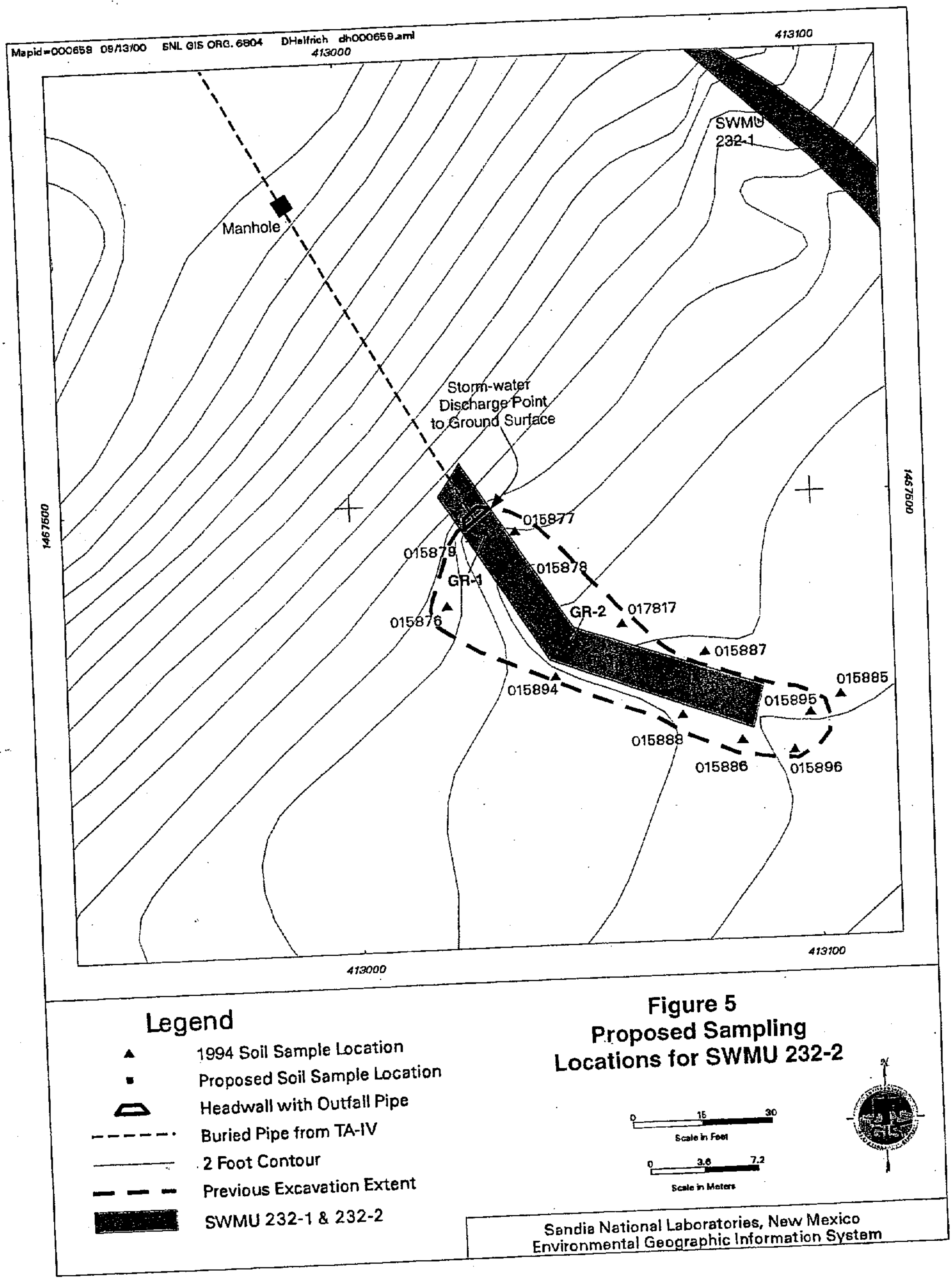
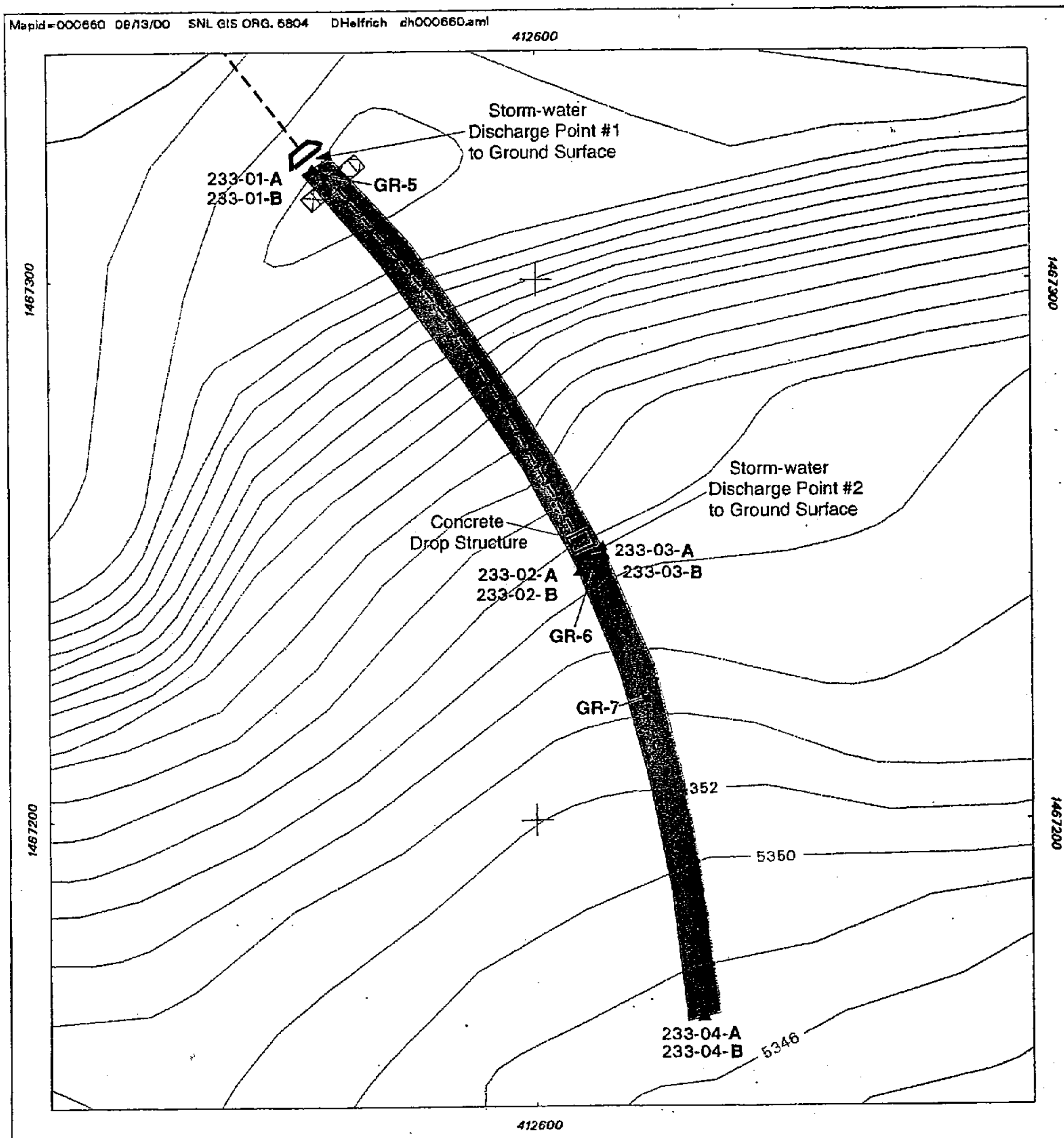


Figure 5
Proposed Sampling Locations for SWMU 232-2

Sandia National Laboratories, New Mexico
Environmental Geographic Information System



Legend

- ▲ 1994 Soil Sample Location
- ▪ Proposed Soil Sample Location
- Headwall with Outfall Pipe
- Storm Water Grate
- Buried Pipe from TA-IV
- 2 Foot Contour
- Unpaved Road
- SWMU 233

Figure 6
Proposed Sampling Locationf for SWMU 233

Scale in Feet: 0, 15, 30

Scale in Meters: 0, 3.6, 7.2

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

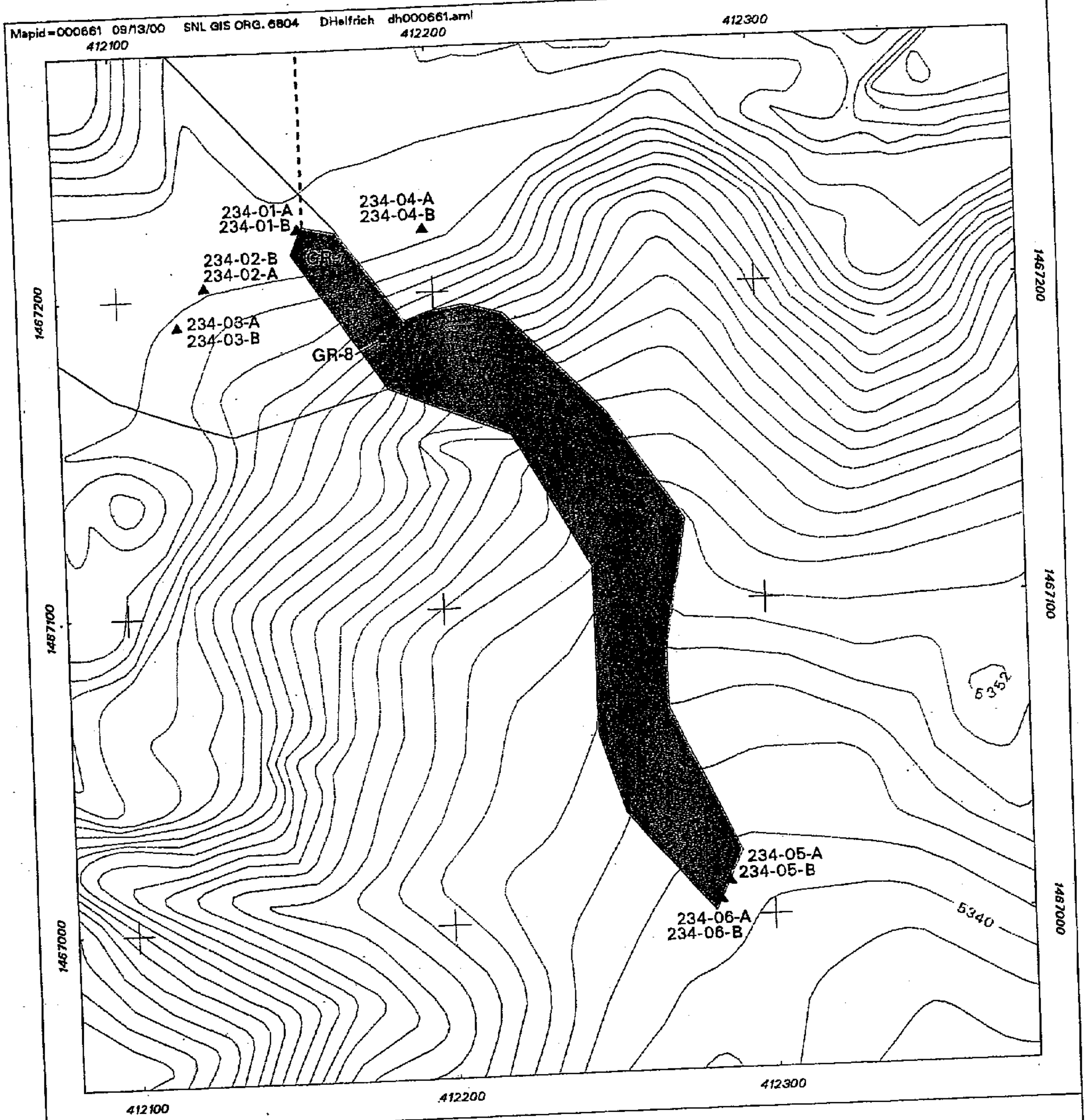


Figure 7
Proposed Sampling Locations for SWMU 234

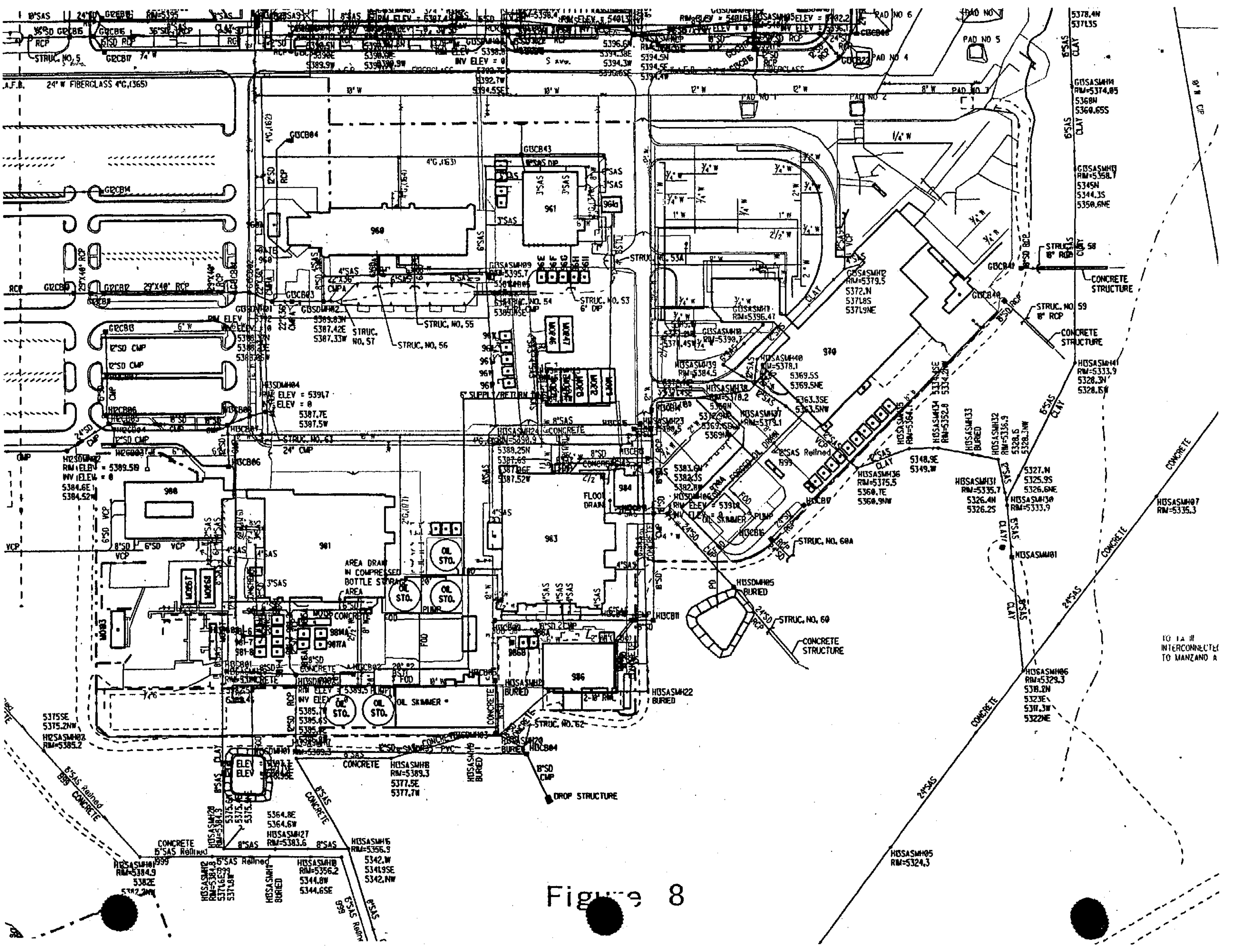
Legend

- ▲ 1994 Soil Sample Location
- ■ Proposed Soil Sample Location
- 2 Foot Contour
- Previous location of buried TA-IV Outfall Pipe
- SWMU 234
- SWMU 46

Scale in Feet: 0, 25, 50

Scale in Meters: 0, 6, 12

Sandia National Laboratories, New Mexico
Environmental Geographic Information System



PAD NO 1
PAD NO 2
PAD NO 4
PAD NO 5
PAD NO 6
24" W FIBERGLASS 4"C,(365)
STRUC. NO. 5
STRUC. NO. 53
STRUC. NO. 55
STRUC. NO. 56
STRUC. NO. 57
STRUC. NO. 59
STRUC. NO. 60
STRUC. NO. 60A
STRUC. NO. 62
CONCRETE STRUCTURE
DROP STRUCTURE
OIL SKIMMER
AREA DRAIN IN COMPRESSED BOTTLE STORAGE AREA
960
961
970
981
983
984
986
988
H13SASMH41 RIM=5333.9 5328.3N 5328.1SW
H13SASMH07 RIM=5335.3
H13SASMH06 RIM=5329.3
H13SASMH05 RIM=5324.3
H13SASMH01
H13SDMH05 BURIED
H13SASMH22 BURIED
H13SASMH18 RIM=5389.3 5377.5E 5377.7W
H13SASMH15 RIM=5356.9 5342.W 5341.9SE 5342.NW
H12SASMH03 RIM=5385.2
TO TA III INTERCONNECTED TO MANZANO A

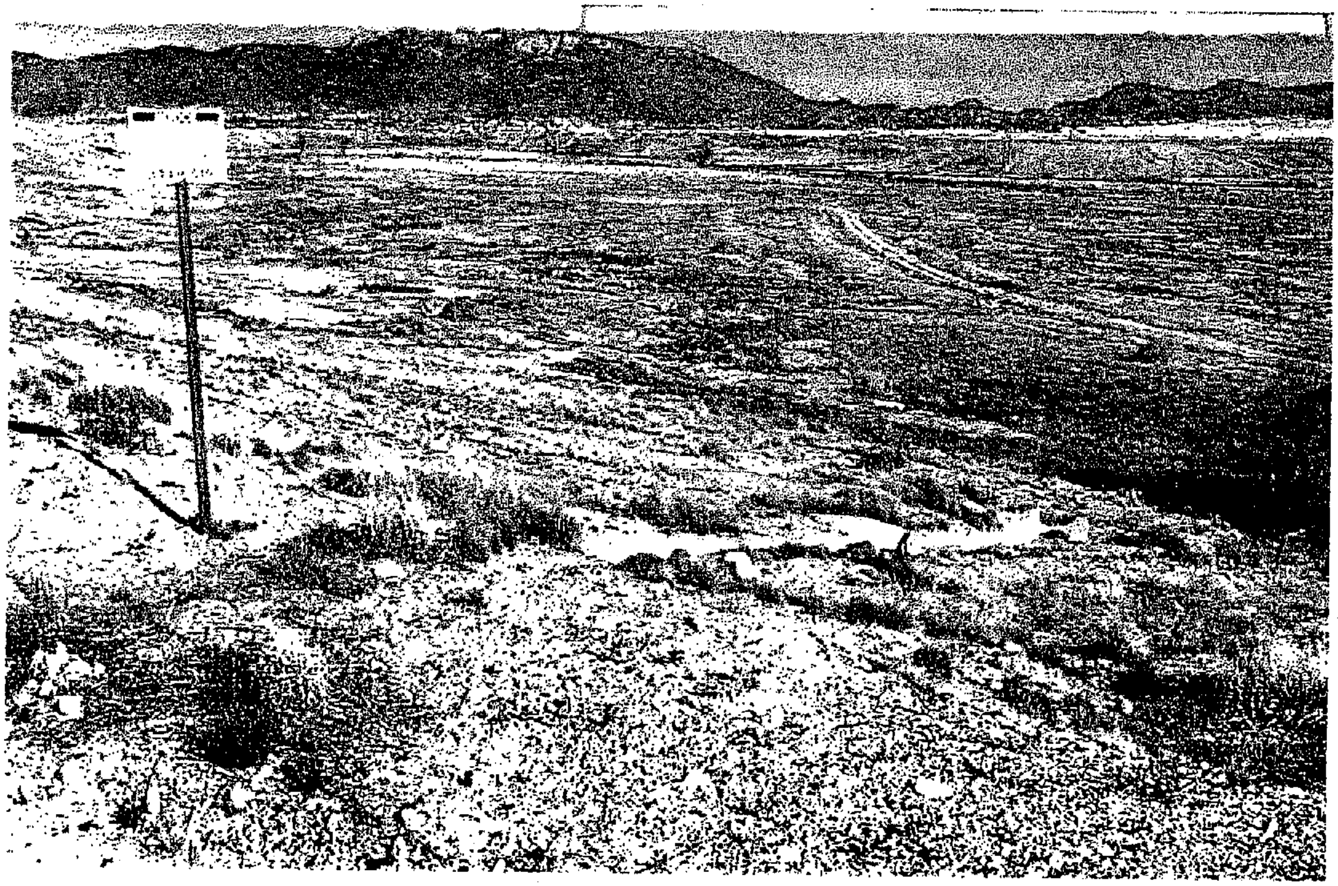
Figure 8

Photograph 1: ER Site 230

Site boundary encompasses the tumbleweed-filled earthen ditch. Lower end of the concrete ditch is the storm-water discharge point where the site begins. Tree at left marks the approximate lower end of the site. [field visit - 29 Nov 2000]

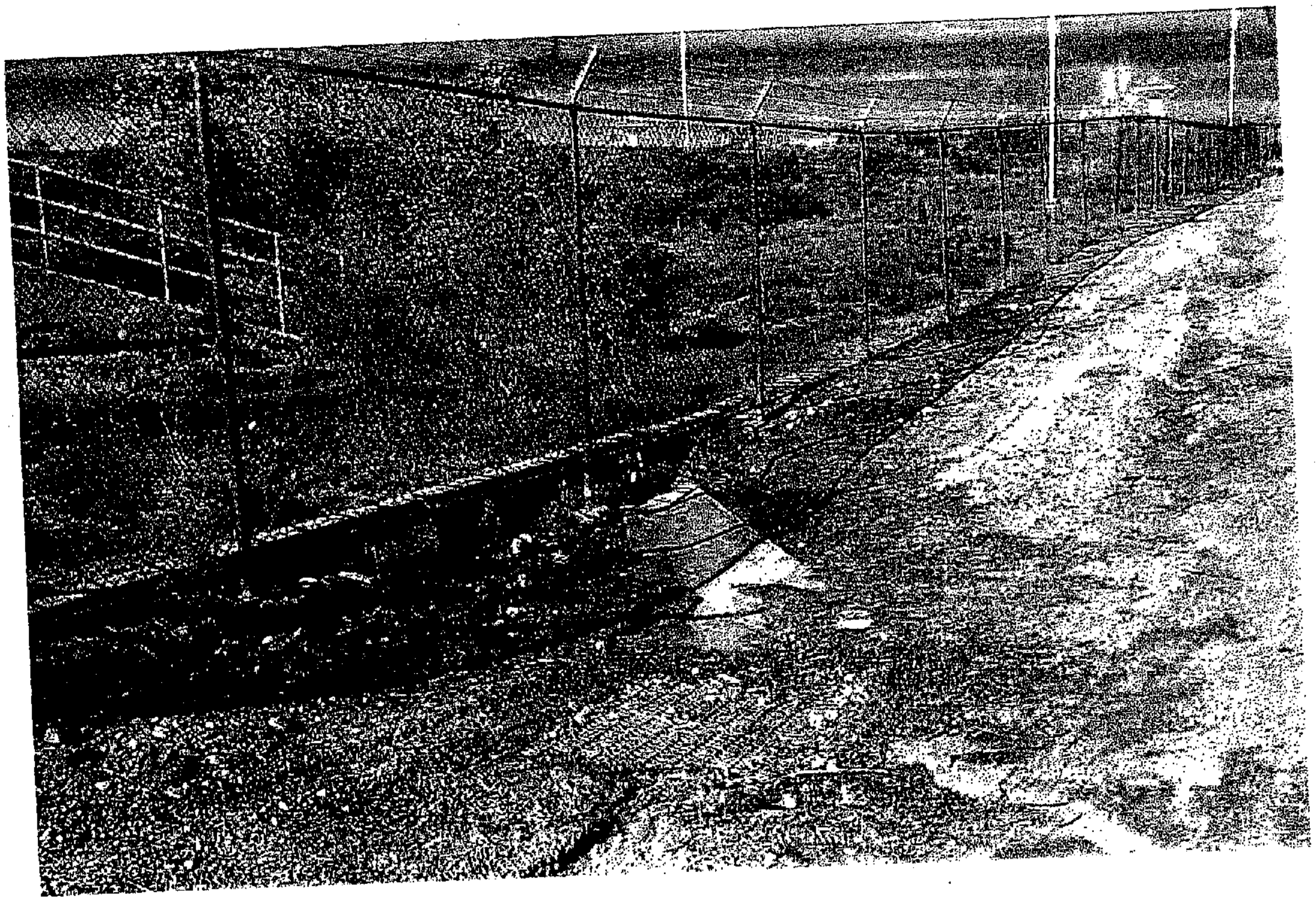
Photograph 2: ER Site 230

ER sign is located about 60 ft west of the site, which starts below the concrete ditch at extreme right of photograph. [field visit - 29 Nov 2000]



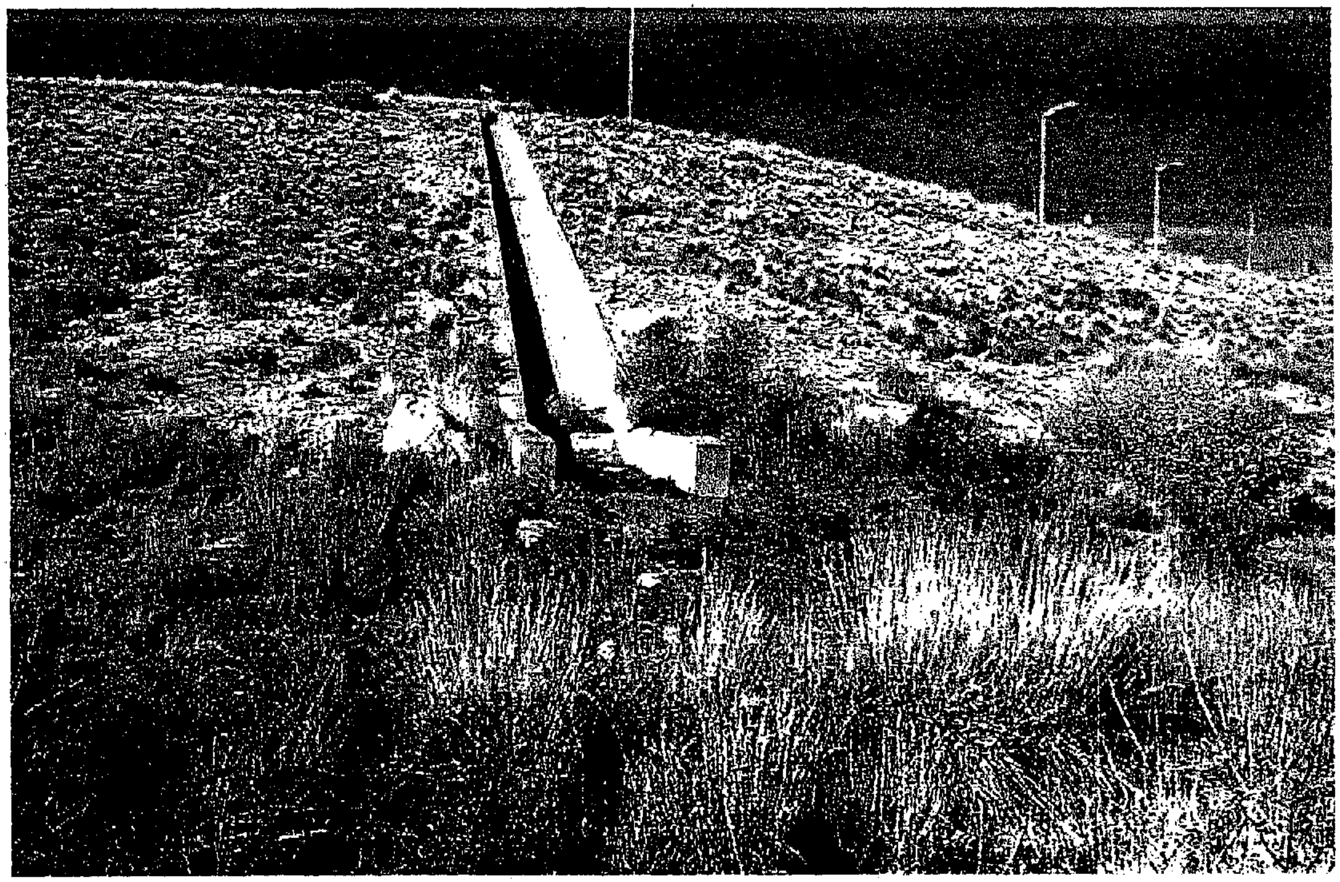
Photograph 3: ER Site 230

The storm-water grate next to the TA-IV fence is plumbed to the concrete ditch above ER Site 230. The grate is located approximately 80 ft west of the site.
[field visit - 29 Nov 2000]



Photograph 4: ER Site 231

Site begins at the lower end of the concrete ditch where storm-water discharges onto the ground surface. [field visit - 29 Nov 2000]

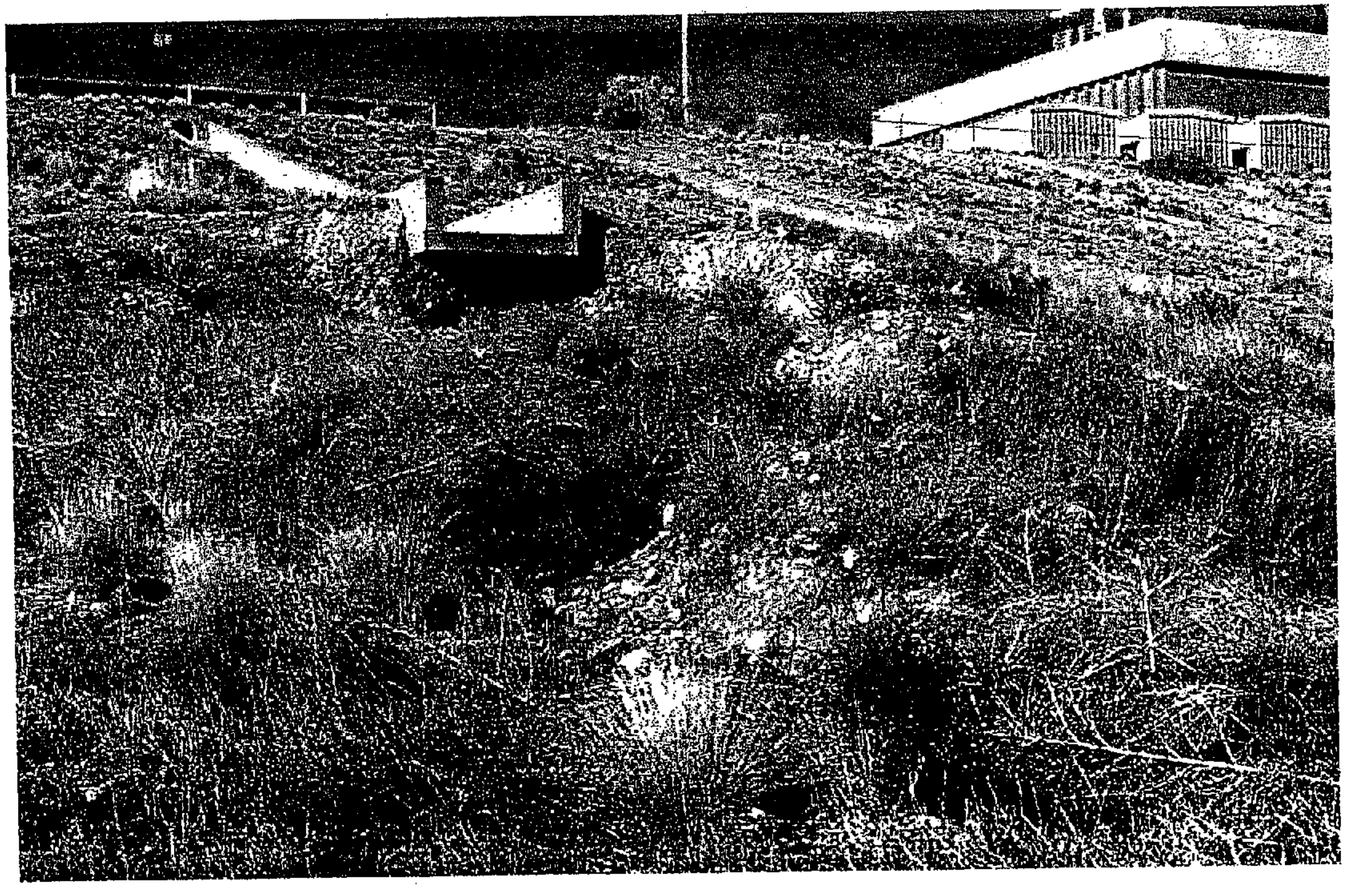


Photograph 5: ER Site 231

ER sign is located about 120 ft northwest of the site, which begins at the lower end of the concrete ditch. [field visit - 29 Nov 2000]

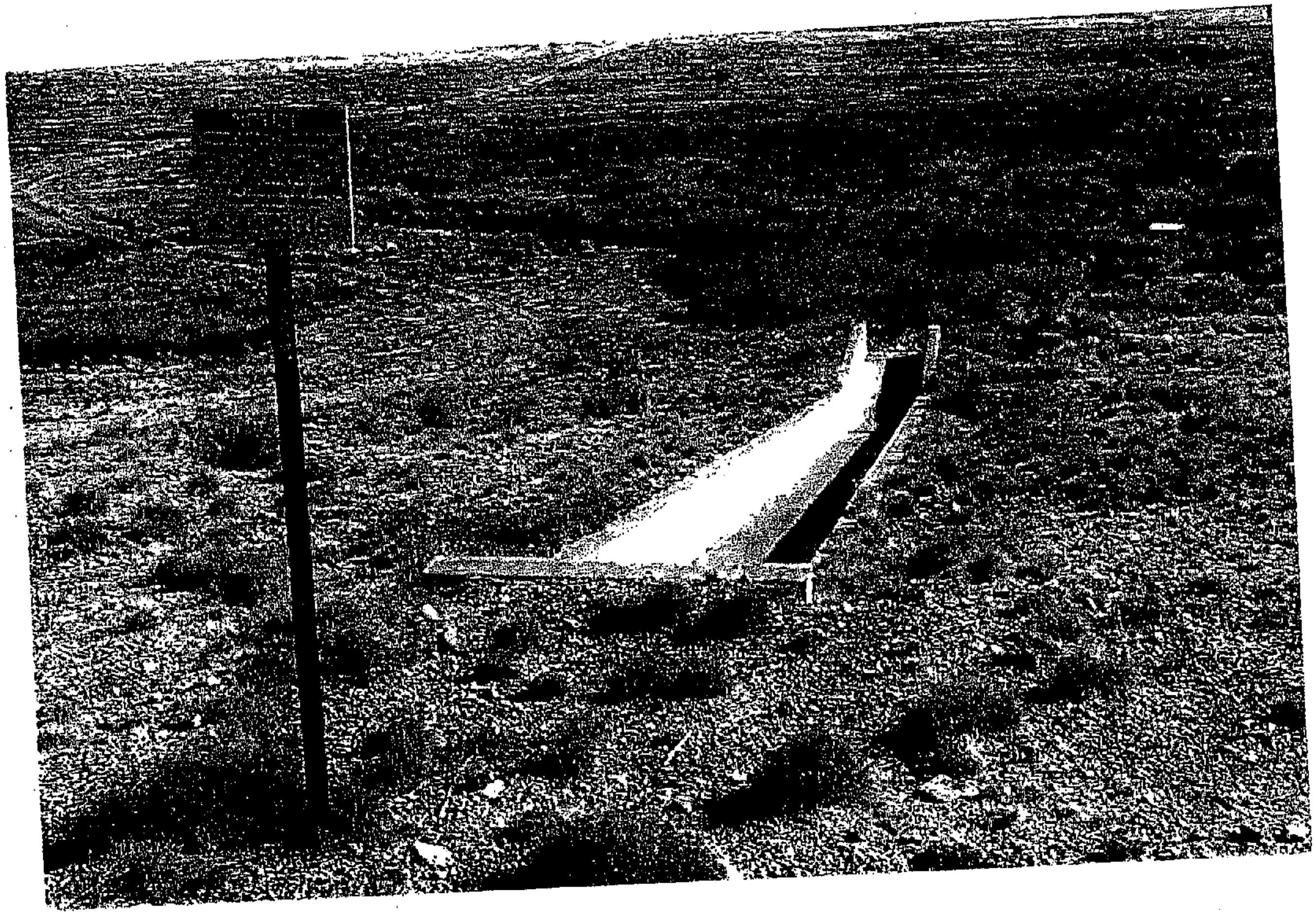
Photograph 6: ER Site 232-1

Site boundary encompasses the tumbleweed-filled earthen ditch. Lower end of concrete ditch is the storm-water discharge point where the site begins. [field visit - 29 Nov 2000]



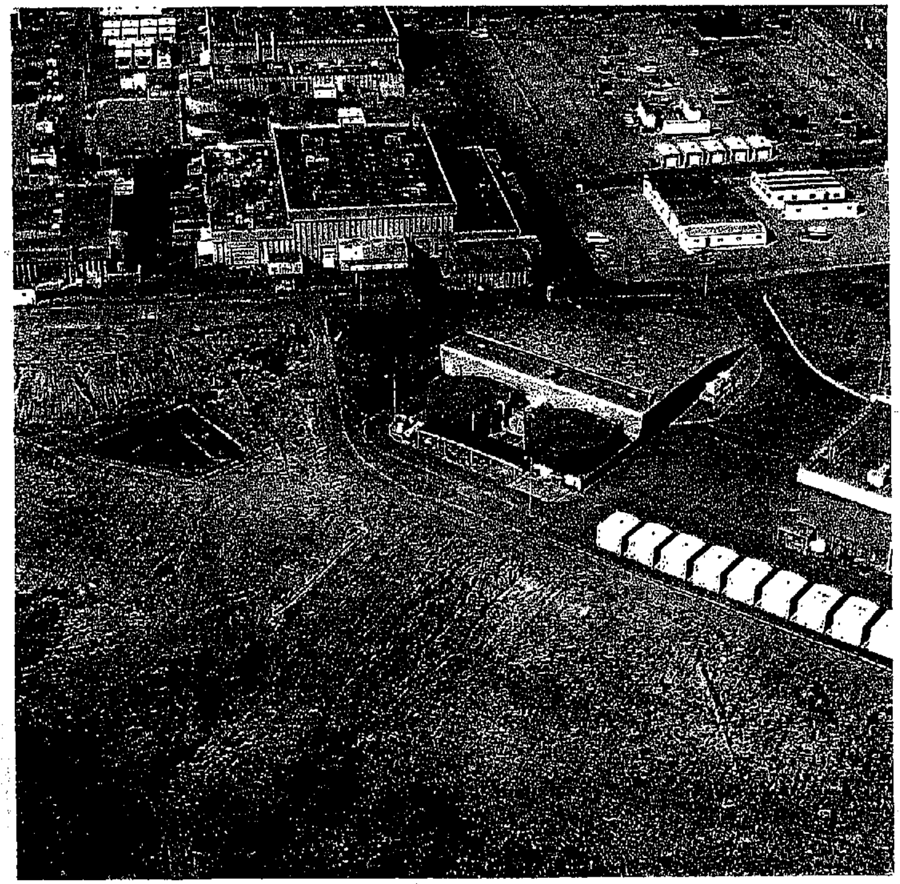
Photograph 7: ER Site 232-1

ER sign is located about 90 ft northwest of the site, which begins just below the concrete ditch. [field visit - 29 Nov 2000]



Photograph 8: ER Sites 232-1 and 232-2

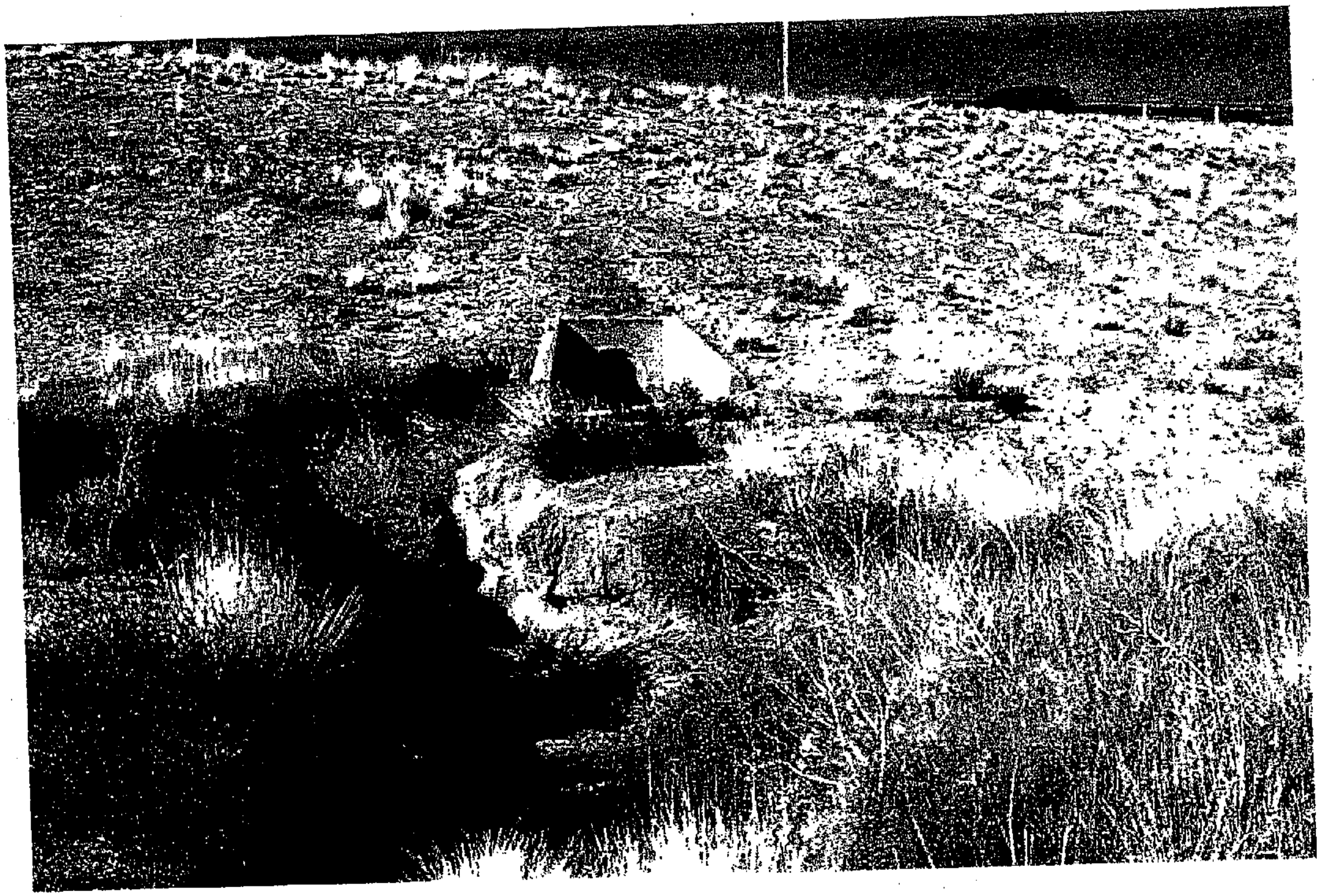
Concrete ditch above ER Site 232-1 is clearly visible in left center of photograph.
The drop structure above ER Site 232-2 is located farther left.
[oblique aerial view to west, early 1990s]



Photograph 9: ER Site 232-2

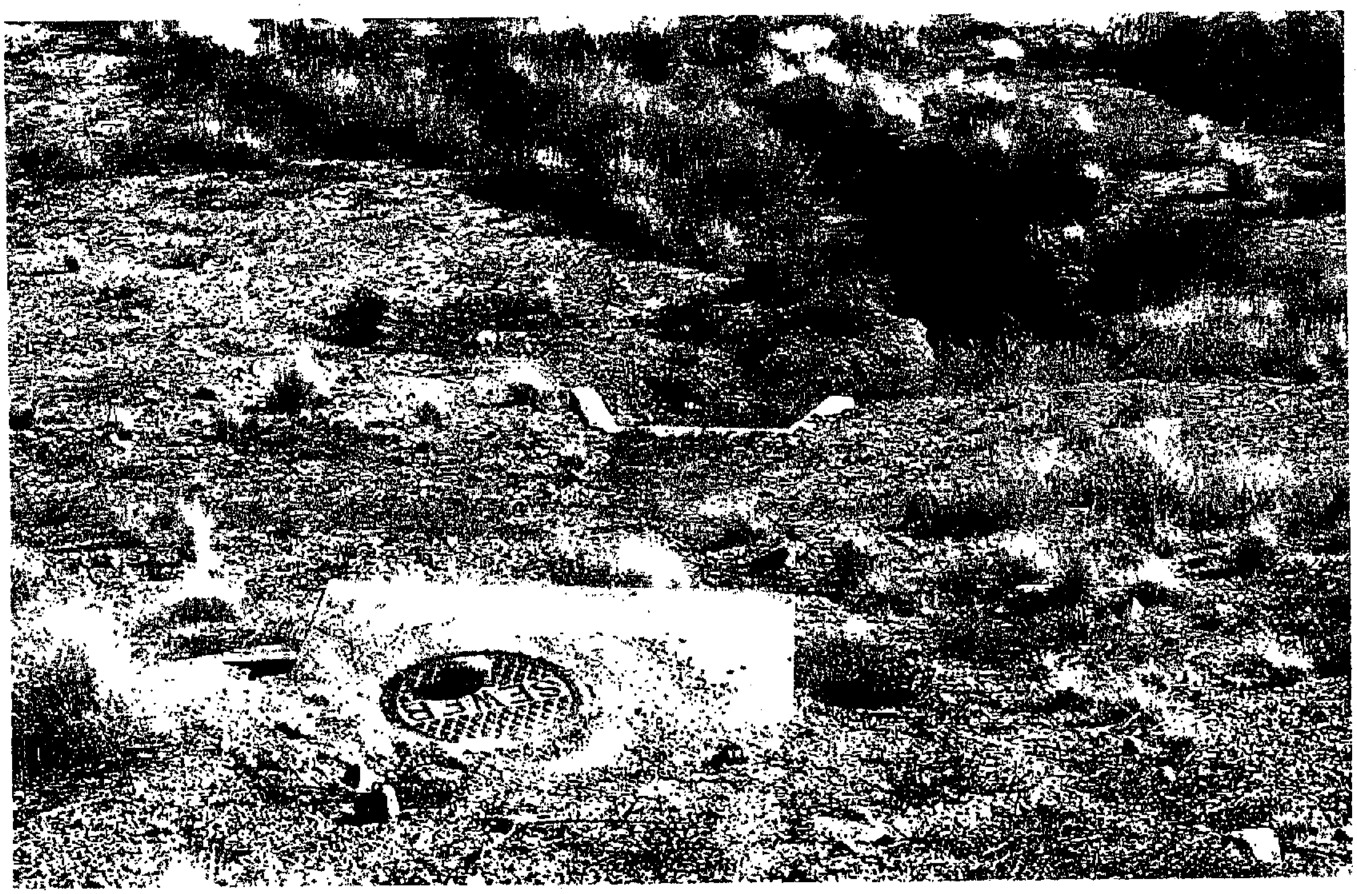
Site boundary encompasses the earthen ditch below the headwall and outfall pipe.

[field visit - 29 Nov 2000]



Photograph 10: ER Site 232-2

Site boundary encompasses the earthen ditch below the headwall. The storm-water access box has a misleading 'sewer' manhole. [field visit - 29 Nov 2000]



Photograph 11: ER Site 233

Site begins at the storm-water discharge point located between the headwall and the red storm-water grate in left center of photograph. Telephone pole with electrical box is at upper left corner of photograph. [field visit - 29 Nov 2000]

Photograph 12: ER Site 233

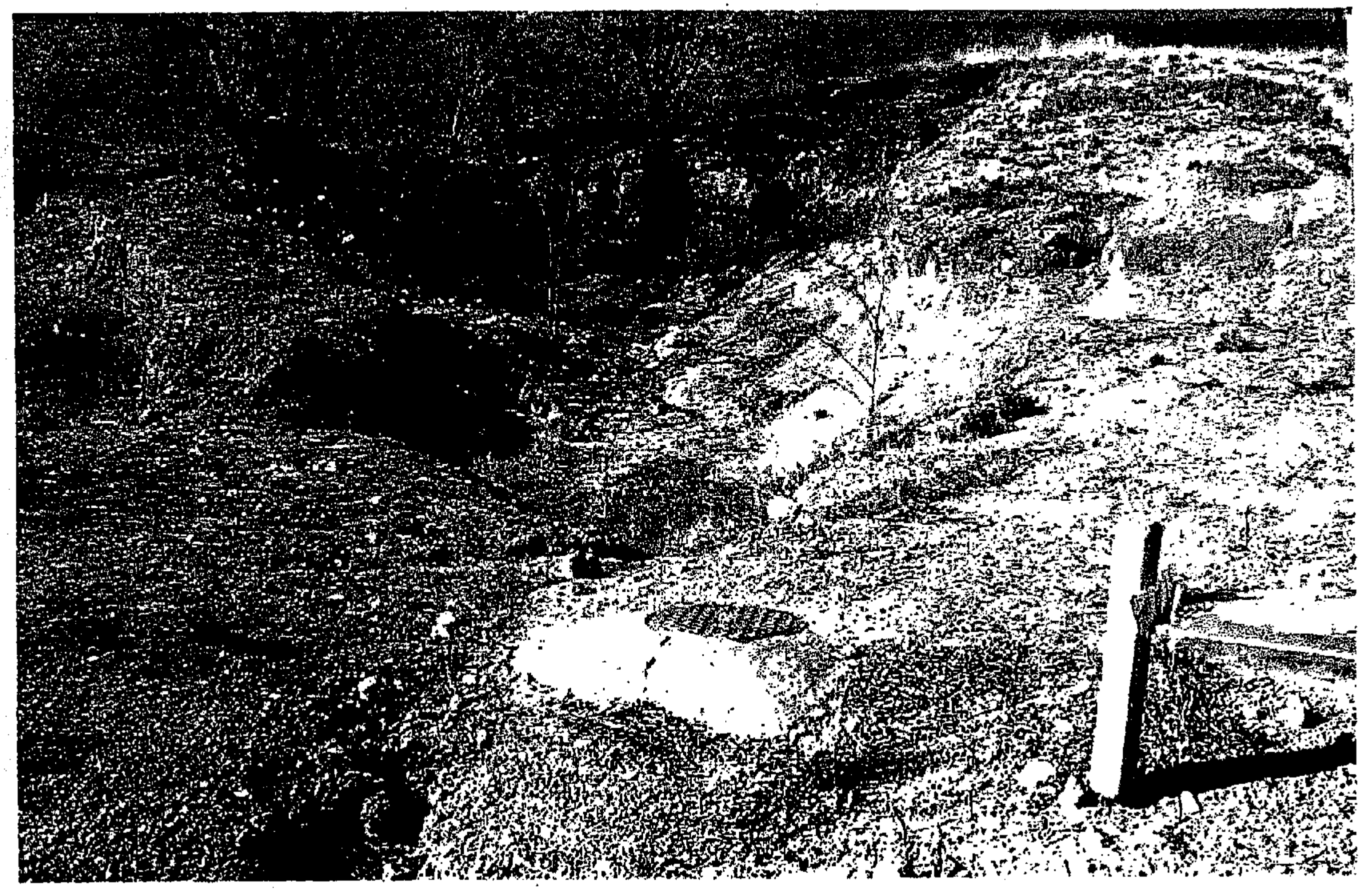
Drop structure on left side of photograph is the second storm-water discharge point at ER Site 233. [field visit - 29 Nov 2000]

Photograph 13: ER Site 233

Site boundary extends from near the telephone pole on skyline, through the drop structure, and along the earthen ditch in foreground. [field visit - 29 Nov 2000]

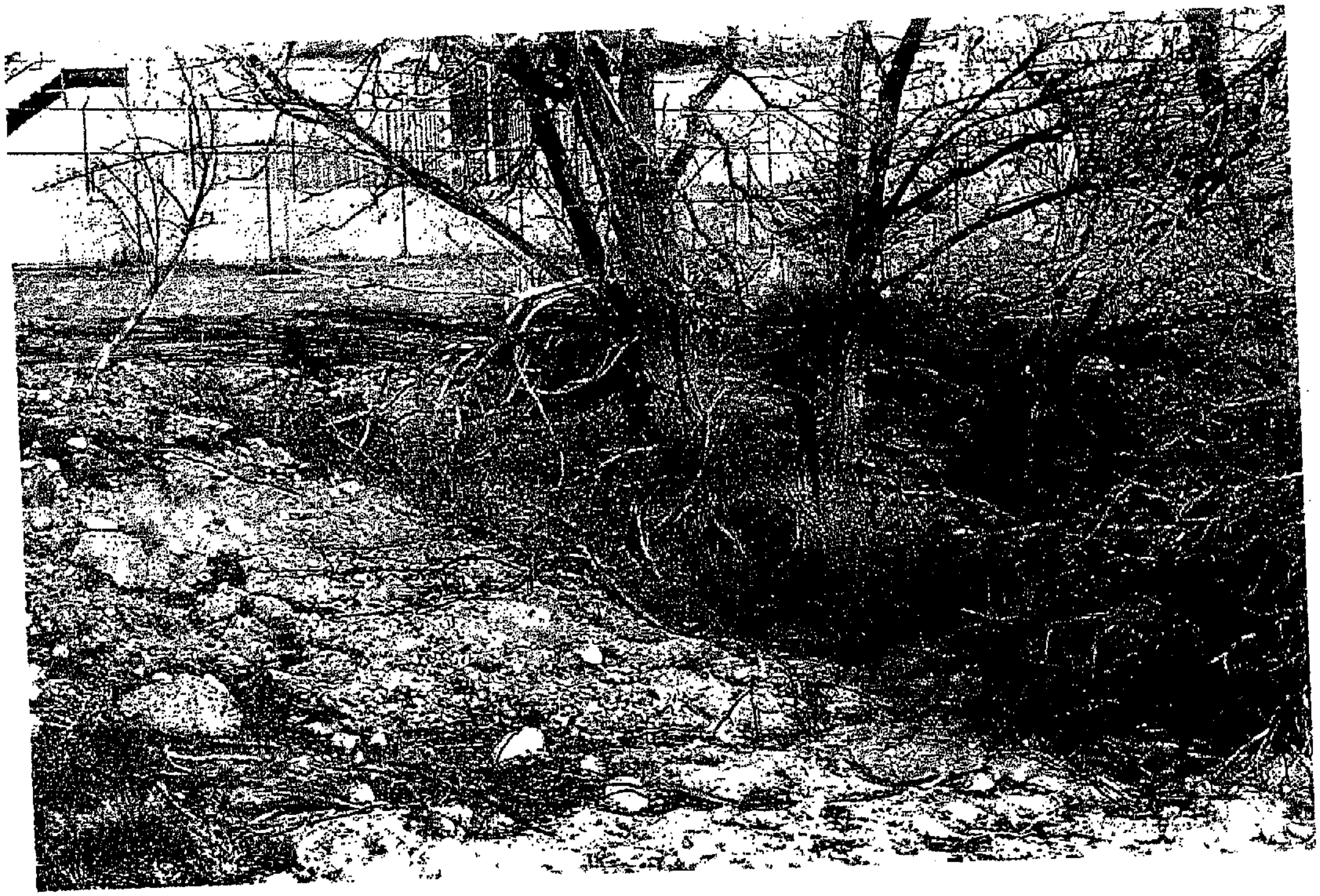
Photograph 14: ER Site 234

Site boundary encompasses the earthen ditch that extends from the previous storm-water discharge point (located near the highest tree in top center of photograph) to the sewer manhole in foreground. The manhole and adjacent electrical vault are not part of the site. [field visit - 29 Nov 2000]



Photograph 15: ER Site 234

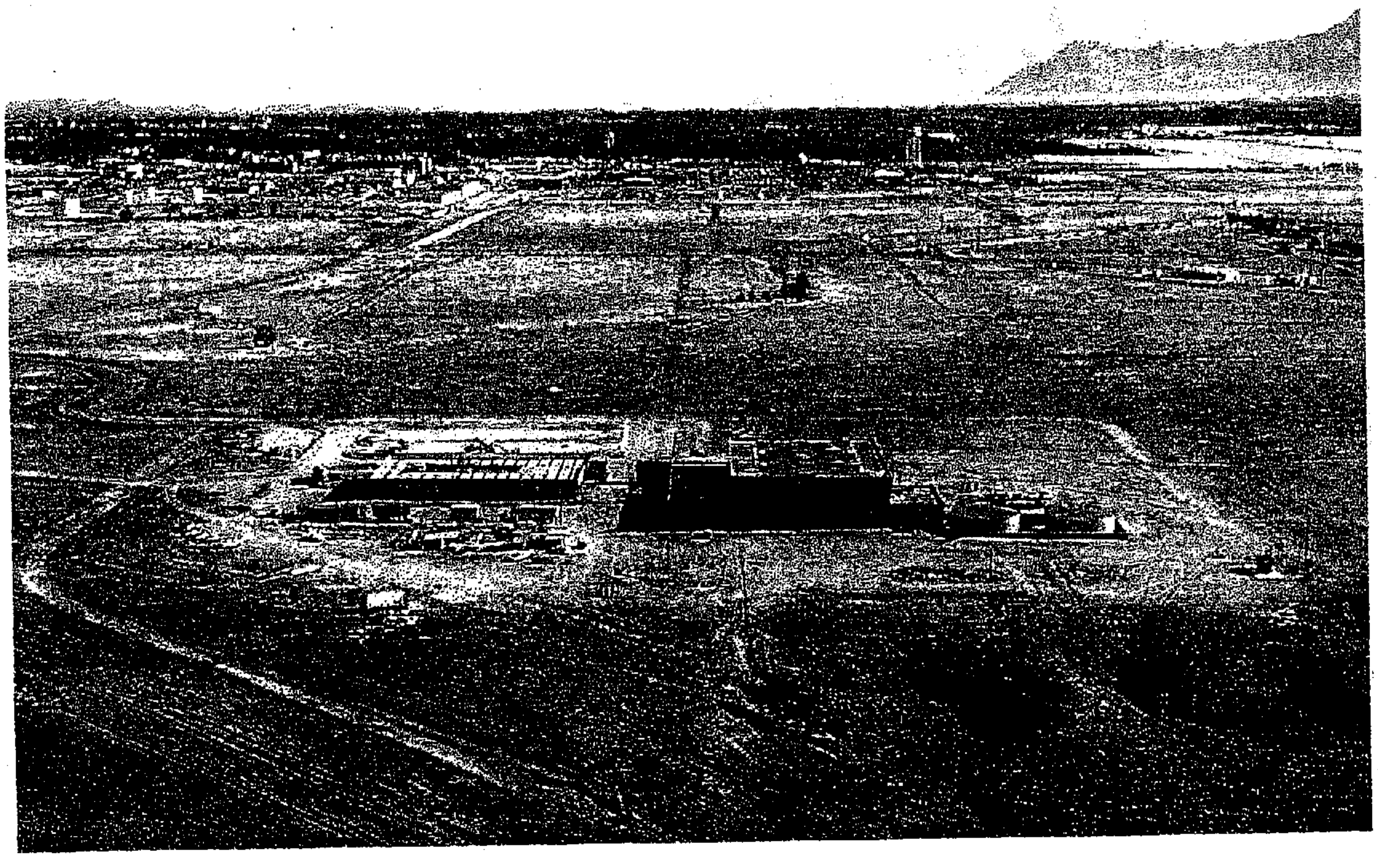
Trees and concrete rubble partially obscure the ditch where storm water from the ER Site 234 pipe previously discharged. TA-I waste water from outfall ditch OD-3 also discharged here prior to the construction of TA-IV. [field visit - 29 Nov 2000]



Photograph 16: ER Sites 46 and 234

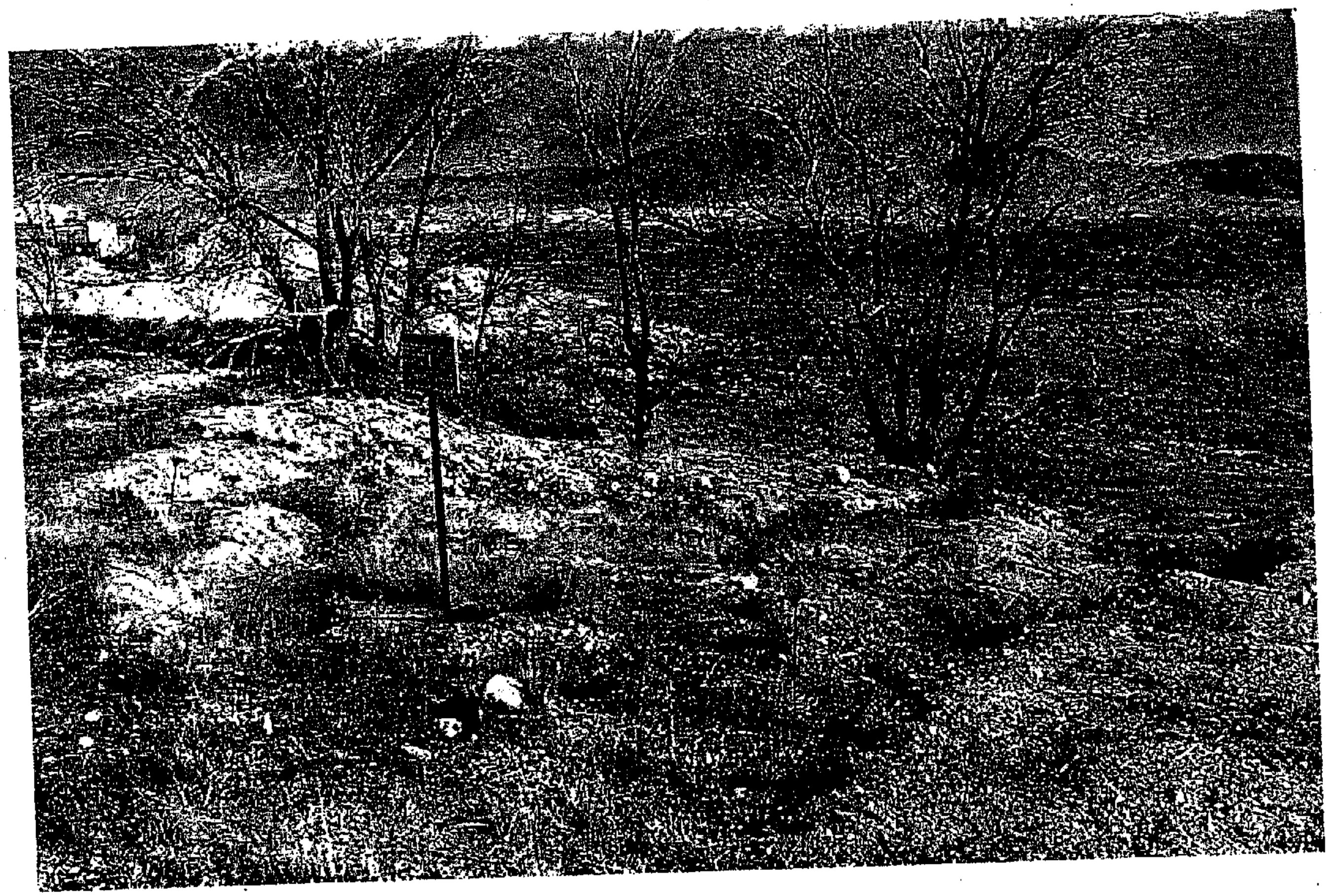
Construction of TA-IV and a trench for the storm-sewer outfall pipe that drained to ER Site 234. A "new" surface-water ditch cuts across the lower-left corner of photograph. The nearby outfall ditch OD-1 is marked by trees.

[oblique aerial view to north, 1978]



Photograph 17: ER Site 46

Steel-rebar markers were placed in August 2000 to mark the surviving segments of acid-waste line outfall ditches OD-1 and OD-2. The upper part of ER Site 234 is located along the trees. [field visit - 29 Nov 2000]



Photograph 18: ER Site 234

The steel-rebar marker in left center of photograph was placed in August 2000 to mark where the storm-sewer outfall pipe was previously located. [field visit - 29 Nov 2000]

Attachment C

ATTACHMENT C

SWMU 231 Risk Screening Assessment Report

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (Concluded)

SWMU 231: RISK SCREENING ASSESSMENT REPORT

I. Site Description and History

Solid Waste Management Unit (SWMU) 231 (the Storm Drain System Outfall) at Sandia National Laboratories/New Mexico (SNL/NM) is located about 150 feet southeast of Technical Area (TA)-IV on land that is owned by Kirtland Air Force Base (KAFB) and leased to the U.S. Department of Energy (DOE). SWMU 231 encompasses 0.04 acres of unpaved ground and consists of a 140-foot-long earthen ditch that occasionally receives storm water from a paved storage yard located on the east side of Building 970. The storm water is directed to the site via buried piping and a concrete ditch. The outfall was built in the early 1980s for the purpose of reducing the amount of soil erosion caused by storm water. The site is situated at the slope break between the steeply sloping, northern rim of Tijeras Arroyo and the nearly flat floodplain below. The vicinity of SWMU 231 is unpaved. Ground elevations at the site range from 5,330 to 5,340 feet above mean sea level (SNL/NM April 1995).

SWMU 231 is one of five storm-water outfalls that serve TA-IV; the other four are SWMUs 230, 232, 233, and 234. The TA-IV storm-water outfalls are managed under two separate regulatory programs (the Environmental Restoration [ER] Project for RCRA Corrective Action, and the Storm Water Program annual reporting for National Pollutant Discharge Elimination System [NPDES] compliance). The outfalls were added to the SWMU list in 1993, even though no chemical releases had been reported for the catchment areas. Similarly, no stained soil has been identified at SWMU 231 during inspections conducted between 1993 and 2002. In 1994, the ground surface was surveyed for unexploded ordnance/high explosives and radioactive materials; no anomalies were detected.

In the June 1995 No Further Action (NFA) Proposal for SWMU 231, the potential contaminants of concern (COCs) were considered to be chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, diesel fuel, and mineral oil. This list of COCs was conservatively based upon chemicals used at TA-IV and included the analytes of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), Resource Conservation and Recovery Act (RCRA) metals, and chromium-VI.

The TA-IV outfalls discharge storm water about a dozen days per year in response to significant precipitation, typically resulting from summer thunderstorms. The outfalls do not discharge industrial waste water or septic waste. The SNL/NM Storm Water Program collects TA-IV storm-water samples from Station 6 and reports the water quality data in the annual SNL/NM Site Environmental Report. Except for a mineral-oil spill at SWMU 232-2 in 1995, no chemical releases have been reported at the TA-IV storm-water outfalls. None of the outfalls have been on the SNL/NM radioactive materials management area list.

The annual precipitation for the area, as measured at the Albuquerque International Sunport, is 8.1 inches. During most rainfall events, rainfall quickly infiltrates the soil near SWMU 231. However, virtually all of the moisture subsequently undergoes evapotranspiration. The estimates of evapotranspiration for the KAFB area range from 95 to 99 percent of the annual rainfall.

No springs or other perennial surface-water bodies are located within four miles of SWMU 231. The site is located approximately 1,500 feet northwest of the active channel of Tijeras Arroyo, but is not within the 100-year floodplain. Surface water flows only about several times per year in that segment of the active channel nearest TA-IV. Tijeras Arroyo is the most significant surface-water drainage feature on KAFB. The arroyo originates in Tijeras Canyon, which is bounded by the Sandia Mountains to the north and the Manzano Mountains to the south. The arroyo trends southwest across KAFB and eventually drains into the Rio Grande, approximately 8.5 miles west of SWMU 231.

Groundwater monitoring for the area surrounding SWMU 231 is conducted as part of the Tijeras Arroyo Groundwater (TAG) Investigation. Two water-bearing zones, the shallow groundwater system and the regional aquifer, underlie SWMU 231. The shallow groundwater system is not used for water supply purposes. The depth to the shallow groundwater system is approximately 300 feet below ground surface (bgs). The depth to the regional aquifer is approximately 470 feet bgs. Both the City of Albuquerque and KAFB utilize the regional aquifer as a water supply source. The nearest downgradient water-supply well is KAFB-1, which is located approximately 1.5 miles northwest of the site.

Grasslands, including such species as blue/black gramma and western cheatgrass, are the dominant plant community surrounding SWMU 231. The site also is vegetated by ruderal species, such as Russian thistle (tumbleweed). Soil at the site has been identified as the Bluepoint-Kokan Association (USDA 1977). For purposes of defining the background levels of metals and radionuclides in soil, this soil has been included as part of the Tijeras Supergroup. The Bluepoint-Kokan Association consists of Bluepoint loamy fine sand, which is developed on slopes of 5 to 15 percent, with Kokan gravelly sand on slopes of 15 to 40 percent. These soils are slightly calcareous and mildly to moderately alkaline. The runoff potential ranges from slow to very rapid, and the hazard of water erosion is slight to severe. The surficial deposits are underlain by the upper unit of the Santa Fe Group (Connell et al. 1999), which consists of coarse- to fine-grained fluvial deposits from the ancestral Rio Grande that intertongue with the coarse-grained alluvial fan/piedmont facies extending westward from the Sandia and Manzano Mountains. The upper Santa Fe Group unit is approximately 3,500 feet thick in the vicinity of the site.

II. Data Quality Objectives

The Data Quality Objectives (DQOs) for SWMU 231 were presented in two documents: the 1994 *Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit* (SAP) (SNL/NM June 1994) and the 2001 *Tijeras Arroyo Outfalls Field Implementation Plan* (FIP) (SNL/NM May 2001). The two plans identified the site-specific confirmatory locations, sample depths, sampling procedures, and analytical requirements. The DQOs also outlined the Quality Control/Quality Assurance (QA/QC) requirements necessary for producing defensible analytical data suitable for risk assessment purposes. The confirmatory sampling was designed to determine whether soil contamination had resulted from the discharge of TA-IV storm water. Therefore, soil samples were collected along the earthen ditch below and downslope of the storm-water discharge point.

On September 26, 1994, eight soil samples were collected, using either a hand trowel or a hand auger, from soil adjacent to the earthen ditch at the corners of the site (Table 1). The sampling was conducted as part of a week-long sampling effort that involved most of the TA-IV storm-water outfalls. The maximum sampling depth was 3 feet bgs. The soil samples were analyzed for VOCs, SVOCs, total petroleum hydrocarbons (TPH), RCRA metals, chromium-VI, and radionuclides (gamma emitters and tritium). The samples were submitted to Environmental Control Technology Corporation (ENCOTEC), Quanterra, and the on-site SNL/NM Radiation Protection Sample Diagnostic (RPSD) Laboratory. The reporting of four TPH detections ranging from 44 to 130 parts per million (ppm) is considered suspect because no VOCs or SVOCs were detected in the soil samples. Nine metals were detected above background screening levels or did not have quantified background screening levels. The only radionuclide reported above background level was U-235 at 0.23 picocuries per gram (pCi/g). As specified in the SAP, none of the September 1994 QA/QC samples for the TA-IV outfalls were collected at SWMU 231. Instead, results of duplicates and equipment (aqueous rinsate) blanks were inferred from the sampling conducted nearby at SWMUs 230, 232, 233, 234, and 235. No significant QA/QC problems were identified for the nearby sites.

Table 1
Number of Analyses for Confirmatory Soil Samples
Collected in 1994 at SWMU 231

Sample Type	VOCs	SVOCs	TPH	RCRA Metals[a]	Radionuclides[b]	Number of Analyses
Soil	4	4	7	8	7	30

[a]Includes Chromium-VI.
[b]Includes isotopic analyses (gamma emitters) and tritium.
Sample numbers: 231-01-A/B through 231-04-A/B.
Sampling date: September 26, 1994.
Analysis Request/Chain-of-Custody forms: 00813, 00814.
RCRA = Resource Conservation and Recovery Act.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
TPH = Total petroleum hydrocarbons.
VOC = Volatile organic compound.

In June 2001, SNL/NM collected soil samples at two locations along the earthen ditch (Table 2). The soil samples were collected at depths of 1 and 5 feet bgs downslope of the storm-water discharge point (the southern end of the concrete ditch). The 1-foot-bgs samples were collected with a hand trowel. Because of the uneven terrain and the large cobbles that serve as erosion control, a backhoe was used to collect the 5-foot-bgs soil samples from the earthen ditch. The New Mexico Environment Department (NMED) verbally approved use of the backhoe before the sampling was conducted. The soil samples were analyzed for VOCs, SVOCs, TPH, RCRA metals, chromium-VI, and radionuclides (gamma emitters, tritium, and gross alpha/beta). The soil samples were submitted to General Engineering Laboratories Inc. (GEL) and the RPSD Laboratory. The only reported VOC was acetone at 3.8 parts per billion (ppb), which was assigned a 'J' value in the data-validation process. Ten SVOCs were reported, but the maximum value was 82.6 ppb J for bis(2-Ethylhexyl)phthalate. Both acetone and bis(2-Ethylhexyl)phthalate are common laboratory artifacts. TPH was not reported above the detection limit of 0.45 ppm. Beryllium and chromium were the only metals detected above

Table 2
Number of Analyses for Confirmatory Soil and QA/QC Samples Collected in 2001 at SWMU 231

Sample Type	VOCs	SVOCs	TPH	RCRA Metals[a]	Radionuclides[b]	Number of Analyses
Soil	3	3	3	3	3	15
Duplicate	1	1	1	1	1	5
VOC Trip Blank	1	–	–	–	–	1
Equipment Blank[c]	1	1	1	1	1	5
Total Samples	6	6	6	6	6	26

[a]Includes Chromium-VI.
[b]Includes isotopic analyses (gamma emitters) and tritium.
[c]QA/QC samples collected on the same day (AR/COC 604559) at nearby SWMU 230 are applicable to SWMU 231.
Sample numbers: TJAOU-231-GR-05 and TJAOU-231-GR-06.
Sampling date: June 11, 2001.
AR/COC forms: 604306, 604308, 604559, 604561.
AR/COC = Analysis request/chain-of-custody.
QA/QC = Quality assurance/quality control.
RCRA = Resource Conservation and Recovery Act.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
TPH = Total Petroleum Hydrocarbon.
VOC = Volatile organic compound.
– = Information not available.

background levels. The only radionuclide reported above background level was U-235 at 0.228 pCi/g.

Table 3 summarizes the analytical methods and the data quality requirements from both the SAP and FIP. Excluding the QA/QC samples, a total of 76 analyses were reported for the SWMU 231 confirmatory soil samples. This includes 72 analyses from the off-site laboratories (ENCOTEC, Quanterra, and GEL) and four samples from the on-site RPSD Laboratory.

A total of 11 QA/QC samples were collected at SWMU 231. As shown in Table 2, the QA/QC samples consisted of duplicates, equipment blanks, and a VOC trip blank. The duplicate soil samples were collected at a ratio of one duplicate per three environmental samples. Equipment (aqueous rinsate) blanks were prepared for each suite of analytes. No significant problems were identified in the QA/QC samples.

The analytical data were verified/validated by SNL/NM in accordance with the ER Project Quality Assurance Project Plan. The 1994 analytical data were reviewed using the Data Verification/Validation (DV) process (SNL/NM July 1994) involving DV1 and DV2 checklists (Attachment I). The 2001 analytical data were reviewed using DV3 procedures according to the "Data Validation Procedure for Chemical and Radiochemical Data" SNL/NM Environmental Restoration Project Analytical Operating Procedure (AOP) 00-03, Rev. 0 (SNL/NM January 2000). The DV3 reports are presented in Attachment I. The gamma-spectroscopy data from the RPSD Laboratory were reviewed according to "Laboratory Data Review Guidelines,"

Table 3
Summary of Data Quality Requirements and Total Number of Analyses for Confirmatory Soil Samples Collected at SWMU 231

Analytical Method[a]	Data Quality Level	Analyses from Off-Site Laboratories[b]	Analyses from On-Site Laboratory[c]
VOCs EPA Method 8260A	Defensible	8	–
SVOCs EPA Method 8270	Defensible	8	–
TPH EPA Method 8015	Defensible	11	–
RCRA metals EPA Method 6010/7000	Defensible	12	–
Chromium-VI EPA Method 6010/7000	Defensible	12	–
Gamma Spectroscopy EPA Method 901.1	Defensible	11	4
Tritium EPA Method 901.1	Defensible	6	–
Gamma Alpha/Beta EPA Method 900	Defensible	4	–
Total number of analyses[d]	–	72	4

[a]From EPA (November 1986).
[b]The off-site laboratories are ENCOTEC, Quanterra, and GEL.
[c]The on-site laboratory is the Radiation Protection Sample Diagnostic Laboratory.
[d]The number of analyses does not include QA/QC samples.

ENCOTEC = Environmental Control Technology Corporation.
EPA = U.S. Environmental Protection Agency.
GEL = General Engineering Laboratories Inc.
QA/QC = Quality assurance/quality control.
RCRA = Resource Conservation and Recovery Act.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.
TPH = Total petroleum hydrocarbon.
VOC = Volatile organic compound.
– = Information not available.

Procedure No: RPSD-02-11, Issue No: 02 (SNL/NM July 1996). The RPSD gamma-spectroscopy results are presented in Attachment I. Review of the 1994 and 2001 analyses confirm that the analytical data from the four analytical laboratories are defensible and therefore acceptable for use in the NFA proposal. Therefore, the DQOs have been fulfilled.

III. Determination of Nature, Rate, and Extent of Contamination

III.1 Introduction

The determination of the nature, migration rate, and extent of contamination at SWMU 231 was based upon an initial conceptual model validated with confirmatory soil sampling. The initial conceptual model was developed from the review of engineering drawings, ER Project records, and NPDES documents. The DQOs contained in the SAP and FIP identified the sample locations, sample density, sample depth, and analytical requirements. The sample data were subsequently used to develop the final conceptual model for SWMU 231. The quality of the data used to specifically determine the nature, migration rate, and extent of contamination is described below.

III.2 Nature of Contamination

Both the nature of contamination and the potential for the degradation of COCs at SWMU 231 were evaluated using laboratory analyses of the confirmatory soil samples (Section IV). The requirements included analyses for VOCs, SVOCs, RCRA metals, chromium-VI, and radionuclides. The analyses characterized potential contaminants resulting from the discharge of TA-IV storm water. The analytes and methods listed in Table 3 are appropriate and adequate for characterizing the COCs and potential degradation products at SWMU 231.

III.3 Rate of Contaminant Migration

SWMU 231 is an active site. No spills of chemical or radioactive materials have been reported for the catchment area that drains to SWMU 231. If any spills or releases had occurred, the rate of COC migration from surficial soil would be dependent predominantly upon precipitation and occasional storm-water flow as described in Section V. Data available from the TAG Investigation; numerous SNL/NM monitoring programs for air, water, and radionuclides; various biological surveys; and meteorological monitoring are adequate for characterizing the rate of COC migration at SWMU 231.

III.4 Extent of Contamination

Surface and subsurface confirmatory soil samples were collected from SWMU 231 in 1994 and again in 2001 to determine whether contaminants were present. The locations and depths of the 2001 samples were determined using verbal guidance from NMED. The two phases (1994 and 2001) of confirmatory soil sampling were collected from the ground surface to a maximum depth of 5 feet. Sampling at a more extensive variety of depths was not a concern at SWMU 231 because no chemical spills have occurred, and neither the concrete ditch nor the surrounding soil were stained or discolored. In summary, the design of the confirmatory sampling was appropriate and adequate to determine the nature, migration rate, and extent of residual COCs in surface and subsurface soils at SWMU 231.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The SWMU 231 NFA proposal describes the identification of COCs and the sampling that was conducted in order to determine the concentration levels of those COCs across the site. Generally, COCs evaluated in this risk assessment include all detected organic and all radiological and inorganic COCs for which samples were analyzed. When the detection limit of an organic compound was too high (i.e., could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetect organic constituents not included in this assessment were found to have detection limits low enough to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation used only the maximum concentration value of each COC found for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997) was selected to provide the background screening listed in Tables 4 and 5. Human health nonradiological COCs also were compared to SNL/NM proposed Subpart S action levels, if applicable (Table 4) (IT July 1994).

Nonradiological inorganic constituents that are essential nutrients, such as iron, magnesium, calcium, potassium and sodium, were not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs were evaluated. The nonradiological COCs included both inorganic and organic compounds.

Table 4 lists nonradiological COCs and Table 5 lists radiological COCs for the human health and ecological risk assessments at SWMU 231. Both tables show the applicable SNL/NM background concentration screening values (Dinwiddie September 1997). Tables 4 and 5 are discussed in Section VI.4 with regard to the human health risk assessment, and in Sections VII.2 and VII.3 with regard to the ecological risk assessment.

V. Fate and Transport

Potential release of COCs at SWMU 231 may have occurred to the surface soil as a result of discharge of storm-water runoff from TA-IV. Wind, water, and biota are natural mechanisms for transport of these COCs from the potential release point. Because the site is an incised channel with surrounding vegetation, wind is unlikely to be a significant mechanism for COC transport from the site.

Water at SWMU 231 is primarily received as storm-water discharge from an outfall located near the base of the northern embankment of Tijeras Arroyo. Storm-water runoff from TA-IV is channeled to this outfall via a concrete ditch. Below the outfall, this water flows through an open, unlined channel to Tijeras Arroyo. Additional water is received directly as precipitation (rain and occasionally snow). Based upon the average rainfall measured at the nearby Albuquerque International Sunport, the site receives approximately 8.1 inches of precipitation per year. Because of the relatively steep slope of the open channel, surface water readily flows from the site, allowing little time to infiltrate. However, the coarse nature of the soil in the channel allows for rapid infiltration near the surface.

Table 4
Nonradiological COCs for Human Health and Ecological Risk Assessments at SWMU 231 with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K_{ow} (for organic COCs)	Bioaccumulator?[b] (BCF>40, Log K_{ow}>4)
Arsenic	5.7	4.4	**No**	44[d]	NA	**Yes**
Barium	240	200	**No**	170[e]	NA	**Yes**
Beryllium	1.03	0.80	**No**	19[d]	NA	No
Cadmium	1.7	<1	**No**	64[d]	NA	**Yes**
Chromium, total	17	16.2	**No**	16[d]	NA	No
Chromium VI	1.6	NC	**Unknown**	16[d]	NA	No
Lead	10	11.2	Yes	49[d]	NA	**Yes**
Mercury	0.0219	<0.1	**Unknown**	5500[d]	NA	**Yes**
Selenium	0.561	<1	**Unknown**	800[g]	NA	**Yes**
Silver	0.25[h]	<1	**Unknown**	0.5[d]	NA	No
Acetone	0.008 J	NA	**NA**	0.69[c]	-0.24[c]	No
Benzo(a)anthracene	0.0397	NA	**NA**	10,000[f]	5.61[f]	**Yes**
Benzo(a)pyrene	0.0569	NA	**NA**	3,000[d]	6.04[d]	**Yes**
Benzo(b)fluoranthene	0.0621	NA	**NA**	–	6.124[f]	**Yes**
Benzo(k)fluoranthene	0.0357	NA	**NA**	93,325[f]	6.84[f]	**Yes**
Bis(2-Ethylhexyl)phthalate	0.0826 J	NA	**NA**	851[i]	7.6[f]	**Yes**
Chrysene	0.0566	NA	**NA**	18,000[f]	5.91[f]	**Yes**
Fluoranthene	0.0425	NA	**NA**	12,302[f]	4.90[f]	**Yes**
Indeno(1,2,3-c,d)pyrene	0.0467	NA	**NA**	59,407[f]	6.58[f]	**Yes**
Phenanthrene[j]	0.0198 J	NA	**NA**	23,800[d]	4.63[d]	**Yes**
Pyrene	0.0605	NA	**NA**	36,300[d]	5.32[f]	**Yes**

Note: **Bold** indicates the COCs that failed the background and/or Subpart S screening procedures and/or are bioaccumulators.
[a]From Dinwiddie (September 1997) Tijeras Supergroup Soils.
[b]NMED (March 1998).
[c]Howard (1990).

Table 4 (Concluded)
Nonradiological COCs for Human Health and Ecological Risk Assessments at SWMU 231 with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

[d]Yanicak (March 1997).
[e]Neumann (1976).
[f]Micromedex (1998).
[g]Callahan et al. (1979).
[h]Parameter was nondetect. Concentration is approximately 0.5 of detection limit.
[i]Howard (1989).
[j]Phenanthrene does not have toxicological parameter values. Anthracene was used as a surrogate compound.

BCF	= Bioconcentration factor.
COC	= Constituent of concern.
J	= Estimated value.
K_{ow}	= Octanol-water partition coefficient.
Log	= Logarithm (base 10).
mg/kg	= Milligram(s) per kilogram.
NA	= Not applicable.
NC	= Not calculated.
NMED	= New Mexico Environment Department.
SNL/NM	= Sandia National Laboratories/New Mexico.
SWMU	= Solid Waste Management Unit.
–	= Information not available.

Table 5
Radiological COCs for Human Health and Ecological Risk Assessments at SWMU 231 with Comparison to the Associated SNL/NM Background Screening Value and BCF

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Is COC a Bioaccumulator?[b] (BCF>40)
Th-232	1.03	1.54	Yes	3000[c]	No[d]
U-238	1.3 (MDA)	1.3	Yes	900[c]	**Yes**
U-235	**0.23**	0.18	**No**	900[c]	**Yes**
H-3	0.007 (MDA)	0.021[e]	Yes	NA	No

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.
[a]From Dinwiddie (September 1997), North Supergroup Soils (background values not calculated for Tijeras).
[b]NMED (March 1998).
[c]Baker and Soldat (1992).
[d]Yanicak (March 1997).
[e]The tritium background value of 0.021 pCi/g was calculated from the Tharp (February 1999) tritium background value of 420 pCi/L. The pCi/L value was converted to the pCi/g value using the assumption of 5 percent soil moisture and a soil density of 1 g/cubic centimeter.

BCF = Bioconcentration factor.
COC = Constituent(s) of concern.
g = Gram(s).
L = Liter.
MDA = Minimum detectable activity.
NMED = New Mexico Environment Department.
pCi = Picocurie(s).
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COCs may be leached deeper into the subsurface soil with this percolation. Because of the arid nature of the environment, evapotranspiration rates are high and most water that infiltrates into the soil (95 to 99 percent) is lost through this process. Because of the low annual precipitation, high evapotranspiration rates, and depth to groundwater at this site (in excess of 270 feet bgs), infiltration and percolation are not expected to be sufficient to leach COCs into groundwater.

COCs can enter the food chain via uptake from the soil solution by plant roots. These COCs may be transported to the aboveground tissues and then may be either consumed by herbivores or returned to the soil as litter. Aboveground litter is capable of transport by wind until consumed by decomposer organisms in the soil. Constituents in plant tissues that are consumed by herbivores may be either absorbed into tissues or returned to the soil in feces (at the site or transported from the site by the herbivore). The herbivore then may be eaten by a carnivore or scavenger and the constituents in the tissues again will be either absorbed or excreted by the consumer. The potential for transport of the constituents within the food chain is dependent upon both the mobility of the species that comprise the food chain and the potential for the constituent to accumulate in tissues and be transferred across the links in the food chain. The natural vegetation at SWMU 231 is grassland and riparian scrubland. Because of the arid environment and ephemeral nature of the flows in the channel, the vegetative cover of the site is relatively low. Therefore, food chain uptake is not considered to be a potentially significant transport mechanism at this site.

The COCs at SWMU 231 include both inorganic and organic constituents. The inorganic constituents include both radiological and nonradiological analytes. The inorganic COCs are elemental in form and generally are not considered to be degradable. Radiological COCs, however, undergo decay to stable isotopes or radioactive daughter elements. Other transformations of inorganic constituents may include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., the conversion of selenite or selenate from soil to seleno-amino acids in plants). The rate of such processes will be limited by the aridity of the environment at this site. Organic COCs may be degraded through photolysis, hydrolysis, and biotransformation. Photolysis requires light, and therefore takes place in the air, at the ground surface, or in surface water. Hydrolysis includes chemical transformations in water and may occur in the soil solution. Biotransformation (i.e., transformation due to plants, animals, and microorganisms) may occur; however, biological activity may be limited by the arid environment at this site. Some organic COCs (e.g., acetone) may be lost through volatilization.

Table 6 summarizes the fate and transport processes that may occur at SWMU 231. Because the site is an open channel for storm-water runoff from TA-IV, the potential for COC transport via surface-water runoff is high. COCs that have leached into the subsurface soil, however, will be protected from transport by surface-water flow. The potential for significant transport by wind is low, and the potential for COCs to leach into groundwater is very low due to both the depth to groundwater and the arid environment. The site is open to use by wildlife, and some vegetation occurs at the site; therefore, uptake into the food chain is possible, but the small size and relatively low vegetative cover of the site make this an insignificant transport mechanism for COCs. The potential for significant loss of COCs by degradation and/or transformation is generally low; however, some organic COCs may be lost near the soil surface through volatilization.

Table 6
Summary of Fate and Transport at SWMU 231

Transport and Fate Mechanism	Existence at Site	Significance
Wind	Yes	Low
Surface runoff	Yes	High
Migration to groundwater	No	None
Food chain uptake	Yes	Low
Transformation/degradation	Yes	Low

SWMU = Solid Waste Management Unit.

VI. Human Health Risk Screening Assessment

VI.1 Introduction

The human health risk screening assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include the following:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways are identified by which a representative population might be exposed to the COCs.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach includes two screening procedures. One screening procedure compares the maximum concentration of the COC to an SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure that compares the maximum concentration of the COC to the SNL/NM proposed Subpart S action level.
Step 4.	Toxicological parameters are identified and referenced for COCs that were not eliminated during the screening steps.
Step 5.	Potential toxicity effects (specified as a hazard index [HI]) and estimated excess cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only applies when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA), NMED, and the DOE to determine whether further evaluation and potential site cleanup are required. Nonradiological COC risk values also are compared to background risk so that an incremental risk can be calculated.
Step 7.	Uncertainties regarding the contents of the previous steps are addressed.

VI.2 Step 1. Site Data

Section I of this risk assessment provides the site description and history for SWMU 231. Section II presents the argument that DQOs were satisfied. Section III describes the determination of the nature, rate, and extent of contamination.

VI.3 Step 2. Pathway Identification

SWMU 231 has been designated with a future land use scenario of industrial (DOE et al. September 1995) (see Appendix 1 for default exposure pathways and parameters). Because of the location and characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs, and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because the potential exists to inhale dust and volatiles. Soil ingestion is included for the radiological COCs as well. No water pathways to the groundwater are considered. Depth to groundwater at SWMU 231 is approximately 270 feet bgs. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is not considered to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land use scenario. However, plant uptake is considered for the residential land use scenario.

Pathway Identification

Nonradiological Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust and volatiles)	Inhalation (dust and volatiles)
Plant uptake (residential only)	Plant uptake (residential only)
	Direct gamma

VI.4 Step 3. COC Screening Procedures

This section discusses Step 3, which includes the two screening procedures. The first screening procedure compared the maximum COC concentration to the background screening level. The second screening procedure compared maximum COC concentrations to SNL/NM proposed Subpart S action levels. This second procedure was applied only to COCs that were not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of nonradiological COCs were compared to the approved SNL/NM maximum screening levels for this area (Dinwiddie September 1997). The SNL/NM maximum background concentration was selected to provide the background screen in Table 4 and was used to calculate risk attributable to background in Table 10 (Section VI.6.2). Only the COCs that either were detected above their respective SNL/NM maximum background screening levels or did not have either a quantifiable or a calculated background screening level were considered in further risk assessment analyses.

For radiological COCs that exceeded the SNL/NM background screening levels, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the

Environment" (DOE 1993). Radiological COCs that did not have a background value and were detected above the analytical minimum detectable activity were carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Results

Tables 4 and 5 present SWMU 231 maximum COC concentrations that were compared to the SNL/NM maximum background values (Dinwiddie September 1997) for the human health risk assessment. For the nonradiological COCs, five constituents were measured at concentrations greater than their respective background values. Four nonradiological COCs had no quantifiable background concentration, so it is not known whether these COCs exceeded background. Eleven COCs were organic compounds that do not have corresponding calculated background concentrations.

For the radiological COCs, one constituent (U-235) exhibited maximum activity concentration (or minimum detectable activity) slightly greater than its respective background value.

VI.4.2 Subpart S Screening Procedure

VI.4.2.1 Methodology

The maximum concentrations of nonradiological COCs not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) documentation. Accordingly, all calculations were based upon the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because all of the samples were taken from the surface and near-surface soils, this assumption is considered valid. If there were ten or fewer COCs, and each had a maximum concentration of less than 1/10 the action level, then the site was judged to pose no significant health hazard to humans. If there were more than ten COCs, then the Subpart S screening procedure was not performed.

VI.4.2.2 Results

Table 4 indicates that more than ten COCs failed the background screening procedure. Therefore, the Subpart S screening procedure was not performed. Thus, all constituents that exceeded the background screening values were carried forward in the risk assessment process, and an individual hazard quotient (HQ), cumulative HI, and excess cancer risk value were calculated for each COC.

Because radiological COCs have no predetermined action levels analogous to proposed Subpart S levels, this step in the screening process was not performed for radiological COCs.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 7 (nonradiological) and 8 (radiological) list the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for the nonradiological COCs in Table 7 were from the Integrated Risk Information System (IRIS) (EPA 1998a), the Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), as well as the Region 9 (EPA 1996) and Region 3 (EPA 1997b) electronic databases. Dose conversion factors (DCFs) used in determining the excess TEDE values for radiological COCs for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993a) as developed in the following documents:

- DCFs for ingestion and inhalation are taken from "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" (EPA 1988).

- DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public" (DOE 1988).

- DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil" (Kocher 1983) and in ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993b).

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI and excess cancer risk for both the potential nonradiological COCs and associated background for both industrial and residential land uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both industrial and residential land uses.

VI.6.1 Exposure Assessment

Appendix 1 provides the equations and parameter input values used in calculating intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both industrial and residential land use scenarios. The equations for nonradiological COCs are based upon the RAGS (EPA 1989). Parameters are based upon information from the RAGS (EPA 1989), as well as other EPA guidance documents, and reflect the reasonable maximum exposure (RME) approach advocated by the RAGS (EPA 1989). For radiological COCs, the coded equations provided in RESRAD computer code are used to estimate the incremental TEDE and cancer risk for individual exposure pathways. Further discussion of this process is provided in the *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD* (Yu et al. 1993a).

Table 7
Toxicological Parameter Values for SWMU 231 Nonradiological COCs

COC Name	RfD_o (mg/kg-d)	Confidence[a]	RfD_{inh} (mg/kg-d)	Confidence[a]	SF_o (mg/kg-day)$^{-1}$	SF_{inh} (mg/kg-day)$^{-1}$	Cancer Class[b]
Arsenic	3E-4[c]	M	–	–	1.5E+0[c]	1.5E+1[c]	A
Barium	7E-2[c]	M	1.4E-4[d]	–	–	–	–
Beryllium	2E-3[c]	L to M	5.7E-6[c]	M	–	8.4E+0[c]	B1
Cadmium	5E-4[c]	H	5.7E-5[d]	–	–	6.3E+0[c]	B1
Chromium, total	1E+0[c]	L	5.7E-7[f]	–	–	–	–
Chromium VI	5E-3[c]	L	–	–	–	4.2E+1[c]	A
Mercury	3E-4[e]	–	8.6E-5[c]	M	–	–	D
Selenium	5E-3[c]	H	–	–	–	–	D
Silver	5E-3[c]	L	–	–	–	–	D
Acetone	1E-1[c]	L	1E-1[d]	–	–	–	D
Benzo(a) anthracene	–	–	–	–	7.3E-1[d]	7.3E-1[d]	–
Benzo(a) pyrene	–	–	–	–	7.3E+0[c]	7.3E+0[d]	B2
Benzo(b) fluoranthene	–	–	–	–	7.3E-1[d]	7.3E-1[d]	B2
Benzo(k) fluoranthene	–	–	–	–	7.3E-2[d]	7.3E-2[d]	B2
Bis(2-ethylhexyl) phthalate	2E-2[d]	–	2.2E-2[d]	–	1.4E-2[d]	1.4E-2[d]	–
Chrysene	–	–	–	–	7.3E-3[d]	7.3E-3[d]	B2
Fluoranthene	4E-2[c]	L	4E-2[d]	–	–	–	D
Indeno(1,2,3-c,d)pyrene	–	–	–	–	7.3E-1[d]	7.3E-1[d]	B2
Phenanthrene[g]	3E-1[c]	L	3E-1[d]	–	–	–	D
Pyrene	3E-2[c]	L	3E-2[d]	–	–	–	D

[a]Confidence associated with IRIS (EPA 1998a) database values. Confidence: L = low, M = medium, H = high.
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998a):
A = Human carcinogen.
B1 = Probable human carcinogen. Limited human data available.
B2 = Probable human carcinogen. Sufficient evidence in animals and inadequate or no evidence in humans.
D = Not classifiable as to human carcinogenicity.
[c]Toxicological parameter values from IRIS electronic database (EPA 1998a).
[d]Toxicological parameter values from EPA Region 9 electronic database (EPA 1996).
[e]Toxicological parameter values from HEAST database (EPA 1997a).
[f]Toxicological parameter values from EPA Region 3 electronic database (EPA 1997b)
[g]Phenanthrene does not have toxicological parameter values. Anthracene was used as a surrogate.

COC = Constituent(s) of concern.
EPA = U.S. Environmental Protection Agency.
HEAST = Health Effects Assessment Summary Tables.
IRIS = Integrated Risk Information System.
mg/kg-d = Milligram(s) per kilogram per day.
(mg/kg-day)$^{-1}$ = Per milligram per kilogram per day.
RfD_{inh} = Inhalation chronic reference dose.
RfD_o = Oral chronic reference dose.
SF_{inh} = Inhalation slope factor.
SF_o = Oral slope factor.
SWMU = Solid Waste Management Unit.
– = Information not available.

Table 8
Radiological Toxicological Parameter Values for SWMU 231 COCs Obtained from RESRAD Risk Coefficients[a]

COC Name	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class[b]
U-235	4.70E-11	1.30E-08	2.70E-07	A

[a]From Yu et al. (1993a).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A = Human carcinogen for high dose and high dose rate (i.e., greater than 50 rem per year). For low-level environmental exposures, the carcinogenic effect has not been observed and documented.

1/pCi = One per picocurie.
COC = Constituent(s) of concern.
EPA = U.S. Environmental Protection Agency.
g/pCi-yr = Gram(s) per picocurie-year.
rem = Roentgen equivalent man.
SF_{ev} = External volume exposure slope factor.
SF_{inh} = Inhalation slope factor.
SF_o = Oral (ingestion) slope factor.
SWMU = Solid Waste Management Unit.

Although the designated land use scenario is industrial for this site, risk and TEDE values for a residential land use scenario also are presented only to provide perspective of potential risk to human health under the more restrictive land use scenario.

VI.6.2 Risk Characterization

Table 9 shows an HI of 0.02 for the SWMU 231 nonradiological COCs and an estimated excess cancer risk of 3E-6 for the designated industrial land use scenario. The numbers presented include exposure from soil ingestion as well as dust and volatile inhalation for nonradiological COCs. Table 10 shows an HI of 0.01 and an excess cancer risk of 2E-6, assuming the maximum background concentrations of the SWMU 231 associated background constituents for the designated industrial land use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the industrial land use scenario, an incremental TEDE of 5.6E-02 millirem (mrem) per year (/yr) was calculated. In accordance with EPA guidance found in Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA 1997c), an incremental TEDE of 15 mrem/yr was used for the probable land use scenario (industrial in this case); the calculated dose value for SWMU 231 for the industrial land use was well below this guideline. The estimated excess cancer risk was 7.7E-7.

For the residential land use scenario nonradioactive COCs, the HI was 2 and the excess cancer risk was 6E-5 (Table 9). The numbers in the table include exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although the EPA (EPA 1991) generally recommends that inhalation not be included in a residential land use scenario, this pathway was included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local

Table 9
Risk Assessment Values for SWMU 231 Nonradiological COCs

COC Name	Maximum Concentration (mg/kg)	Industrial Land Use Scenario[a]		Residential Land Use Scenario[a]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	5.7	0.02	3E-6	0.33	6E-5
Barium	240	0.00	–	0.04	–
Beryllium	1.03	0.00	5E-10	0.00	8E-10
Cadmium	1.7	0.00	6E-10	1.39	1E-9
Chromium, total	17	0.00	–	0.01	–
Chromium VI	1.6	0.00	4E-9	0.00	6E-9
Mercury	0.0219	0.00	–	0.04	–
Selenium	0.561	0.00	–	0.20	–
Silver	0.25[b]	0.00	–	0.01	–
Acetone	0.008 J	0.00	–	0.00	–
Benzo(a)anthracene	0.0397	0.00	1E-8	0.00	1E-7
Benzo(a)pyrene	0.0569	0.00	2E-7	0.00	1E-6
Benzo(b)fluoranthene	0.0621	0.00	2E-8	0.00	2E-7
Benzo(k)fluoranthene	0.0357	0.00	9E-10	0.00	9E-9
Bis(2-ethylhexyl) phthalate	0.0826 J	0.00	4E-10	0.00	3E-9
Chrysene	0.0566	0.00	2E-10	0.00	2E-9
Fluoranthene	0.0425	0.00	–	0.00	–
Indeno(1,2,3-c,d) pyrene	0.0467	0.00	1E-8	0.00	9E-8
Phenanthrene	0.0198 J	0.00	–	0.00	–
Pyrene	0.0605	0.00	–	0.00	–
Total		**0.02**	**3E-6**	**2**	**6E-5**

[a]From EPA (1989).
[b]Parameter was nondetect. Concentration assumed to be approximately 0.5 of detection limit.
COC = Constituent(s) of concern.
EPA = U.S. Environmental Protection Agency.
J = Estimated value.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
– = Information not available.

Table 10
Risk Assessment Values for SWMU 231 Nonradiological Background Constituents

COC Name	Background Concentration[a] (mg/kg)	Industrial Land Use Scenario[b]		Residential Land Use Scenario[b]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	4.4	0.01	2E-6	0.25	5E-5
Barium	200	0.00	–	0.03	–
Beryllium	0.80	0.00	4E-10	0.00	6E-10
Cadmium	<1	–	–	–	–
Chromium, total	16.2	0.00	–	0.01	–
Chromium VI	NC	–	–	–	–
Mercury	<0.1	–	–	–	–
Selenium	<1	–	–	–	–
Silver	<1	–	–	–	–
Total		**0.01**	**2E-6**	**0.3**	**5E-5**

[a]From Dinwiddie (September 1997), Tijeras Supergroup Soils.
[b]From EPA (1989).
COC = Constituent(s) of concern.
EPA = U.S. Environmental Protection Agency.
mg/kg = Milligram(s) per kilogram.
NC = Not calculated.
SWMU = Solid Waste Management Unit.
– = Information not available.

soil, other exposure pathways were not considered (see Appendix 1). Table 10 shows that for the SWMU 231 associated background constituents, the HI is 0.3 and the excess cancer risk is 5E-5.

For the radiological COCs, the incremental TEDE for the residential land use scenario was 8.6E-2 mrem/yr. The guideline being used was an excess TEDE of 75 mrem/yr (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for SWMU 231 for the residential land use scenario was well below this guideline. Consequently, SWMU 231 is eligible for unrestricted radiological release because the residential land use scenario resulted in an incremental TEDE of less than 75 mrem/yr to the on-site receptor. The estimated excess cancer risk was 1.1E-6. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in the RAGS (EPA 1989).

VI.7 Step 6. Comparison of Risk Values to Numerical Guidelines

The human health risk assessment analysis evaluated the potential for adverse health effects for both the industrial land use scenario (the designated land use scenario for this site) and the residential land use scenario.

For the industrial land use scenario, the HI for nonradiological COCs was 0.02 (less than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). Excess cancer risk was estimated at 3E-6. NMED Guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001); thus, the excess cancer risk for this site is below the suggested acceptable risk value. This assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land use scenarios. Assuming the industrial land use scenario, for nonradiological COCs the HI was 0.01 and the excess cancer risk was 2E-6. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers were not rounded before the difference was determined and, therefore, may appear to be inconsistent with numbers presented in tables and within the text. For conservatism, the background constituents that do not have quantified background concentrations are assumed to have an HQ and excess cancer risk of 0.00. Incremental HI was 0.01 and estimated incremental cancer risk was 1.25E-6 for the industrial land use scenario. Both the incremental HI and excess cancer risk to human health from nonradiological COCs were below proposed guidelines considering an industrial land use scenario.

For the industrial land use scenario, incremental TEDE for radiological COCs was 5.6E-02 mrem/yr, which is significantly less than EPA's numerical guideline of 15 mrem/yr. Incremental estimated excess cancer risk was 7.7E-7.

The calculated HI was 2 for the residential land use scenario nonradiological COCs, which is above the numerical guidance. Excess cancer risk was estimated at 6E-5. NMED Guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001); thus, the excess cancer risk for this site is above the suggested acceptable risk value. The HI for associated background for the residential land use scenario was 0.3; the excess cancer risk was estimated at 5E-5. The incremental HI was 1.73, and the estimated incremental cancer risk was 1.14E-5 for the residential land use scenario. Both the incremental HI and excess cancer risk to human health from the nonradiological COCs, considering the residential land use scenario, were above NMED guidance.

The incremental TEDE for a residential land use scenario from the radiological constituents was 8.6E-2 mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in the SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The estimated excess cancer risk was 1.1E-6.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 231 was based upon an initial conceptual model that was validated with confirmatory soil sampling conducted across the site. The sampling was implemented in accordance with the SAP and FIP. The DQOs in the SAP and FIP are considered appropriate for use in the SWMU 231 risk screening assessments. The analytical data, based upon sample location, density, and depth, are representative of the site. The analytical results satisfy the DQOs and were verified/validated in accordance with SNL/NM procedures. The QA/QC findings demonstrate that the analytical data were of adequate quality. Therefore, there is no uncertainty associated with the data quality used to perform the risk screening assessment at SWMU 231.

Because of the location, history of the site, and future land use (DOE et al. September 1995), there is low uncertainty in both the land use scenario and the potentially affected populations that were considered in performing the risk assessment analysis. Because the COCs are found in surface and near-surface soils, and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values. This means that the parameter values in the calculations were conservative and that calculated intakes were probably overestimates. Maximum measured values of COC concentrations were used to provide conservative results.

Table 7 shows the uncertainties (confidence level) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 1998a), the HEAST (EPA 1997a), and the EPA Region 9 (EPA 1996) and EPA Region 3 (EPA 1997b) electronic databases. Where values are not provided, information is not available from these sources. Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to change the conclusion from the risk assessment analysis.

Both the human health HI and excess cancer risk for the nonradiological COCs were acceptable compared to established numerical guidance considering the industrial land use scenario.

For radiological COCs, the conclusion of the risk assessment was that potential effects on human health for both industrial and residential land use scenarios were within guidelines and represent only a small fraction of the estimated 360 mrem/yr received by the average U.S. population (NCRP 1987).

The overall uncertainty in all of the steps in the risk assessment process is not considered to be significant with respect to the conclusion reached.

VI.9 Summary

SWMU 231 identified COCs consisting of some inorganic and radiological compounds. Because of the location of the site, the designated industrial land use scenario, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion as well as dust and volatile inhalation for chemical constituents, and soil ingestion, dust inhalation, and direct gamma exposure for radionuclides. Plant uptake was included as an exposure pathway for the residential land use scenario.

Using conservative assumptions and an RME approach to risk assessment, calculations for nonradiological COCs show that for the industrial land use scenario the HI (0.02) was significantly less than the accepted numerical guidance from EPA. Excess cancer risk (3E-6) was below the acceptable risk value provided by NMED for an industrial land use scenario (Bearzi January 2001). The incremental HI was 0.01, and the incremental cancer risk was 1.25E-6 for the industrial land use scenario.

Incremental TEDE and corresponding estimated cancer risk from radiological COCs were much less than EPA guidance values; the estimated TEDE was 5.6E-02 mrem/yr for the industrial land use scenario. This value was much less than the numerical guidance of 15 mrem/yr in EPA guidance (EPA 1997c). The corresponding incremental estimated cancer risk value was 7.7E-7 for the industrial land use scenario. Furthermore, the incremental TEDE for the residential land use scenario that results from a complete loss of institutional control was only 8.6E-2 mrem/yr with an associated risk of 1.1E-6. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore, SWMU 231 is eligible for unrestricted radiological release.

Uncertainties associated with the calculations are considered to be small relative to the conservatism of this risk assessment analysis. Therefore, it is concluded that this site poses no significant risk to human health under the industrial land use scenario.

VII. Ecological Risk Screening Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils at SWMU 231. A component of the NMED Risk-Based Decision Tree (NMED March 1998) is to conduct an ecological screening assessment that corresponds with that presented in EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997d). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Initial components of NMED's decision tree (a discussion of DQOs, data assessment, and evaluations of both bioaccumulation and fate and transport potential) are addressed in previous sections of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment, whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatisms into the estimation of ecological risks, ecological relevance and professional judgment also are applied as recommended by EPA (EPA 1998b) to ensure that predicted exposures of selected ecological receptors reflect those reasonably expected to occur at the site.

VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of biota at or adjacent to the site to be exposed to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, as well as fate and transport potential. A scoping risk management decision (Section VII.2.4) involves summarizing the scoping results and determining whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 4 and 5), inorganic constituents in soil within the 0- to 5-foot-depth interval that exceeded background concentrations were as follows:

- Arsenic
- Barium

- Beryllium
- Cadmium
- Chromium (total)
- U-235.

Four inorganic constituents that did not have quantified background screening levels and therefore were considered in this risk screening assessment were:

- Chromium VI
- Mercury
- Selenium
- Silver.

Organic analytes detected in soil that exceeded background were as follows:

- Acetone
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Bis(2-ethylhexyl)phthalate
- Chrysene
- Fluoranthene
- Indeno(1,2,3-cd)pyrene
- Phenanthrene
- Pyrene.

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, the following were considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 4 and 5):

- Arsenic
- Barium
- Cadmium
- Mercury
- Selenium
- U-235
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Bis(2-ethylhexyl)phthalate
- Chrysene
- Fluoranthene

- Indeno(1,2,3-cd)pyrene
- Phenanthrene
- Pyrene.

It should be noted, however, that as directed by NMED (NMED March 1998), bioaccumulation for inorganic COCs is assessed exclusively based upon maximum reported bioconcentration factors (BCFs) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

VII.2.3 Fate and Transport Potential

The potential for the COPECs to migrate from the source of contamination to other media or biota is discussed in Section V. As noted in Table 6 (Section V), surface-water runoff is potentially of high significance as a transport mechanism for COPECs at this site. Migration to groundwater is not anticipated. Wind and food chain uptake are expected to be of low significance. Degradation (decay) and transformation of the COPECs also are expected to be of low significance at this site, but volatilization may account for the loss of some organic COPECs (e.g., acetone).

VII.2.4 Scoping Risk-Management Decision

Based upon information gathered through the scoping assessment, it was concluded that complete ecological pathways may be associated with this SWMU and that COPECs also exist at the site. As a consequence, a screening assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Screening Assessment

As concluded in Section VII.2.4, both complete ecological pathways and COPECs are associated with this SWMU. The screening assessment performed for the site involves a quantitative estimate of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure that ecological risks are not underpredicted.

Components within the screening assessment include the following:

- Problem Formulation—sets the stage for the evaluation of potential exposure and risk.
- Exposure Estimation—provides a quantitative estimate of potential exposure.
- Ecological Effects Evaluation—presents benchmarks used to gauge the toxicity of COPECs to specific receptors.

- Risk Characterization—characterizes the ecological risk associated with exposure of the receptors to environmental media at the site.
- Uncertainty Assessment—discusses uncertainties associated with the estimation of exposure and risk.
- Risk Interpretation—evaluates ecological risk in terms of HQs and ecological significance.
- Screening Assessment Scientific/Management Decision Point—presents the decision to risk managers based upon the results of the screening assessment.

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the screening assessment that provides the introduction to the risk evaluation process. Components that are addressed in this section include a discussion of ecological pathways and the ecological setting, identification of COPECs, and selection of ecological receptors. The conceptual model, ecological food webs, and ecological endpoints (other components commonly addressed in a screening assessment) are presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program" (IT July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 231 is approximately 0.04 acre in size. The site is located in an area dominated by grassland habitat. The site itself is an open drainage channel on the lower slope of the northern embankment of Tijeras Arroyo. This slope consists of fill material that covers the original soil surface. The vegetation consists primarily of ruderal and early successional grassland plants. Although the habitat grades into the riparian scrubland habitat of Tijeras Arroyo, this habitat is not well developed on the site due to the steepness of the slope of the embankment and ephemeral nature of the flows (primarily outflow from the TA-IV storm-water system). The site is open to use by wildlife and does not contain perennial surface water. A sensitive species survey of the site was conducted in 1994 (IT February 1995). No threatened, endangered, or other sensitive species were found within this SWMU.

Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface soil. It was assumed that direct uptake of COPECs from soil is the major route of exposure for plants and that exposure of plants to wind-blown soil is minor. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways, and external radiation. Because of the lack of surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact also were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Groundwater is not expected to be affected by COCs at this site.

VII.3.1.2 COPECs

Discharge of storm-water runoff from TA-IV is the potential source of the COPECs associated with the soils at SWMU 231. Inorganic and organic COPECs identified for SWMU 231 are listed in Section VII.2.1. The inorganic COPECs include both radiological and nonradiological analytes. The inorganic analytes were screened against background concentrations and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997) for the area were considered to be COPECs. Nonradiological inorganic constituents that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment as set forth by the EPA (EPA 1989). All organic analytes detected were considered to be COPECs for the site. In order to provide conservatism, this ecological risk assessment was based upon the maximum soil concentrations of the COPECs measured in the surface soil at this site. Tables 4 and 5 present maximum concentrations for the COPECs.

VII.3.1.3 Ecological Receptors

A nonspecific perennial plant was selected as the receptor to represent plant species at the site (IT July 1998). Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associated with it. The deer mouse (*Peromyscus maniculatus*) and the burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected to represent a top predator at this site. The burrowing owl is present at SNL/NM and is designated a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

VII.3.2 Exposure Estimation

For nonradiological COPECs, direct uptake from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water also was considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 11 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT July 1998).

Although home range also is included in this table, exposures for this risk assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from

Table 11
Exposure Factors for Ecological Receptors at SWMU 231

Receptor Species	Class/Order	Trophic Level	Body Weight (kg)[a]	Food Intake Rate (kg/day)[b]	Dietary Composition[c]	Home Range (acres)
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Herbivore	2.39E-2[d]	3.72E-3	Plants: 100% (+ Soil at 2% of intake)	2.7E-1[e]
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	2.39E-2[d]	3.72E-3	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	2.7E-1[e]
Deer Mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Insectivore	2.39E-2[d]	3.72E-3	Invertebrates: 100% (+ Soil at 2% of intake)	2.7E-1[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	1.55E-1[f]	1.73E-2	Rodents: 100% (+ Soil at 2% of intake)	3.5E+1[g]

[a]Body weights are in kg wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kg dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
[d]From Silva and Downing (1995).
[e]EPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).
EPA = U.S. Environmental Protection Agency.
kg = Kilogram(s).
kg/day = Kilogram(s) per day.
SWMU = Solid Waste Management Unit.

the site being investigated. The maximum COPEC concentrations measured from surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose-rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from U-235. Internal and external dose rates to the deer mouse and the burrowing owl are approximated using modified dose-rate models from DOE (DOE 1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998). Radionuclide-dependent data for the dose-rate calculations were obtained from Baker and Soldat (1992). The external-dose-rate model examines the total-body dose-rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with gamma-emitting radionuclides. The external-dose-rate model is the same for both the deer mouse and the burrowing owl. The internal total-body dose-rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a "point" source. Radiation emitted from this point source is absorbed by the body tissues to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma-emitting radionuclides transfer only a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose rate results are summed to calculate a total dose rate from exposure to U-235 in soil.

Table 12 provides the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 13 presents maximum concentrations in soil and derived concentrations in tissues of the various food chain elements that are used to model dietary exposures for each of the wildlife receptors.

VII.3.3 Ecological Effects Evaluation

Table 14 shows benchmark toxicity values for the plant and wildlife receptors. For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the LOAELs or NOAELs for some COPECs.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (IAEA 1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day also should protect other groups within the terrestrial habitat of SWMU 231.

Table 12
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at SWMU 231

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Arsenic	4.0E-2 [a]	1.0E+0 [b]	2.0E-3 [a]
Barium	1.5E-1 [a]	1.0E+0 [b]	2.0E-4 [c]
Beryllium	1.0E-2 [a]	1.0E+0 [b]	1.0E-3 [a]
Cadmium	5.5E-1 [a]	6.0E-1 [d]	5.5E-4 [a]
Chromium (total)	4.0E-2 [c]	1.3E-1 [e]	3.0E-2 [c]
Chromium VI	4.0E-2 [c]	1.3E-1 [e]	3.0E-2 [c]
Mercury	1.0E+0 [c]	1.0E+0 [b]	2.5E-1 [a]
Selenium	5.0E-1 [c]	1.0E+0 [b]	1.0E-1 [c]
Silver	1.0E+0 [c]	2.5E-1 [d]	5.0E-3 [c]
Organic [f]			
Acetone	5.3E+1	1.3E+1	1.0E-8
Benzo(a)anthracene	2.2E-2	2.5E+1	1.2E-2
Benzo(a)pyrene	1.1E-2	2.7E+1	3.8E-2
Benzo(b)fluoranthene	6.2E-3	2.8E+1	1.1E-1
Benzo(k)fluoranthene	4.3E-3	2.9E+1	2.1E-1
Bis(2-ethylhexyl)phthalate	1.6E-3	3.2E+1	1.3E+0
Chrysene	1.5E-2	2.6E+1	2.3E-2
Fluoranthene	5.7E-2	2.3E+1	2.1E-3
Indeno(1,2,3-cd)pyrene	6.1E-3	2.8E+1	1.2E-1
Phenanthrene	8.9E-2	2.2E+1	9.6E-4
Pyrene	3.3E-2	2.4E+1	5.8E-3

[a]From Baes et al. (1984).
[b]Default value.
[c]From NCRP (January 1989).
[d]From Stafford et al. (1991).
[e]From Ma (1982).
[f]Soil-to-plant and food-to-muscle transfer factors from equations developed in Travis and Arms (1988). Soil-to-invertebrate transfer factors from equations developed in Connell and Markwell (1990). All three equations based upon the relationship of the transfer factor to the log K_{ow} value of compound.

K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
NCRP = National Council on Radiation Protection and Measurements.
SWMU = Solid Waste Management Unit.

Table 13
Media Concentrations[a] for Constituents of Potential Ecological Concern at SWMU 231

Constituent of Potential Ecological Concern	Soil (maximum)[a]	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganic				
Arsenic	5.7E+0	2.3E-1	5.7E+0	1.9E-2
Barium	2.4E+2	3.6E+1	2.4E+2	8.9E-2
Beryllium	1.0E+0	1.0E-2	1.0E+0	1.7E-3
Cadmium	1.7E+0	9.4E-1	1.0E+0	1.7E-3
Chromium (total)	1.7E+1	6.8E-1	2.2E+0	1.7E-1
Chromium VI	1.6E+0	6.4E-2	2.1E-1	1.6E-2
Mercury	2.2E-2	2.2E-2	2.2E-2	1.8E-2
Selenium	5.6E-1	2.8E-1	5.6E-1	1.4E-1
Silver	2.5E-1[d]	2.5E-1	6.3E-2	2.5E-3
Organic				
Acetone	8.0E-3[e]	4.3E-1	1.0E-1	8.6E-9
Benzo(a)anthracene	4.0E-2	8.8E-4	1.0E+0	1.8E-2
Benzo(a)pyrene	5.7E-2	6.5E-4	1.5E+0	8.9E-2
Benzo(b)fluoranthene	6.2E-2	3.8E-4	1.7E+0	3.1E-1
Benzo(k)fluoranthene	3.6E-2	1.5E-4	1.0E+0	3.5E-1
Bis(2-ethylhexyl)phthalate	8.3E-2[e]	1.3E-4	2.6E+0	5.3E+0
Chrysene	5.7E-2	8.4E-4	1.5E+0	5.4E-2
Fluoranthene	4.3E-2	2.4E-3	9.8E-1	3.3E-3
Indeno(1,2,3-cd)pyrene	4.7E-2	2.8E-4	1.3E+0	2.4E-1
Phenanthrene	2.0E-2[e]	1.8E-3	4.4E-1	6.7E-4
Pyrene	6.1E-2	2.0E-3	1.5E+0	1.3E-2

[a]In milligrams per kilogram. All biotic media are based upon dry weight of the media. Soil concentration measurements are assumed to have been based upon dry weight. Values have been rounded to two significant digits after calculation.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Based upon the deer mouse with an omnivorous diet. Product of the average concentration ingested in food and soil times the food-to-muscle transfer factor times a wet weight-dry weight conversion factor of 3.125 (EPA 1993).
[d]Parameter is nondetect. Concentration equals 0.5 of the method detection limit.
[e]Based upon an estimated concentration.
EPA = U.S. Environmental Protection Agency.
SWMU = Solid Waste Management Unit.

Table 14
Toxicity Benchmarks for Ecological Receptors at SWMU 231

Constituent of Potential Ecological Concern	Plant Benchmark[a,b]	Mammalian NOAELs			Avian NOAELs		
		Mammalian Test Species[c,d]	Test Species NOAEL[d,e]	Deer Mouse NOAEL[e,f]	Avian Test Species[d]	Test Species NOAEL[d,e]	Burrowing Owl NOAEL[e,g]
Inorganics							
Arsenic	10	mouse	0.126	0.133	mallard	5.14	5.14
Barium	500	rat [h]	5.1	10.5	chicken	20.8	20.8
Beryllium	10	rat	0.66	1.29	–	–	–
Cadmium	3	rat [i]	1.0	1.89	mallard	1.45	1.45
Chromium (total)	1	rat	2737	5354	black duck	1	1
Chromium VI	1	rat	3.28	6.42	–	–	–
Mercury (Organic)	0.3	rat	0.032	0.063	mallard	0.0064	0.006
Mercury (Inorganic)	0.3	mouse	13.2	13.97	Japanese quail	0.45	0.45
Selenium	1	rat	0.2	0.391	screech owl	0.44	0.44
Silver	2	rat	17.8[j]	34.8	–	–	–
Organic							
Acetone	–	rat	10	19.56	–	–	–
Benzo(a)anthracene	18[k]	mouse	1.0[l]	1.058	–	–	–
Benzo(a)pyrene	18[k]	mouse	1.0	1.058	–	–	–
Benzo(b)fluoranthene	18[k]	mouse	1.0[l]	1.058	–	–	–
Benzo(k)fluoranthene	18[k]	mouse	1.0[l]	1.058	–	–	–
Bis(2-ethylhexyl)phthalate	–	mouse	18.3	19.37	ringed dove	1.1	1.1
Chrysene	18[k]	mouse	1.0[j]	1.058	–	–	–
Fluoranthene	18[k]	mouse	12.5[m]	13.2	–	–	–
Indeno(1,2,3-cd)pyrene	18[k]	mouse	1.0[l]	1.058	–	–	–
Phenanthrene	18[k]	mouse	1.0[l]	1.058	–	–	–
Pyrene	18[k]	mouse	7.5[n]	7.94	–	–	–

Refer to footnotes at end of table.

Table 14 (Concluded)
Toxicity Benchmarks for Ecological Receptors at SWMU 231

[a]In milligrams per kilogram soil dry weight.
[b]From Efroymson et al. (1997).
[c]Body weights (in kilograms) for the NOAEL conversion are as follows: lab mouse, 0.030; lab rat, 0.350 (except where noted).
[d]From Sample et al. (1996), except where noted.
[e]In milligrams per kilogram body weight per day.
[f]Based upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kilogram and a mammalian scaling factor of 0.25.
[g]Based upon NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[h]Body weight: 0.435 kilogram.
[i]Body weight: 0.303 kilogram.
[j]Based upon a rat LOAEL of 89 mg/kg/d (EPA, 1998a) and an uncertainty factor of 0.2.
[k]From Sims and Overcash (1983).
[l]No data available. Toxicity value based upon NOAEL for benzo(a)pyrene.
[m]Based upon subchronic NOAEL of 125 mg/kg/d (EPA, 1998a) and an uncertainty factor of 0.1.
[n]Based upon subchronic NOAEL of 75 mg/kg/d (EPA, 1998a) and an uncertainty factor of 0.1.
LOAEL = Lowest-observed-adverse-effect level.
mg/kg/d = Milligram(s) per kilogram per day.
NOAEL = No-observable-adverse-effect level.
SWMU = Solid Waste Management Unit.
— = Insufficient toxicity data.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Table 15 presents the results of these comparisons. HQs are used to quantify the comparison with benchmarks for plant and wildlife exposure.

HQs exceeded unity for total chromium and chromium VI for plant species, and arsenic and barium for both the omnivorous and insectivorous deer mouse. HQs for beryllium, chromium VI, silver, and all organic constituents, except bis(2-ethylhexyl)phthalate, could not be determined for the burrowing owl because of a lack of sufficient toxicity information. As directed by NMED, HIs were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). All receptors had total HIs greater than unity, except the burrowing owl, with a maximum HI of 21.1 for plant species.

Tables 16 and 17 summarize the internal and external dose-rate model results for U-235 for the deer mouse and burrowing owl, respectively. The total radiation dose rate was predicted to be 6.2E-6 rad/day for the deer mouse, and 4.7E-6 rad/day for the burrowing owl. The dose rates for both the deer mouse and burrowing owl are less than the benchmark of 0.1 rad/day.

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks resulting from assumptions used in calculating risk that could either overestimate or underestimate true risk presented at a site. For the ecological risk assessment at SWMU 231, assumptions are made that are more likely to overestimate exposures and risk rather than underestimate them. These conservative assumptions are used in order to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of maximum analyte concentrations measured in soil samples to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and the assumption that all food and soil ingested by the wildlife receptors come from the site. Each of these uncertainties, which are consistent among each of the SWMU-specific ecological risk assessments, is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998).

Uncertainties associated with the estimation of risk to ecological receptors following exposure to U-235 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors. The dose-rate models used for these calculations are based upon conservative estimates on receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic but conservative estimate of a receptor's internal and external exposure to radionuclides in soil.

In the estimation of ecological risk, background concentrations are included as a component of maximum on-site concentrations. Conservatisms in the modeling of exposure and risk can result in the prediction of risk to ecological receptors when exposed at background concentrations. As shown in Table 18, HQs associated with exposures to background are greater than 1.0 for arsenic, barium, and total chromium. In the cases of arsenic and barium, background may account for approximately 77 and 83 percent, respectively, of the HQ values. Conservatisms incorporated into the HQs for these two COPECs include the use of

Table 15
Hazard Quotients for Ecological Receptors at SWMU 231

Constituent of Potential Ecological Concern	Plant HQ[a]	Deer Mouse HQ (Herbivorous)[a]	Deer Mouse HQ (Omnivorous)[a]	Deer Mouse HQ (Insectivorous)[a]	Burrowing Owl HQ[a]
Inorganic					
Arsenic	5.7E-1	4.0E-1	**3.6E+0**	**6.8E+0**	2.9E-3
Barium	4.8E-1	6.0E-1	**2.1E+0**	**3.6E+0**	2.6E-2
Beryllium	1.0E-1	3.7E-3	6.5E-2	1.3E-1	–
Cadmium	5.7E-1	8.0E-2	8.3E-2	8.7E-2	2.7E-3
Chromium (total)	**1.7E+1**	3.0E-5	5.2E-5	7.4E-5	5.7E-2
Chromium VI	**1.6E+0**	2.3E-3	4.1E-3	5.8E-3	–
Mercury (Organic)	7.3E-2	5.6E-2	5.6E-2	5.6E-2	3.1E-1
Mercury (Inorganic)	7.3E-2	2.5E-4	2.5E-4	2.5E-4	4.4E-3
Selenium	5.6E-1	1.2E-1	1.7E-1	2.3E-1	3.7E-2
Silver	1.3E-1	1.1E-3	7.2E-4	3.0E-4	–
Organic					
Acetone	–	3.4E-3	2.1E-3	8.2E-4	–
Benzo(a)anthracene	2.2E-3	2.5E-4	7.3E-2	1.5E-1	–
Benzo(a)pyrene	3.2E-3	2.6E-4	1.1E-1	2.2E-1	–
Benzo(b)fluoranthene	3.5E-3	2.4E-4	1.3E-1	2.6E-1	–
Benzo(k)fluoranthene	2.0E-3	1.3E-4	7.6E-2	1.5E-1	–
Bis(2-ethylhexyl)phthalate	–	1.4E-5	1.0E-2	2.1E-2	5.4E-1
Chrysene	3.1E-3	2.9E-4	1.1E-1	2.2E-1	–
Fluoranthene	2.4E-3	3.8E-5	5.8E-3	1.2E-2	–
Indeno(1,2,3-cd)pyrene	2.6E-3	1.8E-4	9.6E-2	1.9E-1	–
Phenanthrene	1.1E-3	3.2E-4	3.3E-2	6.5E-2	–
Pyrene	3.4E-3	6.2E-5	1.4E-2	2.9E-2	–
HI[b]	**2.1E+1**	**1.3E+0**	**6.7E+0**	**1.2E+1**	9.8E-1

Refer to footnotes at end of table.

Table 15 (Concluded)
Hazard Quotients for Ecological Receptors at SWMU 231

[a]**Bold** values indicate the HQ or HI exceeds unity.
[b]The HI is the sum of individual HQs.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid Waste Management Unit.
– = Insufficient toxicity data available for risk estimation purposes.

Table 16
Internal and External Dose Rates for
Deer Mice Exposed to Radionuclides at SWMU 231

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-235	2.3E-1	2.5E-6	3.8E-6	6.2E-6
Total		2.4E-6	3.8E-6	6.2E-6

pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.

Table 17
Internal and External Dose Rates for
Burrowing Owls Exposed to Radionuclides at SWMU 231

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-235	2.3E-1	9.2E-7	3.8E-6	4.7E-6
Total		9.2E-7	3.8E-6	4.7E-6

pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.

Table 18
HQs for Ecological Receptors Exposed to Background Concentrations at SWMU 231

Constituent of Potential Ecological Concern	Plant HQ[a]	Deer Mouse HQ (Herbivorous)[a]	Deer Mouse HQ (Omnivorous)[a]	Deer Mouse HQ (Insectivorous)[a]	Burrowing Owl HQ[a]
Inorganic					
Arsenic	4.4E-1	3.1E-1	**2.8E+0**	**5.2E+0**	2.2E-3
Barium	4.0E-1	5.0E-1	**1.8E+0**	**3.0E+0**	2.2E-2
Beryllium	8.0E-2	2.9E-3	5.1E-2	9.8E-2	–
Cadmium	1.7E-1	2.4E-2	2.5E-2	2.6E-2	8.1E-4
Chromium (total)	**1.6E+1**	2.8E-5	4.9E-5	7.1E-5	5.4E-2
Chromium VI	–	–	–	–	–
Mercury (Organic)	1.7E-1	1.3E-1	1.3E-1	1.3E-1	7.1E-1
Mercury (Inorganic)	1.7E-1	5.7E-4	5.7E-4	5.7E-4	1.0E-2
Selenium	5.0E-1	1.0E-1	1.5E-1	2.0E-1	3.3E-2
Silver	2.5E-1	2.3E-3	1.4E-3	6.0E-4	–
HI[b]	**1.8E+1**	**1.1E+0**	**5.0E+0**	**8.7E+0**	8.3E-1

[a]**Bold** values indicate the HQ or HI exceeds unity.
[b]The HI is the sum of individual HQs.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid Waste Management Unit.
– = Insufficient background or toxicity data available for risk estimation purposes.

NOAELs for wildlife receptor benchmarks and the assumed (default) soil-to-invertebrate transfer factor of 1 used for both of these metals. For total chromium, background may account for 95 percent of the HQs. The plant toxicity benchmark used for total chromium is based upon a toxicity study that used chromium VI. Because chromium VI is generally more toxic than chromium III (which is the dominant form of chromium in total chromium), this toxicity benchmark is probably conservative, leading to an overestimation of risk to plants for total chromium. It is therefore likely that the actual risks from arsenic, barium, and total chromium at SWMU 231 are overestimated by the HQs calculated in this screening assessment because of conservatisms incorporated into both the exposure assessment and toxicity benchmarks for these COPECs.

A significant source of uncertainty associated with the prediction of ecological risks at this site is the use of the maximum concentrations measured to evaluate exposure and risk. This results in a conservative exposure scenario that does not necessarily reflect actual site conditions. To assess the potential degree of overestimation caused by using the maximum measured soil concentrations in the exposure assessment, average soil concentrations were calculated for the COPECs with HQs greater than unity to determine whether these HQs can be accounted for by the magnitude of the extreme measurement. The mean concentrations of arsenic, barium, and total chromium (2.4, 159, and 7.9 milligrams per kilogram [mg/kg], respectively) were found to be less than their corresponding background screening values. Therefore, risks from exposures to these COPECs at SWMU 231 are likely to be within the background levels as shown in Table 18. The prediction of potential risk from exposure to chromium VI was principally based upon the exceedence of the maximum measured concentration over its corresponding plant toxicity benchmark (1 mg/kg). However, the mean concentration of chromium VI (0.31 mg/kg) is less than the plant toxicity benchmark, indicating that the prediction of potential risk is due to the use of the maximum values as the exposure point concentration for the site.

Another source of uncertainty in this assessment is the assumption of an area use factor of 1. For the purpose of estimating exposure in this screening assessment, all food and soil ingested by the deer mouse and burrowing owl are assumed to come from the site. Therefore, the HQs shown in Table 15 are based upon an assumed area use factor of 1 for both receptors. However, the home ranges of these receptors (as shown in Table 11) are greater than the area of the site (approximately 0.04 acre); therefore, area use factors (i.e., the ratio of the area of the site to the home range of receptor) of less than 1 would be justified for these receptors to reflect the probable fraction of the ingested food and soil that come from the site, as opposed to that which comes from surrounding areas. Based upon the home ranges of these receptors, an area use factor of 0.15 for the deer mouse and 0.0011 for the burrowing owl would be justified. In the cases of the deer mice (all three dietary regimes), this area use factor is sufficient to reduce the HQs for arsenic and barium to values at and below 1.

Based upon this uncertainty analysis, ecological risks at SWMU 231 are expected to be generally low. HQs greater than unity were initially predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to exposure concentration and the contribution of background risk.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 231 were estimated through a screening assessment that incorporated site-specific information when available. Overall, risks to ecological receptors are expected to be low because predicted risks associated with exposure to COPECs are based upon calculations using maximum detected values. The mean concentrations of arsenic, barium, and total chromium were found to be within background range. The mean concentration of chromium VI did not result in any HQs greater than unity. Based upon this final analysis, ecological risks associated with SWMU 231 are expected to be low.

VII.3.7 Screening Assessment Scientific/Management Decision Point

After potential ecological risks associated with the site have been assessed, a decision is made regarding whether the site should be recommended for NFA or whether additional data should be collected to assess actual ecological risk at the site more thoroughly. With respect to this site, ecological risks are predicted to be low. The scientific/management decision is to recommend this site for NFA.

VIII. References

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APPENDIX 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Introduction

Sandia National Laboratories/New Mexico (SNL/NM) proposes that a default set of exposure routes and associated default parameter values be developed for each future land use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM solid waste management units (SWMU) have similar types of contamination and physical settings, SNL/NM believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL/NM views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the U.S. Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED), SNL/NM proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base (KAFB). Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land-use scenario. All three land use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent Hazard index (HI), excess cancer risk and dose values. The EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil
- Ingestion of contaminated fish and shellfish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products

- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water
- Dermal contact with chemicals in soil
- Inhalation of airborne compounds (vapor phase or particulate)
- External exposure to penetrating radiation (immersion in contaminated air, immersion in contaminated water, and exposure from ground surfaces with photon-emitting radionuclides).

Based upon the location of the SNL/NM SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, currently no consumption of fish, shellfish, fruits, vegetables, meat, eggs, or dairy occurs for products that originate on site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land use scenarios, SNL/NM ER has, therefore, excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shellfish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water also is eliminated.

For the residential land use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based upon this evaluation, for future risk assessments the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land use scenarios. However, the potential for dermal exposure to inorganic compounds is not considered significant and will not be included. In general, the dermal exposure pathway is generally not considered to be significant relative to water ingestion and soil ingestion pathways, but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Table 1
Exposure Pathways Considered for Various Land Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation also may be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in RME risk assessment calculations for industrial, recreational, and residential scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., hazard quotients/hazard index [HI], excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

C = contaminant concentration (site specific)
CR = contact rate for the exposure pathway
EFD= exposure frequency and duration
BW = body weight of average exposure individual
AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or HI) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the constituents of concern (COC) present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 1E-6 for Class A and B carcinogens and 1E-5 for Class C carcinogens. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the HI) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL/NM at SWMUs, based upon the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL/NM is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL/NM proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land use scenario. There are no current residential land use designations at SNL/NM ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land use, SNL/NM will provide risk parameter values based upon a residential land use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM ER sites. The parameter values are based upon EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Table 2
Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency	8 hr/day for 250 day	4 hr/wk for 52 wk/yr	350 day/yr
Exposure duration (yr)	25[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	70 adult[a,b] 15 child	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (= 70 y x 365 day/yr) for noncarcinogenic compounds (= ED x 365 day/yr)	25,550[a] 9,125	25,550[a] 10,950	25,550[a] 10,950
Soil Ingestion Pathway			
Ingestion rate	100 mg/day[c]	200 mg/day child 100 mg/day adult	200 mg/day child 100 mg/day adult
Inhalation Pathway			
Inhalation rate (m^3/yr)	5,000[a,b]	260[d]	7,000[a,b,d]
Volatilization factor (m^3/kg)	Chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (liter/day)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	Chemical specific	chemical specific	chemical specific

[a]Risk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).
[b]Exposure Factors Handbook (EPA 1989b).
[c]EPA Region VI guidance.
[d]For radionuclides, RESRAD (Argonne National Laboratory, 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL. 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.
[e]Dermal Exposure Assessment (EPA 1992).

ED = Exposure duration.
EPA = U.S. Environmental Protection Agency.
hr = Hour.
kg = Kilogram(s).
m^2 = Square meter(s).
m^3 = Cubic meter(s).
mg = Milligram(s).
NA = Not available.
wk = Week.
yr = Year.

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ATTACHMENT I

ATTACHMENT I
Data Validation Reports for SWMU 231

SITE 231

DOCUMENTATION COMPLETENESS CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

Project Name Tijeras Arroyo
Case Number 7632.300
Sample Numbers 17898/99/900/901

Page 1 of 4

AR/COC No.	Analytical laboratory	SDG No.
00813	ENCOTEC	TL-095

In the tables below, mark any information that is missing or incorrect.

1.0 Sample Collection Log

Item	Complete? Yes	Complete? No	Corrected? Yes	Corrected? No[a]
Date	✓			
Sheet number and total number of sheets below	✓			
General information	✓			
Sample description	✓			
Sample ID number(s) and fraction number(s)		✓		
Location	✓			
Time of sample collection	✓			
Sample type	✓			
Depth below surface	✓			
QC sample?[b]	✓			
Comments	✓			
Analyses requested	✓			
Project information	✓			
Project name	✓			
Case number/service order number	✓			
Contact information	✓			
Turnaround time	✓			
Regulatory program		✓		
Special QC requirements	✓			
Sample team member(s), their signature(s), and initials	✓			
Sample tracking information (the "Data Entered" and "By" spaces may be empty)	✓			

[a] Describe any uncorrected deficiencies in Section 5.0, "Completeness Assessment," below.
[b] Comments are only required for QC samples; for other samples, this item can be blank.

Reviewed by [signature]

Date: 10-31-94

INFORMATION COPY

SHEARS #49744

DOCUMENTATION COMPLETENESS CHECKLIST (DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

2.0 Analysis Request and Chain of Custody Record

Item	Complete?		Corrected?	
	Yes	No	Yes	No[a]
Page number and total number of pages	✓			
Project information	✓			
Sample shipping information	✓			
Contract and case number	✓			
SMO authorization signature	✓			
Location information	✓			
Sample number(s)/fraction number(s)		✓		
Sample ID information	✓			
Date/time sample(s) collected	✓			
Sample matrix	✓			
Container type(s)	✓			
Sample volume	✓			
Preservative (chemical and/or thermal)	✓			
Sample collection method	✓			
Sample type	✓			
Required analytical testing	✓			
Sample information	✓			
Special instruction/QC requirements	✓			
Custody records	✓			
Lab sample number	✓			
Condition upon receipt	✓			

[a] Describe any uncorrected deficiencies in Section 5.0 "Completeness Assessment" below.

3.0 Document Comparison

Item	Complete?		Corrected?	
	Yes	No	Yes	No[a]
Dates on Sample Collection Log and AR/COC agree.	✓			
Sample team members on the Sample Collection Log and the AR/COC agree.	✓			
Sample ID numbers on Sample Collection Log and AR/COC agree.	✓			
Date and time on Sample Collection Log and AR/COC agree.	✓			
Analyses requested on AR/COC agree with those shown on Sample Collection Log.	✓			
Project information on Sample Collection Log and AR/COC agree.	✓			
The sample location on the Sample Collection Log agrees with the AR/COC and project- specific plan requirements or authorized changes to the plan(s).	✓			
The number of investigative and QC samples collected was that specified in the project-specific plan(s) or authorized changes to the plan(s).	✓			
The analyses requested on the AR/COC were those specified in the project-specific plan(s) or authorized changes to the plan(s).	✓			

[a] Describe any uncorrected deficiencies in Section 5.0, "Completeness Assessment," below.

Reviewed by: [illegible signature] Date: 10-31-94

DOCUMENTATION COMPLETENESS CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

4.0 Analytical Laboratory Report

Item	Complete?		Corrected?	
	Yes	No	Yes	No[a]
Data reviewed, signature	✓			
Date samples received	✓			
Method reference number(s)		✓		
Quality control data	✓			
Matrix spike/matrix spike duplicate data	NA			
Narrative complete	✓			

[a] Describe any uncorrected deficiencies in Section 5.0 "Completeness Assessment" below.

5.0 Completeness Assessment

For each section below, mark the appropriate box and describe any problems that remain unresolved.

5.1 Sample Collection Log

	Yes	No
All boxes on the Sample Collection Log are complete:	☑	☐
Some boxes have been checked no; all problems are resolved.	☑	☐

If any boxes have been checked no, describe problem and resolution:
(1) Sample fractions were used to indicate different "xyz" location, instead of indicating different analysis request.
(2) No regulatory program mentioned

5.2 Analysis Request And Chain Of Custody Record AR/COC

	Yes	No
All boxes on the AR/COC review are complete:	☑	☐
Some boxes have been checked no; all problems are resolved.	☑	☐

If any boxes have been checked no, describe problem and resolution:
(See 5.1)

Reviewed by: [signature]
Date: 10/31-94

DOCUMENTATION COMPLETENESS CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

5.3 Document Comparison	Yes	No
All boxes on the Document Comparison are complete:	☑	☐
Some boxes have been checked no; all problems are resolved.	☑	☐

If any boxes have been checked no, describe problem and resolution: Without the SAP, these boxes marked ? could not be answered

5.4 Analytical Laboratory Report	Yes	No
All boxes on the Lab Report review are complete:	☑	☐
Some boxes have been checked no; all problems are resolved.	☐	☐

If any boxes have been checked no, describe problem and resolution: The aoc requested TPH (8015); the lab ran TPH by 418.1

BASED ON THE REVIEW, DOCUMENTATION IS COMPLETE: ☑ Yes ☐ No

Reviewed by: [signature] Approved by:* ____________
Date: 10-21-94 Date: ____________

* Task/Project Leader must approve data package.

COMMENTS: ____________

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

Project Name Tijeras Arroyo Site 234 Page 1 of 5
Case Number 3637.300
Sample Numbers 17898/99/900/901

AR/COC No. 00813 Analytical laboratory Enkotec SDG No. TI-095
AR/COC No. ____ Analytical laboratory ____ SDG No. ____
AR/COC No. ____ Analytical laboratory ____ SDG No. ____
AR/COC No. ____ Analytical laboratory ____ SDG No. ____

1.0 EVALUATION

Item	Yes	No	If no, Sample ID No./Fraction(s) and Analysis
1) Sample volume, container, and preservation correct?	✓		
2) Holding times met for all samples?	✓		
3) Reporting units appropriate for the matrix and meet project-specific requirements?	✓		
4) Quantitation limit met for all samples?	✓		
5) Accuracy a) Laboratory control sample accuracy reported and met for all samples?	✓		
b) Surrogate data reported and met for all organic samples analyzed by a gas chromatography technique?	✓		

Reviewed by: Doug Salmi
Date: 10-31-94

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

Item	Yes	No	If no, Sample ID No./Fraction(s) and Analysis
c) Matrix spike recovery data reported and met for all samples for which it was requested?	NA		–
6) Precision a) Laboratory control sample precision reported and met for all samples?	✓		
b) Matrix spike duplicate RPD data reported and met for all samples for which it was requested?	NA		
7) Blank data a) Method or reagent blank data reported and met for all samples?	✓		2-Butanone was detected in the method blank and samples; obviously it is a trace, minor contaminate
b) Sampling blank (e.g., field, trip, and equipment) data reported and met?	✓		
8) Narrative included, correct, and complete?	✓		

2.0 COMMENTS: All items marked "No" above must be explained in this section. For each item, give SNL/NM ID No. and the analysis, if appropriate, of all samples affected by the finding.

Reviewed by: [signature]

Date: 10-31-94

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

2.0 COMMENTS CONTINUATION SHEET

Reviewed by: Doug Salmi

Date: 10-31-94

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

3.0 SUMMARY: Summarize the findings in the table below. List only samples/fractions for which deficiencies have been noted. Use the qualifiers given at the end of the table if possible. Explain any other qualifiers in the comments column.

Sample/ Fraction No.	Analysis	Qualifiers	Comments
017898-5	VOC	JB	2-Butanone contaminate
017899-4	"	JB	at low levels was also found
017900-4	"	JB	in the method blank
017901-6	"	JB	
Method Blank	"	J	
017900-4	"	J	Acetone

Attach continuation sheet for additional samples

QUALIFIERS:

J = Estimated quantity (provide reason)
B = Contamination in blank (indicate which blank)
P = Laboratory precision does not meet criteria
R = Reporting units inappropriate
N = There is presumptive evidence of the presence of the material
UJ = The material was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
Q = Quantitation limit does not meet criteria
A = Laboratory accuracy does not meet criteria
U = Analyte is undetected (indicate which analyte and reason for qualification)
NJ = There is presumptive evidence of the presence of the material at an estimated quantity.

Reviewed by: [signature]

Date: 10-31-94

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

SAMPLE FINDINGS SUMMARY CONTINUATION SHEET

Sample/ Fraction No.	Analysis	Qualifiers	Comments

Reviewed by: ____________ Approved by:* ____________

Date: 10-31-94 Date: ____________

*Task/Project Leader must approve data package.

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Site 231

DOCUMENTATION COMPLETENESS CHECKLIST (DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

Project Name Site 230, 231, 232
Case Number 3632.300
Sample Numbers 017902-3, 017905-4, 017898-3, 017901-1, 017890-4, 017892-4

AR/COC No. 00814 Analytical laboratory Quan SL SDG No. 017898-3
AR/COC No. 00817 Analytical laboratory Quan SL SDG No. 017902-3
AR/COC No. 00822 Analytical laboratory Quan SL SDG No. 017890-4
AR/COC No. ______ Analytical laboratory ______ SDG No. ______

In the tables below, mark any information that is missing or incorrect.

1.0 Sample Collection Log

Item	Complete? Yes	Complete? No	Corrected? Yes	Corrected? No[a]
Date	✓			
Sheet number and total number of sheets below	✓			
General information	✓			
Sample description	✓			
Sample ID number(s) and fraction number(s)	✓			
Location	✓			
Time of sample collection	✓			
Sample type	✓			
Depth below surface	✓			
QC sample?[b]	✓			
Comments	✓			
Analyses requested	✓			
Project information	✓			
Project name	✓			
Case number/service order number	✓			
Contact information	✓			
Turnaround time COC	NA			
Regulatory program	NA			
Special QC requirements	NA			
Sample team member(s), their signature(s), and initials	✓			
Sample tracking information (the "Data Entered" and "By" spaces may be empty)	✓			

[a] Describe any uncorrected deficiencies in Section 5.0, "Completeness Assessment," below.
[b] Comments are only required for QC samples; for other samples, this item can be blank.

Reviewed by: Howard Seeley

Date: 11/29/94

INFORMATION COPY

SHEARS # 25374

DOCUMENTATION COMPLETENESS CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

2.0 Analysis Request and Chain of Custody Record

Item	Complete?		Corrected?	
	Yes	No	Yes	No[a]
Page number and total number of pages				
Project information	✓			
Sample shipping information	✓			
Contract and case number	✓			
SMO authorization signature	✓			
Location information	✓			
Sample number(s)/fraction number(s)	✓			
Sample ID information	✓			
Date/time sample(s) collected	✓			
Sample matrix	✓			
Container type(s)	✓			
Sample volume	✓			
Preservative (chemical and/or thermal)	✓			
Sample collection method	✓			
Sample type SLC	NA			
Required analytical testing	✓			
Sample information	✓			
Special instruction/QC requirements	✓			
Custody records	NA			
Lab sample number	✓			
Condition upon receipt	✓			
	✓			

[a] Describe any uncorrected deficiencies in Section 5.0 "Completeness Assessment" below.

3.0 Document Comparison

Item	Complete?		Corrected?	
	Yes	No	Yes	No[a]
Dates on Sample Collection Log and AR/COC agree.	✓			
Sample team members on the Sample Collection Log and the AR/COC agree.		✓		✓
Sample ID numbers on Sample Collection Log and AR/COC agree.	✓			
Date and time on Sample Collection Log and AR/COC agree.	✓			
Analyses requested on AR/COC agree with those shown on Sample Collection Log.	✓			
Project information on Sample Collection Log and AR/COC agree.	✓			
The sample location on the Sample Collection Log agrees with the AR/COC and project- specific plan requirements or authorized changes to the plan(s).	NA			
The number of investigative and QC samples collected was that specified in the project-specific plan(s) or authorized changes to the plan(s).	NA			
The analyses requested on the AR/COC were those specified in the project-specific plan(s) or authorized changes to the plan(s).	NA			

[a] Describe any uncorrected deficiencies in Section 5.0, "Completeness Assessment," below.

Reviewed by: Howard Sedley Date: 11/29/94

DOCUMENTATION COMPLETENESS CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

4.0 Analytical Laboratory Report

Item	Complete?		Corrected?	
	Yes	No	Yes	No[a]
Data reviewed, signature	✓			
Date samples received	✓			
Method reference number(s)	✓			
Quality control data	✓			
Matrix spike/matrix spike duplicate data	✓			
Narrative complete	✓			

[a] Describe any uncorrected deficiencies in Section 5.0 "Completeness Assessment" below.

5.0 Completeness Assessment

For each section below, mark the appropriate box and describe any problems that remain unresolved.

5.1 Sample Collection Log

	Yes	No
All boxes on the Sample Collection Log are complete:	☑	☐
Some boxes have been checked no; all problems are resolved.	☐	☐

If any boxes have been checked no, describe problem and resolution:

____

____

____

____

5.2 Analysis Request And Chain Of Custody Record AR/COC

	Yes	No
All boxes on the AR/COC review are complete:	☑	☐
Some boxes have been checked no; all problems are resolved.	☐	☐

If any boxes have been checked no, describe problem and resolution:

____

____

____

Reviewed by: Howard Sooley

Date: 11/29/94

DOCUMENTATION COMPLETENESS CHECKLIST (DATA VERIFICATION/VALIDATION LEVEL 1—DV1)

5.3 Document Comparison

	Yes	No
All boxes on the Document Comparison are complete:	☐	☑
Some boxes have been checked no; all problems are resolved.	☐	☐

If any boxes have been checked no, describe problem and resolution:
COC-00822 and SCL-01672: the COC lists an additional field team member not on the SCL.

5.4 Analytical Laboratory Report

	Yes	No
All boxes on the Lab Report review are complete:	☑	☐
Some boxes have been checked no; all problems are resolved.	☐	☐

If any boxes have been checked no, describe problem and resolution:

BASED ON THE REVIEW, DOCUMENTATION IS COMPLETE: ☐ Yes ☑ No

Reviewed by: Howard Seeley
Date: 11/29/94

Approved by:*
Date:

* Task/Project Leader must approve data package.

COMMENTS:

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

Project Name Site 230, 231, 232 Page 1 of 5

Case Number 3632.300

Sample Numbers 017902-3, 017905-4, 017898-3, 017901-1, 017890-4, 017892-4

AR/COC No. 00814 Analytical laboratory Quan SL SDG No. 017898-3

AR/COC No. 00817 Analytical laboratory Quan SL SDG No. 017902-3

AR/COC No. 00822 Analytical laboratory Quan SL SDG No. 017890-4

AR/COC No. ______ Analytical laboratory ______ SDG No. ______

1.0 EVALUATION

Item	Yes	No	If no, Sample ID No./Fraction(s) and Analysis
1) Sample volume, container, and preservation correct?	✓		
2) Holding times met for all samples?	✓		
3) Reporting units appropriate for the matrix and meet project-specific requirements?	✓		Tritium in pCi/g.
4) Quantitation limit met for all samples?	✓		
5) Accuracy a) Laboratory control sample accuracy reported and met for all samples?	✓	~~✓~~ 4/15/95	~~All~~ 4/15/95
b) Surrogate data reported and met for all organic samples analyzed by a gas chromatography technique?	NA		

Reviewed by: Howard Seeley

Date: 12-7-94

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

Item	Yes	No	If no, Sample ID No./Fraction(s) and Analysis
c) Matrix spike recovery data reported and met for all samples for which it was requested?	✓	~~[illegible]~~ 2/15/95	~~Att~~ Project mgmt to decide
6) Precision a) Laboratory control sample precision reported and met for all samples?	NA	~~2/15/95~~	~~Att~~ HS
b) Matrix spike duplicate RPD data reported and met for all samples for which it was requested?	NA	~~2/15/95~~	~~Att~~ HS
7) Blank data a) Method or reagent blank data reported and met for all samples?	✓		
b) Sampling blank (e.g., field, trip, and equipment) data reported and met?	NA		
8) Narrative included, correct, and complete?	✓		

2.0 COMMENTS: All items marked "No" above must be explained in this section. For each item, give SNL/NM ID No. and the analysis, if appropriate, of all samples affected by the finding.

Accuracy & precision acceptance criteria was not provided by the lab. This data (LCS 7.R) has been requested (11-25-94). Project ~~[illegible]~~ acceptance criteria not available - project mgr to determine correctness. LCS data recd/cleared 2/15/95 [illegible]

Reviewed by: H. Seeley

Date: 12-7-94

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

2.0 COMMENTS CONTINUATION SHEET

HS
12-7-94

Reviewed by: H. Seeley

Date: 12-7-94

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

3.0 SUMMARY: Summarize the findings in the table below. List only samples/fractions for which deficiencies have been noted. Use the qualifiers given at the end of the table if possible. Explain any other qualifiers in the comments column.

Sample/ Fraction No.	Analysis	Qualifiers	Comments

Attach continuation sheet for additional samples

QUALIFIERS:

J = Estimated quantity (provide reason)
B = Contamination in blank (indicate which blank)
P = Laboratory precision does not meet criteria
R = Reporting units inappropriate
N = There is presumptive evidence of the presence of the material
UJ = The material was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
Q = Quantitation limit does not meet criteria
A = Laboratory accuracy does not meet criteria
U = Analyte is undetected (indicate which analyte and reason for qualification)
NJ = There is presumptive evidence of the presence of the material at an estimated quantity.

Reviewed by: H. Seeley

Date: 12-7-94

DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

SAMPLE FINDINGS SUMMARY CONTINUATION SHEET

Sample/ Fraction No.	Analysis	Qualifiers	Comments
			HS 12/7/94

Reviewed by: Howard Seeley   Approved by:* ______

Date: 12-7-94   Date: ______

*Task/Project Leader must approve data package.

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Sandia National Laboratories (Encotec 231)

SF 2001-SCL (12-93)

ENVIRONMENTAL PROGRAMS SAMPLE COLLECTION LOG

SWMU 231

SCL- 01633

AR/COC No.: AR/COC- 00813

PAGE 1 OF 2

GENERAL INFORMATION

DATE: 9/26/94 WEATHER: Sunny, Clear, 80°F

SAMPLING INFORMATION: ON-SITE CONTACT: Jan Curtis ORG. 7582 PHONE 505-263-3390 AREA 1309 LOCATION Site 231

SAMPLING PROCEDURE REFERENCE: SAP

PURPOSE OF SAMPLING: Preliminary Investigation

SAMPLE DESCRIPTION

MATRIX: ☐ GAS ☐ LIQUID ☐ SLUDGE ☐ SOLID ☐ WATER ☐ OIL ☒ SOIL ☐ HAZ WASTE ☐ OTHER

COLLECTED FROM: ☐ DRUM ☐ TANK ☐ SURFACE WATER ☒ SOIL ☐ WASTE WATER ☐ GROUND WATER ☐ OTHER

Sample Number - Fraction	Time	LOCATION	COMMENTS	Sample Type Grab/Comp.	QC Sample (Y/N)	BNA/TPH	TAL metals/Cr+6	VOC	BNA	TPH
017898-1	1045	Site 231-01-A	Surface Soil 0-6"	C	N	X				
017898-4	1045	Site 231-01-A	Surface Soil 0-6"	C	N		X			
017898-5	1046	Site 231-01-B	Subsurface Soil 6-36"	C	N			X		
017898-6	1045	Site 231-01-B	Subsurface soil 6-36"	C	N				X	
017898-7	1045	Site 231-01-B	Subsurface soil 6-36"	C	N		X			
017899-1	1114	Site 231-02-A	Surface Soil 0-6"	C	N					X
017899-2	1115	Site 231-02-A	Surface soil 0-6"	C	N		X			
017899-3	1114	Site 231-02-B	Subsurface soil 6-36"	C	N		X			

PROJECT: PROJECT NAME Tijeras Arroyo CASE NUMBER 3632.300 PROJECT CONTACT Jim Brinkman ORG. 7582 PHONE 505-848-0455

*ADDITIONAL INFORMATION: (Log Book Ref. #)

SAMPLE TEAM MEMBERS

	NAME	SIGNATURE	INIT	COMPANY/ORGANIZATION
1.	Mary Alboni	Mary Alboni	MA	Weston
2.	JAN CURTIS	Jan M. Curtis	JC	Weston
3.				

SAMPLE TRACKING

SAMPLE DISTRIBUTION: ENCOTEC TRANSPORTED BY: A 44367 SPECIAL HANDLING:

DATE SHIPPED (MM-DD-YY): 9/27/94 DATA ENTERED (MM-DD-YY): 10-3-94 BY: Dean Yrigoyen

*NOTE: Any additional sampling information must be recorded in an SNL-Issued Log Book or SCL Continuation Form with a Reference No. entered in this space.

WHITE - To Sample Management Office PINK - Originator ☐ TO BE COMPLETED BY SMO

Sandia National Laboratories

Encotec 231

SF 2001-SCC (4-94)

ENVIRONMENTAL PROGRAMS SAMPLE COLLECTION LOG

(Continuation)

SCL- 01633

AR/COC No.: AR/COC- 00813.

Sample Number - Fraction	Time	LOCATION	COMMENTS	Sample Type Grab/Comp.	QC Sample (Y/N)	TPH	TAL metals/Cr6	VOC	BNA/TPH				
017899-5	1115	Site 231-02-B	Subsurface soil 6-36"	C	N	X							
017899-4	1115	Site 231-02-B	Subsurface soil 6-36"	C	N	~~X~~ (JC)		X					
017900-2	1130	Site 231-03-A	Surface soil 0-6"	C	N	X							
017900-1	1130	Site 231-03-A	Surface soil 0-6"	C	N		X						
017900-4	1148	Site 231-03-B	Subsurface soil 6-36"	C	N			X					
017900-3	1146	Site 231-03-B	Subsurface soil 6-36"	C	N		X						
017900-5	1146	Site 231-03-B	Subsurface soil 6-36"	C	N	X							
017901-2	1340	Site 231-04-A	Surface soil 0-6"	C	N		X						
017901-3	1342	Site 231-04-A	Surface soil 0-6"	C	N				X				
(JC) ~~017901-1~~	~~1347~~	~~Site 231-04-A~~											
017901-6	1400	Site 231-04-B	Subsurface soil 6-36"	C	N			X					
017901-7	1400	Site 231-04-B	Subsurface soil 6-36"	C	N				X				
017901-5	1400	Site 231-04-B	Subsurface soil 6-36"	C	N		X						

WHITE - To Sample Management Office PINK - Originator

Sandia National Laboratories
SF 2001-COC (12-93)

(Encotec) 231

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

231

AR/COC- 00813

PAGE 1 OF 2

Department No.: 7582
Project/Task Manager: Jim Brinkman
Project Name: Tijeras Arroyo
Sample Team Members: Mary Albani, Jon Curtis
SCL or Logbook Ref. No.: 01633

Date Samples Shipped: 9/27/94
Carrier/Waybill No.: 244367
Lab Destination: Encotec
Lab Contact: Roger Roussell
SMO Contact/Phone: Pam Puissant
Send Report to SMO: D. Constant
SMO Reference No.:

Bill to: Sandia National Laboratories
Supplier Services Department
P.O. Box 5800 MS 0154
Albuquerque, NM 87185-0154

Contract No.: 67-9736A
Case No.: 3632.306
SMO Authorization: [signature]

Sample Number - Fraction	Sample Matrix	Date/Time Collected	Container Type	Sample Volume	Preservative	Required Analytical Testing	Lab Sample Number	Condition on Receipt
017898-1	Soil	9/26/94 1045	Glass	500	4°C	BNA (8270), TPH (8015)	43510	OK
017898-4		1045	Glass	500		TAL Metals (6010/7000), Cr+6*	43511	
017898-5		1046	Stainless Steel	150		VOC (8240)	43512	
017898-6		1045	Glass	500		BNA (8270)	43513	
017898-7		1045		500		TAL metals (6010/7000), Cr+6*	43514	
017899-1		1114		500		TPH (8015)	43515	
017899-2		1115		500		TAL metals (6010/7000), Cr+6*	43516	
017899-3		1114		500		" "	43517	
017899-5		1115		500		TPH (8015)	43518	
017899-4		1115	Stainless Steel	150		VOC (8240)	43519	
017900-2		1130	Glass	500		TPH (8015)	43520	

Possible Hazard Identification: ☒ Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Radiological

*Reference attached radiological screening for specific contact readings.

Turnaround Time: ☒ Normal ☐ Rush ______ Required Report Date ______

Sample Disposal: ☐ Return to Client ☒ Disposal by Lab Archive Until ______

Special Instructions/QC Requirements: *Analyze for Cr+6 only if Cr is detected in metals analysis. List as separate report

	Org.	Date	Time		Org.	Date	Time
1. Relinquished by [signature]	7582	9/27/94	917	4. Relinquished by			
1. Received by [signature]	SMO-7576	9/27	917	4. Received by			
2. Relinquished by [signature]	SMO-7576	9/27	1400	5. Relinquished by			
2. Received by [signature]	Encotec	9/28/94	8:40	5. Received by			
3. Relinquished by				6. Relinquished by			
3. Received by				6. Received by			

WHITE - To Accompany Samples, Laboratory Copy   BLUE - To Accompany Samples, Return to SMO   YELLOW - SMO Suspense Copy   PINK - Field Copy

Sandia National Laboratories

SF 2001-COD (12-93)

ER/SITE 231

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD
(continuation)

231

AR/COC- 00813

PAGE 2 OF 2

Project Name: 7723.1AS Arroyo

Project/Task Manager: Jim

Case No.: 3632.200

Sample Number · Fraction	Sample Matrix	Date/Time Collected	Container Type	Sample Volume	Preservative	Required Analytical Testing	Lab Sample Number	Condition on Receipt
017900-1	Soil	9/26/94 1130	Glass	500	4°C	TAL metals (6010/7000), Cr+6 *	43521	OK
017900-4	↓	1148	SS Sleeve	150	↓	VOC (8240)	43522	↓
017900-3	↓	1146	Glass	500	↓	TAL metals (6010/7000), Cr+6 *	43523	↓
017900-5	↓	1146	Glass	500	↓	TPH (8015)	43524	↓
017901-2	↓	1340	Glass	500	↓	TAL metals (6010/7000), Cr+6 *	43525	↓
017901-3	↓	1342	Glass	500	↓	BNA (8270), TPH (8015)	43526	↓
017901-6	↓	1400	Stainless steel	150	↓	VOC (8240)	43527	↓
017901-7	↓	1400	Glass	500	↓	BNA (8270), TPH (8015)	43528	↓
017901-5	↓	1400	↓	500	↓	TAL metals (6010/7000), Cr+6 *	43529	↓

WHITE - To Accompany Samples, Laboratory Copy BLUE- To Accompany Samples, Return to SMO YELLOW- SMO Suspense Copy PINK- Field Copy

Sandia National Laboratories (Quanterra - St. Louis)

SF 2001-SCL (12-93)

ENVIRONMENTAL PROGRAMS SAMPLE COLLECTION LOG

231

SCL- 01635

AR/COC No.: ~~AR/COC~~ 00814

PAGE 1 OF 1

GENERAL INFORMATION	
DATE:	9/26/94
WEATHER:	Clear, Sunny, 80°F
SAMPLING PROCEDURE REFERENCE:	SAP
PURPOSE OF SAMPLING:	Preliminary Investigation
SAMPLING INFORMATION – ON-SITE CONTACT:	Jan Curtis
ORG.	7582
PHONE	505-263-3390
AREA	1309
LOCATION	Site 231

SAMPLE DESCRIPTION

MATRIX: ☐ GAS ☐ LIQUID ☐ SLUDGE ☐ SOLID ☐ WATER ☐ OIL ☒ SOIL ☐ HAZ WASTE ☐ OTHER

COLLECTED FROM: ☐ DRUM ☐ TANK ☐ SURFACE WATER ☒ SOIL ☐ WASTE WATER ☐ GROUND WATER ☐ OTHER

Sample Number - Fraction	Time	LOCATION	COMMENTS	Sample Type Grab/Comp.	QC Sample (Y/N)	ANALYSES: Tritium/isotopic plutonium/uranium	Tritium
017898-3	1050	Site 231-01-A	Surface soil 0-6"	C	N	X	
017901-1	1347	Site 231-04-A	Surface soil 0-6"	C	N	~~X~~	X
(JC) ~~017901-8~~	~~1400~~	~~Site 231-04-B~~					

PROJECT	
PROJECT NAME	Tijeras Arroyo
CASE NUMBER	3632.00
PROJECT CONTACT	Jim Brinkman
ORG.	7582
PHONE	505-848-0155

*ADDITIONAL INFORMATION: (Log Book Ref. #)

SAMPLE TEAM MEMBERS

	NAME	SIGNATURE	INIT	COMPANY/ORGANIZATION
1.	Mary Albani	Mary Albani	MA	Weston
2.	Jan Curtis	Jan M. Curtis	JC	Weston
3.				

SAMPLE TRACKING

SAMPLE DISTRIBUTION:	Quanterra - St Louis
TRANSPORTED BY:	A 47287
SPECIAL HANDLING:	
DATE SHIPPED (MM-DD-YY):	9/27/94
DATA ENTERED (MM-DD-YY):	10-4-94
BY:	Deongazzi

*NOTE: Any additional sampling information must be recorded in an SNL-Issued Log Book or SCL Continuation Form with a Reference No. entered in this space.

WHITE - To Sample Management Office PINK- Originator ☐ TO BE COMPLETED BY SMO

Sandia National Laboratories

(Quanterra - St. Louis 231)

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

231

AR/COC- 00814

SF 2001-COC (12-93)

PAGE 1 OF 1

Department No.:	7582	Date Samples Shipped:	9/27/94	Bill to:	Sandia National Laboratories
Project/Task Manager:	Jim Brinkman	Carrier/Waybill No.:	A 47282		Supplier Services Department
Project Name:	Tijeras Arroyo	Lab Destination:	Quanterra - St. Louis		P.O. Box 5800 MS 0154
Sample Team Members	Marj Albers	Lab Contact:	Jackie Waddell		Albuquerque, NM 87185-0154
	Jon Curtis	SMO Contact/Phone:	Pam Puissant	Contract No.:	12 - 0841A
		Send Report to SMO:	D. Constant	Case No.:	3633.300
SCL or Logbook Ref. No.:	01635	SMO Reference No.:		SMO Authorization:	[signature]

Sample Number	Fraction	Sample Matrix	Date/Time Collected	Container Type	Sample Volume	Preservative	Required Analytical Testing	Lab Sample Number	Condition on Receipt
017898	-3	Soil	7/26/94 1050	Glass	250	None	Tritium (600 906.0) isotopic plutonium isotopic Uranium *		
017901	-1	↓	↓ 1347	↓	↓	↓	Tritium (600 906.0)		

Possible Hazard Identification
☒ Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Radiological

*Reference attached radiological screening for specific contact readings.

Turnaround Time
☒ Normal ☐ Rush Required Report Date

Special Instructions/QC Requirements
* isotopic Plutonium (600 7-79-081)
isotopic Uranium (HASL-300 4.5)
List in separate report

Sample Disposal
☐ Return to Client ☒ Disposal by Lab Archive Until

1. Relinquished by [signature]	Org. 7582	Date 9/27/94	Time 919	4. Relinquished by	Org.	Date	Time
1. Received by [signature]	Org. SMO 7576	Date 9/27/94	Time 919	4. Received by	Org.	Date	Time
2. Relinquished by [signature]	Org. SMO 7576	Date 9/27/94	Time 1100	5. Relinquished by	Org.	Date	Time
2. Received by	Org.	Date	Time	5. Received by	Org.	Date	Time
3. Relinquished by	Org.	Date	Time	6. Relinquished by	Org.	Date	Time
3. Received by	Org.	Date	Time	6. Received by	Org.	Date	Time

WHITE - To Accompany Samples, Laboratory Copy   BLUE - To Accompany Samples, Return to SMO   YELLOW - SMO Suspense Copy   PINK - Field Copy

Sample Findings Summary

Site: Tijeras Arroyo Ops Unit (Site 46 Drilling)

AR/COC: 604306_308_559_561

Data Type: Organic

Sample ID	EPA 8260B VOCs	75-25-2 (9bromoform)	79-34-5 (1,1,2,2-tetrachloroethylene)	108-05-4 (vinyl acetate)	75-09-2 (methylene chloride)	EPA 8270C SVOCs	117-81-7 (bis(2ethylhexyl)phthalate)
055091-002 TJAOU-230-GR-05-0.0-S				UJ	4.9U,B		
055092-002 TJAOU-230-GR-06-0.0-S					4.87U,B1		
055093-002 TJAOU-230-GR-06-0.0-DU		UJ	UJ	UJ	4.92U,B		
055094-002 TJAOU-230-GR-06-5.0-S					4.94U,B1		
055095-002 TJAOU-230-GR-07-5-S				UJ	5.04U,B		
055096-002 TJAOU-231-GR-05-0.0-S		UJ	UJ	UJ	4.96U,B		
055097-002 TJAOU-231-GR-05-0.0-DU		UJ	UJ	UJ	5.0U,B		
055097-003 TJAOU-231-GR-05-0.0-DU							J
055098-002 TJAOU-231-GR-05-5.0-S				UJ	4.9U,B		
055099-002 TJAOU-231-GR-06-5.0-S		UJ	UJ	UJ	4.95U,B		
055880-002 TJAOU-230-GR-EB1				UJ	5.00U,B		
055881-002 TJAOU-232-1-GR-EB1				UJ	5.00U,B		
055100-001 TJAOU-230-GR-TB1				UJ	5.00U,B		
055101-001 TJAOU-231-GR-TB1				UJ	5.00U,B		

Validated By: Ms. Marcia Hilchey

Date: 09/04/01

Sample Findings Summary

Site: Tijeras Arroyo Ops Unit (Site 46 Drilling) **AR/COC:** 604306_308_559_561 **Data Type:** Inorganic and Radiochemical

Sample ID	7440-39-3 (barium)	7440-43-9 (cadmium)	7440-48-4 (cobalt)	7439-95-4 (magnesium)	7440-02-0 (nickel)	7429-90-5 (aluminum)	7439-94-6 (mercury)	7440-36-0 (antimony)	7440-50-8 (copper)	7440-23-5 (sodium)	18540-29-9 (hexavalent chromium)	Gamma spectroscopy	14932-40-2 (Th-231)
055091-003 TJAOU-230-GR-05-0.0-S								UJ,A2	J	J	UJ,A2		
055092-003 TJAOU-230-GR-06-0.0-S		J,B2						UJ,A2	J	J,B2	UJ,A2		
055093-003 TJAOU-230-GR-06-0.0-DU		J,B2						UJ,A2	J	J,B2	UJ,A2		
055094-003 TJAOU-230-GR-06-5.0-S		J,B2						UJ,A2	J	J	UJ,A2		
055095-003 TJAOU-230-GR-07-5-S		J,B2						UJ,A2	J	J	UJ,A2		
055096-003 TJAOU-231-GR-05-0.0-S		J,B2						UJ,A2	J	J,B2	UJ,A2		
055097-003 TJAOU-231-GR-05-0.0-DU								UJ,A2	J	J,B2	UJ,A2		
055098-003 TJAOU-231-GR-05-5.0-S								UJ,A2	J	J,B2	UJ,A2		
055099-003 TJAOU-231-GR-06-5.0-S								UJ,A2	J	J	UJ,A2		
055880-004 TJAOU-230-GR-EB1	J,B	J,B3	UJ,B3	J,B	J,B	UJ,B3	UJ,B3						
055881-004 TJAOU-232-1-GR-EB1	J,B		UJ,B3	J,B	J,B	UJ,B3	UJ,B3						
055880-008 TJAOU-230-GR-EB1											UJ,HT		
055882-008 TJAOU-231-GR-EB1											J,HT		
055091-005 TJAOU-230-GR-05-0.0-S													R
055092-005 TJAOU-230-GR-06-0.0-S													R
055093-005 TJAOU-230-GR-06-0.0-DU													R
055094-005 TJAOU-230-GR-06-5.0-S													R
055095-005 TJAOU-230-GR-07-5-S													R
055096-005 TJAOU-231-GR-05-0.0-S													R
055097-005 TJAOU-231-GR-05-0.0-DU													R
055098-005 TJAOU-231-GR-05-5.0-S													R
055099-005 TJAOU-231-GR-06-5.0-S													R

Validated By: Ms. Marcia Hilchey **Date:** 09/02/01

Analytical Quality Associates, Inc.
616 Maxine NE
Albuquerque, NM 87123
Phone: 505-299-5201
Fax: 505-299-6744
Email: minteer@aol.com

MEMORANDUM

DATE: 09/04/01

TO: File

FROM: Marcia Hilchey

SUBJECT: Organic Data Review and Validation - SNL
Site: Tijeras Arroyo Ops Unit (Site 46 Drilling); ARCOC #604306, -308, -559, -561
GEL SDG #43904, 43913 Project/Task No. 7225.02.02.06

See the attached Data Validation Worksheets for supporting documentation on the data review and validation.

Summary

All samples were prepared and analyzed with approved procedures using method EPA 8260B VOCs, EPA 8270C SVOCs, and EPA 8015A/B Diesel Range Organics (DRO) and Gasoline Range Organics (GRO). Problems were identified with the data package that result in the qualification of data.

1. VOC: The CCV%D for vinyl acetate associated with soil samples 43904-001, -003, -005, -006, -007, -008, and –009, and that associated with all aqueous samples was >40 and <60, with a low bias. All associated sample results were non-detect and are qualified "UJ."

   Methylene chloride was detected in the equipment blanks, trip blanks, and method blanks at >DL. All associated positive sample results <5x the greatest associated blank value and <RL are qualified "U,B(or B2, or B1)" at the RL.

   Recovery for surrogate toluene-d8 (134%) was slightly above acceptance criteria for sample 43904-003. According to the case narrative, this surrogate recovery was confirmed by re-analysis. The only positive result for this sample was for methylene chloride, which was previously qualified "U" due to blank contamination. All other results were non-detect, therefore no results were qualified.

   The area counts for IS #3 (1,4-dichlorobenzene-d4) were below acceptance criteria but >25% for samples 43904-003, -006, -007, and –009. According to the case narrative, these IS area counts were confirmed by re-analysis. Non-detect results for analytes associated with this IS are qualified "UJ."

2. SVOC: The CCV%D for bis(2-ethylhexyl)phthalate associated with all soil samples was >20 and <40. Associated positive sample results are qualified "J."

Data are acceptable except as noted above. QC measures appear to be adequate. The following sections discuss the data review and validation.

Holding Times/Preservation

All Analysis: All samples were properly preserved and analyzed within the prescribed holding times.

Calibration

DRO and GRO Analyses: The initial and continuing calibrations met QC acceptance criteria.

VOC and SVOC Analyses: The initial and continuing calibrations met QC acceptance criteria except as noted above in the summary section.

Blanks

GRO, DRO, and SVOC Analyses: All blank acceptance criteria were met.

VOC Analyses: All blank acceptance criteria were met except as noted above in the summary section and as follows. Dibromochloromethane was detected in both equipment blanks associated with the soil samples. All associated soil sample results were non-detect and therefore should not be qualified. Toluene was reported in the method blank for the aqueous samples. All associated sample results were non-detect and therefore should not be qualified.

Surrogates

GRO, DRO, and SVOC Analyses: All surrogate acceptance criteria were met.

VOC Analyses: All surrogate acceptance criteria were met except as noted above in the summary section.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) Analysis

DRO, VOC, and SVOC Analyses: All MS/MSD acceptance criteria were met.

GRO Analyses: All MS/MSD acceptance criteria were met. It should be noted that no aqueous MS/MSD analyses were performed due to insufficient sample volume. No sample data should be qualified as a result.

Laboratory Control Samples (LCS/LCSD) Analysis

GRO, VOC, and SVOC Analyses: The LCS/LCSD analyses met all QC acceptance criteria.

DRO Analyses: The soil LCSD RPD slightly exceeded acceptance criteria. Since the MS RPD met acceptance criteria, no sample data were qualified as a result.

Internal Standards (IS)

SVOC Analyses: All IS acceptance criteria were met.

VOC Analyses: All IS acceptance criteria were met except as noted above in the summary section.

DRO and GRO Analyses: Internal standards are not required for these methods.

Other QC

No field blank was submitted on the ARCOC.

The equipment blanks submitted on COC 604559 were considered to be associated with the field samples on COC 604306, and the equipment blanks submitted on COC 604561 were considered to be associated with the field samples on COC 604308 for validation purposes.

The VOC trip blank results were applied only to the samples from the same COCs.

Field duplicate pairs were submitted, however there are no "required" review criteria for field duplicate analyses comparability.

No other specific issues were identified which affect data quality.

Please contact me if you have any questions or comments regarding the review of this package.

Analytical Quality Associates, Inc.
616 Maxine NE
Albuquerque, NM 87123
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MEMORANDUM

DATE: 09/20/01

TO: File

FROM: Marcia Hilchey

SUBJECT: Radiochemical Data Review and Validation - SNL
Site: Tijeras Arroyo Ops Unit (Site 46 Drilling);
ARCOC #604306, -308, -559, -561
GEL SDG #43904, 43913 Project/Task No. 7225.02.02.06

See the attached Data Validation Worksheets for supporting documentation on the data review and validation.

Summary

All samples were prepared and analyzed with approved procedures using methods EPA 096.0 tritium, EPA 900.0 gross alpha/beta (GAB), and HASL300 gamma spectroscopy. Problems were identified with the data package that result in the qualification of data.

It should be noted that some non-gamma radiochemical sample results that are reported at a value greater than the RL (decision level concentration or DLC) might be less than the calculated MDA (minimum detectable activity).

1. Gamma Spectroscopy: According to the case narrative, the laboratory rejected the following data due to: [1] low abundance [2]no valid peak [3]interference. These sample results are qualified "R" (unusable).

   Samples 43904-028 through –034 and -036 Th-231[1]
   Sample 43904-035 Th-231[3]

Data are acceptable except as noted above. QC measures appear to be adequate. The following sections discuss the data review and validation.

Holding Times/Preservation

All Analyses: All samples were properly preserved and analyzed within the prescribed holding times.

Calibration

All Analyses: The case narratives stated that the instruments used were properly calibrated.

Blanks

All Analyses: No target analytes were detected in any method blank at concentrations > the associated RL.

Gross alpha/beta Analyses: Gross beta was reported in the equipment blanks associated with all samples at >RL. All sample results were >5x the associated EB and should therefore not be qualified.

Matrix Spike (MS) Analysis

All Analyses: All MS acceptance criteria were met. It should be noted that the samples used for aqueous gross alpha/beta and gamma spectroscopy MS analyses were from another SDG. No sample data should be qualified as a result.

Laboratory Control Sample (LCS) Analysis

All Analyses: The LCS analyses met all QC acceptance criteria.

Replicates

All Analyses: All replicate acceptance criteria were met. It should be noted that the samples used for aqueous gross alpha/beta and gamma spectroscopy replicate analyses were from another SDG. No sample data should be qualified as a result.

Tracer/Carrier Recovery

All Analyses: Tracers and/or carriers are not used in these methods.

Negative Bias

All Analyses: All sample results met negative bias QC acceptance criteria.

Other QC

Gamma Spectroscopy Analyses: The laboratory rejected data due to low abundance and interfeernce. Data are qualified as noted above in the summary section.

GAB Analyses: The sample planchets were counted for gross beta, then heated to a dull red color, then counted for gross alpha.

The equipment blanks submitted on COC 604559 were considered to be associated with the field samples on COC 604306, and the equipment blanks submitted on COC 604561 were considered to be associated with the field samples on COC 604308 for validation purposes.

Field duplicate pairs were submitted, however there are no "required" review criteria for field duplicate analyses comparability.

No other specific issues were identified which affect data quality.

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Email: minteer@aol.com

MEMORANDUM

DATE: 09/02/01

TO: File

FROM: Marcia Hilchey

SUBJECT: Inorganic Data Review and Validation - SNL
Site: Tijeras Arroyo Ops Unit (Site 46 Drilling); ARCOC #604306, -308, -559, -561
GEL SDG #43904, 43913 Project/Task No. 7225.02.02.06

See the attached Data Validation Worksheets for supporting documentation on the data review and validation.

Summary

All samples were prepared and analyzed with approved procedures using methods EPA 6010B ICP-AES metals, EPA 7471A CVAA mercury, and EPA 7196A hexavalent chromium. Problems were identified with the data package that result in the qualification of data.

1. ICP: Ba, Mg, and Ni were detected in the method blank associated with the aqueous samples. Associated sample results <5x the blank result were qualified "J,B."

   Cd was detected in a CCB associated with the aqueous samples at >DL. Associated sample results <5x the blank result were qualified "J,B3."

   Hg, Al, and Co were reported in CCBs associated with the aqueous samples at negative concentrations. The absolute values were> the DL but < the RL. Associated non-detect results were qualified "UJ,B3."

   Cd and Na were detected in one or more equipment blanks at >DL. Associated soil sample results <5x the blank result were qualified "J,B2."

   Recovery for Sb (46%) in the MS associated with the soil samples was below acceptance criteria. Associated positive sample results were qualified "J,A2"; non-detects were qualified "UJ,A2."

   Replicate RPDs for Cu (37%) and Na (63%) associated with the soil samples exceeded acceptance criteria. Associated sample results >5x RL were qualified "J."

2. Hexavalent Chromium: All aqueous samples were received by the laboratory past the required holding time. Associated positive sample results were qualified "J,HT"; non-detects were qualified "UJ,HT."

Target analyte recovery for the MS associated with the soil samples was below acceptance criteria. All associated sample results were non-detect and were qualified "UJ,A2."

Data are acceptable except as noted above. QC measures appear to be adequate. The following sections discuss the data review and validation.

Holding Times/Preservation

ICP and CVAA Analyses: All samples were properly preserved and analyzed within the prescribed holding times.

Hexavalent Chromium Analyses: The soil samples were properly preserved and analyzed within the prescribed holding times. The aqueous samples were received outside of the required holding time and were qualified as noted above in the summary section.

Calibration

All Analyses: The initial and continuing calibration verifications met all QC acceptance criteria.

Blanks

No target analytes were detected in the blanks except as noted above in the summary and as follows.

ICP Analyses: Cd, Ca, Cu, Mg, Pb, As, and Sb were detected in the ICB and/or CCBs associated with the aqueous samples at >DL. Ba, Mg, and Ni were detected in the method blank associated with the aqueous samples at >DL. Sample results <5x the greatest associated blank concentration were qualified as noted above in the summary section. Associated non-detects and positive results >5x blank concentrations were not qualified.

Ca, Fe, and K were detected in the ICB and/or CCBs associated with the soil samples at >DL. Ba, Ca, Co, Mn, Ni, K, and Zn were detected in the method blank associated with the soil samples at >DL. Sample results <5x the greatest associated blank concentration were qualified as noted above in the summary section. Associated non-detects and positive results >5x blank concentrations were not qualified.

Al, Co, and Na were reported in a CCB associated with the aqueous samples at negative concentrations. The absolute values were > the DL but < the RL. Associated non-detects were qualified as noted above in the summary section. Results >5x DL were not qualified.

Al and Na were reported in the ICB and/or a CCB associated with the soil samples at negative concentrations. The absolute values were > the DL but < the RL. The associated sample results were >5X DL, therefore no sample data were qualified as a result.

Hexavalent Chromium Analyses: Target analyte was detected in the ICB associated with the soil samples at >DL. Associated samples were non-detect, therefore no sample results were qualified.

Matrix Spike (MS) Analysis

ICP and Hexavalent Chromium Analyses: The MS analyses met QC acceptance criteria except as noted above in the summary section. It should be noted that the aqueous MS analysis for the ICP method was performed on a sample from another SNL SDG. No sample data were qualified as a result.

CVAA Analyses: The MS analyses met QC acceptance criteria. It should be noted that the aqueous MS analysis was performed on a sample from another SNL SDG. No sample data were qualified as a result.

Laboratory Control Sample (LCS/LCSD) Analyses

ICP Analyses: LCS recovery for Zn (115%) associated with the aqueous samples was slightly above the lab's acceptance criteria. Since the LCSD recovery acceptance criteria were met, no sample results were qualified.

CVAA and Hexavalent Chromium Analyses: The LCS/LCSD analyses met all QC acceptance criteria.

Replicate Analysis

ICP and CVAA Analyses: The replicate analyses met all QC acceptance criteria except as noted above in the summary section and as follows. The aqueous replicate analyses were performed on a sample from another SNL SDG. No sample data were qualified as a result.

Hexavalent Chromium Analyses: The replicate analyses met all QC acceptance criteria.

ICP Interference Check Sample (ICS)

ICP Analyses: The ICS met all QC acceptance criteria.

ICP Serial Dilution

ICP Analysis: All serial dilution acceptance criteria were met. It should be noted that the aqueous SD analysis was performed on a sample from another SNL SDG. No sample data were qualified as a result.

Other QC

All Analyses: No field blank was submitted on the AR/COC.

The equipment blanks submitted on COC 604559 were considered to be associated with the field samples on COC 604306, and the equipment blanks submitted on COC 604561 were considered to be associated with the field samples on COC 604308 for validation purposes.

Field duplicate pairs were submitted, however there are no "required" review criteria for field duplicate analyses comparability.

(Site 46 Drilling)

Data Validation Summary

Site/Project: Tijeras Arroyo Op Unit Project/Task #: 7225.02.02.06

# of Samples: ______ Matrix: aq./soil

AR/COC #: 604306-308, -559, -561

Laboratory Sample IDs: ______

Laboratory: GEL

Laboratory Report #: 43904 A,B,C,D 43913 (aq)

QC Element	Organics: VOC	Organics: SVOC	Organics: Pesticide/PCB (GRO)	Organics: HPLC (HE) (DRO)	Inorganics: ICP/AES	Inorganics: GFAA/AA	Inorganics: CVAA (Hg)	Inorganics: CN	RAD	Other (Cr6+)
1. Holding Times/Preservation	✓	✓	✓	✓	✓		✓		✓	UJ/J
2. Calibrations	UJ	J	✓	✓	✓		✓		✓	✓
3. Method Blanks	U	✓	✓	✓	J/UJ		UJ		✓	✓
4. MS/MSD	✓	✓	✓	✓	J/UJ		✓		✓	J
5. Laboratory Control Samples	✓	✓	✓	✓	✓		✓		✓	✓
6. Replicates					J		✓		✓	✓
7. Surrogates	✓	✓	✓	✓						n/a
8. Internal Standards	UJ	✓								↓
9. TCL Compound Identification	✓	✓								↓
10. ICP Interference Check Sample					✓					↓
11. ICP Serial Dilution					✓					↓
12. Carrier/Chemical Tracer Recoveries									✓	↓
13. Other QC									R	↓

J = Estimated
U = Not Detected
UJ = Not Detected, Estimated
R = Unusable

Check (√) = Acceptable
Shaded Cells = Not Applicable (also "NA")
NP = Not Provided
Other: lab applied

Reviewed By: ______ Date: 9/2/01

Holding Time and Preservation

Site/Project: Tijeras Arroyo Op Unit (Site 46 Drilling) AR/COC #: 604306 - 308 589 - 561 Laboratory Sample IDs:

Laboratory: GEL Laboratory Report #: 43904

# of Samples: Matrix:

Sample ID	Analytical Method	Holding Time Criteria	Days Holding Time was Exceeded	Preservation Criteria	Preservation Deficiency	Comments
43913-016-015	7196A Cr^{6+}	24 hrs.		✓	–	JWJ

Reviewed By: [signature] Date: 9/3/01

Inorganic Metals

Site/Project: (Site 46 Drilling) Tijeras Arroyo Ops Unit AR/COC #: 604306, -308, -559, -561
Laboratory: GEL Laboratory Report #: 43904
Methods: 6010B 7470A
\# of Samples: 9 Matrix: Soil

Laboratory Sample IDs: 43904-010 → 018

Batch #s: 83129 88951

CAS #/ Analyte	TAL	ICV	CCV	ICB (µg/l)	CCB	Method Blanks (mg/kg)	LCS	LCSD	LCSD RPD	MS	MSD	MSD RPD	Rep. RPD	ICS AB	Serial Dilution	Field Dup. RPD	Equip. Blanks (µg/l)	~~Field~~ 2 EB Blanks	5x6 µg/l	
													✓	✓	✓				37.85	
7429-90-5 Al	✓	✓	✓	✓	-21.7	✓	✓	✓	✓	✓							1.12J	.862JR	23.7	
7440-39-3 Ba					✓	.237														
7440-41-7 Be					✓	✓											.256J		1.28	
7440-43-9 Cd					✓	✓											155	157	1150	
7440-70-2 Ca					13.9	11.5														
7440-47-3 Cr					✓	✓													7.73 ~~3.865~~	
7440-48-4 Co					✓								37							
7440-50-8 Cu					✓	.0773							✓						27.6	
7439-89-6 Fe					5.51	✓											28.7JR	21.6JR	143.5	108
7439-95-4 Mg					✓	✓													6.7	
7439-96-5 Mn					✓	.0671											2.55JB	1.88JB	27.2	
7440-02-0 Ni					✓	.272											59.6	34	294	
7440-09-7 K					15.5	2.94														
7440-22-4 Ag													63				135	124	675	620
7440-23-5 Na				-8.62	750	✓							✓							
7440-62-2 V				✓		✓							✓				4.71JA		42.1	
7440-66-6 Zn				✓	✓	.421							✓							
7439-92-1 Pb	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓										
7782-49-2 Se					✓					✓										
7440-38-2 As																			22.8	
7440-36-0 Sb					4.56					46									26.5	
7440-28-0 Tl					5.29															
7439-97-6 Hg	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓										
Cyanide CN																				

57 .85 39.

Notes: Shaded rows are RCRA metals. Solids-to-aqueous conversion: mg / kg = µg / g : [(µg / g) x (sample mass {g} / sample vol. {ml}) x (1000 ml / 1 liter)] / Dilution Factor = µg / l

Comments:
EB : sample
1 -007 : -010 → 014
2 -008 : -015 → 018

dups:
-011 : -012
-016 : -015

ICP mg/kg (20/dt) = µg/l
CVAA mg/kg (20/dt) = µg/l

Reviewed By: [signature] Date: 9/2/01

Inorganic Metals

(Site 46 Drilling)

Site/Project: Tijeras Arroyo Ops Unit AR/COC #: 604306-308 -559 -561 Laboratory Sample IDs:

Laboratory: GEL Laboratory Report #: 43913 43913 - 007, -008

Methods: 6010 B 7470A Batch #s: 84383 89878 86352 - Hg

# of Samples: 2 Matrix: aqueous

IDL

CAS # / Analyte	TAL	ICV	CCV	ICB (µg/l)	CCB	Method Blanks (mg/l)	LCS	LCSD	LCSD RPD	MS	MSD	MSD RPD	Rep. RPD	ICS AB	Serial Dilution	Field Dup. RPD	Equip. Blanks	Field Blanks	5x blk mg/l	
														✓	✓				.03797	
7.57 7429-90-5 Al	✓	✓	✓	✓	-17	✓	✓	✓	✓										.00336	
7440-39-3 Ba	✓				✓	.000677													.00368	
7440-41-7 Be	✓				✓														.0448	
7440-43-9 Cd	✓				.736															
7440-70-2 Ca	✓				8.95														.002K	
7440-47-3 Cr	✓																		.00411	
419 7440-48-4 Co	✓				-.467															
7440-50-8 Cu	✓				.817														.0491	
7439-89-6 Fe	✓				✓															
7439-95-4 Mg	✓				5.06	.00981													.0121	
7439-96-5 Mn	✓				✓															
7440-02-0 Ni	✓					.00242														
7440-09-7 K	✓					✓														
7440-22-4 Ag	✓																			
7440-23-5 Na	✓																			
7440-62-2 V	✓						1.15													
7440-66-6 Zn	✓													✓	✓				.0131	
7439-92-1 Pb	✓	✓	✓	✓	2.62	✓	✓												.0146	
7782-49-2 Se	✓			✓	✓														.0192	
7440-38-2 As	✓			2.97	2.92															
7440-36-0 Sb	✓			✓	3.84															
7440-28-0 Tl	✓			✓	✓														.000225m	
.057 7439-97-6 Hg	✓	✓	✓	-.0431	-.027	✓														
Cyanide CN																				

Notes: Shaded rows are RCRA metals. Solids-to-aqueous conversion: mg / kg = µg / g.: [(µg / g) x (sample mass {g} / sample vol. {ml}) x (1000 ml / 1 liter)] / Dilution Factor = µg / l

Comments: Other SDG (sim.): ICP dp/MS/SD
CVAA dp/MS

Reviewed By: [signature] Date: 9/2/01

(Site 46 Drilling)

General Chemistry

Site/Project: Tijeras Arroyo Ops Unit AR/COC #: 607306, 308, 559, 561

Laboratory: GEL Laboratory Report #: 43904

Methods: 7196A Cr^{6+}

\# of Samples: 9 Matrix: soil

Laboratory Sample IDs: 43904-010 → 018

Batch #s: 85987 -010 → 015 89038 -016 → 018

CAS #	Analyte	TAL	ICV	CCV	ICB	CCB	Method Blanks	LCS	LCSD	LCSD RPD	MS	MSD	MSD RPD	Rep. RPD	ICS AB	Serial Dilution	Field Dup. RPD	Equip. Blanks	Field Blanks
			mg/l ✓	✓	✓	✓												mg/l	
	Cr^{6+}	✓	✓ 0.9		0.9		+ .101	✓	✓	✓	44 68			✓				1: 6.0 2: .006 J/HT	

Comments: EB : Sample
1 -015 -010 → 014
2 -016 -015 → 018

(mg/kg)(10) = mg/l

all ND

Reviewed By: [signature] Date: 9/2/01

General Chemistry

Site/Project: (Site 46 Drilling) Tijeras Arroyo Ops Unit AR/COC #: 604306, 308, 559, 561 Laboratory Sample IDs: 43913-015, -016

Laboratory: GEL Laboratory Report #: 43913

Methods: Cr 6+ 7196A

# of Samples: 2 Matrix: aq. Batch #s:

CAS #	Analyte	TAL	ICV	CCV	ICB	CCB	Method Blanks	LCS	LCSD	LCSD RPD	MS	MSD	MSD RPD	Rep. RPD	ICS AB	Serial Dilution	Field Dup. RPD	Equip. Blanks	Field Blanks
	Cr^{6+}		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓					

Comments:
past holding time: UJ, HT +J

Reviewed By: [signature] Date: 9/2/01

Radiochemistry

(Site 4B Drilling)

Site/Project: Tijeras Arroyo Op. Un. AR/COC #: 604306, -308, -559, -561

Laboratory: GEL Laboratory Report #:

Methods: tritium 906.0, GAB 900.0 γ spec. HASL 300

\# of Samples: Matrix: soil

Laboratory Sample IDs: 43904-019→027 H3 83512
-028→036 GAB, γ 83689, 85146

Batch #s:

QC Element

Analyte	Method Blanks	LCS	MS	Rep RER	Equip. Blanks	Field Dup. RER	Field Blanks	Sample ID	Isotope	IS/Trace	Sample ID	Isotope	IS/Trace
										50-105			50-105
Criteria	U	20%	25%	<1.0	U	<1.0	U						
H3	✓	✓	✓	✓									
U-238													
U-234													
U-235/-236													
Th-232													
Th-228													
Th-230													
Pu-239/-240													
Gross Alpha	✓	✓	✓	✓	3.538								
Nonvolatile Beta	✓ 2.92	✓	✓	✓	1.637		.63						
Ra-226													
Ra-28													
Ni-63													
Gamma Spec. Am-241	✓	✓		✓									
Gamma Spec. Cs-137	✓	✓		✓									
Gamma Spec. Co-60	✓	✓		✓									

Parameter	Method	Typical Tracer	Typical Carrier
Iso-U	Alpha spec.	U-232	NA
Iso-Pu	Alpha spec.	Pu-242	NA
Iso-Th	Alpha spec.	Th-229	NA
Am-241	Alpha spec.	Am-242	NA
Sr-90	Beta	Y ingrowth	NA
Ni-63	Beta	NA	Ni by ICP
Ra-226	Deamination	NA	NA
Ra-226	Alpha spec.	Ba-133 or Ra-225	NA
Ra-228	Gamma spec.	Ba-133	NA

Gamma spec. LCS contains: Am-241, Cs-137, and Co-60

GAB: Count/Flare/count

Comments: EB: Smpl

-011, -013 } -028, -029, -030, -031, -032

-009 - 019, -020, -021, -022, -023

-010 - -024, -025, -026, -027

-012, -014 } -033, -034, -035, -036

Reviewed By: [signature] Date: 9/2/01

Radiochemistry

(Site 46 Drilling)

Site/Project: Tijeras Arroyo Op Unit AR/COC #: 604306, 308, 559, 561

Laboratory: GEL Laboratory Report #: 43913

Methods: Tritium 906.0, GAB 900.0, γ spec.

\# of Samples: 2 Matrix: aqueous

Laboratory Sample IDs: 43913-009 → 14

Batch #s: 83483 83671 85712

Analyte	Method Blanks	LCS	MS	Rep RER	Equip. Blanks	Field Dup. RER	Field Blanks	Sample ID	Isotope	IS/Trace	Sample ID	Isotope	IS/Trace
										50-105			50-105
Criteria	U	20%	25%	<1.0	U	<1.0	U						
H3	✓	✓	✓	✓									
U-238													
U-234													
U-235/-236													
Th-232													
Th-228													
Th-230													
Pu-239/-240													
Gross Alpha	✓	✓											
Nonvolatile Beta	✓	✓											
Ra-226													
Ra-28													
Ni-63													
Gamma Spec. Am-241	✓	✓											
Gamma Spec. Cs-137	✓	✓											
Gamma Spec. Co-60	✓	✓											

Parameter	Method	Typical Tracer	Typical Carrier
Iso-U	Alpha spec.	U-232	NA
Iso-Pu	Alpha spec.	Pu-242	NA
Iso-Th	Alpha spec.	Th-229	NA
Am-241	Alpha spec.	Am-242	NA
Sr-90	Beta	Y ingrowth	NA
Ni-63	Beta	NA	Ni by ICP
Ra-226	Deamination	NA	NA
Ra-226	Alpha spec.	Ba-133 or Ra-225	NA
Ra-228	Gamma spec.	Ba-133	NA

Gamma spec. LCS contains: Am-241, Cs-137, and Co-60

GAB - flame/count/flame

Comments: other SDG: GAB ms/dp ; γ dp/ms

Reviewed By: [signature] Date: 9/2/01

(Site 46 Drilling)

Radiochemistry

Site/Project: Tijeras Arroyo Op Unit AR/COC #: 604306, -308, -559, -561

Laboratory: GEL Laboratory Report #: 43913

Methods: tritium 906.0, GAB 900.0, γ spec.

\# of Samples: 2 Matrix: aqueous

Laboratory Sample IDs: 43913-009 → 14

Batch #s: 83483 83671 85712

Analyte	QC Element												
	Method Blanks	LCS	MS	Rep RER	Equip. Blanks	Field Dup. RER	Field Blanks	Sample ID	Isotope	IS/Trace	Sample ID	Isotope	IS/Trace
Criteria	U	20%	25%	<1.0	U	<1.0	U						
H3	✓	✓	✓	✓						50-105			50-105
U-238													
U-234													
U-235/-236													
Th-232													
Th-228													
Th-230													
Pu-239/-240													
Gross Alpha	✓	✓											
Nonvolatile Beta	✓	✓											
Ra-226													
Ra-28													
Ni-63													
Gamma Spec. Am-241	✓	✓											
Gamma Spec. Cs-137	✓	✓											
Gamma Spec. Co-60	✓	✓											

Parameter	Method	Typical Tracer	Typical Carrier
Iso-U	Alpha spec.	U-232	NA
Iso-Pu	Alpha spec.	Pu-242	NA
Iso-Th	Alpha spec.	Th-229	NA
Am-241	Alpha spec.	Am-242	NA
Sr-90	Beta	Y ingrowth	NA
Ni-63	Beta	NA	Ni by ICP
Ra-226	Deamination	NA	NA
Ra-226	Alpha spec.	Ba-133 or Ra-225	NA
Ra-228	Gamma spec.	Ba-133	NA

Gamma spec. LCS contains: Am-241, Cs-137, and Co-60

GAB - flame/count/flame

Comments: other SOC: GAB ms/dp; γ dp/ms

Reviewed By: [signature] Date: 9/2/04

P

(Site 46 Drilling)

Organics (supplemental) GRO

Site/Project: Tijeras Arroyo OU nit AR/COC #: 604306, -308, -559, -561 # of Samples: 2 Matrix: aqueous

Laboratory: GEL Laboratory Report #: 43913 Laboratory Sample IDs: 43913-019, -020

Methods: GRO 8015B Batch #s: 83196 6/15 9/15 VOC1A

IS	CAS #	Name	TCL	Min. RF	Intercept	Calib. RF	Calib. RSD/ R^2	CCV %D	Method Blks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Trip Blanks		
						>.05	<20% / 0.99	20%												
\		GRO	✓			✓	✓	✓	✓	✓	✓	✓								

Comments:
no MS/MSD
insuff. vol.

Notes: Shaded rows are RCRA compounds.

all surrogates: OK

P

Organics (supplemental) DRO

(Site 46 Drilling)

Site/Project: Tijeras Arroyo Ops Unit AR/COC #: 604306, 308, 359, 661

Laboratory: GEL Laboratory Report #: 43904

Methods: 8015A/B DRO

# of Samples: 9 Matrix: soil

Laboratory Sample IDs: 43904-010→018

Batch #s: 6/16 6/21

IS	CAS #	Name	TCL	Min. RF	Intercept	Calib. RF	Calib. RSD/ R²	CCV %D	Method Blks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Trip Blanks		
						>.05	<20% / 0.99	20%												
/		DRO	✓		✓	✓	✓	✓	✓	✓	✓	26	✓	✓	✓		7.61' 7.12	/		

Comments:
EB: Smpl.
-017 -010→014
-[illegible] -015→018

Notes: Shaded rows are RCRA compounds.

dup
-012 : -013
-015 : -016

no IS

(Site 46 Drilling)

Semivolatile Organics (SW 846 Method 8270)

Site/Project: Tijeras Arroyo Ops Unit AR/COC #: 604306, -308, -559, -561 Laboratory Sample IDs:

Laboratory: GEL Laboratory Report #: 43904 43904-010 → 018

Methods: 8270

# of Samples: 9 Matrix: Soil Batch #s: 83528

IS	BNA	CAS #	NAME	TCL	Min. RF	Intercept	Calib. RF	Calib. RSD/ R^2	CCV %D	Method Blanks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Field Blanks		
							>.05	<20% / 0.99	20%												
1	A	108-95-2	Phenol	✓	0.80		✓	✓	✓	✓	✓					✓		✓			
1	BN	111-44-4	bis(2-Chloroethyl)ether		0.70																
1	A	95-57-8	2-Chlorophenol		0.80						✓					✓					
1	BN	541-73-1	1,3-Dichlorobenzene		0.60																
1	BN	106-46-7	1,4-Dichlorobenzene		0.50						✓					✓					
1	BN	95-50-1	1,2-Dichlorobenzene		0.40																
1	A	95-48-7	2-Methylphenol		0.70						✓					✓					
1	BN	108-60-1	bis(2-chloroisopropyl)ether		0.01																
1	A	106-44-5	4-Methylphenol		0.60						✓					✓					
1	BN	621-64-7	N-Nitroso-di-n-propylamine		0.50						✓					✓					
1	BN	67-72-1	Hexachloroethane		0.30						✓					✓					
2	BN	98-95-3	Nitrobenzene		0.20						✓					✓					
2	BN	78-59-1	Isophorone		0.40																
2	A	88-75-5	2-Nitrophenol		0.10																
2	A	105-67-9	2,4-Dimethylphenol		0.20																
2	BN	111-91-1	bis(2-Chloroethoxy)methane		0.30																
2	A	120-83-2	2,4-Dichlorophenol		0.20																
2	BN	120-82-1	1,2,4-Trichlorobenzene		0.20						✓					✓					
2	BN	91-20-3	Naphthalene		0.70																
2	BN	106-47-8	4-Chloroaniline		0.01																
2	BN	87-68-3	Hexachlorobutadiene		0.01						✓					✓					
2	A	59-50-7	4-Chloro-3-methylphenol		0.20						✓					✓					
2	BN	91-57-6	2-Methylnaphthalene		0.40																
3	BN	77-47-4	Hexachlorocyclopentadiene		0.01																
3	A	88-06-2	2,4,6-Trichlorophenol		0.20						✓					✓					
3	A	95-95-4	2,4,5-Trichlorophenol		0.20						✓					✓					

Comments: ~06 hit bis(2ch)ph ∴ J

Notes: Shaded rows are RCRA compounds.

Reviewed By: [signature] Date: 7/1/01

Semivolatile Organics

Site/Project: ______ AR/COC #: 604306-308-559-561 Batch #s: ______

Laboratory: ______ Laboratory Report #: ______ # of Samples: ______ Matrix: Soil

IS	BNA	CAS #	NAME	TCL	Min. RF	Intercept	Calib. RF	Calib. RSD/ R^2	CCV %D	Method Blanks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Field Blanks
							>.05	<20% / 0.99	20%										
3	BN	91-58-7	2-Chloronaphthalene	✓	0.80		✓	✓	✓	✓								✓	
3	BN	88-74-4	2-Nitroaniline		0.01														
3	BN	131-11-3	Dimethylphthalate		0.01														
3	BN	208-96-8	Acenaphthylene		0.90														
3	BN	606-20-2	2,6-Dinitrotoluene		0.20														
3	BN	99-09-2	3-Nitroaniline		0.01														
3	BN	83-32-9	Acenaphthene		0.90						✓								
3	A	51-28-5	2,4-Dinitrophenol		0.01														
3	A	100-02-7	4-Nitrophenol		0.01						✓								
3	BN	132-64-9	Dibenzofuran		0.80														
3	BN	121-14-2	2,4-Dinitrotoluene		0.20						✓								
3	BN	84-66-2	Diethylphthalate		0.01														
3	BN	7005-72-3	4-Chlorophenyl-phenylether		0.40														
3	BN	86-73-7	Fluorene		0.90														
3	BN	100-01-6	4-Nitroaniline		0.01														
4	A	534-52-1	4,6-Dinitro-2-methylphenol		0.01														
4	BN	86-30-6	N-Nitrosodiphenylamine (1)		0.01														
4	BN	101-55-3	4-Bromophenyl-phenylether	✓	0.10														
4	BN	118-74-1	Hexachlorobenzene		0.10						✓								
4	A	87-86-5	Pentachlorophenol		0.05						✓								
4	BN	85-01-8	Phenanthrene		0.70														
4	BN	120-12-7	Anthracene		0.70														
4	BN	86-74-8	Carbazole		0.01														
4	BN	84-74-2	Di-n-butylphthalate		0.01														
4	BN	206-44-0	Fluoranthene		0.60														
5	BN	129-00-0	Pyrene		0.60						✓								
5	BN	85-68-7	Butylbenzylphthalate		0.01														
5	BN	91-94-1	3,3'-Dichlorobenzidine		0.01														
5	BN	56-55-3	Benzo(a)anthracene		0.80														

Comments:

Semivolatile Organics

Site/Project: ______ AR/COC #: 604326-308-557-561 Batch #s: ______

Laboratory: ______ Laboratory Report #: ______ # of Samples: ______ Matrix: soil

IS	BNA	CAS #	NAME	TCL	Min. RF	Intercept	Calib. RF	Calib. RSD/ R^2	CCV %D	Method Blanks	LCS	LCS D	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Field Blanks	
							>.05	<20% / 0.99	20%											
5	BN	218-01-9	Chrysene	✓	0.70		✓	✓	✓	✓								✓		
5	BN	117-81-7	bis(2-Ethylhexyl)phthalate		0.01				+24.9											
6	BN	117-84-0	Di-n-octylphthalate		0.01				✓											
6	BN	205-99-2	Benzo(b)fluoranthene		0.70															
6	BN	207-08-9	Benzo(k)fluoranthene		0.70															
6	BN	50-32-8	Benzo(a)pyrene		0.70															
6	BN	193-39-5	Indeno(1,2,3-cd)pyrene		0.50															
6	BN	53-70-3	Dibenz(a,h)anthracene		0.40															
6	BN	191-24-2	Benzo(g,h,i)perylene		0.50															
			diphenylamine																	

Surrogate Recovery Outliers

Sample	SMC 1	SMC 2	SMC 3	SMC 4	SMC 5	SMC 6	SMC 7	SMC 8
				met criteria				

SMC 1: Nitrobenzene-d5 (BN)
SMC 2: 2-Fluorobiphenyl (BN)
SMC 3: p-Terphenyl-d14 (BN)
SMC 4: Phenol-d6 (A)
SMC 5: 2-Fluorophenol (A)
SMC 6: 2,4,6-Tribromophenol (A)
SMC 7: 2-2-Chlorophenol-d4 (A)
SMC 8: 1,2-Dichlorobenzene-d4 (BN)

Comments: blk : smpl.
-005 -010, -011, -012, -013, -014
-006 -015, -016, -017, -018

all(M) dup
-015 & 0-016 - hits
-012, -013

Internal Standard Outliers

Sample	IS 1-area	IS 1-RT	IS 2-area	IS 2-RT	IS 3-area	IS 3-RT	IS 4-area	IS 4-RT	IS 5-area	IS 5-RT	IS 6-area	IS 6-RT
					met criteria							

IS 1: 1,4-Dichlorobenzene-d4 (BN)
IS 2: Naphthalene-d8 (BN)
IS 3: Acenaphthene-d10 (BN)
IS 4: Phenathrene-d10 (BN)
IS 5: Chrysene-d12 (BN)
IS 6: Perylene-d12 (BN)

(Site 4B Drilling)

Semivolatile Organics (SW 846 Method 8270)

Site/Project: Tijeras Arroyo GW AR/COC #: 604306-308-559-561 Laboratory Sample IDs:

Laboratory: GEL Laboratory Report #: 43904

Methods: 8270C

# of Samples: 2 Matrix: aqueous MSOS 4/24 Batch #s: 83316 5,6 6/15 6/24

IS	BNA	CAS #	NAME	TCL	Min. RF	Intercept	Calib. RF >.05	Calib. RSD/ R^2 <20%/0.99	CCV %D 20%	Method Blanks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Field Blanks		
1	A	108-95-2	Phenol	✓	0.80		✓	✓	✓	✓	✓	✓	✓								
1	BN	111-44-4	bis(2-Chloroethyl)ether	✓	0.70																
1	A	95-57-8	2-Chlorophenol	✓	0.80						✓	✓	✓								
1	BN	541-73-1	1,3-Dichlorobenzene	✓	0.60																
1	BN	106-46-7	1,4-Dichlorobenzene	✓	0.50						✓	✓	✓								
1	BN	95-50-1	1,2-Dichlorobenzene	✓	0.40																
1	A	95-48-7	2-Methylphenol	✓	0.70						✓	✓	✓								
1	BN	108-60-1	bis(2-chloroisopropyl)ether	✓	0.01																
1	A	106-44-5	4-Methylphenol	✓	0.60						✓	✓	✓								
1	BN	621-64-7	N-Nitroso-di-n-propylamine	✓	0.50						✓	✓	✓								
1	BN	67-72-1	Hexachloroethane	✓	0.30						✓	✓	✓								
2	BN	98-95-3	Nitrobenzene	✓	0.20						✓	✓	✓								
2	BN	78-59-1	Isophorone	✓	0.40																
2	A	88-75-5	2-Nitrophenol	✓	0.10																
2	A	105-67-9	2,4-Dimethylphenol	✓	0.20																
2	BN	111-91-1	bis(2-Chloroethoxy)methane	✓	0.30																
2	A	120-83-2	2,4-Dichlorophenol	✓	0.20																
2	BN	120-82-1	1,2,4-Trichlorobenzene	✓	0.20						✓	✓	✓								
2	BN	91-20-3	Naphthalene	✓	0.70																
2	BN	106-47-8	4-Chloroaniline	✓	0.01																
2	BN	87-68-3	Hexachlorobutadiene	✓	0.01						✓	✓	✓								
2	A	59-50-7	4-Chloro-3-methylphenol	✓	0.20						✓	✓	✓								
2	BN	91-57-6	2-Methylnaphthalene	✓	0.40																
3	BN	77-47-4	Hexachlorocyclopentadiene	✓	0.01																
3	A	88-06-2	2,4,6-Trichlorophenol	✓	0.20						✓	✓	✓								
3	A	95-95-4	2,4,5-Trichlorophenol	✓	0.20						✓	✓	✓								

Notes: Shaded rows are RCRA compounds.

Comments:

Reviewed By: [signature] Date: 9/1/01

Semivolatile Organics

Site/Project: ____________ AR/COC #: 604306, 308, 559, 561 Batch #s: ____________

Laboratory: ____________ Laboratory Report #: ____________ # of Samples: ____________ Matrix: 94

IS	BNA	CAS #	NAME	TCL	Min. RF	Intercept	Calib. RF	Calib. RSD/ R^2	CCV %D	Method Blanks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Field Blanks
							>.05	<20% / 0.99	20%										
3	BN	91-58-7	2-Chloronaphthalene	✓	0.80		✓	✓	✓	✓									
3	BN	88-74-4	2-Nitroaniline	✓	0.01														
3	BN	131-11-3	Dimethylphthalate	✓	0.01														
3	BN	208-96-8	Acenaphthylene	✓	0.90														
3	BN	606-20-2	2,6-Dinitrotoluene	✓	0.20														
3	BN	99-09-2	3-Nitroaniline	✓	0.01														
3	BN	83-32-9	Acenaphthene	✓	0.90						✓								
3	A	51-28-5	2,4-Dinitrophenol	✓	0.01														
3	A	100-02-7	4-Nitrophenol	✓	0.01						✓								
3	BN	132-64-9	Dibenzofuran	✓	0.80														
3	BN	121-14-2	2,4-Dinitrotoluene	✓	0.20						✓								
3	BN	84-66-2	Diethylphthalate	✓	0.01														
3	BN	7005-72-3	4-Chlorophenyl-phenylether	✓	0.40														
3	BN	86-73-7	Fluorene	✓	0.90														
3	BN	100-01-6	4-Nitroaniline	✓	0.01														
4	A	534-52-1	4,6-Dinitro-2-methylphenol	✓	0.01														
4	BN	86-30-6	N-Nitrosodiphenylamine (1)		0.01														
4	BN	101-55-3	4-Bromophenyl-phenylether	✓	0.10														
4	BN	118-74-1	Hexachlorobenzene	✓	0.10						✓								
4	A	87-86-5	Pentachlorophenol	✓	0.05						✓								
4	BN	85-01-8	Phenanthrene	✓	0.70														
4	BN	120-12-7	Anthracene	✓	0.70														
4	BN	86-74-8	Carbazole	✓	0.01														
4	BN	84-74-2	Di-n-butylphthalate	✓	0.01														
4	BN	206-44-0	Fluoranthene	✓	0.60														
5	BN	129-00-0	Pyrene	✓	0.60						✓								
5	BN	85-68-7	Butylbenzylphthalate	✓	0.01														
5	BN	91-94-1	3,3'-Dichlorobenzidine	✓	0.01														
5	BN	56-55-3	Benzo(a)anthracene	✓	0.80														

Comments:

Semivolatile Organics

Site/Project: ____________ AR/COC #: 604306-308, 559, 561 Batch #s: ____________

Laboratory: ____________ Laboratory Report #: ____________ # of Samples: ____________ Matrix: aq

IS	BNA	CAS #	NAME	TCL	Min. RF	Intercept	Calib. RF	Calib. RSD/ R^2	CCV %D	Method Blanks	LCS	LCS D	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Field Blanks		
							>.05	<20% / 0.99	20%												
5	BN	218-01-9	Chrysene	✓	0.70		✓	✓	✓	✓											
5	BN	117-81-7	bis(2-Ethylhexyl)phthalate	✓	0.01																
6	BN	117-84-0	Di-n-octylphthalate	✓	0.01																
6	BN	205-99-2	Benzo(b)fluoranthene	✓	0.70																
6	BN	207-08-9	Benzo(k)fluoranthene	✓	0.70																
6	BN	50-32-8	Benzo(a)pyrene	✓	0.70																
6	BN	193-39-5	Indeno(1,2,3-cd)pyrene	✓	0.50																
6	BN	53-70-3	Dibenz(a,h)anthracene	✓	0.40																
6	BN	191-24-2	Benzo(g,h,i)perylene	✓	0.50																
			diphenylamine	✓																	

Surrogate Recovery Outliers

Sample	SMC 1	SMC 2	SMC 3	SMC 4	SMC 5	SMC 6	SMC 7	SMC 8
				not criteria				

SMC 1: Nitrobenzene-d5 (BN) SMC 2: 2-Fluorobiphenyl (BN) SMC 3: p-Terphenyl-d14 (BN)
SMC 4: Phenol-d6 (A) SMC 5: 2-Fluorophenol (A) SMC 6: 2,4,6-Tribromophenol (A)
SMC 7: 2-2-Chlorophenol-d4 (A) SMC 8: 1,2-Dichlorobenzene-d4 (BN)

Comments:

Internal Standard Outliers

Sample	IS 1-area	IS 1-RT	IS 2-area	IS 2-RT	IS 3-area	IS 3-RT	IS 4-area	IS 4-RT	IS 5-area	IS 5-RT	IS 6-area	IS 6-RT
						not criteria						

IS 1: 1,4-Dichlorobenzene-d4 (BN) IS 2: Naphthalene-d8 (BN) IS 3: Acenaphthene-d10 (BN)
IS 4: Phenanthrene-d10 (BN) IS 5: Chrysene-d12 (BN) IS 6: Perylene-d12 (BN)

Volatile Organics (SW 846 Method 8260)

Site 46 Drilling

Site/Project: Tijeras Arroyo Op. Unit AR/COC #: 604306, -308, -557, -561

Laboratory: GEL

Laboratory Report #: 43904

Methods: 8260B

\# of Samples: 9

Matrix: soil

Laboratory Sample IDs: 43904-001 → 009

Batch #s: 84027 * 1,3,5,6,7,8,9 + 2,4

IS	CAS #	Name	TCL	Min. RF	Intercept	Calib. RF >.05	Calib. RSD/ R^2 <20%/0.99	CCV %D 20%	Method Blks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Trip Blanks	5X(10) blk	(no printed header)
1	74-87-3	Chloromethane	✓	0.10		✓	✓	✓	✓											
1	74-83-9	Bromomethane		0.10																
1	75-01-4	vinyl chloride		0.10														1.68	1.9	19.0	24.9
1	75-00-3	Chloroethane		0.01					2.49											
1	75-09-2	methylene chloride (10xblk)		0.01					✓											
1	67-64-1	acetone(10xblk)		0.01																
1	75-15-0	carbon disulfide		0.10						✓										
1	75-35-4	1,1-dichloroethene		0.20																
1	75-34-3	1,1-dichloroethane		0.10																
1	67-66-3	Chloroform		0.20																
1	107-06-2	1,2-dichloroethane		0.10																
1	78-93-3	2-butanone(10xblk)		0.01																
2	71-55-6	1,1,1-trichloroethane		0.10																
2	56-23-5	carbon tetrachloride		0.10																
2	75-27-4	Bromodichloromethane		0.20																
2	78-87-5	1,2-dichloropropane		0.01																
2	10061-01-5	cis-1,3-dichloropropene		0.20						✓								.205		2.05	
2	79-01-6	Trichloroethene		0.30																
2	124-48-1	Dibromochloromethane		0.10																
2	79-00-5	1,1,2-trichloroethane		0.10						✓										
2	71-43-2	Benzene		0.50																
2	10061-02-6	trans-1,3-dichloropropene		0.10																
2 (3)	75-25-2	Bromoform		0.10																
3	108-10-1	4-methyl-2-pentanone		0.10																
3	591-78-6	2-hexanone		0.01																
3	127-18-4	Tetrachloroethene		0.20																
3 (3)	79-34-5	1,1,2,2-tetrachloroethane		0.30						✓										
3	108-88-3	toluene(10xblk)		0.40						✓										
3	108-90-7	Chlorobenzene		0.50																
3	100-41-4	Ethylbenzene		0.10																
3	100-42-5	Styrene		0.30																
3	1330-20-7	xylenes(total)		0.30																
	540-59-0	1,2-dichloroethylene(total)		0.01																
	110-75-8	2-chloroethyl vinyl ether				✓	✓	45.8	✓											
		vinyl acetate	✓																	

Notes: Shaded rows are RCRA compounds.

Comments:

Reviewed By: [signature] Date: 8/30/0?

Volatile Organics

Site/Project: ______ AR/COC #: 604306, -308, -859, -561 Batch #s: ______

Laboratory: ______ Laboratory Report #: ______ # of Samples: ______ Matrix: soil

Surrogate Recovery and Internal Standard Outliers (SW 846 Method 8260)

Sample	SMC 1	SMC 2	(1-(3) SMC 3	IS 1 area	IS 1 RT	IS 2 area	IS 2 RT	IS 3 area	IS 3 RT
-003			134	low				low, 72.5%	
-006								low, 72.5%	
-007								low, 72.5%	
-009								low, 72.5%	

SMC 1: 4-Bromofluorobenzene
SMC 2: 1,2-Dichloroethane-d4
SMC 3: Toluene-d8

IS 1: Bromochloromethane
IS 2: 1,4-Difluorobenzene
IS 3: ~~Chlorobenzene-d5~~ 1,4-dichlorobenzene-d4

Comments: blk : smpl
-002, -004 : -001, -002, -003, -004, -005 ①
-003 -001 : -006, -007, -008, -009 ②
~~-002~~

dup of : -003 : -002
-007 : -006

Surr + IS recoveries confirmed by re-anal (narr.)

Site 46 Drilling

Volatile Organics (SW 846 Method 8260)

Site/Project: Tijeras Arroyo Gas Unit AR/COC #: 604306-308, -559, -561 # of Samples: 4 Matrix: aqueous

Laboratory: GEL Laboratory Report #: 43904 913 Laboratory Sample IDs:

Methods: 8260B Batch #s: 83124

IS	CAS #	Name	TCL	Min RF	Intercept	Calib. RF >.05	Calib. RSD/R² <20%/0.99	CCV %D 20%	Method Blks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	Equip. Blanks	Trip Blanks	5x(10x) blk
1	74-87-3	Chloromethane	✓	0.10	✓	✓	✓	✓	✓										
1	74-83-9	Bromomethane	✓	0.10															
1	75-01-4	vinyl chloride	✓	0.10															18.3
1	75-00-3	Chloroethane	✓	0.01	✓				1.83										
1	75-09-2	methylene chloride (10xblk)	✓	0.01	✓				✓										
1	67-64-1	acetone(10xblk)	✓	0.01															
1	75-15-0	carbon disulfide	✓	0.10	✓					✓	✓	✓	✓	✓	✓				
1	75-35-4	1,1-dichloroethene	✓	0.20															
1	75-34-3	1,1-dichloroethane	✓	0.10															
1	67-66-3	Chloroform	✓	0.20															
1	107-06-2	1,2-dichloroethane	✓	0.10															
1	78-93-3	2-butanone(10xblk)	✓	0.01															
2	71-55-6	1,1,1-trichloroethane	✓	0.10															
2	56-23-5	carbon tetrachloride	✓	0.10															
2	75-27-4	Bromodichloromethane	✓	0.20															
2	78-87-5	1,2-dichloropropane	✓	0.01															
2	10061-01-5	cis-1,3-dichloropropene	✓	0.20		2.76				✓	✓	✓	✓	✓	✓				
2	79-01-6	Trichloroethene	✓	0.30		✓													
2	124-48-1	Dibromochloromethane	✓	0.10															
2	79-00-5	1,1,2-trichloroethane	✓	0.10						✓	✓	✓	✓	✓	✓				
2	71-43-2	Benzene	✓	0.50															
2	10061-02-6	trans-1,3-dichloropropene	✓	0.10															
2	75-25-2	Bromoform	✓	0.10															
3	108-10-1	4-methyl-2-pentanone	✓	0.10															
3	591-78-6	2-hexanone	✓	0.01															
3	127-18-4	Tetrachloroethene	✓	0.20							✓	✓	✓	✓	✓				2.47
3	79-34-5	1,1,2,2-tetrachloroethane	✓	0.30	✓				2.47	✓	✓	✓	✓	✓	✓				
3	108-88-3	toluene(10xblk)	✓	0.40					✓	✓									
3	108-90-7	Chlorobenzene	✓	0.50	✓														
3	100-41-4	Ethylbenzene	✓	0.10															
3	100-42-5	Styrene	✓	0.30	✓														
3	1330-20-7	xylenes(total)	✓	0.30	✓														
	540-59-0	1,2-dichloroethylene(total)	✓	0.01															
	110-75-8	2-chloroethyl vinyl ether	✓				✓	✓	-51.3	✓									
		Vinyl acetate																	

Notes: Shaded rows are RCRA compounds.

Comments:

Reviewed By: [signature] Date: 8/30/01

Volatile Organics

Site/Project: ______ AR/COC #: 604326, 328, 559, 561 Batch #s: ______

Laboratory: ______ Laboratory Report #: ______ # of Samples: ______ Matrix: aq.

Surrogate Recovery and Internal Standard Outliers (SW 846 Method 8260)

Sample	SMC 1	SMC 2	SMC 3	IS 1 area	IS 1 RT	IS 2 area	IS 2 RT	IS 3 area	IS 3 RT
		net							
		criteria				net.			
						criteria			

SMC 1: 4-Bromofluorobenzene
SMC 2: 1,2-Dichloroethane-d4
SMC 3: Toluene-d8

IS 1: Bromochloromethane
IS 2: 1,4-Difluorobenzene
IS 3: Chlorobenzene-d5

Comments:

ANALYSIS REQUEST AND CHAIN OF CUSTODY

AR/COC 604306

Internal Lab Batch No. N/A

SAR/WR No.

Dept. No./Mail Stop:	6133/1087
Project/Task Manager:	Sue Collins
Project Name:	Site 46
Record Center Code:	ER/1309/230/DAT
Logbook Ref. No.:	ER078
Service Order No.	CF0102-01

Date Samples Shipped:	6-12-01
Carrier/Waybill No.	444476
Lab Contact:	Edie Kent
Lab Destination:	General Engineering Labs
SMO Contact/Phone:	P. Puissant/844-3185
Send Report to SMO:	Suzi Jensen

Contract No: AJ2480A

Project/Task No.: 7225/02.02.06

SMO Authorization: [signature]

☑ Waste Characterization

RCRA Date:

☑ Send:Preliminary/report to John Copland

☐ Validation Required

☐ Released by COC No.: 113904

Bill To: Sandia National Labs (Accounts Payable) PO Box 5800, MS-0154, Albuquerque, NM 87185-05

Location: Tech Area.

Reference LOV(available at SMO)

Sample No.-Fraction	ER Sample ID or Sample Location Detail	Beginning Depth (ft)	ER Site No.	Date/Time(hr) Collected	Sample Matrix	Container Type	Container Volume	Preserve. Alt@4C	Collection Method	Sample Type	Parameter & Method Requested	Lab Sample ID
055091-002	TJAOU-230-GR-05-0.0-S	0.0	230	6.11.01/ ~~1028~~ 1120	S	AG	125 ml	4C	G	SA	VOCs (8260) GRO	001
055091-003	TJAOU-230-GR-05-0.0-S	0.0	230	6.11.01/ 1120	S	AG	1L	4C	G	SA	SVOCs(8270), TAL Metals (6010/7471), Cr-6(7196), TPH(8015) DRO	010
055091-004	TJAOU-230-GR-05-0.0-S	0.0	230	6.11.01/ 1120	S	G	2x1L	4C	G	SA	Tritium	019
055091-005	TJAOU-230-GR-05-0.0-S	0.0	230	6.11.01/ 1120	S	G	500 ml	4C	G	SA	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	028
055092-002	TJAOU-230-GR-06-0.0-S	0.0	230	6.11.01/1055	S	AG	125 ml	4C	G	SA	VOCs (8260) GRO	002
055092-003	TJAOU-230-GR-06-0.0-S	0.0	230	6.11.01/1055	S	AG	1L	4C	G	SA	SVOCs(8270), TAL Metals (6010/7471), Cr-6(7196), TPH(8015) DRO	011
055092-004	TJAOU-230-GR-06-0.0-S	0.0	230	6.11.01/1055	S	G	2x1L	4C	G	SA	Tritium	020
055092-005	TJAOU-230-GR-06-0.0-S	0.0	230	6.11.01/1055	S	G	500 ml	4C	G	SA	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	029

RMMA ☐ Yes ☑ No Ref. No.

Sample Disposal ☐ Return to Client ☑ Disposal by lab

Turnaround Time ☐ 7 Day* ☐ 15 Day* ☑ 30 Day ☐ Negotiated TAT

Return Samples By:

Sample Tracking / SMO Use: Date Entered(mm/dd/yy) / Entered by / QC inits.

Special Instructions/QC Requirements:

EDD ☑ Yes ☐ No

Raw Data Package ☑ Yes ☐ No

*Send/e-mail report to:

*Please list as separate report.

Abnormal Conditions on Receipt: 3.0°C

Sample Team Members	Name	Signature	Init	Company/Organization/Phone/Cellular
	Robin Ryan	[signature]	RR	GRAM/6133/845-8821
	Margaret Sanchez	[signature]		RF Weston/6135/845-3267

		Org.	Date	Time		Org.	Date	Time
1.Relinquished by	[signature]	6133	6-11-01	1540	4.Relinquished by			
1. Received by	[signature]	6133	6/11/01	1540	4. Received by			
2.Relinquished by	[signature]	6133	6/12/01	1130	5.Relinquished by			
2. Received by	Patricia [signature]	Gel	6/13/01	09:30	5. Received by			
3.Relinquished by					6.Relinquished by			
3. Received by					6. Received by			

*7 & 15 Day Turnaround Time: ERCL requires prior notification.

CONTRACT LABORATORY
Analysis Request And Chain Of Custody (Continuation)

AR/COC- 604306

Project Name: Site 46 | Project/Task Manger: Sue Collins | Project/Task No.: 7225.02.02.06

Location: Tech Area
Building / Room

Reference LOV (available at SMO)

Sample No-Fraction	ER Sample ID or Sample Location detail	Beginning Depth (ft)	ER Site No.	Date/Time (hr) Collected	Sample Matrix	Container Type	Container Volume	Preservative	Collection Method	Sample Type	Parameter & Method Requested	Lab use: Lab Sample ID
055093-002	TJAOU-230-GR-06-0.0-DU	0.0	230	6.11.01/1058	S	AG	125 ml	4C	G	DU	VOCs (8260) GRO	003
055093-003	TJAOU-230-GR-06-0.0-DU	0.0	230	6.11.01/1058	S	AG	1L	4C	G	DU	SVOCs (8270), TAL Metals (6010/ 7471), Cr-VI (7196), TPH (8015) DRO	012
055093-004	TJAOU-230-GR-06-0.0-DU	0.0	230	6.11.01/1058	S	G	2x1L	4C	G	DU	Tritium	021
055093-005	TJAOU-230-GR-06-0.0-DU	0.0	230	6.11.01/1058	S	G	500 ml	4C	G	DU	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	030
055094-002	TJAOU-230-GR-06-5.0-S	5.0	230	6.11.01/1110	S	AG	125 ml	4C	G	SA	VOCs (8260) GRO	004
055094-003	TJAOU-230-GR-06-5.0-S	5.0	230	6.11.01/1110	S	AG	1L	4C	G	SA	SVOCs (8270), TAL Metals (6010/ 7471), Cr-VI (7196), TPH (8015) DRO	013
055094-004	TJAOU-230-GR-06-5.0-S	5.0	230	6.11.01/1110	S	G	2x1L	4C	G	SA	Tritium	022
055094-005	TJAOU-230-GR-06-5.0-S	5.0	230	6.11.01/1110	S	G	500 ml	4C	G	SA	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	031
055095-002	TJAOU-230-GR-07-5-S	5.0	230	6.11.01/1028	S	AG	125 ml	4C	G	SA	VOCs (8260) GRO	005
055095-003	TJAOU-230-GR-07-5-S	5.0	230	6.11.01/1028	S	AG	1L	4C	G	SA	SVOCs (8270), TAL Metals (6010/ 7471), Cr-VI (7196), TPH (8015) DRO	014
055095-004	TJAOU-230-GR-07-5-S	5.0	230	6.11.01/1030	S	G	2x1L	4C	G	SA	Tritium	023
055095-005	TJAOU-230-GR-07-5-S	5.0	230	6.11.01/1030	S	G	500 ml	4C	G	SA	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	032
055100-001	JAOU-230-GR-TB1	N/A	230	6.11.01/1020	DIW	G	3x40ml	4C,HCL	G	TB	VOCs (8260)	43713-001

LAB USE

Abnormal Conditions on Receipt

Recipient Initials

CONTRACT LABORATORY
ANALYSIS REQUEST AND CHAIN OF CUSTODY

Page 1 of 2

AR/COC 604308

Internal Lab Batch No. N/A   SAR/WR No.

Dept. No./Mail Stop: 6133/1087
Project/Task Manager: Sue Collins
Project Name: Site 46
Record Center Code: ER/1309/231/DAT
Logbook Ref. No.: ER078
Service Order No. CF0102-01

Date Samples Shipped: 6/12/01
Carrier/Waybill No.
Lab Contact: Edie Kent
Lab Destination: General Engineering Labs
SMO Contact/Phone: P. Puissant/844-3185
Send Report to SMO: Suzi Jensen

Contract No: AJ2480A
Project/Task No.: 7225/02.02.06
SMO Authorization: [signature]

☑ Waste Characterization
RCRA Date=
☑ Send:Preliminary/report to John Copland
☐ Validation Required
☐ Released by COC No.:
Bill To: Sandia National Labs (Accounts Payable)
PO Box 5800, MS-0154, Albuquerque, NM 87185-05

Reference LOV(available at SMO)

Location Sample No.-Fraction	Tech Area ER Sample ID or Sample Location Detail	Beginning Depth (ft)	ER Site No.	Date/Time(hr) Collected	Sample Matrix	Container Type	Container Volume	Preserve All@4C	Collection Method	Sample Type	Parameter & Method Requested	Lab Sample ID
055096-002	TJAOU-231-GR-05-0.0-S	0.0	231	6.11.01/1350	S	AG	125 ml	4C	G	SA	VOCs (8260) GRO	002
055096-003	TJAOU-231-GR-05-0.0-S	0.0	231	6.11.01/1350	S	AG	1L	4C	G	SA	SVOCs(8270), TAL Metals (6010/7471), Cr-6(7196), TPH(8015) DRO	015
055096-004	TJAOU-231-GR-05-0.0-S	0.0	231	6.11.01/1350	S	G	2x1L	4C	G	SA	Tritium	024
055096-005	TJAOU-231-GR-05-0.0-S	0.0	231	6.11.01/1350	S	G	500 ml	4C	G	SA	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	033
055097-002	TJAOU-231-GR-05-0.0-DU	0.0	231	6.11.01/1351	S	AG	125 ml	4C	G	~~SA~~ DU	VOCs (8260) GRO	007
055097-003	TJAOU-231-GR-05-0.0-DU	0.0	231	6.11.01/1351	S	AG	1L	4C	G	~~SA~~ DU	SVOCs(8270), TAL Metals (6010/7471), Cr-6(7196), TPH(8015) DRO	016
055097-004	TJAOU-231-GR-05-0.0-DU	0.0	231	6.11.01/1351	S	G	2x1L	4C	G	~~SA~~ DU	Tritium	025
055097-005	TJAOU-231-GR-05-0.0-DU	0.0	231	6.11.01/1351	S	G	500 ml	4C	G	~~SA~~ DU	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	034

RMMA ☐ Yes ☑ No Ref. No.
Sample Disposal ☐ Return to Client ☑ Disposal by lab
Turnaround Time ☐ 7 Day* ☐ 15 Day* ☑ 30 Day ☐ Negotiated TAT
Return Samples By:

Sample Tracking — SMO Use
Date Entered(mm/dd/yy)
Entered by:
QC inits.

Special Instructions/QC Requirements:
EDD ☑ Yes ☐ No
Raw Data Package ☑ Yes ☐ No
*Send/e-mail report to:
*Please list as separate report.

Abnormal Conditions on Receipt: 3°C

Sample Team Members Name	Signature	Init	Company/Organization/Phone/Cellular
Robin Ryan	[signature]	RR	GRAM/6133/845-8821
Margaret Sanchez	M Sanchez	MS	RF Weston/6135/845-3267

	Org.	Date	Time		Org.	Date	Time
1.Relinquished by [signature]	6133	6/11/01	1630	4.Relinquished by			
1. Received by [signature] SMO	6132	6/11/01	1630	4. Received by			
2.Relinquished by [signature] SMO	6132	6/12/01	1045	5.Relinquished by			
2. Received by Patricia Dauer	Gel	6/13/01	0930	5. Received by			
3.Relinquished by				6.Relinquished by			
3. Received by				6. Received by			

*7 & 15 Day Turnaround Time: ERCL requires prior notification.

SF 2001-COC (7/00)

CONTRACT LABORATORY
Analysis Request And Chain Of Custody (Continuation)

AR/COC- 604308

Project Name: Site 46 | Project/Task Manger: Sue Collins | Project/Task No.: 7225.02.02.06

Reference LOV (available at SMO)

Location: Building / Sample No-Fraction	Tech Area: Room / ER Sample ID or Sample Location detail	Beginning Depth (ft)	ER Site No.	Date/Time (hr) Collected	Sample Matrix	Container Type	Container Volume	Preserv-ative	Collection Method	Sample Type	Parameter & Method Requested	Lab use: Lab Sample ID
055098-002	TJAOU-231-GR-05-5.0-S	5.0	231	6/11.01/ 1410	S	AG	125 ml	4C	G	~~BK DU~~ SA	VOCs (8260) GRO	008
055098-003	TJAOU-231-GR-05-5.0-S	5.0	231	6/11.01/ 1410	S	AG	1L	4C	G	SA ~~DU~~	SVOCs (8270), TAL Metals (6010/ 7471), Cr-VI (7196), TPH (8015) DRO	017
055098-004	TJAOU-231-GR-05-5.0-S	5.0	231	6/11.01/ 1410	S	G	2x1L	4C	G	SA ~~DU~~	Tritium	026
055098-005	TJAOU-231-GR-05-5.0-S	5.0	231	6/11.01/ 1410	S	G	500 ml	4C	G	SA ~~DU~~	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	035
055099-002	TJAOU-231-GR-06-5.0-S	5.0	231	6/11.01/ 1430	S	AG	125 ml	4C	G	SA	VOCs (8260) GRO	009
055099-003	TJAOU-231-GR-06-5.0-S	5.0	231	6/11.01/ 1430	S	AG	1L	4C	G	SA	SVOCs (8270), TAL Metals (6010/ 7471), Cr-VI (7196), TPH (8015) DRO	018
055099-004	TJAOU-231-GR-06-5.0-S	5.0	231	6/11.01/ 1430	S	G	2x1L	4C	G	SA	Tritium	027
055099-005	TJAOU-231-GR-06-5.0-S	5.0	231	6/11.01/ 1430	S	G	500 ml	4C	G	SA	Gamma Spec (HASL 300.0) Gross Alpha/Beta (900)	036
055101-001	TJAOU-231-GR-TB1	N/A	231	6/11.01/ 1345	DIW	G	3x40ml	4C,HCL	G	TB	VOCs (8260)	4393.001

LAB USE

Abnormal Conditions on Receipt

Recipient Initials: PAS

SF 2001-COC (7/00)

CONTRACT LABORATORY

ANALYSIS REQUEST AND CHAIN OF CUSTODY

AR/COC 604559

Internal Lab

Batch No. N/A

SAR/WR No.

Dept. No./Mail Stop:	6133/1087	Date Samples Shipped:	6-12-01	Contract No:	AJ2480A
Project/Task Manager:	Sue Collins	Carrier/Waybill No.	[illegible]	Project/Task No.:	7225.02.02.06
Project Name:	Site 46	Lab Contact:	Edie Kent	SMO Authorization:	[signature]
Record Center Code:	ER/1309/230/DAT	Lab Destination:	General Engineering Labs		
Logbook Ref. No.:	ER078 1	SMO Contact/Phone:	P. Puissant/844-3185		
Service Order No.	CF0104-01	Send Report to SMO:	Suzi Jensen		

☑ Waste Characterization
RCRA Date=
☐ Send:Preliminary/report to
☐ Validation Required
☐ Released by COC No.:
Bill To: Sandia National Labs (Accounts Payable)
PO Box 5800, MS-0154, Albuquerque, NM 87185-0154

Location: Tech Area Tijeras Arroyo

Reference LOV(available at SMO)

Sample No.-Fraction	ER Sample ID or Sample Location Detail	Beginning Depth (ft)	ER Site No.	Date/Time(hr) Collected	Sample Matrix	Container Type	Container Volume	Preserve All@4C	Collection Method	Sample Type	Parameter & Method Requested	Lab Sample ID
055880-002	TJAOU-230-GR-EB1	N/A	230	6/11.01/1135	DIW	G	3x40 ml	4C, HCL	G	EB	VOCs (8260)	43913 002
055880-003	TJAOU-230-GR-EB1	N/A	230	6.11.01/1136	DIW	AG	2x1L	4C	G	EB	SVOCs (8270	005
055880-004	TJAOU-230-GR-EB1	N/A	230	6.11.01/1136	DIW	P	500 ml 250 ml	4C, HNO3	G	EB	TAL METALS (6010/7471)	007
055880-005	TJAOU-230-GR-EB1	N/A	230	6.11.01/1137	DIW	AG	250 ml	4C	G	EB	Tritium	009
055880-006	TJAOU-230-GR-EB1	N/A	230	6.11.01/1137	DIW	P	1 L	4C, HNO3	G	EB	Gross Alpha/Gross Beta (900)	011
055880-007	TJAOU-230-GR-EB1	N/A	230	6.11.01/1137	DIW	P	1 L	4C, HNO3	G	EB	Gamma Spec (300.0)	013
055880-008	TJAOU-230-GR-EB1	N/A	230	6.11.01/1138	DIW	P	250 ml	4C	G	EB	Cr-6 (7196)	015
055880-009	TJAOU-230-GR-EB1	N/A	230	6.11.01/1138	DIW	AG	2x1L	4C	G	EB	TPH (8015 Diesel Range)	017
055880-010	TJAOU-230-GR-EB1	N/A	230	6.11.01/1139	DIW	G	3x40 ml	4C, HCL	G	EB	TPH (8015 Gas Range)	019

RMMA ☐ Yes ☑ No Ref. No.

Sample Disposal ☐ Return to Client ☑ Disposal by lab

Turnaround Time ☐ 7 Day* ☐ 15 Day* ☑ 30 Day ☐ Negotiated TAT

SMO Use: Sample Tracking; Date Entered(mm/dd/yy); Entered by; QC inits.

Special Instructions/QC Requirements:
EDD ☑ Yes ☒ No RR
Raw Data Package ☑ Yes ☐ No
*Send/e-mail report to:
*Please list as separate report.

Abnormal Conditions on Receipt: 4.0°c

Return Samples By:

Sample Team Members Name	Signature	Init	Company/Organization/Phone/Cellular
Robin Ryan	R Ryan	RR	GRAM/6133/845-8821
N Sanchez	N Sanchez	NS	Weston 6135/845 3267

	Name	Org.	Date	Time
1.Relinquished by	[signature]	6133	6/11/01	1550
1. Received by	[signature]	6132	6/11/01	1550
2.Relinquished by	[signature]	6132	6/12/01	1015
2. Received by	Patrick Dover	GEL	6/13/01	0930
3.Relinquished by				
3. Received by				
4.Relinquished by				
4. Received by				
5.Relinquished by				
5. Received by				
6.Relinquished by				
6. Received by				

*7 & 15 Day Turnaround Time: ERCL requires prior notification.

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SF 2001-COC (7/00)

CONTRACT LABORATORY
ANALYSIS REQUEST AND CHAIN OF CUSTODY

AR/COC 604561

Internal Lab Batch No.: N/A   SARA/WR No.

Dept. No./Mail Stop:	6133/1087	Date Samples Shipped:	6-12-01	Contract No:	AJ2480A
Project/Task Manager:	Sue Collins	Carrier/Waybill No.:	744476	Project/Task No.:	7225/02.02.09
Project Name:	Site 46	Lab Contact:	Edie Kent	SMO Authorization:	[signature]
Record Center Code:	ER/1309/232-1/DAT	Lab Destination:	General Engineering Labs		
Logbook Ref. No.:	ER078	SMO Contact/Phone:	P. Puissant/844-3185		
Service Order No.	CF0103-01	Send Report to SMO:	Suzi Jensen		

☑ Waste Characterization
RCRA Date=
☐ Send:Preliminary/report to
☐ Validation Required
☐ Released by COC No.:
Bill To: Sandia National Labs (Accounts Payable) PO Box 5800, MS-0154, Albuquerque, NM 87185-05

Location: Tech Area Tijeras Arroyo — Reference LOV(available at SMO)

Sample No.-Fraction	ER Sample ID or Sample Location Detail	Beginning Depth (ft)	ER Site No.	Date/Time(hr) Collected	Sample Matrix	Container Type	Container Volume	Preservative	Collection Method	Sample Type	Parameter & Method Requested	Lab Sample ID
055882-002	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1440	DIW	G	3x40 ml	4C, HCL	G	EB	VOCs (8260)	003
055882-003	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1440	DIW	AG	2x1L	4C	G	EB	SVOCs (8270	006
055882-004	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1441	DIW	P	~~250~~ 500 ml	4C, HNO3	G	EB	TAL METALS (6010/7471)	008
055882-005	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1441	DIW	AG	~~250 ml~~ 1L	4C	G	EB	Tritium	010
055882-006	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1442	DIW	P	1 L	4C, HNO3	G	EB	Gross Alpha/Gross Beta (900)	012
055882-007	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1442	DIW	P	1 L	4C, HNO3	G	EB	Gamma Spec (300.0)	014
055882-008	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1442	DIW	P	250 ml	4C	G	EB	Cr-6 (7196)	016
055882-009	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1443	DIW	AG	2x1L	4C	G	EB	TPH (8015 Diesel Range)	018
055882-010	TJAOU-232-1-GR-EB1	N/A	232-1	6.11.01/1443	DIW	G	3x40 ml	4C, HCL	G	EB	TPH (8015 Gas Range)	020

RMMA ☐ Yes ☑ No   Ref. No.
Sample Disposal ☐ Return to Client ☑ Disposal by lab
Turnaround Time ☐ 7 Day* ☐ 15 Day* ☑ 30 Day ☐ Negotiated TAT

SMO Use: Sample Tracking; Date Entered(mm/dd/yy); Entered by; QC inits.

Special Instructions/QC Requirements:
EDD ☑ Yes ☑ No
Raw Data Package ☑ Yes ☐ No
*Send/e-mail report to:
*Please list as separate report.

Abnormal Conditions on Receipt: 3.0°C

Return Samples By:

Sample Team Members	Name	Signature	Init	Company/Organization/Phone/Cellular
	Robin Ryan	R Ryan	RR	GRAM/6133/845-8821
	H Sanchez	M Dudley	MD	REWeston/6135/845-3267

	Org.	Date	Time		Org.	Date	Time
1.Relinquished by [signature]	6133	6/11/01	1620	4.Relinquished by			
1. Received by [signature] SMO	6132	6/11/01	1620	4. Received by			
2.Relinquished by [signature] SMO	6132	6/12/01	1110	5.Relinquished by			
2. Received by Patricia Dover	GEL	6/13/01	09:30	5. Received by			
3.Relinquished by				6.Relinquished by			
3. Received by				6. Received by			

*7 & 15 Day Turnaround Time: ERCL requires prior notification.

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Contract Verification Review (CVR)

Project Leader: COLLINS

Project Name: TIJERAS ARROYO OP UNIT (SITE 46 DRILLING)

Case No. 7225_02.02.06

AR/COC No. 604306, 604386, 604559 & 604561

Analytical Lab: GEL

SDG No. 43904A—D

In the tables below, mark any information that is missing or incorrect and give an explanation.

1.0 Analysis Request and Chain of Custody Record and Log-In Information

Line No.	Item	Complete? Yes	Complete? No	If no, explain	Resolved? Yes	Resolved? No
1.1	All items on COC complete - data entry clerk initialed and dated	X				
1.2	Container type(s) correct for analyses requested	X				
1.3	Sample volume adequate for # and types of analyses requested	X				
1.4	Preservative correct for analyses requested	X				
1.5	Custody records continuous and complete	X				
1.6	Lab sample number(s) provided and SNL sample number(s) cross referenced and correct	X				
1.7	Date samples received	X				
1.8	Condition upon receipt information provided	X				

2.0 Analytical Laboratory Report

Line No.	Item	Complete? Yes	Complete? No	If no, explain	Resolved? Yes	Resolved? No
2.1	Data reviewed, signature	X				
2.2	Method reference number(s) complete and correct	X				
2.3	QC analysis and acceptance limits provided (MB, LCS, Replicate)	X				
2.4	Matrix spike/matrix spike duplicate data provided(if requested)	X				
2.5	Detection limits provided; PQL and MDL(or IDL), MDA and L_c	X				
2.6	QC batch numbers provided	X				
2.7	Dilution factors provided and all dilution levels reported	X				
2.8	Data reported in appropriate units and using correct significant figures	X				
2.9	Radiochemistry analysis uncertainty (2 sigma error) and tracer recovery (if applicable) reported	X				
2.10	Narrative provided	X				
2.11	TAT met	X				
2.12	Hold times met		X	CHROMIUM-6+ SAMPLES #055880-008 & 055881-008 RECEIVED PAST HOLDING TIME	X	
2.13	Contractual qualifiers provided	X				
2.14	All requested result and TIC (if requested) data provided	X				

Contract Verification Review (Continued)

3.0 Data Quality Evaluation Item	Yes	No	If no, Sample ID No./Fraction(s) and Analysis
3.1 Are reporting units appropriate for the matrix and meet contract specified or project-specific requirements? Inorganics and metals reported as ppm (mg/liter or mg/Kg)? Tritium reported in picocuries per liter with percent moisture for soil samples? Units consistent between QC samples and sample data	X		
3.2 Quantitation limit met for all samples	X		
3.3 Accuracy a) Laboratory control samples accuracy reported and met for all samples		X	DRO LCD FAILED RECOVERY LIMITS (aq)
b) Surrogate data reported and met for all organic samples analyzed by a gas chromatography technique		X	SURROGATE FOR VOC SAMPLE #055093-002 FAILED RECOVERY LIMITS
c) Matrix spike recovery data reported and met		X	ANTIMONY FAILED RECOVERY LIMITS FOR SPIKE CHROMIUM-6+ SPIKE FAILED RECOVERY LIMITS
3.4 Precision a) Replicate sample precision reported and met for all inorganic and radiochemistry samples		X	RPD FOR COPPER & SODIUM OUTSIDE ACCEPTANCE LIMITS
b) Matrix spike duplicate RPD data reported and met for all organic samples	X		
3.5 Blank data a) Method or reagent blank data reported and met for all samples		X	METHYLENE CHLORIDE DETECTED IN VOC METHOD BLANK FOR SOILS METHYLENE CHLORIDE & TOLUENE DETECTED IN VOC METHOD BLANK FOR WATERS CALCIUM DETECTED IN METALS METHOD BLANK
b) Sampling blank (e.g., field, trip, and equipment) data reported and met		X	METHYLENE CHLORIDE DETECTED IN VOC TRIP BLANK DBCM & METHYLENE CHLORIDE DETECTED IN VOC EQUIPMENT BLANKS
3.6 Contractual qualifiers provided: "J"- estimated quantity; "B"-analyte found in method blank above the MDL for organic or above the PQL for inorganic; "U"-analyte undetected (results are below the MDL, IDL, or MDA (radiochemical)); "H"-analysis done beyond the holding time	X		
3.7 Narrative addresses planchet flaming for gross alpha/beta	X		
3.8 Narrative included, correct, and complete	X		
3.9 Second column confirmation data provided for methods 8330 (high explosives) and pesticides/PCBs	NA		

Contract Verification Review (Continued)

4.0 Calibration and Validation Documentation Item	Yes	No	Comments
4.1 GC/MS (8260, 8270, etc.) a) 12-hour tune check provided	X		
b) Initial calibration provided	X		
c) Continuing calibration provided	X		
d) Internal standard performance data provided	X		
e) Instrument run logs provided	X		
4.2 GC/HPLC (8330 and 8010 and 8082) a) Initial calibration provided	X		
b) Continuing calibration provided	X		
c) Instrument run logs provided	X		
4.3 Inorganics (metals) a) Initial calibration provided	X		
b) Continuing calibration provided	X		
c) ICP interference check sample data provided	X		
d) ICP serial dilution provided	X		
e) Instrument run logs provided	X		
4.4 Radiochemistry a) Instrument run logs provided	X		

5.0 Problem Resolution

Summarize the findings in the table below. List only samples/fractions for which deficiencies have been noted.

Sample/Fraction No.	Analysis	Problems/Comments/Resolutions

Were deficiencies unresolved? ☐ Yes ☑ No

Based on the review, this data package is complete. ☑ Yes ☐ No

If no, provide: nonconformance report or correction request number ____________ and date correction request was submitted: ________

Reviewed by: W. Palencia Date: 8-1-2001 Closed by: ____________ Date: ____________

Records Center Code: ER / 1309 / 230 DAT

SMO ANALYTICAL DATA ROUTING FORM

Project Name: Tijeras Arroyo Op Unit (Site 46 Drilling)

Task No./Service Order: 7225_02.02.06 / CF0 102

SNL Task Leader: COLLINS

Org/Mail Stop: 06133/1087

SMO Project Coordinator: SALMI

Sample Ship Date: 6/12/01

ARCOC	Lab	Lab ID	Preliminary Received	Final Received	EDD Req'd YES	EDD Req'd NO	EDD Rec'd YES	EDD Rec'd NO
604306	GEL	43904A		7/16/01	X		X	
~~604386~~ 08	GEL	43904B		7/16/01	X		X	
604559	GEL	43904C		7/16/01	X		x	
604561	GEL	43904D		7/16/01	X		x	

	Date		
Correction Requested from Lab:		Correction Request #:	
Corrections Received:		Requester:	
Review Complete:	8-1-01	Signature:	W. Palencia
Priority Data Faxed:		Faxed To:	
Preliminary Notification:		Person Notified:	
Final Transmittal:	8-1-01	Transmitted To:	Collins
		Transmitted By:	Palencia
Filed in Records Center/ER:		Filed By:	

Comments: Electronic data on Q:/SMO/STAR/EDD by COC

To validation 8/2/01

Received (Records Center) By: ______________________

Supplemental
Risk

Sandia National Laboratories/New Mexico
Environmental Restoration Project

Supplemental Risk Document Supporting Class 3 Permit Modification Process

October 2003

United States Department of Energy
Sandia Site Office

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Appendix

ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
AOC	Area of Concern
COC	constituent of concern
DOE	U.S. Department of Energy
EBP	Explosive Burn Pit
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
gal	gallon
HE	high explosives
HI	hazard index
JP-4	jet propulsion fuel grade 4
JP-8	jet propulsion fuel grade 8
KAFB	Kirtland Air Force Base
kg	kilogram(s)
LAARC	Light Airtransport Accident Resistant Container
LCBS	Lurance Canyon Burn Site
mg	milligram(s)
NFA	no further action
NMED	New Mexico Environment Department
OU	Operable Unit
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylenetrinitramine
SNL/NM	Sandia National Laboratories/New Mexico
SOBP	Small Open Burn Pool
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TA	Technical Area
TNT	2,4,6-trinitrotoluene
UCL	upper confidence limit
USAF	U.S. Air Force
USFS	U.S. Forest Service
VCM	voluntary corrective measure
VOC	volatile organic compound

1.0 INTRODUCTION

This supplemental risk document was prepared to support no further action (NFA) determination and subsequent removal of 16 Solid Waste Management Units (SWMUs) and 2 Areas of Concern (AOCs) from the Hazardous and Solid Waste Amendments Module of the Resource Conservation and Recovery Act (RCRA) Permit for Sandia National Laboratories/New Mexico (SNL/NM) (U.S. Environmental Protection Agency [EPA] ID No. 5890110518). See Figure 1-1 for the locations of these SWMUs and AOCs.

Initially, risk assessments were performed for these sites considering the designated land use provided in the land use workbooks (DOE et al. September 1995, DOE et al. October 1995, DOE and USAF January 1996, and DOE and USAF March 1996). However, in January 2001, the New Mexico Environment Department (NMED) promulgated risk-based screening levels for RCRA Corrective Action Sites in New Mexico (Bearzi January 2001). The letter stated that "until statutory authority exists allowing restriction of future land use, corrective action sites applying for NFA determination (an NFA) under a risk-based approach cannot use industrial risk-based screening levels for soils." SNL/NM has determined from the letter that no more SWMUs or AOCs will be approved for NFA, under either industrial or recreational land use, unless the site also poses an insignificant risk to human health under the residential land use scenario.

In addition, in April 2003, the NMED requested that SNL/NM change its risk approach to include the dermal pathway for all land use scenarios and to eliminate the food ingestion pathway for the residential land use scenario.

This report presents a short site history and additional risk assessment analysis of 16 SWMUs and 2 AOCs. Each of these sites has been proposed for NFA based upon industrial or recreational land use scenarios. This supplemental analysis evaluates each site using a residential scenario and is based upon guidance provided in NMED's "Technical Background Document for Development of Soil Screening Levels" (NMED December 2000). Appendix 1 contains the SNL/NM default exposure pathways and input parameters. For SWMUs and AOCs that exceeded NMED guidance risk levels, summary statistics (95% upper confidence level [UCL] of the mean) were calculated following standard EPA guidance (EPA 1992) for the chemicals that contributed the most to the overall risk.

Additional information containing more detailed descriptions of site location, site history, site characterization, Voluntary Corrective Measures (VCMs)/Voluntary Corrective Actions (VCAs) (if applicable), verification sampling events, and other related data are contained in the respective SWMU's NFA proposal, Request for Supplemental Information (RSI), or Notice of Deficiency (NOD) documents. Supplemental information for each SWMU is identified in Table 1-1.

This report is organized by Operable Unit (OU) in ascending order with SWMUs in ascending order within each OU.

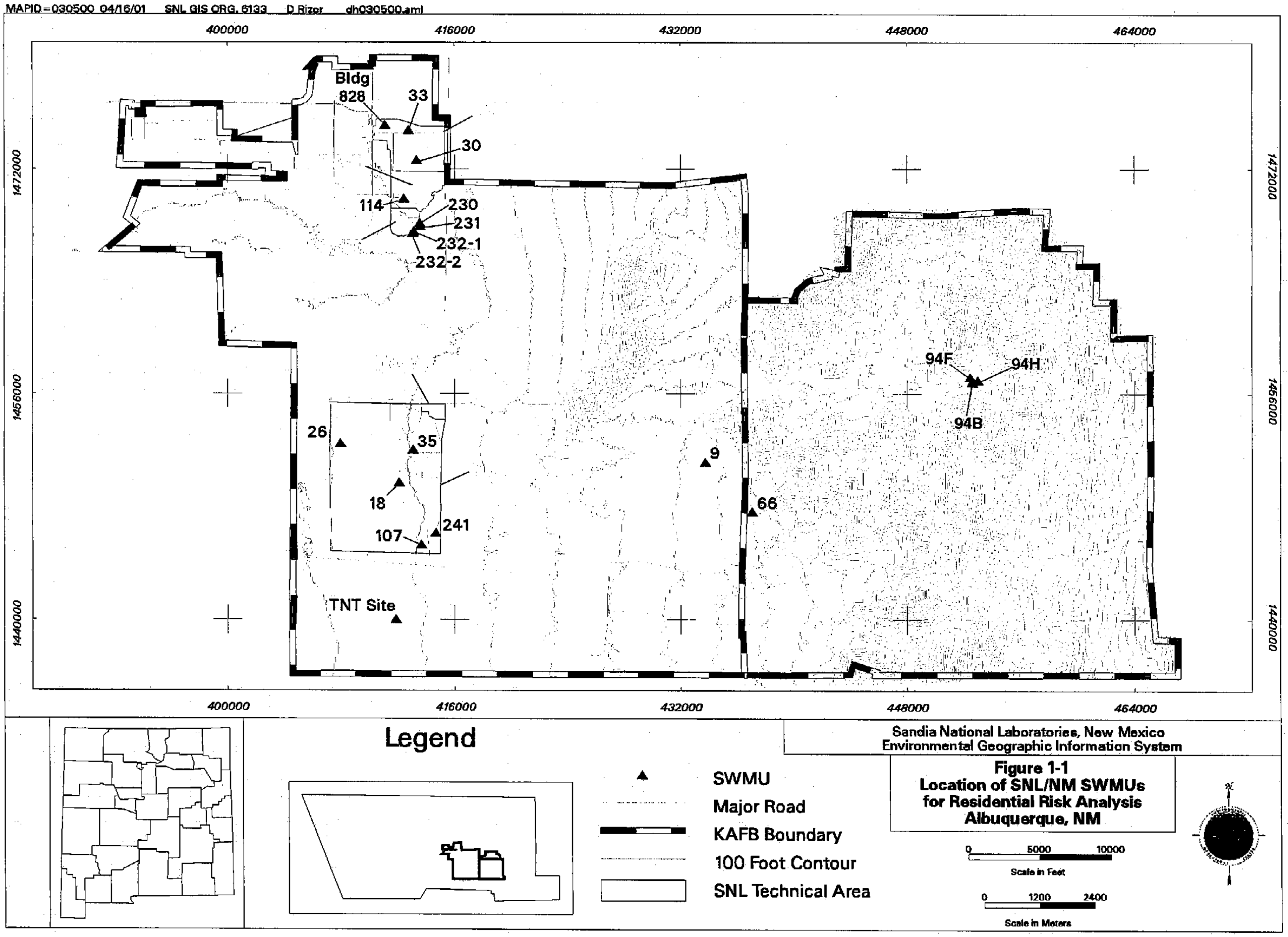

Figure 1-1
Location of SNL/NM SWMUs for Residential Risk Analysis Albuquerque, NM

Table 1-1
Location of Supplemental Information for Each SNL/NM SWMU or AOC Proposed for NFA

OU Name	OU	SWMU/ AOC	NFA Date Submitted/ Batch No.	NOD or RSI Submittal Date	Comments
TA-I	1302	30	September 30, 2001/16	NA	
TA-I	1302	33	October 3, 1996/5	June 2001 September 10, 2001	The June 2001 response was not complete; the September 2001 response included results of additional sampling and risk assessment.
TA-I	1302	828	December 1996	June 2001 July 16, 2001 (SWMU Assessment Report)	PCB immunoassay data in letter of December 1996 indicated that SNL/NM did not consider this site a SWMU.
TA-II	1303	114	July 19, 1996/4	January 31, 2003	
TA-III/V	1306	18	Aug 11, 1997/8	October 1997 July 1998 June 2002	
TA-III/V	1306	26	June 1996	October 1997 July 1998 August 14, 2001	NFA originally proposed in the RFI report in June 1996.
TA-III/V	1306	35	June 1996	October 1997 July 1998 July 31, 2001	NFA originally proposed in the RFI report in June 1996.
TA-III/V	1306	107	June 1996	October 1997 July 1998 August 9, 2001	NFA originally proposed in the RFI report in June 1996.
TA-III/V	1306	241	June 1996	October 1997 July 1998 August 24, 2001	NFA originally proposed in the RFI report in June 1996.
Tijeras Arroyo	1309	230	August 28, 1995/2	December 2002	
Tijeras Arroyo	1309	231	August 28, 1995/2	December 2002	
Tijeras Arroyo	1309	232-1	August 11, 1997/8	December 2002	

Refer to footnotes at end of table.

Table 1-1 (Concluded)
Location of Supplemental Information for Each SNL/NM SWMU or AOC Proposed for NFA

OU Name	OU	SWMU/ AOC	NFA Date Submitted/ Batch No.	NOD or RSI Submittal Date	Comments
Tijeras Arroyo	1309	232-2	August 11, 1997/8	December 2002	
Foothills Test Area	1332	66	October 3, 1996/5	May 11, 1998	
Canyons Test Area	1333	94B	September 30, 2001/16	NA	
Canyons Test Area	1333	94F	September 30, 2001/16	NA	
Canyons Test Area	1333	94H	September 24, 2002/17	NA	
Central Coyote Test Area	1334	9	August 31, 1999/14	July 6, 1998	
Southwest Test Area	1335	TNT Site	September 24, 2002/17	NA	

AOC = Area of Concern.
NA = Not applicable.
NFA = No Further Action.
NOD = Notice of Deficiency.
OU = Operable Unit.
PCB = Polychlorinated biphenyl.
RCRA = Resource Conservation and Recovery Act.
RFI = RCRA Facility Investigation.
RSI = Request for Supplemental Information.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
TA = Technical Area.
TNT = 2,4,6-trinitrotoluene.

5.2 SWMU 231: Storm Drain System Outfall (for TA-IV)

5.2.1 Site Location and Operational History

SWMU 231, the Storm Drain System Outfall, at SNL/NM is located about 150 feet southeast of TA-IV on land that is owned by KAFB and leased to the DOE (Figure 5.2.1-1). SWMU 231 encompasses 0.04 acre of unpaved ground and consists of a 140-foot-long earthen ditch that occasionally receives storm water from a paved storage yard located on the east side of Building 970. The storm water is directed to the site via buried piping and a concrete ditch.

The outfall was built in the early 1980s for the purpose of reducing the amount of soil erosion caused by storm water. The site is situated at the slope break between the steeply sloping, northern rim of Tijeras Arroyo and the nearly flat floodplain below. The vicinity of SWMU 231 is unpaved. Ground elevations at the site range from 5,330 to 5,340 feet amsl.

In the June 1995 NFA Proposal for SWMU 231, the potential COCs were considered to be chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, diesel fuel, and mineral oil. This list of COCs was conservatively based upon chemicals used at TA-IV.

5.2.2 Results of Risk Analysis

The initial risk assessment calculation was performed using maximum COC concentrations and the methods specified in NMED's "Technical Background Document for Development of Soil Screening Levels" (NMED December 2000). As shown in Table 5.2.2-1, the total human health HI (0.39) is lower than the NMED guidance value of 1 for the residential land use scenario. The total estimated excess cancer risk is 1E-5 for the residential land use scenario. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001), thus the excess cancer risk for this site is approximately equal to the suggested acceptable risk value.

Although the total estimated excess cancer risk is slightly higher than the NMED guidelines for the residential land use scenario, maximum COC concentrations were used in the risk calculation. However, average concentrations are more representative of actual site conditions. The 95% UCL of the average concentration for arsenic (3.1 mg/kg), the main contributor to the excess cancer risk (Appendix 2), is lower than the background value of 4.4 mg/kg for the North Area Supergroup; therefore, arsenic is eliminated from the risk calculation. With the removal of arsenic, the total estimated excess cancer risk is reduced to 1E-6. Thus, using realistic concentrations in the risk calculations that more accurately depict actual site conditions, the total estimated excess cancer risk is lower than NMED guidelines.

In conclusion, human health risk is within the acceptable range according to NMED guidance for the residential land use scenario.

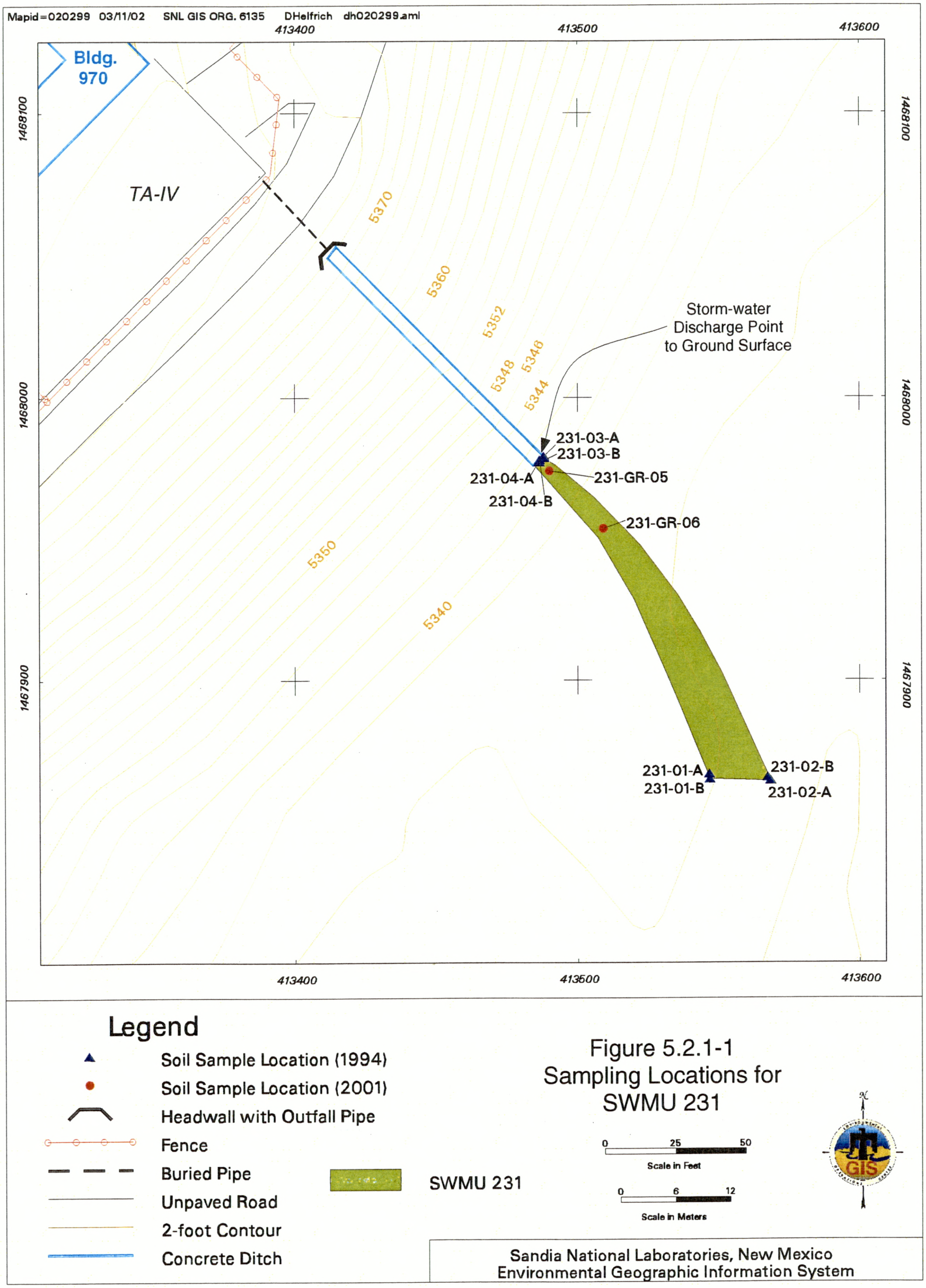

Figure 5.2.1-1
Sampling Locations for
SWMU 231

Table 5.2.2-1
Human Health Risk Assessment Values for SWMU 231 Nonradiological COCs

COC	Maximum Concentration/ UCL (mg/kg)	Residential Land Use Scenario[a] (Maximum Concentrations)		Residential Land Use Scenario[a] (UCL Concentrations)	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Inorganic					
Arsenic	5.7/**3.1**	0.26	1E-5	*	*
Barium	240	0.05	--	0.05	--
Beryllium	1.03	0.01	9E-10	0.01	9E-10
Cadmium	1.7	0.04	1E-9	0.04	1E-9
Chromium, total	17	0.00	--	0.00	--
Chromium VI	1.6	0.01	7E-9	0.01	7E-9
Mercury	0.0219	0.00	--	0.00	--
Selenium	0.5 61	0.00	--	0.00	--
Silver	0.25[b]	0.00	--	0.00	--
Organic					
Acetone	0.008 J	0.00	--	0.00	--
Benzo(a)anthracene	0.0397	0.00	6E-8	0.00	6E-8
Benzo(a)pyrene	0.0569	0.00	9E-7	0.00	9E-7
Benzo(b)fluoranthene	0.0621	0.00	1E-7	0.00	1E-7
Benzo(k)fluoranthene	0.0357	0.00	6E-9	0.00	6E-9
bis(2-Ethylhexyl) phthalate	0.0826 J	0.00	2E-9	0.00	2E-9
Chrysene	0.0566	0.00	9E-10	0.00	9E-10
Fluoranthene	0.0425	0.00	--	0.00	--
Indeno(1,2,3-c,d)pyrene	0.0467	0.00	8E-8	0.00	8E-8
Phenanthrene[c]	0.0198 J	0.02	--	0.02	--
Pyrene	0.0605	0.00	--	0.00	--
Total		**0.39**	**1E-5**	**0.13**	**1E-6**

Note: UCLs are calculated only for risk drivers. UCL concentrations are in **bold**.
[a]EPA 1989.
[b]Parameter was not detected. Concentration assumed to be approximately one-half the detection limit.
[c]Toxicological parameter values for phenanthrene were not found in toxicological databases. Anthracene was selected as a surrogate compound.
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
J = Estimated concentration.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
UCL = Upper confidence limit.
-- = Information not available.
* = UCL concentration was below background screening level. Therefore risk was not calculated.

10.0 REFERENCES

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U.S. Environmental Protection Agency (EPA), 1992. "Supplemental Guidance to RAGS: Calculating the Concentration Term," Publication 9285.7-081, Office of Solid Waste and Emergency Response, Washington, D.C.

APPENDIX 1
Exposure Pathway Discussion for Chemical and Radionuclide Contamination
Sandia National Laboratories/New Mexico

APPENDIX 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Introduction

Sandia National Laboratories/New Mexico (SNL/NM) uses a default set of exposure routes and associated default parameter values developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) Project sites. This default set of exposure scenarios and parameter values are invoked for risk assessments unless site-specific information suggests other parameter values. Because many SNL/NM solid waste management units (SWMUs) have similar types of contamination and physical settings, SNL/NM believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values facilitates the risk assessments and subsequent review.

The default exposure routes and parameter values used are those that SNL/NM views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the U.S. Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED), SNL/NM will use these default exposure routes and parameter values in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base. Approximately 240 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites and the biological resources present. When evaluating potential human health risk the current or reasonably foreseeable land use negotiated and approved for the specific SWMU/AOC, aggregate, or watershed will be used. The following references generally document these land uses: *Workbook: Future Use Management Area 2 (DOE et al. September 1995); Workbook: Future Use Management Area 1 (DOE et al. October 1995); Workbook: Future Use Management Areas 3, 4, 5, and 6 (DOE and USAF January 1996); Workbook: Future Use Management Area 7 (DOE and USAF March 1996)*. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land-use scenario. Therefore, all three land-use scenarios will be addressed in this document.

The SNL/NM ER Project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent hazard index (HI), excess cancer risk and dose values. The EPA (EPA 1989) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil

- Ingestion of contaminated fish and shellfish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water
- Dermal contact with chemicals in soil
- Inhalation of airborne compounds (vapor phase or particulate)
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water; and exposure from ground surfaces with photon-emitting radionuclides)

Based upon the location of the SNL/NM SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land-use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, there is currently no consumption of fish, shellfish, fruits, vegetables, meat, eggs, or dairy products that originate on site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land-use scenarios, SNL/NM ER has, therefore, excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shellfish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

Based upon this evaluation, for future risk assessments the exposure routes that will be considered are shown in Table 1.

Table 1
Exposure Pathways Considered for Various Land-Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact (nonradiological constituents only) soil only	Dermal contact (nonradiological constituents only) soil only	Dermal contact (nonradiological constituents only) soil only
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land-use scenarios. The general equation for calculating potential intakes via these routes is shown below. The equations are taken from "Assessing Human Health Risks Posed by Chemicals: Screening-Level Risk Assessment" (NMED March 2000) and "Technical Background Document for Development of Soil Screening Levels" (NMED December 2000). Equations from both documents are based upon the "Risk Assessment Guidance for Superfund" (RAGS): Volume 1 (EPA 1989, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). RESRAD is the only code designated by the U.S. Department of Energy (DOE) in DOE Order 5400.5 for the evaluation of radioactively contaminated sites (DOE 1993). The Nuclear Regulatory Commission (NRC) has approved the use of RESRAD for dose evaluation by licensees involved in decommissioning, NRC staff evaluation of waste disposal requests, and dose evaluation of sites being reviewed by NRC staff. EPA Science Advisory Board reviewed the RESRAD model. EPA used RESRAD in their rulemaking on radiation site cleanup regulations. RESRAD code has been verified, undergone several benchmarking analyses, and been included in the International Atomic Energy Agency's VAMP and BIOMOVS II projects to compare environmental transport models.

Also shown are the default values SNL/NM ER will use in RME risk assessment calculations for industrial, recreational, and residential land-use scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993) or by directly accessing the RESRAD websites at: http://web.ead.anl.gov/resrad/home2/ or http://web.ead.anl.gov/resrad/documents/.

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., hazard quotients/HI, excess cancer risk, or radiation total effective dose equivalent [TEDE] [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

where;

C	= contaminant concentration (site specific)
CR	= contact rate for the exposure pathway
EFD	= exposure frequency and duration
BW	= body weight of average exposure individual
AT	= time over which exposure is averaged.

For nonradiological constituents of concern (COCs), the total risk/dose (either cancer risk or HI) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants. For radionuclides, the calculated radiation exposure, expressed as TEDE is compared directly to the exposure guidelines of 15 millirem per year (mrem/year) for industrial and recreational future use and 75 mrem/year for the unlikely event that institutional control of the site is lost and the site is used for residential purposes (EPA 1997).

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk of 1E-5 for nonradiological carcinogens. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the HI) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard from radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site. This estimated dose is used to calculate an assumed risk. However, this calculated risk is presented for illustration purposes only, not to determine compliance with regulations.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989) and are outlined below. The RESRAD Manual (ANL 1993) describes similar equations for the calculation of radiological exposures.

Soil Ingestion

A receptor can ingest soil or dust directly by working in the contaminated soil. Indirect ingestion can occur from sources such as unwashed hands introducing contaminated soil to food that is then eaten. An estimate of intake from ingesting soil will be calculated as follows:

$$I_s = \frac{C_s * IR * CF * EF * ED}{BW * AT}$$

where:

- I_s = Intake of contaminant from soil ingestion (milligrams [mg]/kilogram [kg]-day)
- C_s = Chemical concentration in soil (mg/kg)
- IR = Ingestion rate (mg soil/day)
- CF = Conversion factor (1E-6 kg/mg)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time (period over which exposure is averaged) (days)

It should be noted that it is conservatively assumed that the receptor only ingests soil from the contaminated source.

Soil Inhalation

A receptor can inhale soil or dust directly by working in the contaminated soil. An estimate of intake from inhaling soil will be calculated as follows (EPA August 1997):

$$I_s = \frac{C_s * IR * EF * ED * \left(1/_{VF} \; or \; 1/_{PEF} \right)}{BW * AT}$$

where:

- I_s = Intake of contaminant from soil inhalation (mg/kg-day)
- C_s = Chemical concentration in soil (mg/kg)
- IR = Inhalation rate (cubic meters [m^3]/day)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- VF = soil-to-air volatilization factor (m^3/kg)
- PEF = particulate emission factor (m^3/kg)
- BW = Body weight (kg)
- AT = Averaging time (period over which exposure is averaged) (days)

Soil Dermal Contact

$$D_a = \frac{C_s * CF * SA * AF * ABS * EF * ED}{BW * AT}$$

where:

- D_a = Absorbed dose (mg/kg-day)
- C_s = Chemical concentration in soil (mg/kg)
- CF = Conversion factor (1E-6 kg/mg)
- SA = Skin surface area available for contact (cm^2/event)
- AF = Soil to skin adherence factor (mg/cm^2)
- ABS = Absorption factor (unitless)
- EF = Exposure frequency (events/year)

ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Groundwater Ingestion

A receptor can ingest water by drinking it or through using household water for cooking. An estimate of intake from ingesting water will be calculated as follows (EPA August 1997):

$$I_w = \frac{C_w * IR * EF * ED}{BW * AT}$$

where:

I_w = Intake of contaminant from water ingestion (mg/kg/day)
C_w = Chemical concentration in water (mg/liter [L])
IR = Ingestion rate (L/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Groundwater Inhalation

The amount of a constituent taken into the body via exposure to volatilization from showering or other household water uses will be evaluated using the concentration of the constituent in the water source (EPA 1991 and 1992). An estimate of intake from volatile inhalation from groundwater will be calculated as follows (EPA 1991):

$$I_w = \frac{C_w * K * IR_i * EF * ED}{BW * AT}$$

where:

I_w = Intake of volatile in water from inhalation (mg/kg/day)
C_w = Chemical concentration in water (mg/L)
K = volatilization factor (0.5 L/m^3)
IR_i = Inhalation rate (m^3/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged—days)

For volatile compounds, volatilization from groundwater can be an important exposure pathway from showering and other household uses of groundwater. This exposure pathway will only be evaluated for organic chemicals with a Henry's Law constant greater than $1x10^{-5}$ and with a molecular weight of 200 grams/mole or less (EPA 1991).

Tables 2 and 3 show the default parameter values suggested for use by SNL/NM at SWMUs, based upon the selected land-use scenarios for nonradiological and radiological COCs, respectively. References are given at the end of the table indicating the source for the chosen parameter values. SNL/NM uses default values that are consistent with both regulatory guidance and the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways, based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

<u>Summary</u>

SNL/NM will use the described default exposure routes and parameter values in risk assessments at sites that have an industrial, recreational, or residential future land-use scenario. There are no current residential land-use designations at SNL/NM ER sites, but NMED has requested this scenario to be considered to provide perspective of the risk under the more restrictive land-use scenario. For sites designated as industrial or recreational land use, SNL/NM will provide risk parameter values based upon a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM ER sites. The parameter values are based upon EPA guidance and supplemented by information from other government sources. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Table 2
Default Nonradiological Exposure Parameter Values for Various Land-Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure Frequency (day/yr)	250[a,b]	8.7 (4 hr/wk for 52 wk/yr)[a,b]	350[a,b]
Exposure Duration (yr)	25[a,b,c]	30[a,b,c]	30[a,b,c]
Body Weight (kg)	70[a,b,c]	70 Adult[a,b,c] 15 Child[a,b,c]	70 Adult[a,b,c] 15 Child[a,b,c]
Averaging Time (days) for Carcinogenic Compounds (= 70 yr x 365 day/yr) for Noncarcinogenic Compounds (= ED x 365 day/yr)	25,550[a,b] 9,125[a,b]	25,550[a,b] 10,950[a,b]	25,550[a,b] 10,950[a,b]
Soil Ingestion Pathway			
Ingestion Rate (mg/day)	100[a,b]	200 Child[a,b] 100 Adult[a,b]	200 Child[a,b] 100 Adult[a,b]
Inhalation Pathway			
Inhalation Rate (m^3/day)	20[a,b]	15 Child[a] 30 Adult[a]	10 Child[a] 20 Adult[a]
Volatilization Factor (m^3/kg)	Chemical Specific	Chemical Specific	Chemical Specific
Particulate Emission Factor (m^3/kg)	1.36E9[a]	1.36E9[a]	1.36E9[a]
Water Ingestion Pathway			
Ingestion Rate (liter/day)	2.4[a]	2.4[a]	2.4[a]
Dermal Pathway			
Skin Adherence Factor (mg/cm^2)	0.2[a]	0.2 Child[a] 0.07 Adult[a]	0.2 Child[a] 0.07 Adult[a]
Exposed Surface Area for Soil/Dust (cm^2/day)	3,300[a]	2,800 Child[a] 5,700 Adult[a]	2,800 Child[a] 5,700 Adult[a]
Skin Adsorption Factor	Chemical Specific	Chemical Specific	Chemical Specific

[a]Technical Background Document for Development of Soil Screening Levels (NMED December 2000).
[b]Risk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).
[c]Exposure Factors Handbook (EPA August 1997).

ED = Exposure duration.
EPA = U.S. Environmental Protection Agency.
hr = Hour(s).
kg = Kilogram(s).
m = Meter(s).
mg = Milligram(s).
NA = Not available.
wk = Week(s).
yr = Year(s).

Table 3
Default Radiological Exposure Parameter Values for Various Land-Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure Frequency	8 hr/day for 250 day/yr	4 hr/wk for 52 wk/yr	365 day/yr
Exposure Duration (yr)	25[a,b]	30[a,b]	30[a,b]
Body Weight (kg)	70 Adult[a,b]	70 Adult[a,b]	70 Adult[a,b]
Soil Ingestion Pathway			
Ingestion Rate	100 mg/day[c]	100 mg/day[c]	100 mg/day[c]
Averaging Time (days) (= 30 yr x 365 day/yr)	10,950[d]	10,950[d]	10,950[d]
Inhalation Pathway			
Inhalation Rate (m^3/yr)	7,300[d,e]	10,950[e]	7,300[d,e]
Mass Loading for Inhalation g/m^3	1.36 E-5[d]	1.36 E-5[d]	1.36 E-5[d]
Food Ingestion Pathway			
Ingestion Rate, Leafy Vegetables (kg/yr)	NA	NA	16.5[c]
Ingestion Rate, Fruits, Non-Leafy Vegetables & Grain (kg/yr)	NA	NA	101.8[b]
Fraction Ingested	NA	NA	0.25[b,d]

[a]Risk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).
[b]Exposure Factors Handbook (EPA August 1997).
[c]EPA Region VI guidance (EPA 1996).
[d]For radionuclides, RESRAD (ANL 1993).
[e]SNL/NM (February 1998).
EPA = U.S. Environmental Protection Agency.
g = Gram(s)
hr = Hour(s).
kg = Kilogram(s).
m = Meter(s).
mg = Milligram(s).
NA = Not applicable.
wk = Week(s).
yr = Year(s).

References

ANL, see Argonne National Laboratory.

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APPENDIX 2
Calculation of the Upper 95% Confidence Limits of Mean Concentrations

APPENDIX 2
CALCULATION OF THE UPPER 95% CONFIDENCE LIMITS OF MEAN CONCENTRATIONS

For conservatism, Sandia National Laboratories/New Mexico uses the maximum concentration of the constituents of concern (COCs) for initial risk calculation. If the maximum concentrations produce risk above New Mexico Environment Department (NMED) guidelines, conservatism with this approach is evaluated and, if appropriate, a more realistic approach is applied. When the site has been adequately characterized, an estimate of the mean concentration of the COCs is more representative of actual site conditions. The NMED has proposed the use of the 95% upper confidence limit (UCL) of the mean to represent average concentrations at a site (NMED December 2000). The 95% UCL is calculated according to NMED guidance (Tharp June 2002) using the U.S. Environmental Protection Agency ProUCL program (EPA April 2002). Attached are the outputs from that program and the calculated UCLs used in the risk analysis.

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SWMU 30

SWMU 30	
Summary Statistics for	Antimony
Number of Samples	204
Minimum	0.592
Maximum	5.8
Mean	1.19702
Median	1.05
Standard Deviation	0.674566
Variance	0.455039
Coefficient of Variation	0.563538
Skewness	5.207189
Lilliefors Test Statisitic	0.522539
Lilliefors 5% Critical Value	0.062032
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	1.275061
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	1.293103
Modified-t	1.27793
95 % Non-parametric UCL	
CLT	1.274704
Jackknife	1.275061
Standard Bootstrap	1.274023
Bootstrap-t	1.301275
Chebyshev (Mean, Std)	1.402886

SWMU 30	
Summary Statistics for	Arsenic
Number of Samples	217
Minimum	1.3
Maximum	8.4
Mean	4.002535
Median	3.9
Standard Deviation	1.22699
Variance	1.505505
Coefficient of Variation	0.306553
Skewness	0.907574
Lilliefors Test Statisitic	0.108883
Lilliefors 5% Critical Value	0.060146
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
97.5 % UCL (Assuming Normal Data)	
Student's-t	4.166707
97.5 % UCL (Adjusted for Skewness)	
Adjusted-CLT	4.173213
Modified-t	4.167562
97.5 % Non-parametric UCL	
CLT	4.165787
Jackknife	4.166707
Standard Bootstrap	4.160514
Bootstrap-t	4.16847
Chebyshev (Mean, Std)	4.522702

SWMU 30			
Summary Statistics for	Barium	Summary Statistics for	ln(Barium)
Number of Samples	217	Minimum	4.356709
Minimum	78	Maximum	6.927558
Maximum	1020	Mean	5.199119
Mean	199.659	Standard Deviation	0.421616
Median	179	Variance	0.17776
Standard Deviation	105.0009		
Variance	11025.2	Lilliefors Test Statisitic	0.050666
Coefficient of Variation	0.525901	Lilliefors 5% Critical Value	0.060146
Skewness	3.144076	Data are Lognormal at 5% Significance Leve	
95 % UCL (Assuming Normal Data)		Estimates Assuming Lognormal Distribution	
Student's-t	211.4339	MLE Mean	197.947
		MLE Standard Deviation	87.30759
95 % UCL (Adjusted for Skewness)		MLE Coefficient of Variation	0.441065
Adjusted-CLT	213.009	MLE Skewness	1.409001
Modified-t	211.6874	MLE Median	181.1127
		MLE 80% Quantile	258.6265
95 % Non-parametric UCL		MLE 90% Quantile	311.3433
CLT	211.3834	MLE 95% Quantile	362.3743
Jackknife	211.4339	MLE 99% Quantile	482.8946
Standard Bootstrap	211.2211		
Bootstrap-t	213.794	MVU Estimate of Median	181.0385
Chebyshev (Mean, Std)	230.7289	MVU Estimate of Mean	197.8589
		MVU Estimate of Std. Dev.	87.11469
		MVU Estimate of SE of Mean	5.899481
		UCL Assuming Lognormal Distribution	
		95% H-UCL	208.2126
		95% Chebyshev (MVUE) UCL	223.5741
		99% Chebyshev (MVUE) UCL	256.558
		Recommended UCL to use:	
		Student's-t or H-UCL	

SWMU 30				
Summary Statistics for			Cadmium	
Number of Samples			216	
Minimum			0.038	
Maximum			26	
Mean			0.577157	
Median			0.05	
Standard Deviation			2.125555	
Variance			4.517985	
Coefficient of Variation			3.6828	
Skewness			9.07822	
Lilliefors Test Statisitic			0.399881	
Lilliefors 5% Critical Value			0.060285	
Data not Normal at 5% Significance Level				
Data not Lognormal: Try Non-parametric UCL				
99	% UCL (Assuming Normal Data)			
Student's-t			0.916134	
99	% UCL (Adjusted for Skewness)			
Adjusted-CLT			1.089653	
Modified-t			0.931023	
99	% Non-parametric UCL			
CLT			0.913607	
Jackknife			0.916134	
Standard Bootstrap			0.920487	
Bootstrap-t			1.443623	
Chebyshev (Mean, Std)			2.016165	

SWMU 30	
Summary Statistics for	Chromium
Number of Samples	217
Minimum	1.9
Maximum	35.3
Mean	6.657604
Median	6.3
Standard Deviation	3.184934
Variance	10.1438
Coefficient of Variation	0.47839
Skewness	4.020673
Lilliefors Test Statisitic	0.16202
Lilliefors 5% Critical Value	0.060146
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
99 % UCL (Assuming Normal Data)	
Student's-t	7.164337
99 % UCL (Adjusted for Skewness)	
Adjusted-CLT	7.276868
Modified-t	7.174172
99 % Non-parametric UCL	
CLT	7.160577
Jackknife	7.164337
Standard Bootstrap	7.147358
Bootstrap-t	7.305035
Chebyshev (Mean, Std)	8.80884

SWMU 30				
Summary Statistics for			Copper	
Number of Samples			217	
Minimum			2.7	
Maximum			1080	
Mean			27.84719	
Median			8	
Standard Deviation			106.352	
Variance			11310.75	
Coefficient of Variation			3.819129	
Skewness			7.75972	
Lilliefors Test Statisitic			0.407154	
Lilliefors 5% Critical Value			0.060146	
Data not Normal at 5% Significance Level				
Data not Lognormal: Try Non-parametric UCL				
99	% UCL (Assuming Normal Data)			
Student's-t			44.76812	
99	% UCL (Adjusted for Skewness)			
Adjusted-CLT			52.13701	
Modified-t			45.40197	
99	% Non-parametric UCL			
CLT			44.6426	
Jackknife			44.76812	
Standard Bootstrap			45.00691	
Bootstrap-t			107.3865	
Chebyshev (Mean, Std)			99.68175	

SWMU 30				
Summary Statistics for			Thallium	
Number of Samples			217	
Minimum			0.1025	
Maximum			1.8	
Mean			0.63735	
Median			0.5	
Standard Deviation			0.299855	
Variance			0.089913	
Coefficient of Variation			0.470472	
Skewness			0.990108	
Lilliefors Test Statisitic			0.340138	
Lilliefors 5% Critical Value			0.060146	
Data not Normal at 5% Significance Level				
Data not Lognormal: Try Non-parametric UCL				
95	% UCL (Assuming Normal Data)			
Student's-t			0.670976	
95	% UCL (Adjusted for Skewness)			
Adjusted-CLT			0.672294	
Modified-t			0.671204	
95	% Non-parametric UCL			
CLT			0.670832	
Jackknife			0.670976	
Standard Bootstrap			0.670844	
Bootstrap-t			0.672638	
Chebyshev (Mean, Std)			0.726078	

SWMU 30	
Summary Statistics for	Benzo(a)anthracene
Number of Samples	203
Minimum	0.0105
Maximum	1.8
Mean	0.03954433498
Median	0.0105
Standard Deviation	0.1691337364
Variance	0.0286062208
Coefficient of Variation	4.277066147
Skewness	9.600429941
Lilliefors Test Statisitic	0.4318272266
Lilliefors 5% Critical Value	0.0621850092
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	0.0591601219
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.06761699862
Modified-t	0.06049325538
95 % Non-parametric UCL	
CLT	0.05907016396
Jackknife	0.0591601219
Standard Bootstrap	0.05903257542
Bootstrap-t	0.1467307946
Chebyshev (Mean, Std)	0.09128821899

SWMU 30	
Summary Statistics for	Benzo(a)pyrene
Number of Samples	203
Minimum	0.0105
Maximum	1.4
Mean	0.03557881773
Median	0.0105
Standard Deviation	0.1393922228
Variance	0.01943019178
Coefficient of Variation	3.917843022
Skewness	9.421068241
Lilliefors Test Statisitic	0.4286094696
Lilliefors 5% Critical Value	0.0621850092
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	0.05174524437
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.058583413
Modified-t	0.0528234247
95 % Non-parametric UCL	
CLT	0.05167110519
Jackknife	0.05174524437
Standard Bootstrap	0.05196916335
Bootstrap-t	0.1148218532
Chebyshev (Mean, Std)	0.0782237398

SWMU 30	
Summary Statistics for	Benzo(b)fluoranthene
Number of Samples	203
Minimum	0.023
Maximum	2.2
Mean	0.06532019704
Median	0.048
Standard Deviation	0.1651837589
Variance	0.02728567419
Coefficient of Variation	2.528831301
Skewness	11.16394414
Lilliefors Test Statisitic	0.4235276709
Lilliefors 5% Critical Value	0.0621850092
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	0.0844778736
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.09409666668
Modified-t	0.08599191486
95 % Non-parametric UCL	
CLT	0.08439001656
Jackknife	0.0844778736
Standard Bootstrap	0.08404098284
Bootstrap-t	0.1178602954
Chebyshev (Mean, Std)	0.1158556457

SWMU 30		
Summary Statistics for	Benzo(ghi)perylene	
Number of Samples	203	
Minimum	0.038	
Maximum	1.125	
Mean	0.1176403941	
Median	0.1125	
Standard Deviation	0.1628316608	
Variance	0.02651414975	
Coefficient of Variation	1.384147529	
Skewness	5.347718539	
Lilliefors Test Statisitic	0.4633309945	
Lilliefors 5% Critical Value	0.0621850092	
Data not Normal at 5% Significance Level		
Data not Lognormal: Try Non-parametric UCL		
95 % UCL (Assuming Normal Data)		
Student's-t	0.1365252791	
95 % UCL (Adjusted for Skewness)		
Adjusted-CLT	0.1410221154	
Modified-t	0.1372402035	
95 % Non-parametric UCL		
CLT	0.1364386731	
Jackknife	0.1365252791	
Standard Bootstrap	0.136196107	
Bootstrap-t	0.1466069039	
Chebyshev (Mean, Std)	0.1674562543	

SMMU 30	
Summary Statistics for	Dibenz[a,h]anthracene
Number of Samples	203
Minimum	0.012
Maximum	0.31
Mean	0.01787684729
Median	0.012
Standard Deviation	0.02480437533
Variance	0.0006152570356
Coefficient of Variation	1.387513969
Skewness	9.236559483
Lilliefors Test Statisitic	0.4407174179
Lilliefors 5% Critical Value	0.0621850092
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	0.02075360832
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.02194634773
Modified-t	0.02094170937
95 % Non-parametric UCL	
CLT	0.0207404155
Jackknife	0.02075360832
Standard Bootstrap	0.02076194131
Bootstrap-t	0.02450798073
Chebyshev (Mean, Std)	0.02546536716

SWMU 30			
Summary Statistics for		Indeno(1,2,3-c,d)pyrene	
Number of Samples		203	
Minimum		0.011	
Maximum		0.77	
Mean		0.02982512315	
Median		0.011	
Standard Deviation		0.07208069398	
Variance		0.005195626445	
Coefficient of Variation		2.416777749	
Skewness		8.831107245	
Lilliefors Test Statisitic		0.396981787	
Lilliefors 5% Critical Value		0.0621850092	
Data not Normal at 5% Significance Level			
Data not Lognormal: Try Non-parametric UCL			
95	% UCL (Assuming Normal Data)		
Student's-t		0.03818489551	
95	% UCL (Adjusted for Skewness)		
Adjusted-CLT		0.04149712607	
Modified-t		0.03870751648	
95	% Non-parametric UCL		
CLT		0.03814655762	
Jackknife		0.03818489551	
Standard Bootstrap		0.03804524108	
Bootstrap-t		0.05624577682	
Chebyshev (Mean, Std)		0.05187711082	

SWMU 30				
Summary Statistics for			Phenanthrene	
Number of Samples			203	
Minimum			0.0115	
Maximum			2.6	
Mean			0.04084482759	
Median			0.0115	
Standard Deviation			0.2026506146	
Variance			0.04106727159	
Coefficient of Variation			4.961475579	
Skewness			11.05978798	
Lilliefors Test Statisitic			0.4424323824	
Lilliefors 5% Critical Value			0.0621850092	
Data not Normal at 5% Significance Level				
Data not Lognormal: Try Non-parametric UCL				
95	% UCL (Assuming Normal Data)			
Student's-t			0.0643478339	
95	% UCL (Adjusted for Skewness)			
Adjusted-CLT			0.07603725356	
Modified-t			0.06618795938	
95	% Non-parametric UCL			
CLT			0.06424004919	
Jackknife			0.0643478339	
Standard Bootstrap			0.06453160258	
Bootstrap-t			0.1529764859	
Chebyshev (Mean, Std)			0.1028426887	

SWMU 33

SWMU 33		
Summary Statistics for	Arsenic	
Number of Samples	44	
Minimum	0.84	
Maximum	4.8	
Mean	2.489545	
Median	2.4	
Standard Deviation	0.955654	
Variance	0.913274	
Coefficient of Variation	0.383867	
Skewness	0.56107	
Shapiro-Wilk Test Statisitic	0.958688	
Shapiro-Wilk 5% Critical Value	0.944	
Data are Normal at 5% Significance Level		
Recommended UCL to use	Student's-t	
95 % UCL (Assuming Normal Data)		
Student's-t	2.731738	
95 % UCL (Adjusted for Skewness)		
Adjusted-CLT	2.739541	
Modified-t	2.733769	
95 % Non-parametric UCL		
CLT	2.72652	
Jackknife	2.731738	
Standard Bootstrap	2.722356	
Bootstrap-t	2.741929	
Chebyshev (Mean, Std)	3.117533	

SWMU 114

SWMU 114	
Summary Statistics for	arsenic
Number of Samples	415
Minimum	0.05
Maximum	4.8
Mean	2.044892
Median	1.9
Standard Deviation	0.879985
Variance	0.774373
Coefficient of Variation	0.430333
Skewness	0.558008
Lilliefors Test Statisitic	0.089123
Lilliefors 5% Critical Value	0.043492
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	2.116103
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	2.117208
Modified-t	2.1163
95 % Non-parametric UCL	
CLT	2.115944
Jackknife	2.116103
Standard Bootstrap	2.115682
Bootstrap-t	2.116594
Chebyshev (Mean, Std)	2.233182

SWMU 18

SWMU 18				
Summary Statistics for	cadmium		Summary Statistics for	ln(cadmiur
Number of Samples	34		Minimum	-4.961845
Minimum	0.007		Maximum	2.939162
Maximum	18.9		Mean	-1.088843
Mean	2.276644		Standard Deviation	2.047891
Median	0.25		Variance	4.193858
Standard Deviation	5.031886			
Variance	25.31988		Shapiro-Wilk Test Statisitic	0.965653
Coefficient of Variation	2.210221		Shapiro-Wilk 5% Critical Value	0.933
Skewness	2.637362		Data are Lognormal at 5% Significance Leve	
95 % UCL (Assuming Normal Data)			Estimates Assuming Lognormal Distribution	
Student's-t	3.737085		MLE Mean	2.740352
			MLE Standard Deviation	22.14062
95 % UCL (Adjusted for Skewness)			MLE Coefficient of Variation	8.079481
Adjusted-CLT	4.113153		MLE Skewness	551.6509
Modified-t	3.802139		MLE Median	0.336606
			MLE 80% Quantile	1.899566
95 % Non-parametric UCL			MLE 90% Quantile	4.677189
CLT	3.696089		MLE 95% Quantile	9.776075
Jackknife	3.737085		MLE 99% Quantile	39.43099
Standard Bootstrap	3.646522			
Bootstrap-t	4.531744		MVU Estimate of Median	0.316438
Chebyshev (Mean, Std)	6.038205		MVU Estimate of Mean	2.322436
			MVU Estimate of Std. Dev.	10.3463
			MVU Estimate of SE of Mean	1.126493
			UCL Assuming Lognormal Distribution	
			95% H-UCL	10.77957
			95% Chebyshev (MVUE) UCL	7.232705
			99% Chebyshev (MVUE) UCL	13.5309
			Recommended UCL to use:	
			95 % Chebyshev (MVUE) UCL	

SWMU 18			
Summary Statistics for		benzo(a)pyrene	
Number of Samples		22	
Minimum		0.001	
Maximum		0.289	
Mean		0.01409090909	
Median		0.001	
Standard Deviation		0.06140180631	
Variance		0.003770181818	
Coefficient of Variation		4.357547545	
Skewness		4.69041576	
Shapiro-Wilk Test Statisitic		0.2207134286	
Shapiro-Wilk 5% Critical Value		0.911	
Data not Normal at 5% Significance Level			
Data not Lognormal: Try Non-parametric UCL			
95	% UCL (Assuming Normal Data)		
Student's-t		0.03661699432	
95	% UCL (Adjusted for Skewness)		
Adjusted-CLT		0.0496113644	
Modified-t		0.0387988125	
95	% Non-parametric UCL		
CLT		0.0356235384	
Jackknife		0.03661699432	
Standard Bootstrap		0.03470468779	
Bootstrap-t		-1.#QNAN	
Chebyshev (Mean, Std)		0.0711528589	

SWMU 241

SWMU 241				
Summary Statistics for	Antimony		Summary Statistics for	ln(Antimon
Number of Samples	8		Minimum	0.841567
Minimum	2.32		Maximum	3.387774
Maximum	29.6		Mean	1.754299
Mean	8.2525		Standard Deviation	0.825739
Median	5		Variance	0.681845
Standard Deviation	9.083127			
Variance	82.50319		Shapiro-Wilk Test Statisitic	0.860459
Coefficient of Variation	1.100652		Shapiro-Wilk 5% Critical Value	0.818
Skewness	2.345822		Data are Lognormal at 5% Significance Leve	
95 % UCL (Assuming Normal Data)			Estimates Assuming Lognormal Distribution	
Student's-t	14.33669		MLE Mean	8.127239
			MLE Standard Deviation	8.035384
95 % UCL (Adjusted for Skewness)			MLE Coefficient of Variation	0.988698
Adjusted-CLT	16.38064		MLE Skewness	3.932569
Modified-t	14.7806		MLE Median	5.779393
			MLE 80% Quantile	11.61211
95 % Non-parametric UCL			MLE 90% Quantile	16.69941
CLT	13.53473		MLE 95% Quantile	22.48031
Jackknife	14.33669		MLE 99% Quantile	39.4474
Standard Bootstrap	13.21739			
Bootstrap-t	38.05266		MVU Estimate of Median	5.537147
Chebyshev (Mean, Std)	22.25054		MVU Estimate of Mean	7.716609
			MVU Estimate of Std. Dev.	6.557507
			MVU Estimate of SE of Mean	2.296024
			UCL Assuming Lognormal Distribution	
			95% H-UCL	21.16858
			95% Chebyshev (MVUE) UCL	17.72475
			99% Chebyshev (MVUE) UCL	30.56176
			Recommended UCL to use:	
			H-UCL	

SWMU 230

SWMU 230			
Summary Statistics for	arsenic	Summary Statistics for	ln(arsenic)
Number of Samples	14	Minimum	0.262364
Minimum	1.3	Maximum	1.88707
Maximum	6.6	Mean	0.832538
Mean	2.504286	Standard Deviation	0.394922
Median	2.15	Variance	0.155963
Standard Deviation	1.307197		
Variance	1.708765	Shapiro-Wilk Test Statisitic	0.89551
Coefficient of Variation	0.521984	Shapiro-Wilk 5% Critical Value	0.874
Skewness	2.651345	Data are Lognormal at 5% Significance Leve	
95 % UCL (Assuming Normal Data)		Estimates Assuming Lognormal Distribution	
Student's-t	3.122985	MLE Mean	2.485614
		MLE Standard Deviation	1.021171
95 % UCL (Adjusted for Skewness)		MLE Coefficient of Variation	0.410833
Adjusted-CLT	3.343458	MLE Skewness	1.301839
Modified-t	3.164244	MLE Median	2.299147
		MLE 80% Quantile	3.209923
95 % Non-parametric UCL		MLE 90% Quantile	3.819092
CLT	3.078937	MLE 95% Quantile	4.402553
Jackknife	3.122985	MLE 99% Quantile	5.761089
Standard Bootstrap	3.051074		
Bootstrap-t	3.865287	MVU Estimate of Median	2.286371
Chebyshev (Mean, Std)	4.027125	MVU Estimate of Mean	2.470953
		MVU Estimate of Std. Dev.	0.994565
		MVU Estimate of SE of Mean	0.265542
		UCL Assuming Lognormal Distribution	
		95% H-UCL	3.088412
		95% Chebyshev (MVUE) UCL	3.628424
		99% Chebyshev (MVUE) UCL	5.113063
		Recommended UCL to use:	
		Student's-t or H-UCL	

SWMU 231

SWMU 231			
Summary Statistics for	arsenic	Summary Statistics for	ln(arsenic)
Number of Samples	12	Minimum	0.182322
Minimum	1.2	Maximum	1.740466
Maximum	5.7	Mean	0.766958
Mean	2.374167	Standard Deviation	0.44689
Median	2.25	Variance	0.199711
Standard Deviation	1.217378		
Variance	1.482008	Shapiro-Wilk Test Statisitic	0.930821
Coefficient of Variation	0.51276	Shapiro-Wilk 5% Critical Value	0.859
Skewness	1.953615	Data are Lognormal at 5% Significance Leve	
95 % UCL (Assuming Normal Data)		Estimates Assuming Lognormal Distribution	
Student's-t	3.005288	MLE Mean	2.379317
		MLE Standard Deviation	1.118658
95 % UCL (Adjusted for Skewness)		MLE Coefficient of Variation	0.470159
Adjusted-CLT	3.163982	MLE Skewness	1.514406
Modified-t	3.03832	MLE Median	2.153206
		MLE 80% Quantile	3.141122
95 % Non-parametric UCL		MLE 90% Quantile	3.823675
CLT	2.952212	MLE 95% Quantile	4.491076
Jackknife	3.005288	MLE 99% Quantile	6.088639
Standard Bootstrap	2.921609		
Bootstrap-t	3.377078	MVU Estimate of Median	2.135352
Chebyshev (Mean, Std)	3.906	MVU Estimate of Mean	2.358104
		MVU Estimate of Std. Dev.	1.07576
		MVU Estimate of SE of Mean	0.310095
		UCL Assuming Lognormal Distribution	
		95% H-UCL	3.1481
		95% Chebyshev (MVUE) UCL	3.709775
		99% Chebyshev (MVUE) UCL	5.443506
		Recommended UCL to use:	
		Student's-t or H-UCL	

SWMU 232-1

SWMU 232-1					
Summary Statistics for		arsenic		Summary Statistics for	ln(arsenic)
Number of Samples		12		Minimum	-0.020203
Minimum		0.98		Maximum	1.629241
Maximum		5.1		Mean	0.609288
Mean		2.093333		Standard Deviation	0.516373
Median		1.7		Variance	0.266641
Standard Deviation		1.205354			
Variance		1.452879		Shapiro-Wilk Test Statisitic	0.948733
Coefficient of Variation		0.575806		Shapiro-Wilk 5% Critical Value	0.859
Skewness		1.531818		Data are Lognormal at 5% Significance Leve	
95	% UCL (Assuming Normal Data)			Estimates Assuming Lognormal Distribution	
Student's-t		2.718222		MLE Mean	2.10141
				MLE Standard Deviation	1.161629
95	% UCL (Adjusted for Skewness)			MLE Coefficient of Variation	0.552786
Adjusted-CLT		2.830077		MLE Skewness	1.827272
Modified-t		2.743866		MLE Median	1.839121
				MLE 80% Quantile	2.845171
95	% Non-parametric UCL			MLE 90% Quantile	3.570934
CLT		2.66567		MLE 95% Quantile	4.300458
Jackknife		2.718222		MLE 99% Quantile	6.112718
Standard Bootstrap		2.64416			
Bootstrap-t		3.04951		MVU Estimate of Median	1.818784
Chebyshev (Mean, Std)		3.610037		MVU Estimate of Mean	2.075856
				MVU Estimate of Std. Dev.	1.101586
				MVU Estimate of SE of Mean	0.317199
				UCL Assuming Lognormal Distribution	
				95% H-UCL	2.94203
				95% Chebyshev (MVUE) UCL	3.458497
				99% Chebyshev (MVUE) UCL	5.231951
				Recommended UCL to use:	
				H-UCL	

SWMU 66

SWMU 66					
Summary Statistics for		Arsenic		Summary Statistics for	ln(Arsenic)
Number of Samples		44		Minimum	0.741937
Minimum		2.1		Maximum	2.734368
Maximum		15.4		Mean	1.705288
Mean		6.1025		Standard Deviation	0.460243
Median		5.635		Variance	0.211824
Standard Deviation		2.891816			
Variance		8.362601		Shapiro-Wilk Test Statisitic	0.967748
Coefficient of Variation		0.473874		Shapiro-Wilk 5% Critical Value	0.944
Skewness		1.121094		Data are Lognormal at 5% Significance Leve	
95	% UCL (Assuming Normal Data)			Estimates Assuming Lognormal Distribution	
Student's-t		6.835376		MLE Mean	6.11778
				MLE Standard Deviation	2.971565
95	% UCL (Adjusted for Skewness)			MLE Coefficient of Variation	0.485726
Adjusted-CLT		6.898317		MLE Skewness	1.571775
Modified-t		6.847656		MLE Median	5.502968
				MLE 80% Quantile	8.118885
95	% Non-parametric UCL			MLE 90% Quantile	9.941319
CLT		6.819587		MLE 95% Quantile	11.73279
Jackknife		6.835376		MLE 99% Quantile	16.05166
Standard Bootstrap		6.810294			
Bootstrap-t		6.954678		MVU Estimate of Median	5.489737
Chebyshev (Mean, Std)		8.002795		MVU Estimate of Mean	6.101627
				MVU Estimate of Std. Dev.	2.934049
				MVU Estimate of SE of Mean	0.441066
				UCL Assuming Lognormal Distribution	
				95% H-UCL	6.974174
				95% Chebyshev (MVUE) UCL	8.024188
				99% Chebyshev (MVUE) UCL	10.49018
				Recommended UCL to use:	
				Student's-t or H-UCL	

SWMU 9

SWMU 9	
Summary Statistics for	2-Amino-4,6-dinitrotoluene
Number of Samples	76
Minimum	0.0033
Maximum	3.68
Mean	0.2118302632
Median	0.0067
Standard Deviation	0.5817663116
Variance	0.3384520413
Coefficient of Variation	2.746379592
Skewness	4.69054563
Lilliefors Test Statisitic	0.3600058379
Lilliefors 5% Critical Value	0.1016311701
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
95 % UCL (Assuming Normal Data)	
Student's-t	0.3229693582
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	0.3599618782
Modified-t	0.3289535719
95 % Non-parametric UCL	
CLT	0.3215965643
Jackknife	0.3229693582
Standard Bootstrap	0.3234650063
Bootstrap-t	0.4583355893
Chebyshev (Mean, Std)	0.502713419

SWMU 9			
Summary Statistics for		4-Amino-2,6-dinitrotoluene	
Number of Samples		76	
Minimum		0.00275	
Maximum		2.29	
Mean		0.1574065789	
Median		0.00505	
Standard Deviation		0.3890942839	
Variance		0.1513943618	
Coefficient of Variation		2.471906108	
Skewness		3.830155045	
Lilliefors Test Statisitic		0.362837273	
Lilliefors 5% Critical Value		0.1016311701	
Data not Normal at 5% Significance Level			
Data not Lognormal: Try Non-parametric UCL			
95	% UCL (Assuming Normal Data)		
Student's-t		0.2317381202	
95	% UCL (Adjusted for Skewness)		
Adjusted-CLT		0.2517725796	
Modified-t		0.2350063032	
95	% Non-parametric UCL		
CLT		0.2308199745	
Jackknife		0.2317381202	
Standard Bootstrap		0.2310650059	
Bootstrap-t		0.2743577913	
Chebyshev (Mean, Std)		0.3519537209	

SWMU 9		
Summary Statistics for	Benzo(a)pyrene	
Number of Samples	73	
Minimum	0.036	
Maximum	0.12	
Mean	0.03715068493	
Median	0.036	
Standard Deviation	0.009831456364	
Variance	9.665753425E-005	
Coefficient of Variation	0.2646372841	
Skewness	8.544003745	
Lilliefors Test Statisitic	0.5328876937	
Lilliefors 5% Critical Value	0.1036984564	
Data not Normal at 5% Significance Level		
Data not Lognormal: Try Non-parametric UCL		
95 % UCL (Assuming Normal Data)		
Student's-t	0.03906806366	
95 % UCL (Adjusted for Skewness)		
Adjusted-CLT	0.04027291673	
Modified-t	0.03925984448	
95 % Non-parametric UCL		
CLT	0.03904339322	
Jackknife	0.03906806366	
Standard Bootstrap	0.03906780011	
Bootstrap-t	-1.#QNAN	
Chebyshev (Mean, Std)	0.04216640426	

SWMU 9				
Summary Statistics for			Benzo(g,h,l)perylene	
Number of Samples			73	
Minimum			0.0405	
Maximum			0.13	
Mean			0.04267808219	
Median			0.0405	
Standard Deviation			0.01317309175	
Variance			0.0001735303463	
Coefficient of Variation			0.308661755	
Skewness			6.060960979	
Lilliefors Test Statisitic			0.5382658485	
Lilliefors 5% Critical Value			0.1036984564	
Data not Normal at 5% Significance Level				
Data not Lognormal: Try Non-parametric UCL				
95	% UCL (Assuming Normal Data)			
Student's-t			0.045247163	
95	% UCL (Adjusted for Skewness)			
Adjusted-CLT			0.04638276345	
Modified-t			0.04542944975	
95	% Non-parametric UCL			
CLT			0.04521410727	
Jackknife			0.045247163	
Standard Bootstrap			0.04516633511	
Bootstrap-t			-1.#QNAN	
Chebyshev (Mean, Std)			0.04939860543	

From File				
Summary Statistics for			RDX	
Number of Samples			76	
Minimum			0.00485	
Maximum			26	
Mean			2.863429	
Median			0.874	
Standard Deviation			5.348326	
Variance			28.60459	
Coefficient of Variation			1.867805	
Skewness			2.954668	
Lilliefors Test Statisitic			0.296504	
Lilliefors 5% Critical Value			0.101631	
Data not Normal at 5% Significance Level				
Data not Lognormal: Try Non-parametric UCL				
99	% UCL (Assuming Normal Data)			
Student's-t			4.321769	
99	% UCL (Adjusted for Skewness)			
Adjusted-CLT			4.700381	
Modified-t			4.356424	
99	% Non-parametric UCL			
CLT			4.290632	
Jackknife			4.321769	
Standard Bootstrap			4.30461	
Bootstrap-t			5.294516	
Chebyshev (Mean, Std)			8.967627	

SWMU 9	
Summary Statistics for	2,4,6-Trinitrotoluene
Number of Samples	76
Minimum	0.00285
Maximum	18
Mean	0.8988052632
Median	0.00705
Standard Deviation	3.304352648
Variance	10.91874642
Coefficient of Variation	3.676383287
Skewness	4.555488479
Lilliefors Test Statisitic	0.4199366114
Lilliefors 5% Critical Value	0.1016311701
Data not Normal at 5% Significance Level	
Data not Lognormal: Try Non-parametric UCL	
99 % UCL (Assuming Normal Data)	
Student's-t	1.799810502
99 % UCL (Adjusted for Skewness)	
Adjusted-CLT	2.170886233
Modified-t	1.832821336
99 % Non-parametric UCL	
CLT	1.780573098
Jackknife	1.799810502
Standard Bootstrap	1.771129398
Bootstrap-t	6.030904486
Chebyshev (Mean, Std)	4.670158322

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