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Preliminary Screening Evaluations of the Ash Debris
(PRS 73-002)

Environmental Restoration Project

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A Department of Energy
Environmental Cleanup Program

Los Alamos
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EXECUTIVE SUMMARY

The purpose of this document is to provide the results of preliminary human health and ecological screening evaluations of the ash debris and the areas surrounding this site, i.e., both lateral to and downgradient from the ash debris. The results of this evaluation are intended to provide a general description and magnitude of the potential risks to human health and the environment as a consequence of exposure to the ash debris. In addition, the evaluation provides a comparison of the potential risks associated with the surrounding areas and a delineation of the extent of the contamination from the ash debris.

The site is comprised of an incinerator building (TA-73-2) and a surface disposal area (referred to as the ash debris). The ash debris is the result of incinerator operations to destroy classified documents and later the burning of municipal trash. The ash debris is located on the southern slope below the rim of Pueblo Canyon and immediately north of the incinerator building. It is essentially a wedge-shaped mass, with maximum dimensions of approximately 150 ft wide and 160 ft long. The thickness of the ash ranges from 0 ft at the edges to greater than 8 ft at several locations. The distance from the lower edge of the ash debris to the bottom of Pueblo Canyon is nearly 400 vertical feet.

Samples have been collected from the ash debris as well as the drainages below the ash debris and the areas on either side of the ash debris. Analytical results from these samples have detected metals, organic chemicals, and radionuclides in all of the areas sampled. The ash debris had 18 metals and six radionuclides detected above background and 33 organic chemicals detected. By comparison, the drainages below the ash debris had four metals detected above background and five organic chemicals detected, while the areas on either side of the ash debris had seven metals detected above background and 14 organic chemicals detected. Radionuclides were not analyzed for in either of these areas, but screening data from the drainages indicated that radioactivity was below background.

A preliminary human health risk-based screening evaluation was conducted on each of the areas sampled to determine the potential hazards and risks to human receptors. The exposure concentrations for each area were compared to risk-based screening values for a residential and a recreational exposure scenario. Based on the preliminary screening evaluation, the ash debris presents a potential for unacceptable risk to human health with respect to noncarcinogenic and carcinogenic risk for residential exposure (Table E-1). Potential risk from radionuclides is also above the dose limit of 15 mrem/yr for residential exposure (Table E-1). By comparison, the recreational exposure results in less potential hazard, risk, and dose for noncarcinogens, carcinogens, and radionuclides to individuals. The potential noncarcinogenic hazard and radionuclide dose are approximately one to two orders of magnitude less than the potential residential hazard, respectively, while the potential carcinogenic risk is approximately 1/3 the residential value (Table E-1). The potential risk of the ash debris to residents and recreational users is an order of magnitude or more compared to the potential risk derived for the drainages and the areas on either side of the ash debris (Table E-1).

TABLE E-1
SUMMARY OF HAZARD INDICES AND RISKS/DOSES FOR THE ASH DEBRIS AND SURROUNDING AREAS

Effects Category	Residential Exposure			Recreational Exposure		
	Ash Debris	Drainages	Lateral	Ash Debris	Drainages	Lateral
Noncarcinogens[a]	24.8	0.2	0.3	2.7	0.03	0.05
Carcinogens[b]	3×10^{-4}	3×10^{-7}	2×10^{-5}	8×10^{-5}	2×10^{-7}	6×10^{-6}
Radionuclides[c]	20	NA[d]	NA	0.7	NA	NA

[a] Values are the unitless hazard indices for each area.
[b] Values are the total incremental lifetime cancer risk for each area.
[c] Value is the total doses in mrem/yr for the ash debris.
[d] NA = not available; radionuclides have not been analyzed for in the drainages and the areas on either side of the ash debris.

A preliminary ecological risk screening evaluation was also conducted on the sampling results for the ash debris, the drainage below the ash debris, and the area on either side of the ash debris in order to determine the potential for adverse ecological impacts. The evaluation compared the exposure concentrations to ecological screening values for nine terrestrial receptors [a plant, the earthworm, deer mouse, vagrant shrew, desert cottontail, American robin, American kestrel (with and without an all meat diet), and the red fox] designed to represent different trophic levels. Based on the observed site conditions and the results of the preliminary screening evaluation, the ash debris does pose a potential for adverse ecological impacts to some or all of the receptors. There has been some release of contamination, primarily inorganic chemicals, into the drainages and areas immediately below or adjacent to the ash debris. However, the hazard index values in the drainages and on either side of the ash debris are an order of magnitude or more below the hazard index values from the ash debris (Table E-2).

The ash debris is exposed and subject to the effects of wind and storm water runoff. The available sampling data collected in and around this site indicates that despite these environmental influences there has been little movement of contaminated material from the ash debris. In addition, the concentrations of contaminants decreases as the distance from the ash debris increases and are below background concentrations or detection limits at the bottom of the Pueblo Canyon where the drainages join the ephemeral stream channel. The number of contaminants detected in these areas is also much less than the number of contaminants detected within the ash debris. The highest concentrations of contaminants in these areas are close to the ash debris, i.e., within approximately 10-ft on either side of the ash debris and within approximately 250 ft below the ash debris. In general, the area of the drainages below PRS and the areas adjacent to the PRS along the canyon walls appears to be representative of a healthy terrestrial ecosystem that is commonly encountered in northern New Mexico and have not been adversely impacted by the ash debris.

TABLE E-2
SUMMARY OF HAZARD INDEX ANALYSES FOR THE ASH DEBRIS AND SURROUNDING AREAS

ECOLOGICAL SCREENING RECEPTORS	HAZARD INDEX VALUES		
	ASH DEBRIS	DRAINAGES	LATERAL AREAS
Plant	1316	51.4	58.8
Earthworm	352	6.1	8.7
Deer Mouse	270	0.9	10.3
Vagrant Shrew	238	0.4	9.1
Desert Cottontail	21	0.3	0.7
Red Fox	6.6	0.04	0.1
Robin	618	40.5	18.4
Kestral	157	16	1.8
Kestral (with an all meat diet)	199	23.9	0.4

INTRODUCTION

Purpose

The purpose of this document is to provide the results of preliminary human health and ecological screening evaluations of the ash debris and the areas surrounding this site, i.e., both lateral to and downgradient from the ash debris. The ash debris is the result of incinerator operations to destroy classified documents and later the burning of municipal trash. This site is of concern because it has been found to contain a number of contaminants at relatively high concentrations that may pose the potential for adverse impacts to human and ecological receptors. In addition, it is located on the southern slope below the rim of Pueblo Canyon and has the potential to be transported by storm water runoff and wind. Its presence within the Pueblo Canyon watershed has also elicited concerns about the introduction of contamination into the surface water system and ultimately migration down the canyon.

The results of this evaluation are intended to provide a general description and magnitude of the potential risks to human health and the environment as a consequence of exposure to the ash debris. In addition, the evaluation provides a comparison of the potential risks associated with the surrounding areas and a delineation of the extent of the contamination from the ash debris.

It should be noted that the results presented here might not be the final estimations of the potential risks associated with this site. Although the overall conclusions may remain the same, the values presented are preliminary and subject to change. Reasons for changes in the estimated values includes, but are not limited to, the following,

- collection of additional data, if necessary, for further characterization of extent,
- in-depth review of data quality to determine the adequacy of available sampling data,
- changes in the toxicity values used to calculate human health reference doses and cancer slope factors,
- modifications in the ecological values as more information is obtained and reviewed,
- changes in the ecological values as the database is finalized and approved by the New Mexico Environment Department, and
- changes in exposure parameters to more representative conditions if a baseline risk assessment is conducted for this site.

Ultimately, a final RCRA Facility Investigation (RFI) report, corrective measures study (CMS) report, or similar report will be written to present the potential risks and/or remedial alternatives associated with this potential release site.

Site Description

The site is comprised of an incinerator building and surface disposal area (referred to as the ash debris). The incinerator was located on Department of Energy (DOE) property in a two-story building, TA-73-2, north/northwest of the present Los Alamos County Airport terminal building near the southern slope of Pueblo Canyon. The first floor of the building was referred to as the stoking floor, and the second floor as the charging floor. A six-foot diameter stack was located behind the building. The ash debris is located immediately north of the incinerator building on the south-facing slope of Pueblo Canyon just below the rim. The upper portion of the ash debris is located on DOE property, but the majority of the area is on Los Alamos County property. The potential release site (PRS 73-002) is listed on the HSWA Module VIII, Table A.

The ash debris is essentially wedge-shaped, with its maximum dimensions being approximately 150 ft wide and 160 ft long. The thickness of the ash ranges from 0 ft at the edges to greater than 8 ft at several locations. The distance from the lower edge of the ash debris to the bottom of Pueblo Canyon is nearly 400 vertical feet.

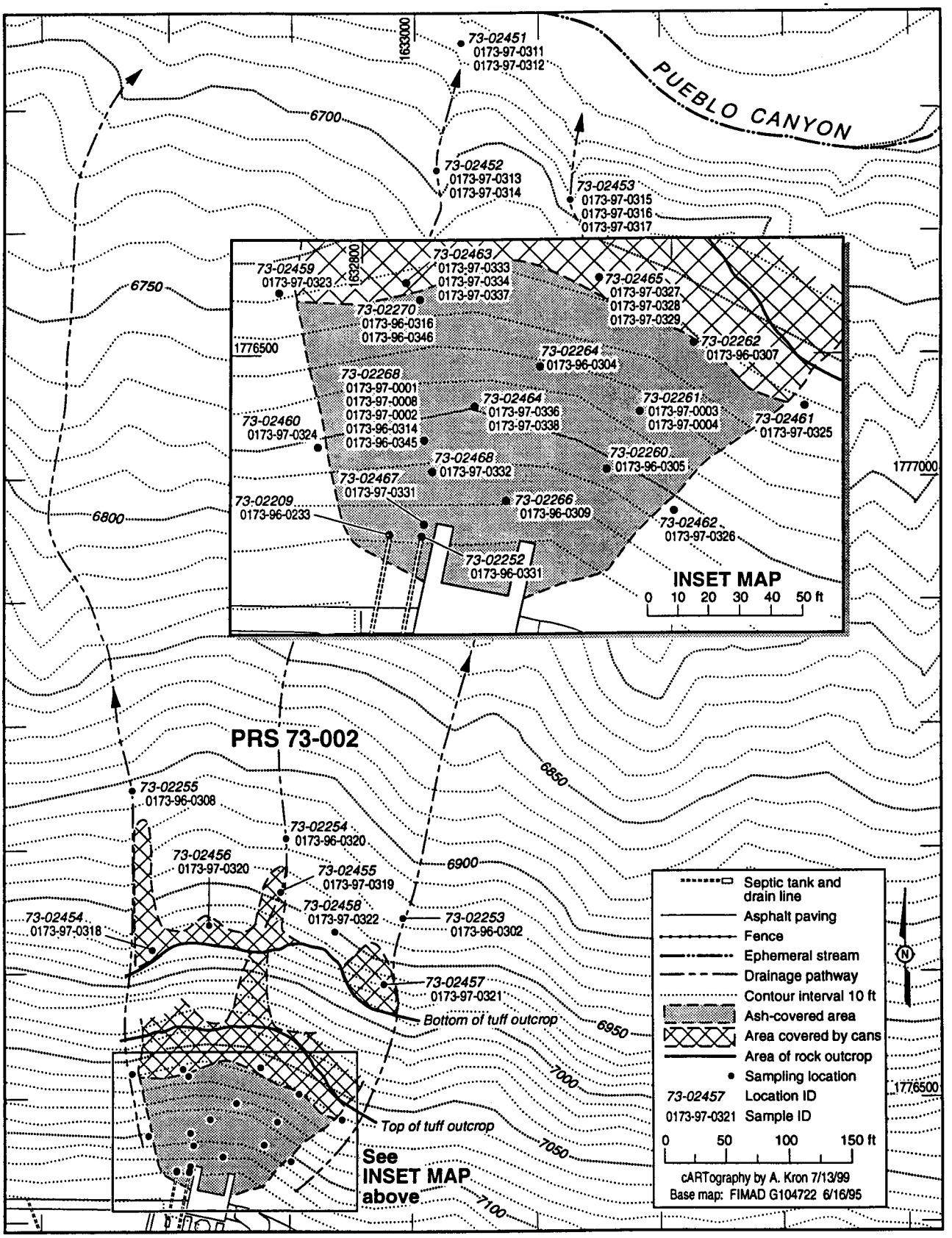

Figure 1. Sampling locations for PRS 73-002.

TABLE 1
SUMMARY OF SAMPLES COLLECTED AT PRS-73-002

LOCATION ID	SAMPLE ID	DEPTH (ft.)	DATE COLL.	MATRIX/LOCATION	VOCs	SVOCs	PEST/ PCBs	HG	METALS	TCLP METALS	DIOXINS/ FURANS	GROSS a,b,g	H3	GSCAN	ISO U	ISO PU
73-02209	0173-96-0233	0.3-0.8	7/1/96	Sdy. soil & ash w/ abund. metal & glass frags. PRS 73-004(a) outfall.	2385	2385	2385	NA	2384	NA	NA	2389	2389	NA	NA	NA
73-02253	0173-96-0302	0-0.5	6/20/96	Crse. snd. & grvl. sed.; slightly damp. East drainage below ash.	2326	2326	2326	2327	2327	NA	NA	2328	2328	NA	NA	NA
73-02264	0173-96-0304	0-1	6/28/96	Ash w/ occ. organic debris and metal & glass frags.	2368	2368	2368	2369	2369	NA	NA	2370	2370	NA	NA	NA
73-02260	0173-96-0305	0-0.7	6/28/96	Ash w/ org. debris and abund. metal & glass debris.	2368	2368	2368	2369	2369	NA	NA	2370	2370	NA	NA	NA
73-02262	0173-96-0307	0-1	6/28/96	Mostly metal w/ occ. glass debris; v. little ash.	2368	2368	2368	2369	2369	NA	NA	2370	2370	NA	NA	NA
73-02255	0173-96-0308	0-0.5	6/20/96	Slty. sndy. sed.; slightly damp. West drainage below ash.	2326	2326	2326	2327	2327	NA	NA	2328	2328	NA	NA	NA
73-02266	0173-96-0309	0-1	6/28/96	Ash w/ org. debris and metal & glass frags.	2368	2368	2368	2369	2369	NA	NA	2370	2370	NA	NA	NA
73-02268	0173-96-0314	0-1	6/28/96	Ash w/ abund. metal & glass debris.	2368	2368	2368	2369	2369	NA	NA	2370	2370	NA	NA	NA
73-02270	0173-96-0316	0-1	6/28/96	Metal & glass debris w/ occ. ash.	2368	2368	2368	2369	2369	NA	NA	2370	2370	NA	NA	NA
73-02254	0173-96-0320	0-0.5	6/20/96	Slty. sndy. sed.; slightly damp. Middle drainage below ash.	2326	2326	2326	2327	2327	NA	NA	2328	2328	NA	NA	NA
73-02252	0173-96-0331	0.1-0.3	6/13/96	Slty. soil & ash w/ fine glass & metal debris. PRS 73-006 outfall.	2286	2286	2286	2287	2287	NA	NA	2288	2288	NA	NA	NA
73-02268	0173-96-0345[b]	0-1	6/28/96	Ash w/ abund. metal & glass debris.	2368	2368	2368	2369	2369	NA	NA	2370	2370	NA	NA	NA
73-02270	0173-96-0346[b]	0-1	6/28/96	Metal & glass debris w/ occ. ash.	2368	2368	2368	2369	2369	NA	NA	2370	2370	NA	NA	NA
73-02268	0173-97-0001	1.2-2.2	1/2/97	Ash & org. material.	2860	2860	2860	NA	2861	NA	2860	NA	NA	NA	NA	NA
73-02268	0173-97-0002	0.5-1	1/2/97	Ash & debris.	NA	NA	NA	NA	2861	2861	2860	NA	NA	NA	NA	NA
73-02261	0173-97-0003	0.5-1	1/2/97	Ash & debris (slag & glass).	NA	NA	NA	NA	2861	2861	2860	NA	NA	NA	NA	NA
73-02261	0173-97-0004	3.5-4.5	1/2/97	Ash & debris.	2860	2860	2860	NA	2861	NA	2860	NA	NA	NA	NA	NA
73-02268	0173-97-0008[b]	1.2-2.2	1/2/97	Ash & org. material.	2860	2860	2860	NA	2861	NA	2860	NA	NA	NA	NA	NA
73-02451	0173-97-0311	0.1-0.5	10/10/97	Slty. sndy. sed.; slightly damp. Middle drainage @ canyon bottom.	NA	NA	NA	NA	3794	NA	3793	NA	NA	NA	NA	NA
73-02451	0173-97-0312	0.5-1.0	10/10/97	Slty. sndy. sed.; slightly damp. Middle drainage @ canyon bottom.	NA	NA	NA	NA	3794	NA	3793	NA	NA	NA	NA	NA
73-02452	0173-97-0313	0.1-0.5	10/10/97	Sndy. slty. sed. w/ occ. tuff frags. Middle drainage near canyon bottom.	NA	NA	NA	NA	3794	NA	3793	NA	NA	NA	NA	NA
73-02452	0173-97-0314	0.5-1.0	10/10/97	Sndy. slty. sed. w/ occ. tuff frags. Middle drainage near canyon bottom.	NA	NA	NA	NA	3794	NA	3793	NA	NA	NA	NA	NA
73-02453	0173-97-0315	0.1-0.5	10/10/97	Med. to crse. snd. & pebble sed. East drainage near canyon bottom.	NA	NA	NA	NA	3794	NA	3793	NA	NA	NA	NA	NA
73-02453	0173-97-0316[b]	0.1-0.5	10/10/97	Med. to crse. snd. & pebble sed. East drainage near canyon bottom.	NA	NA	NA	NA	3794	NA	3793	NA	NA	NA	NA	NA
73-02453	0173-97-0317	1.5-2.0	10/10/97	Med. to crse. snd. & pebble sed. East drainage near canyon bottom.	NA	NA	NA	NA	3794	NA	3793	NA	NA	NA	NA	NA
73-02454	0173-97-0318	0.1-0.5	10/14/97	[redacted]	NA	3805	NA	NA	3806	NA	3804	NA	NA	NA	NA	NA
73-02455	0173-97-0319	0.1-0.5	10/14/97	[redacted]	NA	3805	NA	NA	3806	NA	3804	NA	NA	NA	NA	NA
73-02456	0173-97-0320	0.1-0.5	10/14/97	[redacted]	NA	3805	NA	NA	3806	NA	3804	NA	NA	NA	NA	NA
73-02457	0173-97-0321	0.1-0.5	10/14/97	[redacted]	NA	3805	NA	NA	3806	NA	3804	NA	NA	NA	NA	NA
73-02458	0173-97-0322	0.1-0.5	10/14/97	[redacted]	NA	3805	NA	NA	3806	NA	3804	NA	NA	NA	NA	NA
73-02459	0173-97-0323	0.1-0.5	10/15/97	Brn/moist soil. West extent.	NA	3808	NA	NA	3810	NA	NA	NA	NA	NA	NA	NA
73-02460	0173-97-0324	0.1-0.5	10/15/97	Brn/moist soil. West extent.	NA	3808	NA	NA	3810	NA	3809	NA	NA	NA	NA	NA
73-02461	0173-97-0325	0.1-0.5	10/15/97	Brn/moist soil. East extent.	NA	3808	NA	NA	3810	NA	3809	NA	NA	NA	NA	NA
73-02462	0173-97-0326	0.1-0.5	10/15/97	Brn/moist soil. East extent.	NA	3808	NA	NA	3810	NA	NA	NA	NA	NA	NA	NA
73-02465	0173-97-0327	3.2-3.7	10/16/97	Can frags. w/ slight amount of ash and soil.	NA	NA	NA	NA	NA	NA	3821	NA	NA	NA	NA	NA
73-02465	0173-97-0328	4.2-4.5	10/16/97	[redacted]	3820	3820	NA	NA	3822	NA	3821	NA	NA	NA	NA	NA
73-02465	0173-97-0329[d]	4.5-4.8	10/16/97	[redacted]	3820	NA	NA	NA	NA	NA	3821	NA	NA	NA	NA	NA
73-02467	0173-97-0331	0.1-0.5	10/17/97	Ash w/ glass and metal frags.	NA	NA	NA	NA	NA	NA	NA	3826	NA	3826	3826	NA
73-02468	0173-97-0332	0.1-0.5	10/17/97	Ash w/ glass and metal frags.	NA	NA	NA	NA	NA	NA	NA	3826	NA	3826	3826	NA
73-02463	0173-97-0333	3.5-4.0	10/17/97	[redacted]	3823	3823	NA	NA	3825	NA	3824	NA	NA	NA	NA	NA
73-02463	0173-97-0334[d]	4.0-4.3	10/17/97	[redacted]	NA	NA	NA	NA	NA	NA	3824	NA	NA	NA	NA	NA
73-02464	0173-97-0336	7.0-7.5	10/17/97	Ash w/ glass and metal frags.	NA	NA	NA	NA	NA	NA	3824	NA	NA	NA	NA	NA
73-02463	0173-97-0337[b]	3.5-4.0	10/17/97	[redacted]	3823	3823	NA	NA	3825	NA	3824	NA	NA	NA	NA	NA
73-02464	0173-97-0338[b]	7.0-7.5	10/17/97	Ash w/ glass and metal frags.	NA	NA	NA	NA	NA	NA	3824	NA	NA	NA	NA	NA
73-10000	RE73-98-0001	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10000	RE73-98-0002[b]	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10001	RE73-98-0003	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10003	RE73-98-0004	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10004	RE73-98-0005	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10005	RE73-98-0006	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10006	RE73-98-0007	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10007	RE73-98-0008	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10008	RE73-98-0009	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10009	RE73-98-0010	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10010	RE73-98-0011	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10011	RE73-98-0012	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10026	RE73-98-0027	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872

LOCATION ID	SAMPLE ID	DEPTH (ft.)	DATE COLL.	MATRIX/LOCATION	VOCs	SVOCs	PEST/ PCBs	HG	METALS	TCLP METALS	DIOXINS/ FURANS	GROSS a,b,g	H3	GSCAN	ISO U	ISO PU
73-10027	RE73-98-0028	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10028	RE73-98-0029	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10029	RE73-98-0030	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10030	RE73-98-0031	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10031	RE73-98-0032	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10032	RE73-98-0033	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10033	RE73-98-0034	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10034	RE73-98-0035	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10035	RE73-98-0036	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10036	RE73-98-0037	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10037	RE73-98-0038	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10002	RE73-98-0066	0-0.5	10/5/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872
73-10034	RE73-98-0068[b]	0-0.5	10/8/98	Ash and debris.	NA	NA	NA	NA	NA	NA	NA	NA	NA	4872	4872	4872

Notes:

NA = Not analyzed

[b] Duplicate sample

[d] Extract and hold pending results of overlying sample.

= Ash

= Sediment downgradient of ash

= Soil downgradient of ash but possibly below cans

= Soil - lateral extent

= Soil or tuff below cans/ash

The outfalls from two associated PRSs, 73-004(a) and 73-006, discharged onto the ash disposal area. PRS 73-004(a), a former septic tank that served the incinerator building, was located approximately 10 feet northwest of the incinerator building's northwest corner. An initial RFI was conducted in July 1996, and the septic tank was removed as part of a VCA in August 1996. The inlet and outlet drainlines were removed as part of a second RFI investigation conducted in February 1999. PRS 73-006, the east and west floor drains from the incinerator building, were also investigated as part of the July 1996 RFI. The east drainline could not be located and was assumed to have been previously removed. The west drainline was removed as part of the second RFI conducted in February 1999.

Operational History

The incinerator operated for a short time beginning in 1947. The incinerator's primary purpose was to destroy classified documents from the Laboratory. It was used for this purpose for only about one year because it did not function properly resulting in incomplete combustion. The incinerator was also used to burn municipal trash. In June 1948, The Zia Company acquired the incinerator building, and used it until September 1973. Before 1973, but sometime after incineration had ceased, the building was used by the Los Alamos Dog Obedience Club. The incinerator equipment and stack have been removed, but no information on the removal operation is available. In the recent past, the building was used by Budget Car Rental for equipment storage and is currently used by a sporting goods store for inventory storage.

Historical information indicates no treatment, storage, or disposal of hazardous wastes at the incinerator building. The primary source of potential contamination would have been materials disposed in the garbage that was brought for incineration. There were no known releases from this site except at the associated outfalls and the ash debris. Both outfalls ceased operation prior to the enactment of permitting regulations.

PRELIMINARY DATA REVIEW FOR THE ASH DEBRIS AND SURROUNDING AREAS

A total of seventy samples were collected from the ash debris and the surrounding areas (drainages below the ash debris and areas on either side of the ash debris) (Figure 1). The samples include 51 samples collected from within the ash debris, 15 samples collected from the drainages, and 4 samples collected from either side of the ash debris. These samples were collected during three separate sampling events beginning in 1996 and continuing in 1997 and 1998. Samples were sent to off-site, fixed analytical laboratories and analyzed for some or all of the following: target analyte list (TAL) metals, pesticides/PCBs, semivolatile organic compounds, (SVOCs), volatile organic compounds (VOCs) (1996 and 1997 samples), dioxins and furans (1997 samples only), tritium (1996 only), isotopic plutonium, isotopic uranium, and radionuclides by gamma scan (1998 samples only). A summary of samples collected and what the samples were analyzed for is presented in Table 1.

The data collected have undergone baseline validation according to the ER Project procedures. The results for individual samples were qualified using the ER Project data validation process by assessing QC parameters, such as surrogate recoveries, matrix spike recoveries, internal standards, blank contamination, laboratory duplicate analysis, and detection status. The ER Project data validation process adheres to the Environmental Protection Agency's (EPA) "Contract Laboratory Program National Functional Guidelines for Inorganic Data Review" (EPA 1994, ER ID48639) and "Contract Laboratory Program National Functional Guidelines for Organic Data Review" (EPA 1994, ER ID48640) for data validation and incorporates LANL-specific reason codes for qualifying data. Based on the Laboratory's baseline validation, the data for the ash debris and the surrounding areas as a whole are of good quality and sufficient for decision-making purposes.

Ash Debris Inorganic Data

A comparison of the inorganic sample results to Laboratory background values (BVs) was conducted in order to compare the concentrations detected in the ash debris to uncontaminated soil concentrations. The background comparison was conducted using soil BVs because this is the environmental medium on the surface of the canyon slope surrounding the ash debris and is the medium that has been deposited on the surface of the ash debris. The soil BVs were obtained from "Inorganic and Radionuclide Background Data for Soils, Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (LANL 1998, ER ID 59730). The analytical and sample preparation methods used in analyzing the samples collected during the RFI were comparable to the methods used to determine the background data set with the following exception. The inorganic data from the PRS were produced by inductively coupled plasma emission spectroscopy (ICPES), which may result in elevated detection limits compared to the background data, which were produced by inductively coupled mass spectroscopy (ICPMS).

The 95% upper confidence limit (UCL) of the arithmetic mean of the analytical results for each inorganic chemical was used in the comparison to soil BVs. This comparison found that UCLs for aluminum, beryllium, magnesium, potassium, and vanadium were below their respective soil BVs, while the other inorganic chemicals were greater than their respective soil BVs. Antimony, arsenic, barium, cadmium, calcium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, sodium, thallium, and zinc are, therefore, retained as chemicals of potential concern (COPCs) and evaluated further by the human health and ecological screening assessments. The results of the background comparison are presented in Table 2 with inorganics greater than BV bolded.

TABLE 2
COMPARISON OF INORGANIC CHEMICALS IN THE ASH DEBRIS TO SOIL BACKGROUND VALUES

Analyte	Range of Sample Values (mg/kg)	95% UCL (mg/kg)	Soil BV (mg/kg)
Aluminum	840 – 32000	15086	29200
Antimony	**0.71(U)[a] – 159**	**56.2**	**0.83**
Arsenic	**1.3 – 90**	**47**	**8.17**
Barium	**10 – 6280**	**2132**	**295**
Beryllium	0.21 (J) – 2.9(U)	1.0	1.83
Cadmium	**0.04(U) – 42.9**	**13.2**	**0.4**
Calcium	**270 – 45900**	**24482**	**6120**
Chromium	**1.3 – 133**	**71.9**	**19.3**
Cobalt	**1.0(U) – 37.8**	**18.8**	**8.64**
Copper	**1.1(U) – 6330**	**1962**	**14.7**
Iron	**6.4(U) – 431000**	**139678**	**21500**
Lead	**2.3 – 13100**	**4222**	**22.3**
Magnesium	160 – 6016	2850	4610
Manganese	**95 – 1960**	**1915**	**671**
Mercury	**0.02(U) – 19**	**5.7**	**0.1**
Nickel	**1.7 – 236**	**94.3**	**15.4**
Potassium	290 – 5040	3381	3460
Selenium	**1.0(U) – 4.3**	**1.84**	**1.52**
Silver	**0.15(U) – 448**	**104.1**	**1**
Sodium	**55 – 7760**	**1568**	**915**
Thallium	**0.026(U) – 10.6**	**4.9**	**0.73**
Vanadium	1.1 – 62	19.9	39.6
Zinc	**18 - 7170**	**3052**	**48.8**

[a] The "U" qualifier in parentheses indicates an undetected value.

Ash Debris Radionuclide Data

A comparison of the radionuclide sample results to Laboratory background/fallout values was conducted in order to compare the concentrations detected in the ash debris to uncontaminated soil concentrations. The background comparison was conducted using soil BVs because this is the environmental medium on the surface of the canyon slope surrounding the ash debris and is the medium that has been deposited on the surface of the ash debris. The soil BVs were obtained from "Inorganic and Radionuclide Background Data for Soils, Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (LANL 1998, ER ID 59730). The analytical and sample preparation methods used in analyzing the samples collected during the RFI were comparable to the methods used to determine the background data set.

The 95% UCL of the arithmetic mean of the analytical results for each detected radionuclide was used in the comparison to soil background/fallout values. This comparison found that UCLs for cesium-137, plutonium-238, and tritium were below their soil background/fallout values, while the other detected radionuclides were greater than their soil background/fallout values. As a result, amercium-241, plutonium-239, radium-226, uranium-234, uranium-235, and uranium-238 are retained as COPCs and evaluated further by the human health and ecological screening assessments. The results of the background/fallout comparison are presented in Table 3 and the radionuclides greater than BV are bolded.

TABLE 3
COMPARISON OF RADIONUCLIDES IN THE ASH DEBRIS TO SOIL BACKGROUND/FALLOUT VALUES

Analyte	Range of Sample Values (pCi/g)	95% UCL (pCi/g)	Soil BV (pCi/g)
Amercium-241	**-0.03(U)[a] – 1.33**	**0.16**	**0.013[b]**
Cesium-137	0.07(U) – 1.51	0.49	1.65[b]
Plutonium-238	-0.0017(U) – 0.066	0.005	0.023[b]
Plutonium-239	**0.0022(U) – 2.82**	**1.3**	**0.054[b]**
Radium-226	**0(U) – 11.1**	**5.3**	**2.59**
Tritium	-0.02(U) – 0.15	0.077	0.08[b,c]
Uranium-234	**0.48 – 17.1**	**7.2**	**2.59**
Uranium-235	**0(U) – 0.97**	**0.4**	**0.2**
Uranium-238	**0.5 – 15.9**	**5.2**	**2.29**

[a] The "U" qualifier in parentheses indicates an undetected value.
[b] Value applies to samples collected from 0-6 in.
[c] Value calculated based on 10% moisture.

Ash Debris Organic Data

A number of organic chemicals were detected in the samples collected from the ash debris. These organics included pesticides, PCBs (polychlorinated biphenyls), PAHs (polynuclear aromatic hydrocarbons), other SVOCs, dioxins/furans, and VOCs. All of these chemicals are retained as COPCs and evaluated further by the human health and ecological screening assessments. In addition, three PAHs (anthracene, acenaphthene, and benzo(a)pyrene) are included because other chemicals in this group were detected in the ash debris and these chemicals were detected either in the drainage below the ash debris or in the area next to the ash debris. A summary of the detected organic compounds is provided in Table 4.

TABLE 4
ORGANIC CHEMICALS IN THE ASH DEBRIS

Analyte	Range of Sample Values (mg/kg)	95% UCL (mg/kg)	Number of Detects
Acenaphthene	0.34(U)[a] – 1.8(U)	0.66	0
Anthracene	0.34(U) – 1.8(U)	0.66	0
Aroclor-1254	0.034(U) – 3.7(U)	0.58	6
Benzo(a)anthracene	0.043(J)[b] – 1.8(U)	0.67	3
Benzo(a)pyrene	0.34(U) – 1.8(U)	0.66	0
Benzo(b)fluoranthene	0.076(J) – 1.8(U)	0.67	2
Benzo(k)fluoranthene	0.075(J) – 1.8(U)	0.69	2
beta-BHC	0.0007(U) – 0.18(U)	0.028	1
Bis(2-ethyhexyl)phthalate	0.12(J) – 1.8(U)	0.65	2
alpha-Chlordane	0.0017(U) – 0.18(U)	0.078	1
gamma-Chlordane	0.0017(U) – 0.18(U)	0.029	1
Chrysene	0.047(J) – 1.8(U)	0.75	3
4,4'-DDT	0.0034(U) – 3.9	0.48	8
4,4'-DDE	0.0034(U) – 0.78	0.14	10
4,4'-DDD	0.0034(U) – 1.3	0.83	2
1,2-Dichlorobenzene	0.005(U) – 0.12(J)	0.34	1
1,3-Dichlorobenzene	0.005(U) – 0.12(J)	0.022	1
1,4-Dichlorobenzene	0.005(U) – 0.048	0.012	2

[a] The "U" qualifier in parentheses indicates an undetected value.
[b] The "J" qualifier in parentheses indicates an estimated detected value.

TABLE 4
ORGANIC CHEMICALS IN THE ASH DEBRIS
Continued

Analyte	Range of Sample Values (mg/kg)	95% UCL (mg/kg)	Number of Detects
Di-n-butyl phthalate	0.05(J) – 1.5(U)	0.44	5
Endosulfan I	0.0007(U)[a] – 0.18(U)	0.028	1
Fluoranthene	0.078(J)[b] – 1.5(U)	0.54	2
Dioxins/Furans	0.000003(U) – 0.001443[c]	0.000441[c]	9
4-Isopropyltoluene	0.005(U) – 0.032(U)	0.013	1
2-Methylnaphthalene	0.25(J) – 1.5(U)	0.57	1
Naphthalene	0.34(U) – 1.5(U)	0.5	1
Phenanthrene	0.25(J) – 1.5(U)	0.54	2
Phenol	0.34(U) – 1.5(U)	0.56	1
Pyrene	0.049(J) – 1.8(U)	0.63	2
Tetrachloroethene	0.002(J) – 0.032(U)	0.012	7
1,1,1-Trichloroethane	0.002(U) – 0.032(U)	0.013	15
Trichloroethene	0.002(J) – 0.032(U)	0.012	14
Trichlorofluoromethane	0.005(U) – 0.041	0.016	15
1,3,5-Trimethylbenzene	0.005(U) – 0.01	0.012	1

[a] The "U" qualifier in parentheses indicates an undetected value.
[b] The "J" qualifier in parentheses indicates an estimated detected value.
[c] Values were obtained using the toxicity equivalency factors recommended by EPA for dioxin (see Attachment 1).

Drainage Inorganic Data

A comparison of the inorganic sample results for the drainage leading from the ash debris slope to Laboratory BVs was conducted in order to determine whether there had been a release from the ash debris into the drainage. The background comparison was conducted using soil BVs because the material in the drainages is the same as the surface soil on the canyon slope. The soil BVs were obtained from "Inorganic and Radionuclide Background Data for Soils, Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (LANL 1998, ER ID 59730). The analytical and sample preparation methods used in analyzing the samples collected during the RFI were comparable to the methods used to determine the background data set with the following exception. The inorganic data from the drainage were produced by inductively coupled plasma emission spectroscopy (ICPES) with radial view for three samples, which resulted in elevated detection limits for antimony, cadmium, mercury, silver, and thallium compared to the background data, which were produced by inductively coupled mass spectroscopy (ICPMS). The other twelve samples were analyzed by ICPES with axial view, which provides lower detection limits that are comparable to ICPMS results.

The 95% UCL of the arithmetic mean was used for the majority of the inorganic chemicals in the soil BV comparison. However, eight inorganic chemicals (aluminum, calcium, iron, magnesium, potassium, sodium, vanadium, and zinc) were only analyzed in three samples, which are an insufficient number of samples to calculate the 95% UCL. As a result, the background comparison for these metals was conducted using the maximum detected concentration. The comparison found that cadmium, lead, and zinc were detected above their respective BVs, while the other inorganic chemicals were detected below their respective soil BVs (Table 5). Cadmium, lead, and zinc (bolded in Table 5) were retained as COPCs and evaluated further in the human health and ecological screening assessments. Antimony, mercury, silver, and thallium had elevated detection limits above their soil BVs in three samples because as mentioned above the analytical method used did not produce low detection limits. Antimony was not detected in twelve other samples that had detection limits below the soil BV (ICPES with axial view). Mercury and silver were detected in five and one samples, respectively, with low detection limits at

concentrations below the soil BVs, while thallium was detected in two samples with low detection limits at concentrations slightly above the soil BV. These detected concentrations of thallium (0.8 mg/kg and 0.87 mg/kg) were within the range of background values in the data set (0.06 mg/kg to 1 mg/kg) and are not considered to be different from background. Based on this information, antimony, mercury, silver, and thallium are not considered to be different from background despite the detection limits greater than the soil BVs and were not evaluated further in the human health and ecological screening assessments.

TABLE 5
COMPARISON OF INORGANIC CHEMICALS IN THE DRAINAGE TO SOIL BACKGROUND VALUES

Analyte	Range of Sample Values (mg/kg)	95% UCL or Maximum Concentrations (mg/kg)	Soil BV (mg/kg)
Aluminum	1400 – 4400	4400[a]	29200
Antimony	0.21(U)[b] – 12(U)	5.7(U)	0.83
Arsenic	0.79 – 2.5	1.6	8.17
Barium	6.2 – 110	110[a]	295
Beryllium	0.52(U) – 0.62(U)	0.62(U)[a]	1.83
Cadmium	**0.04(U) – 12.2**	**2.3**	**0.4**
Calcium	1300 – 2400	2400[a]	6120
Chromium	1.1 – 4.6	3.1	19.3
Cobalt	0.78 – 9.9	2.9	8.64
Copper	0.4 – 5.4	3.6	14.7
Iron	4400 – 7200	7200[a]	21500
Lead	**8.6 – 168**	**41**	**22.3**
Magnesium	270 – 720	720[a]	4610
Manganese	99.3 – 790	377	671
Mercury	0.02(U) – 0.12(U)	0.06	0.1
Nickel	0.8 – 3.9	3.5	15.4
Potassium	240 – 770	770[a]	3460
Selenium	0.21(U) – 0.25(U)	0.25(U)	1.52
Silver	0.14(U) – 2.5(U)	0.99	1
Sodium	43 – 83	83[a]	915
Thallium	0.53(U) – 1.5(U)	0.92	0.73
Vanadium	3.4 – 7.5	7.5[a]	39.6
Zinc	**42 - 470**	**470[a]**	**48.8**

[a] Values are the maximum detected concentrations or the maximum detection limits for each inorganic.
[b] The "U" qualifier in parentheses indicates an undetected value.

Drainage Radionuclide Data

Gross alpha, gross beta, and gross gamma measurements were collected from the soil in the drainage below the ash debris. The results of the radioactivity screening were below or similar to Laboratory background (Table 6). Tritium was analyzed for in three samples from the drainage and was detected at concentrations below the background/fallout value (Table 6). As a result, additional samples were not analyzed for radionuclides in the drainage. Based on this information, gross alpha, beta, and gamma radiation and tritium are not considered to be different from background and were not evaluated further in the human health and ecological screening assessments.

TABLE 6
RADIOACTIVITY SCREENING AND TRITIUM RESULTS FROM THE DRAINAGE

Analyte	Range of Sample Values (pCi/g)	Maximum Detected Value (pCi/g)	Soil BV (pCi/g)
Gross alpha	0.66 – 3.6	3.6	31.3
Gross beta	1.0 – 4.3	4.3	48.5
Gross gamma	8.1 – 16.5	16.5	10.7
Tritium	0.025 – 0.064	0.064	0.08[a,b]

[a] Value applies to samples collected from 0-6 in.
[b] Value calculated based on 10% moisture.

Drainage Organic Data

Organic chemicals were detected in the samples collected from the drainage. These organics included pesticides, SVOCs, and dioxins/furans. All of these chemicals are retained as COPCs and evaluated further by the human health and ecological screening assessments. A summary of the detected organic compounds is provided in Table 7.

TABLE 7
ORGANIC CHEMICALS DETECTED IN THE DRAINAGE

Analyte	Range of Sample Values (mg/kg)	95% UCL or Maximum Detected Value (mg/kg)	Number of Detects
Benzoic acid	0.043(J)[a] – 1.9(U)[b]	0.092	2
alpha-Chlordane	0.0017(U) – 0.0035	0.0035[c]	1
4,4'-DDT	0.0035(U) – 0.034	0.034[c]	1
4,4'-DDE	0.0035(U) – 0.029	0.029[c]	1
Dioxins/Furans	0.0000005(U) – 0.000002(U)[d]	0.0000012[d]	3

[a] The "J" qualifier in parentheses indicates an estimated detected value.
[b] The "U" qualifier in parentheses indicates an undetected value.
[c] Values are the maximum detected concentrations or the maximum detection limits for each inorganic.
[d] Values were obtained using the toxicity equivalency factors recommended by EPA for dioxin (Attachment 1).

Lateral Inorganic Data

A comparison of the inorganic sample results from the samples collected on either side of the ash debris to Laboratory BVs was conducted in order to determine whether elevated inorganic concentrations were present beyond the lateral bounds of the ash debris. The background comparison was conducted using soil BVs because the material on the canyon slope is soil. The soil BVs were obtained from "Inorganic and Radionuclide Background Data for Soils, Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (LANL 1998, ER ID 59730). The analytical and sample preparation methods used in analyzing the samples collected during the RFI were comparable to the methods used to determine the background data set. The inorganic data on either side of the ash debris were produced by ICPES with axial view, which provides lower detection limits that are comparable to ICPMS.

The background comparison for the inorganic chemicals was conducted using the maximum detected concentration. The 95% UCL of the arithmetic mean was not used because a total of four samples were collected from either side of the ash debris, which are an insufficient number of samples to calculate the 95% UCL. The comparison found that barium, cadmium, copper, lead, mercury, silver, and thallium were detected above their respective BVs, while the other inorganic chemicals were detected below their respective soil BVs (Table 8). Cadmium had two detected concentrations (0.81 mg/kg and 0.65 mg/kg) and thallium had one detected concentration (0.77 mg/kg) above their soil BVs. The detected concentrations of cadmium and thallium were within the ranges of background values in the data sets (0.2 mg/kg to 2.6 mg/kg for cadmium and 0.063

mg/kg to 1.0 mg/kg for thallium) and are not considered to be different from background. Based on this information, barium, copper, lead, mercury, and silver were retained as COPCs (bolded in Table 8) and evaluated further in the human health and ecological screening assessments, while cadmium and thallium were not evaluated further. The highest concentration of each inorganic chemical was detected in the samples collected beyond the eastern boundary of the ash debris with the exception of thallium.

TABLE 8
COMPARISON OF INORGANIC CHEMICALS ON EITHER SIDE OF THE ASH DEBRIS TO SOIL BACKGROUND VALUES[a]

Analyte	Range of Sample Values (mg/kg)	Maximum Detected Concentrations (mg/kg)	Soil BV (mg/kg)
Aluminum	NA[b]	NA	29200
Antimony	0.72 – 0.83	0.83	0.83
Arsenic	2.4 – 3.3	3.3	8.17
Barium	**77.5 – 415**	**415**	**295**
Beryllium	NA	NA	1.83
Cadmium	0.11(J)[c] – 0.81(J)	0.81(J)	0.4
Calcium	NA	NA	6120
Chromium	4.5 – 9.8	9.8	19.3
Cobalt	2.5(J) – 5.3(J)	5.3(J)	8.64
Copper	**9.6 – 40.2**	**40.2**	**14.7**
Iron	NA	NA	21500
Lead	**23.4 – 83.7**	**83.7**	**22.3**
Magnesium	NA	NA	4610
Manganese	298 - 519	519	671
Mercury	**0.05(J) – 0.24**	**0.24**	**0.1**
Nickel	3.9(J) – 8.2(J)	8.2(J)	15.4
Potassium	NA	NA	3460
Selenium	NA	NA	1.52
Silver	**1.1(J) – 10.7**	**10.7**	**1**
Sodium	NA	NA	915
Thallium	0.55 – 0.77(J)	0.77(J)	0.73
Vanadium	NA	NA	39.6
Zinc	NA	NA	48.8

[a] Total of four samples collected; two on each side of the ash debris.
[b] NA = not analyzed
[c] The "J" qualifier in parentheses indicates an estimated detected value.

Lateral Radionuclide Data

The samples collected from the area on either side of the ash debris were not analyzed for radionuclides.

Lateral Organic Data

Several organic chemicals were detected in the samples collected from the drainage. These organics included PAHs, other SVOCs, and dioxins/furans. The detected organics were found in the samples collected from beyond the eastern boundary of the ash debris, while only dioxins/furans were detected in the samples collected beyond the western boundary of the ash debris. The concentration of dioxins/furans detected in the western sample was an order of magnitude below the eastern sample. All of these chemicals are retained as COPCs and evaluated further by the human health and ecological screening assessments. A summary of the detected organic compounds is provided in Table 9.

TABLE 9
ORGANIC CHEMICALS ON EITHER SIDE OF THE ASH DEBRIS [a]

Analyte	Range of Sample Values (mg/kg)	Maximum Detected Concentration (mg/kg)	Number of Detects
Acenaphthene	0.035(J)[b] – 0.78	0.78	2
Anthracene	0.061(J) – 0.41(U)[c]	0.061(J)	1
Benzo(a)anthracene	0.1(J) – 0.41(U)	0.1(J)	1
Benzo(a)pyrene	0.11(J) – 0.41(U)	0.11(J)	1
Benzo(b)fluoranthene	0.21(J) – 0.41(U)	0.21(J)	1
Benzoic acid	0.051(J) – 2.9(U)	0.051(J)	1
Bis(2-ethyhexyl)phthalate	0.05(J) – 0.41(U)	0.05(J)	1
Chrysene	0.11(J) – 0.41(U)	0.11(J)	1
Di-n-butyl phthalate	0.077(J) – 0.41(U)	0.077(J)	1
Fluoranthene	0.24 (J) – 0.41(U)	0.24(J)	1
Dioxins/Furans	0.0000016(J) – 0.000013(J)[d]	0.000013[d]	2[e]
Naphthalene	0.041(J) – 0.41(U)	0.041(J)	1
Phenanthrene	0.21(J) – 0.41(U)	0.21(J)	1
Pyrene	0.32(J) – 0.41(U)	0.32(J)	1

[a] Total of four samples collected; two on each side of the ash debris.
[b] The "J" qualifier in parentheses indicates an estimated detected value.
[c] The "U" qualifier in parentheses indicates an undetected value.
[d] Values were obtained using the toxicity equivalency factors recommended by EPA for dioxin (Attachment 1).
[e] Only two of four samples analyzed for dioxins and furans; one on each side of the ash debris.

Summary

Based on the comparison to background values for inorganic chemicals, several metals have been identified as chemicals of potential concern (COPCs) in the ash debris, the drainages, and the areas on either side of the ash debris. The exposure concentrations for eighteen metals were above their respective soil BVs in the ash debris. By comparison, the exposure concentrations or maximum detected values for four and seven metals, respectively, were above the BVs in the drainages and lateral areas.

The comparison of detected radionuclides in the ash debris to their respective background/fallout values resulted in six radionuclides being identified as COPCs. The exposure concentrations for these radionuclides were above their respective background/fallout values. Radionuclides were not analyzed for in the drainages or on either side of the ash debris. However, screening data from the drainage areas indicated that radioactivity was below Laboratory background levels.

The evaluation of the sampling data identified a number of organic chemicals as COPCs in the ash debris, the drainages, and the areas on either side of the ash debris. There were 33 organic chemicals (semivolatile organics, volatile organics, PCBs/pesticides, and dioxin/furans) detected in the ash debris compared to five and 14 organic chemicals detected in the drainages (semivolatile organic, pesticides, and dioxins/furans) and on either side of the ash debris (semivolatile organics and dioxins/furans), respectively.

PRELIMINARY HUMAN HEALTH SCREENING EVALUATION OF THE ASH DEBRIS AND SURROUNDING AREAS

A preliminary human health screening evaluation was conducted on the sampling results for the ash debris. The screening evaluation was conducted separately for three different areas: the ash

debris, the drainage below the ash debris, and the area on either side of the ash debris. The screening evaluation was conducted by comparing the exposure concentrations of chemicals detected at the site to screening values for each chemical. The screening values were calculated using the most current toxicity information, exposure parameters, and equations. These values are based on either a residential or recreational exposure scenario. The methodology for calculating the residential values for nonradionuclides is presented in Appendix C of the 1998 Installation Work Plan (LANL 1998, ER ID 62060). The residential values for radionuclides were calculated using a computer model (RESRAD) developed by Argonne National Laboratory. The recreational values for nonradionuclides and radionuclides were calculated using the canyons human health risk screening model (LANL 1998, ER ID 62049). These two scenarios were chosen because the residential exposure represents the highest level of potential exposure and provides a conservative estimate of risk, while the recreational exposure is more representative of potential use of the site (i.e., hikers/walkers). The two scenarios differ with respect to their exposure assumptions. For example, the exposure frequency is assumed to be 350 days/yr for the residential setting vs. 75 days/yr for the recreational setting. In addition, an exposure time of 24 hrs/day is implied for the resident, while the exposure time for the trail user is assumed to be 1 hr/day.

A residential scenario is used to evaluate areas where there are occupied residences on or adjacent to a potential release site as well as sites that may be developed as residential areas. Under this land use, present-day risk is expected to result from frequent, repeated contact with contaminated media. The assumptions used account for daily exposure over a long period of time and generally result in the highest potential exposure and risk to an individual. The exposure pathways related to this scenario that are routinely evaluated (and upon which the screening values are based) include incidental ingestion of soil, inhalation of particulates and/or vapors, and dermal contact.

The recreational scenario pertains to individuals that may be exposed as a result of spending a limited amount of time in outdoor activities on or near a potential release site. Under this land use, activities such as hiking, walking, jogging, camping, biking, hunting, and fishing may be addressed. The recreational activity most likely in this situation is the trail user (i.e., hikers and walkers) and is the only use evaluated by the screening evaluation. Other uses may be evaluated by modifying the exposure parameters. For example, the exposure for a jogger may be evaluated by changing the inhalation rate, the exposure time, or the exposure frequency. The exposure pathways related to the recreational scenario that are routinely evaluated (and upon which the screening values are based) are incidental ingestion of soil, inhalation of particulates and/or vapors, and dermal contact.

The chemicals detected at a site were separated by the type of compound and/or general effect that occurs as a result of exposure. The chemical groups, which include noncarcinogens, carcinogens, and radionuclides, are evaluated separately for each area related to the ash debris, i.e., the ash debris slope, the drainages, and the area adjacent to the ash debris. For noncarcinogens, the screening value represents a concentration that would not be expected to be associated with adverse health effects. The ratio of the exposure concentration of a chemical to its screening value (residential or recreational) is the hazard quotient. A hazard quotient above one indicates a potential for toxicity from exposure to that chemical. The summation of all hazard quotients result in a hazard index that provides an overall indication of potential for noncarcinogenic adverse health effects.

For carcinogens, the screening value represents a total excess lifetime cancer risk of 1.0×10^{-6} (one in a million) resulting from exposure. By using a ratio of exposure concentration of a carcinogen to screening value, a probability of induction of cancer (risk) is determined. The acceptable target risk range, as established by the EPA (EPA 1990, ER ID 55594), is one in ten thousand to one in one million (10^{-4} to 10^{-6}) occurrences of excess cancer in a population. An overall excess cancer risk that exceeds 10^{-4} is an indication of potential unacceptable risk.

In order to determine the dose of radiation received by exposure to radionuclides, the exposure concentration in the environment is compared to the screening value of the individual radionuclide. The target dose level used for radionuclide screening value calculations is 10 mrem/yr based on the DOE's annual effective dose rate of 100 mrem/yr from all sources (DOE 1990, ER ID 58980). Further investigation of sites exceeding 10 mrem/yr is consistent with DOE regulatory guidance. Only samples from within the ash debris area have been analyzed for radionuclides.

Ash Debris Area

The data review for the ash debris sampling results identified 18 inorganic chemicals and six radionuclides greater than their respective background/fallout values. Additionally, 33 organic chemicals were detected. These chemicals were identified as noncarcinogens, carcinogens, or radionuclides and compared to their respective screening values.

The comparison of the noncarcinogenic chemicals detected in the ash debris to the residential and recreational screening values is presented in Table 10. Antimony, arsenic, iron, and lead are all greater than their respective residential screening values. The hazard index of 24.8 for the residential setting indicates a potential for adverse health effects, with lead contributing approximately 42% of the HI. In contrast, only lead is greater than its recreational screening value and contributes approximately 78% of the HI. The hazard index of 2.8 would indicate a very low potential for adverse health effects from exposure to these chemicals at these concentrations in the recreational setting. Concentrations greater than screening values are bolded in Table 10.

TABLE 10
COMPARISON OF NONCARCINOGENIC COPCs IN THE ASH DEBRIS TO SCREENING VALUES

Analyte	Exposure Concentration (mg/kg)	Residential Screening Value (mg/kg)	Recreational Screening Value (mg/kg)	Residential Hazard Quotient	Recreational Hazard Quotient
Acenaphthene	0.66	2600	32000	0.0003	0.00002
Anthracene	0.66	14000	160000	0.00005	0.000004
Antimony	**56.2**	**30**	890	**1.9**	0.06
Aroclor-1254	0.58	0.97	16	0.6	0.04
Arsenic	**47**	**21**	390	**2.2**	0.1
Barium	2132	5200	150000	0.4	0.01
Cadmium	13.2	37	2200	0.4	0.006
Calcium	24482	NA	NA	NA	NA
Cobalt	18.8	3300	7600	0.006	0.002
Copper	1962	2800	87000	0.07	0.02
1,2-Dichlorobenzene	0.34	370	48000	0.0009	0.000007
1,3-Dichlorobenzene	0.022	41	16000	0.0005	0.000001
Di-n-butyl phthalate	0.44	5500	53000	0.00008	0.000008
Endosulfan I[a]	0.028	330	3200	0.00008	0.000009
Fluoranthene	0.54	200	22000	0.003	0.00002
Iron	**139678**	**22000**	560000	**6.3**	0.2
4-Isopropyltoluene[b]	0.013	160	53000	0.00008	0.0000002
Lead	**4222**	**400**	2000	**10.5**	**2.1**
Manganese	1915	3100	17000	0.6	0.1

[a] There are no screening values for endosulfan I; the values used are for endosulfan.
[b] There are no screening values for isopropyltoluene; the values used are for isopropylbenzene (cumene).
NA = Not available

TABLE 10
COMPARISON OF NONCARCINOGENIC COPCs IN THE ASH DEBRIS TO SCREENING VALUES
Continued

Analyte	Exposure Concentration (mg/kg)	Residential Screening Value (mg/kg)	Recreational Screening Value (mg/kg)	Residential Hazard Quotient	Recreational Hazard Quotient
Mercury	5.7	22	660	0.3	0.009
2-Methylnaphthalene[c]	0.57	5.5	2200	0.1	0.0003
Naphthalene	0.5	5.5	2200	0.1	0.0002
Nickel	94.3	1500	44000	0.06	0.002
Phenanthrene[d]	0.54	14000	16000	0.00004	0.00003
Phenol	0.56	33000	300000	0.00002	0.000002
Pyrene	0.63	1500	16000	0.0004	0.00004
Selenium	1.84	370	11000	0.005	0.0002
Silver	104.1	370	11000	0.3	0.009
Sodium	1568	NA	NA	NA	NA
Thallium	4.9	5.2	180	0.9	0.03
1,1,1-Trichloroethane	0.013	6800	19000	0.000002	0.0000007
Trichlorofluoromethane	0.016	380	160000	0.00004	0.0000001
1,3,5-Trimethylbenzene	0.012	21	27000	0.0006	0.0000004
Zinc	3052	22000	560000	0.1	0.005
			Hazard Index	**24.8**	**2.7**

[c] There are no screening values for 2-methylnaphthalene; the values used are for naphthalene.
[d] There are no screening values for phenanthrene; the values used are for anthracene.
NA = Not available

The comparison of the exposure concentrations of the carcinogenic chemicals detected in the ash debris to the residential and recreational screening values is presented in Table 11. The total of 259.6 for a residential setting is equal to approximately 3 in 10,000 or 3×10^{-4} excess cancer risk. This risk is at the low end of the acceptable risk range and is considered marginal. The total of 75.6 for a recreational exposure setting is equal to approximately 8 in 100,000 or 8×10^{-5} excess cancer risk. This risk is in the middle of the acceptable risk range. Concentrations greater than screening values are bolded. For both exposure scenarios, arsenic, dioxins/furans, and benzo(a)pyrene contribute the most to the total. Arsenic and dioxins/furans contribute approximately 48% and 45%, respectively, to the total incremental cancer risk to a resident from the ash debris. These two chemicals contribute approximately 19% and 73%, respectively, to the total incremental cancer risk to a trail user from the ash debris.

TABLE 11
COMPARISON OF CARCINOGENIC COPCs IN THE ASH DEBRIS TO SCREENING VALUES

Analyte	Exposure Concentration (mg/kg)	Residential Screening Value (mg/kg)	Recreational Screening Value (mg/kg)	Exposure Concentration /Residential Screening Value	Exposure Concentration /Recreational Screening Value
Aroclor-1254	**0.58**	**0.29**	0.95	**2.0**	0.6
Arsenic	**47**	**0.38**	**3.3**	**123.7**	**14.2**
Benzo(a)anthracene	**0.67**	**0.56**	1.7	**1.3**	0.4
Benzo(a)pyrene	**0.66**	**0.056**	**0.17**	**11.8**	**3.9**
Benzo(b)fluoranthene	**0.67**	**0.56**	1.7	**1.2**	0.4
Benzo(k)fluoranthene	0.69	5.6	17.0	0.1	0.04
beta-BHC	0.028	0.3	4.4	0.3	0.004
Bis(2-ethyhexyl)phthalate	0.65	32	90.0	0.02	0.007

TABLE 11
COMPARISON OF CARCINOGENIC COPCs IN THE ASH DEBRIS TO SCREENING VALUES
Continued

Analyte	Exposure Concentration (mg/kg)	Residential Screening Value (mg/kg)	Recreational Screening Value (mg/kg)	Exposure Concentration /Residential Screening Value	Exposure Concentration /Recreational Screening Value
alpha-Chlordane	0.078	1.6	3.6	0.05	0.02
gamma-Chlordane	0.029	1.6	3.6	0.02	0.008
Chromium (total)	**71.9**	**30**	78.0	**2.4**	0.9
Chrysene	0.75	56	170.0	0.01	0.004
4,4'-DDT	0.48	1.7	3.7	0.3	0.02
4,4'-DDE	0.14	1.7	3.7	0.08	0.007
4,4'-DDD	0.83	2.4	5.3	0.3	0.01
1,4-Dichlorobenzene	0.012	3	294.6	0.004	0.00004
Dioxins/Furans	**0.000441**	**0.0000038**	**0.000008**	**116.1**	**55.1**
Tetrachloroethene	0.012	4.7	24	0.003	0.00008
Trichloroethene	0.012	2.7	110	0.004	0.00002
			Total	**259.6**	**75.6**

The comparison of the exposure concentrations of the radionuclides detected in the ash debris to the residential and recreational screening values is presented in Table 12. A total of one would indicate a dose level of 10 mrem/yr. The totals of 1.9 and 0.07 indicate yearly dose levels of 19 mrem/yr and 0.7 mrem/year, respectively, for the residential and recreational settings. The primary contributors to the total doses for the residential exposure are radium-226 and uranium-234 contributing approximately 55% and 30% of the dose, respectively. The total dose for residential exposure is greater than 15 mrem/yr, which is the acceptable level for unrestricted release of residential sites (DOE 1990, ER ID 58980). The total dose for recreational use is well below the 15 mrem/yr total dose limit.

TABLE 12
COMPARISON OF RADIONUCLIDE COPCs IN THE ASH DEBRIS TO SCREENING VALUES

Analyte	Exposure Concentrations (pCi/g)	Residential Screening Value (pCi/g)	Recreational Screening Value (pCi/g)	Exposure Concentration /Residential Screening Value	Exposure Concentration /Recreational Screening Value
Amercium-241	0.16	22	200.2	0.007	0.0008
Plutonium-239	1.3	24	207.6	0.05	0.006
Radium-226	**5.3**	**5.0**	91.4	**1.1**	0.06
Uranium-234	7.2	13	1779.7	0.6	0.004
Uranium-235	0.4	10	860.2	0.04	0.0005
Uranium-238	5.2	67	1574	0.08	0.003
			Total	**1.9**	**0.07**

Drainage Areas Below the Ash Debris

The data review for the sampling results from the drainage area below the ash debris identified three inorganic chemicals greater than their respective background values and five organic chemicals, including dioxins and furans, detected in the soil. The comparisons of the exposure concentrations of the noncarcinogens detected in the drainage area to their respective screening values are presented in Table 13. For the residential exposure, none of the chemicals has a hazard quotient greater than 0.1. The residential exposure hazard index is 0.2. The recreational exposure hazard index is 0.03. Based on this comparison of exposure concentrations to screening values, exposure to these chemicals in the drainages below the ash debris would not be expected to pose a potential for adverse health effects under either scenario.

TABLE 13
COMPARISON OF NONCARCINOGENIC COPCs IN THE DRAINAGE AREA TO SCREENING VALUES

Analyte	Exposure Concentration (mg/kg)	Residential Screening Value (mg/kg)	Recreational Screening Value (mg/kg)	Residential Hazard Quotient	Recreational Hazard Quotient
Benzoic Acid	0.092	100000	1500000	0.000001	0.000006
Cadmium	2.3	37	2200	0.06	0.001
Lead	41	400	2000	0.1	0.02
Zinc	470	22000	56000	0.02	0.008
			Hazard Index	**0.2**	**0.03**

The comparisons of the exposure concentrations of the carcinogens detected in the drainage area to their respective screening values are presented in Table 14. The total for a residential setting of 0.3 is equal to a cancer risk of 0.3 in a million (which is 3 in 10 million) or 3.0×10^{-7} excess cancer risk. The total for a recreational setting of 0.2 is equal to a cancer risk of 0.2 in a million (which is 2 in 10 million) or 2.0×10^{-7} excess cancer risk. These risks are above the target risk range of 10^{-4} to 10^{-6} and are considered as acceptable potential risk levels. For both exposure scenarios, dioxins/furans contribute nearly 100% of the total incremental cancer risk.

TABLE 14
COMPARISON OF CARCINOGENIC COPCs IN THE DRAINAGE AREA TO SCREENING VALUES

Analyte	Exposure Concentration (mg/kg)	Residential Screening Value (mg/kg)	Recreational Screening Value (mg/kg)	Exposure Concentration /Residential Screening Value	Exposure Concentration /Recreational Screening Value
alpha-Chlordane	0.0035	1.6	3.6	0.002	0.001
4,4'-DDT	0.034	1.7	3.7	0.02	0.009
4,4'-DDE	0.029	1.7	3.7	0.02	0.008
Dioxins/Furans	0.0000012	0.0000038	0.000008	0.3	0.2
			Total	**0.3**	**0.2**

Areas on Either Side of the Ash Debris

The data review for the sampling results from the area on either side of the ash debris identified five inorganic chemicals greater than their respective background values and 14 organic chemicals, including dioxins and furans, detected in the soil. The comparisons of the exposure concentrations of the noncarcinogens detected in the drainage area to their respective screening values are presented in Table 15. None of the noncarcinogenic chemicals were greater than their respective screening values and only lead was greater than 0.1 of its residential screening value. The hazard index for both the residential and recreational exposure scenarios is less than one,

indicating that these chemicals are not expected to present an unacceptable risk to human health.

TABLE 15
COMPARISON OF NONCARCINOGENIC COPCs IN THE LATERAL SAMPLES TO SCREENING VALUES

Analyte	Exposure Concentration (mg/kg)	Residential Screening Value (mg/kg)	Recreational Screening Value (mg/kg)	Residential Hazard Quotient	Recreational Hazard Quotient
Acenaphthene	0.78	2600	32000	0.0003	0.00002
Anthracene	0.061(J)	14000	160000	0.000004	0.0000004
Barium	415	5200	150000	0.08	0.003
Benzoic Acid	0.051(J)	100000	1500000	0.0000005	0.00000003
Copper	40.2	2800	87000	0.01	0.0005
Di-n-butyl phthalate	0.077(J)	5500	53000	0.00001	0.000001
Fluoranthene	0.24(J)	200	22000	0.001	0.00001
Lead	83.7	400	2000	0.2	0.04
Mercury	0.24	22	660	0.01	0.0004
Naphthalene	0.041(J)	5.5	2200	0.007	0.00002
Phenanthrene[a]	0.21(J)	14000	16000	0.00002	0.00001
Pyrene	0.32(J)	1500	16000	0.0002	0.00002
Silver	10.7	370	11000	0.03	0.001
			Hazard Index	**0.3**	**0.05**

[a] There are no screening values for phenanthrene; the values used are for anthracene.

The comparisons of the exposure concentrations of the carcinogens detected in the lateral samples to their respective screening values are presented in Table 16. The total for a residential setting of 17.6 is equal to approximately two in 100,000 or 2×10^{-5} excess cancer risk. The total for a recreational exposure of 6.3 is equal to approximately 6 in a million or 6×10^{-6} excess cancer risk, These potential risk levels are approximately in the middle of the target risk range (10^{-4} to 10^{-6}) and are considered as acceptable potential risk levels. Benzo(a)pyrene has the highest potential cancer risk in both settings, while dioxins/furans are the next highest contributors. Benzo(a)pyrene contributes with approximately 67% and 62% of the total potential risk, respectively, and dioxins/furans contribute approximately 19% and 25%, respectively, of the total potential risk.

TABLE 16
COMPARISON OF CARCINOGENIC COPCs IN LATERAL SAMPLES TO SCREENING VALUES

Analyte	Exposure Concentration (mg/kg)	Residential Screening Value (mg/kg)	Recreational Screening Value (mg/kg)	Exposure Concentration /Residential Screening Value	Exposure Concentration /Recreational Screening Value
Benzo(a)anthracene	**0.67**	**0.56**	1.7	**1.2**	0.4
Benzo(a)pyrene	**0.66**	**0.056**	**0.17**	**11.8**	**3.9**
Benzo(b)fluoranthene	**0.67**	**0.56**	1.7	**1.2**	0.4
Bis(2-ethyhexyl)phthalate	0.65	32	90	0.02	0.007
Chrysene	0.75	56	170	0.01	0.004
Dioxins/Furans	**0.000013**	**0.0000038**	**0.000008**	**3.4**	**1.6**
			Total	**17.6**	**6.3**

Summary

Based on the preliminary screening evaluation, the ash debris presents a potential for unacceptable risk to human health with respect to noncarcinogenic and carcinogenic risk for residential exposure (Table 17). Potential risk from radionuclides is also above the dose limit of 15 mrem/yr for residential exposure (Table 17). This potential unacceptable risk is dependent on having a residence on or near this site. The ash debris is located on the steep south slope of Pueblo Canyon in back of the Los Alamos County Airport. It is also located approximately 900 ft east of a residential area. Because the area will probably remain a commercial/industrial area as part of the airport, the likelihood of a residence being built on or near this site is small. Therefore, the potential risk associated with this land use probably will not be realized. By comparison, the recreational exposure results in less potential hazard, risk, and dose for noncarcinogens, carcinogens, and radionuclides to individuals. The potential noncarcinogenic hazard and radionuclide dose are approximately one to two orders of magnitude less than the potential residential hazard, respectively, while the potential carcinogenic risk is approximately 1/3 the residential value (Table 17). The extent to which this area is used or will be used for hiking/walking is unknown. However, the steepness of the slope and the land use of the area (i.e., the airport) limit accessibility. It is unlikely that any individuals would hike down from the mesa top or up from the canyon bottom because of the severity of the slope and lack of proper trails (Photos 1 and 2). Any hiking or walking would occur along the mesa edge rather than the slope and exposure would be more limited than assumed by the screening values. The screening values assume a one-hour exposure time, which would require remaining in this area for an extended period. An individual hiking or walking would pass this site in just a few seconds and may stop for a short period of time (i.e., a few minutes). As a result, the potential risk to an individual would be less than that indicated by the recreational scenario.

The ash debris is exposed and subject to the effects of wind and storm water runoff. The available sampling data collected in and around this site indicates that despite these environmental influences there has been little movement of contaminated material from the ash debris. The potential risk of the ash debris to residents and recreational users is an order of magnitude or more compared to the potential risk derived for the drainages and the areas on either side of the ash debris (Table 17). In addition, the number of contaminants detected in these areas is much less than the number of contaminants detected within the ash debris (Figures 2 and 3). The highest concentrations of contaminants in these areas are close to the ash debris, i.e., within approximately 10-ft on either side of the ash debris and within approximately 250 ft below the ash debris. The concentrations of the contaminants in the drainages subsequently decreases to less than background or near detection limits at the bottom of the Pueblo Canyon where the drainages join the ephemeral stream channel (Figures 4 and 5). The concentrations of contaminants would decrease in a similar manner laterally along the areas on either side of the ash debris. As a result, any hikers or walkers traversing the bottom of the canyon below the ash debris would not be exposed to any hazard, risk, or dose from the contaminants in the ash debris.

TABLE 17
SUMMARY OF HAZARD INDICES AND RISKS/DOSES FOR THE ASH DEBRIS AND SURROUNDING AREAS

Effects Category	Residential Exposure			Recreational Exposure		
	Ash Debris	Drainages	Lateral	Ash Debris	Drainages	Lateral
Noncarcinogens[a]	24.8	0.2	0.3	2.7	0.03	0.05
Carcinogens[b]	3×10^{-4}	3×10^{-7}	2×10^{-5}	8×10^{-5}	2×10^{-7}	6×10^{-6}
Radionuclides[c]	20	NA[d]	NA	0.7	NA	NA

[a] Values are the unitless hazard indices for each area.
[b] Values are the total incremental cancer risk for each area.
[c] Value is the total doses in mrem/yr for the ash debris.
[d] NA = not available; radionuclides have not been analyzed for in the drainages and the areas on either side of the ash debris.

Photo 1: Collecting samples on ash debris slope. View to north from top of mesa.

Photo 2: Collecting samples on ash debris slope. View to northeast from top of mesa. Note road at bottom of Pueblo Canyon.

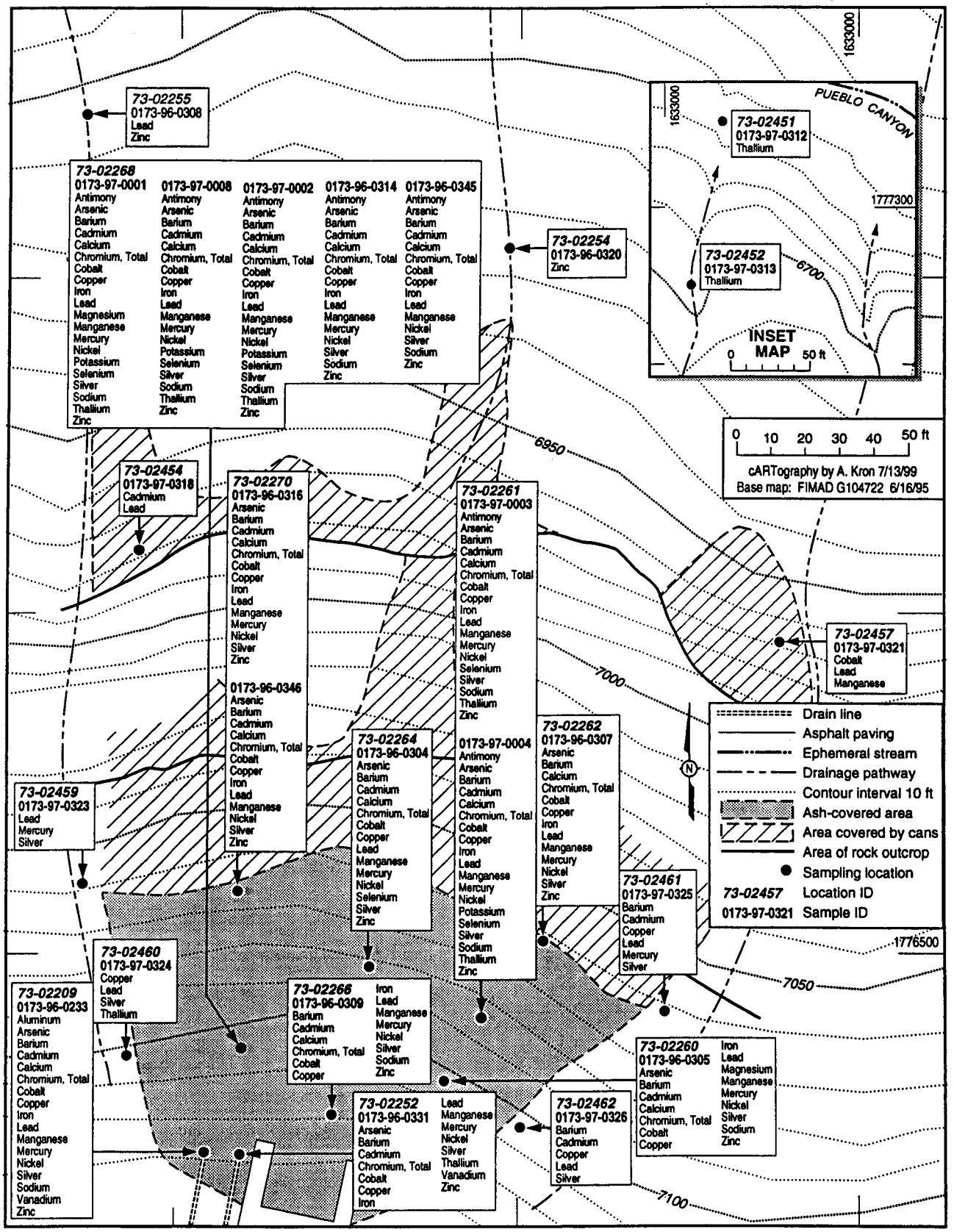

Figure 2. Inorganic chemicals detected at concentrations above BVs.

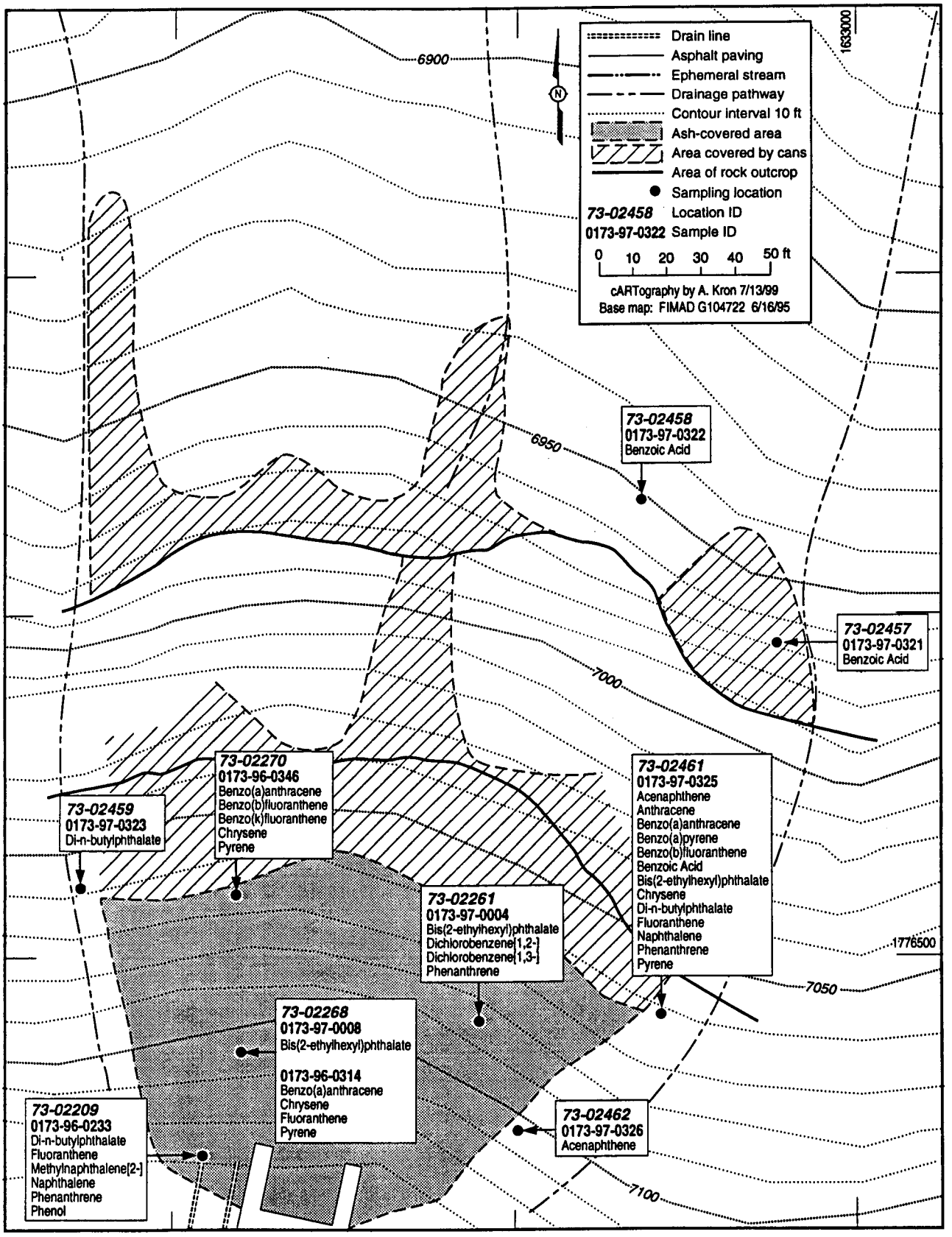

Figure 3. Detected semivolatile organic chemicals.

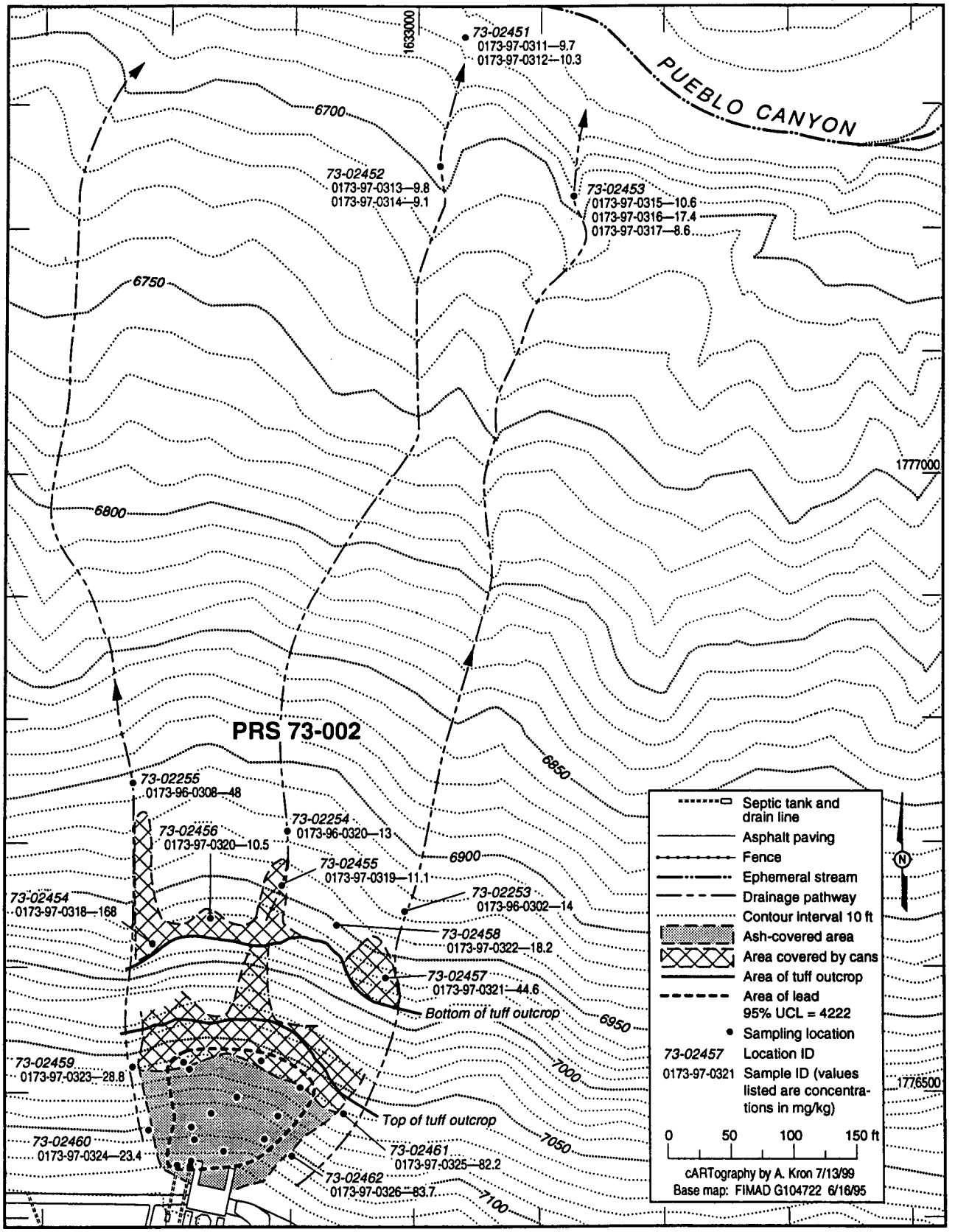

Figure 4. Summary of distribution of lead concentrations at PRS 73-002.

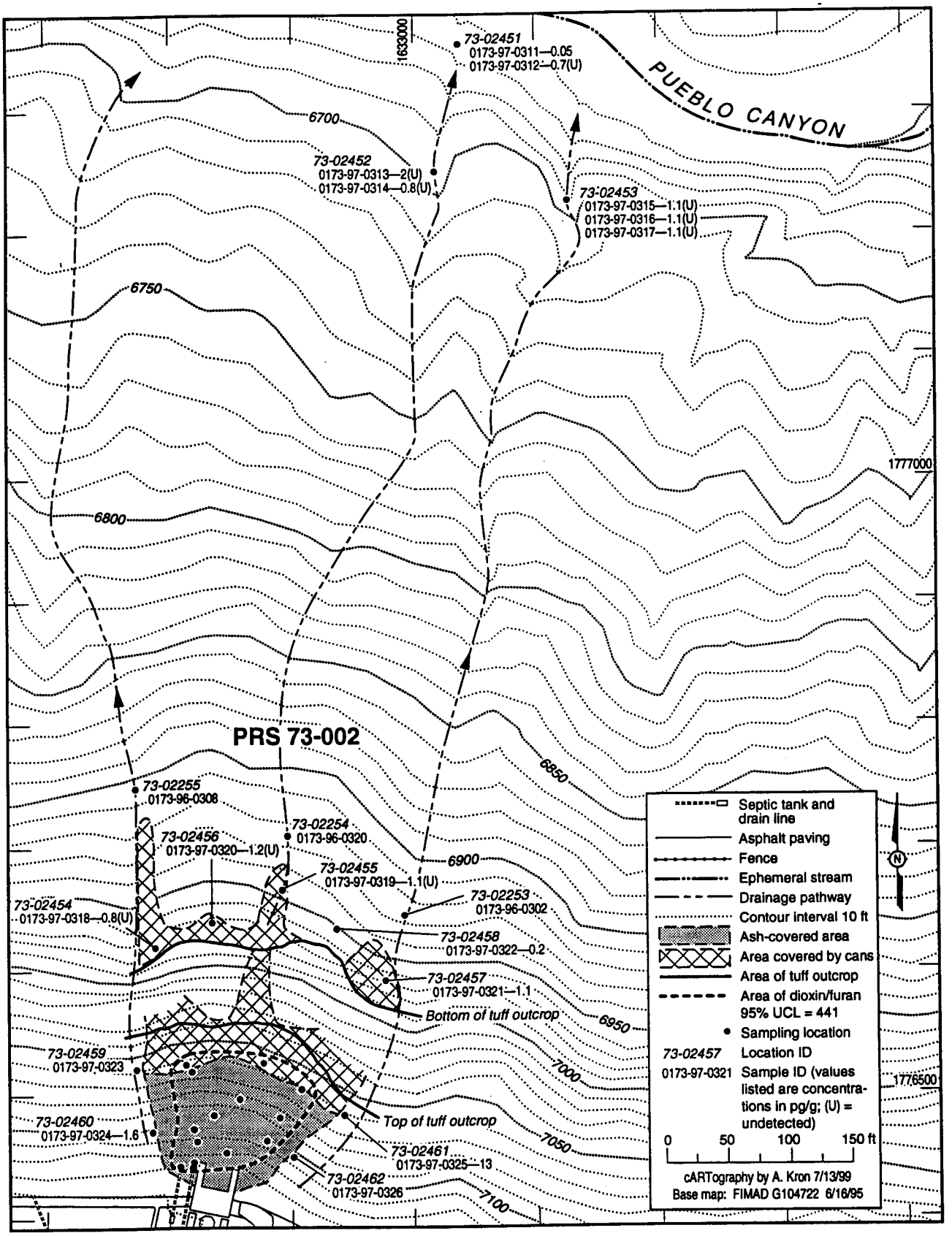

Figure 5. Summary of distribution of dioxin/furan concentrations at PRS 73-002.

PRELIMINARY ECOLOGICAL SCREENING EVALUATION FOR THE ASH DEBRIS AND SURROUNDING AREAS

A preliminary ecological screening evaluation was conducted on the sampling results for the ash debris. A screening evaluation was conducted separately for the ash debris, the drainage below the ash debris, and the area on either side of the ash debris in order to determine the potential for adverse ecological impacts. The purpose of the ecological screening evaluation is to identify chemicals of potential ecological concern (COPECs). The evaluation involves the calculation of hazard quotients (HQs) and hazard indices (HIs) for all chemicals of potential concern (COPCs) identified in the data review for all appropriate screening receptors as described in Kelly et al. (1998, ER ID 57916). The HQ analysis is based on the exposure concentration for each COPC and is calculated by dividing these values by the soil ESLs for nine screening receptors. The screening receptors for which ESLs have been derived include a plant, the earthworm, deer mouse, vagrant shrew, desert cottontail, American robin, American kestrel (with and without an all meat diet), and the red fox. The ESLs for these receptors were based on similar species and derived from an experimentally determined no observed adverse effect levels (NOAELs), lowest observed adverse effect levels (LOAELs), or lethal doses to 50% of the population (LD50s). The rationale for these receptors and the derivation of ESLs are based on the approach presented in Kelly et al. (1998, ER ID 57916) and LANL (1998, ER ID Package 186).

The screening evaluation involves an initial comparison of the exposure concentration for a chemical to the minimum ecological screening level (ESL) to obtain a maximum HQ for the chemical. If the maximum HQ resulting from this comparison is 0.1 or greater, a more detailed HI analysis is conducted for that chemical to determine if the potential for adverse ecological impacts exists and the overall contribution of the chemical to the HI for each receptor. A HI is the sum of HQs across contaminants with like effects for a given screening receptor. The chemicals resulting in a HQ greater than 1.0 or contribute more than 0.1 to a HI greater than 1.0 are identified as COPECs and are considered to be an indicator of potential adverse impacts. The analysis is designed to be conservative (i.e., some assumptions may not represent actual conditions) in order to minimize the possibility of eliminating an analyte that may pose a potential ecological risk.

Ash Debris Area

Table 18 presents a comparison of the exposure concentrations for the COPCs identified in the ash debris to the minimum soil ESL for each analyte. Calcium, iron, and sodium do not have ESLs for comparison. However, the comparison to soil BVs for these three inorganic chemicals indicates that the exposure concentrations are within a factor of 6.5 or less and that a comparison to the maximum background concentration in the respective background data sets indicates that the exposure concentrations are within a factor of 3.9 or less. Therefore, any potential adverse ecological effects are minimal and these three inorganic chemicals are not evaluated further. Because the HQs for all of the other inorganic COPCs are greater than 1.0, these chemicals are considered to be COPECs (bolded in Table 18) and are further evaluated in a HI analysis (Table 19).

The maximum HQs for the PAHs are less than 1.0, except for naphthalene (HQ=3.3), with four PAH HQs of 0.1 or more. These five PAHs (acenaphthene, benzo(a)anthracene, benzo(a)pyrene, chrysene, and naphthalene) are considered COPECs and are further evaluated in a HI analysis (Table 19). The other six PAHs have HQs of 0.01 or less and not evaluated further. Bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, aroclor-1254, 4,4'-DDT, and 4,4'-DDE also have HQs greater than 1.0 and are considered COPECs (Table 19). The other detected organics (phenol, beta-BHC, alpha-chlordane, gamma-chlordane, endosulfan I, 1,4-dichlorobenzene, tetrachloroethene, 1,1,1-trichloroethane, and trichloroethene) have maximum HQs of 0.02 or less and are not considered to be COPECs. Seven detected organic chemicals (4,4'-DDD, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 4-isopropyltoluene, trichlorofluoromethane, 1,3,5-trimethylbenzene, and dioxins/furans) do not currently have ESLs in the database and cannot be

evaluated for the potential to pose adverse ecological effects. Five of these chemicals were detected in only one or two samples, while trichlorofluoromethane and dioxins/furans were detected in 15 and 9 samples, respectively. Based on the HQ analysis, ten organic chemicals are identified as COPECs (bolded in Table 18) and are evaluated further (Table 19).

The maximum HQs for amercium-241 and plutonium-239 are less than 0.1 and are not evaluated further (Table 18). The maximum HQs for radium-226, uranium-234, uranium-235, and uranium-238 are approximately 1.0 or greater (bolded in Table 18). These radionuclides are considered to be COPECs and are further evaluated in a HI analysis (Table 19).

TABLE 18
COMPARISON OF EXPOSURE CONCENTRATIONS WITH MINIMUM ESLs FOR THE ASH DEBRIS

Analyte	Exposure Concentrations[a]	BVs	Minimum ESL	Receptor	HQ[c]
Nonradionuclide Chemicals (mg/kg)					
Antimony	**56.2**	**0.83**	**0.5**	**Plant**	**112.4**
Arsenic	**47**	**8.17**	**1.2**	**Shrew**	**40.8**
Barium	**2132**	**295**	**40.1**	**Robin**	**53.2**
Cadmium	**13.2**	**0.4**	**1.0**	**Plant**	**13.2**
Calcium	24482	6120	-	-	4.0[b]
Chromium	**71.9**	**19.3**	**3.1**	**Plant**	**23.2**
Cobalt	**18.8**	**8.64**	**0.39**	**Robin**	**48.7**
Copper	**1962**	**14.7**	**13**	**Earthworm**	**150.9**
Iron	139,678	21500	No ESLs	-	6.5[b]
Lead	**4222**	**22.3**	**20**	**Plant**	**211.1**
Manganese	**1915**	**671**	**50**	**Plant**	**38.3**
Mercury	**5.7**	**0.1**	**0.05**	**Earthworm**	**114**
Nickel	**94.3**	**15.4**	**20**	**Plant**	**4.7**
Selenium	**1.84**	**1.52**	**0.5**	**Plant**	**3.7**
Silver	**104.1**	**1.0**	**0.2**	**Plant**	**520.5**
Sodium	1568	915	No ESLs	-	1.7[b]
Thallium	**4.9**	**0.73**	**0.068**	**Shrew**	**72.3**
Zinc	**3052**	**48.8**	**10**	**Plant**	**305.2**
Acenaphthene	**0.66**	**NA**	**2.5**	**Plant**	**0.3**
Anthracene	0.66	NA	443	Deer mouse	0.001
Benzo(a)anthracene	**0.67**	**NA**	**6.7**	**Shrew**	**0.1**
Benzo(a)pyrene	**0.66**	**NA**	**3.8**	**Shrew**	**0.2**
Benzo(b)fluoranthene	0.67	NA	15	Shrew	0.04
Benzo(k)fluoranthene	0.69	NA	26.9	Shrew	0.03
Chrysene	**0.75**	**NA**	**6.7**	**Shrew**	**0.1**
Fluoranthene	0.54	NA	52.6	Shrew	0.01
2-Methylnaphthalene	0.57	NA	11	Deer mouse	0.05
Naphthalene	**0.5**	**NA**	**0.15**	**Robin**	**3.3**
Phenanthrene	0.54	NA	228	Deer mouse	0.002
Pyrene	0.63	NA	31.6	Shrew	0.02
Bis(2-ethylhexyl)phthalate	**0.65**	**NA**	**0.24**	**Kestral (all meat diet)**	**2.7**
Di-n-butyl phthalate	**0.44**	**NA**	**0.1**	**Robin**	**4.4**
Phenol	0.56	NA	7.9	Plant	0.07
Aroclor-1254	**0.58**	**NA**	**0.14**	**Robin**	**4.1**

[a] Exposure concentrations are the 95% UCL of the arithmetic mean.
[b] The HQ is the ratio of the exposure concentration to the ESL.

TABLE 18
COMPARISON OF EXPOSURE CONCENTRATIONS WITH MINIMUM ESLs FOR THE ASH DEBRIS
Continued

Analyte	Exposure Concentrations[a]	BVs	Minimum ESL	Receptor	HQ[c]
Nonradionuclide Chemicals (mg/kg)					
beta-BHC	0.028	NA	1.8	Deer mouse	0.02
alpha-Chlordane	0.078	NA	1.7	Robin	0.05
gamma-Chlordane	0.029	NA	1.7	Robin	0.02
4,4'-DDT	**0.48**	**NA**	**0.0021**	**Robin**	**228.6**
4,4'-DDE	**0.14**	**NA**	**0.0017**	**Robin**	**82.4**
4,4'-DDD	0.83	NA	No ESLs	-	-
Endosulfan I	0.028	NA	0.68	Deer mouse	0.04
1,2-Dichlorobenzene	0.34	NA	No ESLs	-	-
1,3-Dichlorobenzene	0.022	NA	No ESLs	-	-
1,4-Dichlorobenzene	0.012	NA	12.8	Earthworm	0.0009
4-Isopropyltoluene	0.013	NA	No ESLs	-	-
Tetrachloroethene	0.012	NA	4.9	Deer mouse	0.002
1,1,1-Trichloroethane	0.013	NA	3200	Deer mouse	0.000004
Trichloroethene	0.012	NA	2.5	Deer mouse	0.005
Trichlorofluoromethane	0.016	NA	No ESLs	-	-
1,3,5-Trimethylbenzene	0.012	NA	No ESLs	-	-
Dioxins/Furans	0.000441	NA	No ESLs	-	-
Radionuclide Chemicals (pCi/g)					
Amercium-241	0.16	0.013	87.4	Earthworm	0.002
Plutonium-239	1.3	0.054	32.8	Plant	0.04
Radium-226	**5.3**	**2.59**	**0.16**	**Robin**	**33.1**
Uranium-234	**7.2**	**2.59**	**0.29**	**Robin**	**24.8**
Uranium-235	**0.4**	**0.2**	**0.32**	**Robin**	**1.3**
Uranium-238	**5.2**	**2.29**	**0.33**	**Robin**	**15.7**

[a] Exposure concentrations are the 95% UCL of the arithmetic mean.
[b] The HQ is the ratio of the exposure concentration to the ESL.

The HI is the sum of HQs for chemicals with common toxicological endpoints for a given receptor. For the purposes of ecological screening, it is assumed that radionuclides have a common toxicological effect and that nonradionuclides could have a common toxicological effect. Although it is likely that this assumption is incorrect, especially for nonradionuclides, the COPCs are grouped together in the comparison to ESLs. The HIs for nonradionuclide chemicals are greater than 1.0 for all of the receptors The HIs are driven primarily by the inorganic COPECs i.e., antimony, arsenic, barium, copper, lead, mercury, silver, thallium, and zinc, for the plant, earthworm, and mammalian receptors. The HIs are driven by inorganic COPECs, i.e., barium, cobalt, lead, silver, and zinc, as well as pesticides, i.e., DDT and DDE, for the avian receptors. The PAH HQs are 0.3 or less, except for naphthalene, and do not greatly influence the HI for any receptor. Similarly, the HQs for phthalates [bis(2-ethylhexyl)phthalate and di-n-butyl phthalate] are less than 0.1 for the mammalian receptors and approximately 4.0 or less for the avian receptors. These two groups of chemicals contribute only about 1% or less to the HI for a given receptor and do not present a potential for adverse ecological impacts to the receptors.

TABLE 19
HAZARD INDEX ANALYSIS FOR THE ASH DEBRIS

Analyte	HQ Plant	HQ Earthworm	HQ Mouse	HQ Shrew	HQ Cottontail	HQ Robin	HQ Kestrel	HQ Kestrel (all meat diet)	HQ Red Fox
Nonradionuclide Chemicals									
Antimony	112.4	-	55.1	48.9	3.6	-	-	-	0.6
Arsenic	4.7	6.9	39.8	40.9	0.9	4.7	0.5	0.02	0.5
Barium	2.1	-	49.2	45.6	2.6	53.2	5.3	0.2	0.6
Cadmium	13.2	1.3	1.6	0.9	0.3	3.0	0.3	0.02	0.02
Chromium	23.2	-	0.0005	0.0006	0.00006	7.8	0.6	0.2	0.00004
Cobalt	7.5		13.4	10.3	1.4	48.7	5.0	0.5	0.3
Copper	19.6	150.9	18.2	5.8	5.0	6.7	0.6	0.1	0.3
Lead	211.1	42.2	8.9	7.3	2.2	72.3	4.4	2.2	0.7
Manganese	38.3	-	7.2	0.9	2.4	0.4	0.04	0.004	0.03
Mercury	0.2	114	0.09	0.05	0.02	6.6	0.8	0.3	0.005
Nickel	4.7	0.9	0.1	0.1	0.02	0.3	0.03	0.003	0.003
Selenium	3.7	0.2	1.4	1.0	0.004	2.2	0.2	0.05	0.05
Silver	520.5	-	0.7	0.2	0.2	49.8	4.4	0.7	0.009
Thallium	49	-	68.4	72.3	0.7	-	-	-	2.1
Zinc	305.2	35.9	3.5	0.8	1.0	39.7	5.1	3.5	0.2
Acenaphthene	0.3	-	0.002	0.002	0.00008	-	-	-	0.00002
Benzo(a)anthracene	0.04	-	0.1	0.1	0.0006	-	-	-	0.02
Benzo(a)pyrene	-	-	0.2	0.2	0.0008	-	-	-	0.07
Chrysene	-	-	0.1	0.1	0.0007	-	-	-	0.02
Naphthalene	-	-	0.02	0.02	0.002	3.3	0.3	0.008	0.0001
Bis(2-ethylhexyl)phthalate	-	-	0.01	0.01	0.00003	0.8	1.4	2.7	0.07
Di-n-butyl phthalate	0.002	-	0.0002	0.0002	0.000003	4.4	0.4	0.03	0.000003
Aroclor-1254	0.06	-	2.2	2.2	1.1	4.1	0.7	0.6	0.8
4,4'-DDT	-	-	0.2	0.2	0.0007	226.4	80.2	114.3	0.2
4,4'-DDE	-	-	0.004	0.004	0.00001	84.3	45.6	73.7	0.007
Hazard Index	**1316**	**352**	**270**	**238**	**21**	**618**	**157**	**199**	**6.6**
Radionuclide Chemicals									
Radium-226	0.0006	0.1	6.8	7.0	0.1	33.1	3.3	0.1	0.09
Uranium-234	0.00002	0.07	0.05	0.05	0.0005	24.7	2.5	0.1	0.0006
Uranium-235	0.000002	0.004	0.003	0.003	0.00003	1.3	0.1	0.005	0.00004
Uranium-238	0.0002	0.05	0.03	0.03	0.002	15.7	1.6	0.06	0.002
Hazard Index	**0.0008**	**0.2**	**6.9**	**7.1**	**0.1**	**74.8**	**7.5**	**0.3**	**0.09**

The HIs for radionuclides are greater than 1.0 for the deer mouse, shrew, robin, and kestral and less than 1.0 for the plant, earthworm, cottontail, kestral with a 100% meat diet, and the red fox. The HIs are driven by radium-226 for the mouse and shrew and by radium-226, uranium-234, and uranium-238 for the robin and kestral. The most sensitive receptor to the radionuclides is the robin with a HI approximately an order of magnitude greater than the next most sensitive receptor. Uranium-235 has HQs of approximately 1.0 or less and contributes approximately 2% or less to the HI for a given receptor. Therefore, this radionuclide does not present a potential for adverse ecological impacts to the receptors.

Threatened and endangered (T&E) species are potential receptors for exposure to contaminants in this portion of Pueblo Canyon. The Laboratory's Ecology Group (ESH-20) intersected the PRS location information from FIMAD with T&E species habitat using the geographical information system (GIS) databases to determine the likelihood of the presence of T&E species in this area. The T&E review of this portion of Pueblo Canyon found that this PRS is within the core area for foraging and nesting habitat for the Mexican spotted owl and the American peregrine falcon. No other T&E species are potentially impacted by the contamination from this PRS. The ecological screening receptor that serves as a surrogate for the owl and falcon in the calculation of screening values is the kestrel with a 100% meat diet. The maximum HQs for this receptor are 114.3 and 73.7 for 4,4'-DDT and 4,4'-DDE, respectively, which contributes almost 95% of the HI. The other HQs are 3.5 or less with many of the HQs being less than 1.0. Based on this analysis, there may be a potential for adverse ecological impacts to T&E species from the pesticides. The radionuclide HI for this receptor is 0.3 indicating that there is no potential for adverse ecological impacts from radionuclides to T&E species at this site.

The relatively high HQ and HI values for the nonradionuclide COPECs to a majority of the receptors suggest that there is a potential for adverse ecological impacts. A visit to the site supports this assumption in that the area of the ash debris is largely unvegetated at the top portion of the site and vegetated in the lower portion by a woody shrub that is different from the natural vegetation in the surrounding area (dominated by ponderosa pine and shrub oak) (Photos 2 and 3). This may be due as much to the nature of the material as to the contamination present in the ash. The ash is much darker in color, heavier and more compacted, and coarser in texture than the native soils. The fact that some vegetation has begun to colonize the area indicates that the ecosystem may be slowly recovering from the contamination and that the ash debris is becoming more stabilized over time. There is also a general absence of other receptors, most notably burrowing animals such as gophers. Despite the high concentrations of several chemicals in the area, the concentrations appear to be localized to the ash debris disposal area, which is approximately 0.5 acres. The wildlife receptors generally have similar or larger home ranges than the area encompassed by the contamination. The home range for the short-tailed shrew (assumed to be similar for the vagrant shrew) is approximately ½ - 1 acre and the deer mouse is approximately ½ - 3 acres, according to Burt and Grossenheider (1976, ER ID 59097). The adult American robin has a home range of approximately 0.4 acres for supporting nestlings and approximately 2.0 acres for fledglings (EPA 1993, ER ID 59109). The other wildlife receptors (including T&E species) have larger home ranges. As a result, exposure to the elevated concentrations of COPECs may be infrequent. In addition, the lack of foraging and nesting habitat would decrease the exposure and probably results in avoidance of the area by receptors. The area surrounding the site as well as the canyon slope up canyon and down canyon from the ash debris provides excellent habitat for most receptors, including T&E species. Therefore, the small area of contamination encompassed by the ash debris is probably insignificant with respect to the quality and amount of habitat available to receptors.

Drainage Areas Below the Ash Debris

Table 20 presents a comparison of the exposure concentrations for the COPCs identified in the drainages to the minimum terrestrial ESL for each analyte. Three inorganic chemicals, five organic chemicals, and no radionuclides are included in this comparison (Table 18). The maximum HQs for cadmium, lead, zinc, DDT, and DDE are greater than 1.0, while the HQs for benzoic acid and alpha-chlordane are less than 0.1. Therefore, the three inorganic chemicals and two pesticides are identified as COPECs (bolded in Table 20) and are further evaluated in a HI analysis (Table 21). Dioxins/furans do not have ESLs for comparisons and cannot be evaluated for the potential to pose adverse ecological effects.

TABLE 20
COMPARISON OF EXPOSURE CONCENTRATIONS WITH MINIMUM ESLs FOR THE DRAINAGE BELOW THE ASH DEBRIS

Analyte	Exposure Concentrations	BVs	Minimum ESL	Receptor	HQ
Nonradionuclide Chemicals (mg/kg)					
Cadmium	**2.3[a]**	**0.4**	**1.0**	**Plant**	**2.3**
Lead	**41[a]**	**22.3**	**20**	**Plant**	**2.1**
Zinc	**470**	**48.8**	**10**	**Plant**	**47**
Benzoic acid	0.092	NA	8.36	Deer mouse	0.01
alpha-Chlordane	0.0035	NA	1.7	Robin	0.002
4,4'-DDT	**0.034**	**NA**	**0.0021**	**Robin**	**16.2**
4,4'-DDE	**0.029**	**NA**	**0.0017**	**Robin**	**17.0**
Dioxins/Furans	0.0000012[a]	NA	No ESLs	-	-

[a] Values are 95% UCLs.

TABLE 21
HAZARD INDEX ANALYSIS FOR THE DRAINAGES BELOW THE ASH DEBRIS

Analyte	HQ Plant	HQ Earthworm	HQ Mouse	HQ Shrew	HQ Cottontail	HQ Robin	HQ Kestrel	HQ Kestrel (all meat diet)	HQ Red Fox
Cadmium	2.3	0.2	0.3	0.2	0.05	0.5	0.05	0.003	0.003
Lead	2.1	0.4	0.09	0.07	0.02	0.7	0.04	0.02	0.007
Zinc	47	5.5	0.5	0.1	0.2	6.1	0.8	0.5	0.02
4,4'-DDT	-	-	0.01	0.01	0.00005	16.2	5.7	8.1	0.01
4,4'-DDE	-	-	0.0008	0.0008	0.000003	17.0	9.4	15.3	0.002
Hazard Index	**51.4**	**6.1**	**0.9**	**0.4**	**0.3**	**40.5**	**16.0**	**23.9**	**0.04**

The HI is the sum of HQs for chemicals with common toxicological endpoints for a given receptor. The HIs for nonradionuclide chemicals are greater than 1.0 for the plant, earthworm, robin, kestral, and the kestral with 100% met diet and less than 1.0 for the deer mouse, shrew, cottontail, and red fox. The HIs are driven primarily by the inorganic COPECs, in particular zinc, for the plant and earthworm, and by the pesticides, DDT and DDE, for the avian receptors.

The T&E species are potential receptors for exposure to contaminants in this portion of Pueblo Canyon. As previously described, the T&E review of this portion of Pueblo Canyon found that this PRS is within the core area for foraging and nesting habitat for the Mexican spotted owl and the American peregrine falcon. No other T&E species are potentially impacted by the contamination from this PRS. The ecological screening receptor that serves as a surrogate for the owl and falcon in the calculation of screening values is the kestrel with a 100% meat diet. The maximum HQs for this receptor are 8.1 and 15.3 for 4,4'-DDT and 4,4'-DDE, respectively, which

contributes almost 98% of the HI. The HQs for the other receptors are 0.5 or less. Based on this analysis, there is some potential for adverse ecological impacts to T&E species from the pesticides.

The relatively low HQ and HI values for the nonradionuclide COPECs to the receptors suggest that there is little or no potential for adverse ecological impacts. A visit to the site supports this assumption in that the area in the drainages and below the ash debris is well vegetated with natural vegetation (dominated by ponderosa pine and shrub oak) and provides excellent habitat for most receptors, including T&E species (Photos 2 and 3). The wildlife receptors have relatively large home ranges as described above, resulting in infrequent or no exposure to the elevated concentrations of COPECs. In addition, the surrounding area in the canyon as well as the canyon slope upcanyon and downcanyon from the ash debris appears to represent a healthy terrestrial ecosystem. Therefore, the small area of contamination in the upper portion of the drainages is probably insignificant with respect to the overall quality and amount of habitat available to receptors.

Areas on Either Side of the Ash Debris

Table 22 presents a comparison of the maximum detected concentrations for the COPCs identified in the area on either side of the ash debris to the minimum terrestrial ESL for each analyte. Five inorganic chemicals, fourteen organic chemicals, and no radionuclides are included in this comparison (Table 18). The maximum HQs for barium, copper, lead, mercury, and silver are greater than 1.0, while the HQs for acenaphthene, naphthalene, bis(2-ethylhexyl)phthalate, and di-n-butyl phthalate are greater than 0.1. Therefore, five inorganic chemicals and four organic chemicals are identified as COPECs (bolded in Table 22) and are further evaluated in a HI analysis (Table 23). The other organic chemicals, except for dioxins/furans, had maximum HQs less than 0.1 and are not evaluated further. Dioxins/furans do not have ESLs for comparisons and cannot be evaluated for the potential to pose adverse ecological effects.

TABLE 22
COMPARISON OF EXPOSURE CONCENTRATIONS WITH MINIMUM ESLs FOR THE AREA ON EITHER SIDE OF THE ASH DEBRIS

Analyte	Exposure Concentrations	BVs	Minimum ESL	Receptor	HQ[c]
Barium	**415**	**295**	**40.1**	**Robin**	**10.3**
Copper	**40.2**	**14.7**	**13**	**Earthworm**	**3.1**
Lead	**83.7**	**22.3**	**20**	**Plant**	**4.2**
Mercury	**0.24**	**0.1**	**0.05**	**Earthworm**	**4.8**
Silver	**10.7**	**1.0**	**0.2**	**Plant**	**53.5**
Acenaphthene	**0.78**	**NA**	**2.5**	**Plant**	**0.3**
Anthracene	0.061(J)	NA	443	Deer mouse	0.0001
Benzo(a)anthracene	0.1(J)	NA	6.7	Shrew	0.01
Benzo(a)pyrene	0.11(J)	NA	3.8	Shrew	0.03
Benzo(b)fluoranthene	0.21(J)	NA	15	Shrew	0.01
Chrysene	0.11(J)	NA	6.7	Shrew	0.02
Fluoranthene	0.24(J)	NA	52.6	Shrew	0.005
Naphthalene	**0.041(J)**	**NA**	**0.15**	**Robin**	**0.3**
Phrenanthrene	0.21(J)	NA	228	Deer mouse	0.0009
Pyrene	0.32(J)	NA	31.6	Shrew	0.01
Bis(2-ethylhexyl)phthalate	**0.05(J)**	**NA**	**0.24**	**Kestral (all meat diet)**	**0.2**
Di-n-butyl phthalate	**0.077(J)**	**NA**	**0.1**	**Robin**	**0.8**
Benzoic acid	0.051(J)	NA	8.36	Deer mouse	0.006
Dioxins/Furans	0.000013	NA	-	-	-

TABLE 23
HAZARD INDEX ANALYSIS FOR THE AREA ON EITHER SIDE OF THE ASH DEBRIS

Analyte	HQ Plant	HQ Earthworm	HQ Mouse	HQ Shrew	HQ Cottontail	HQ Robin	HQ Kestrel	HQ Kestrel (all meat diet)	HQ Red Fox
Barium	0.4	-	9.6	8.9	0.5	10.3	1.0	0.04	0.1
Copper	0.4	3.1	0.4	0.1	0.1	0.1	0.01	0.002	0.006
Lead	4.2	0.8	0.2	0.1	0.04	1.4	0.09	0.04	0.01
Mercury	0.007	4.8	0.004	0.002	0.0007	0.3	0.03	0.01	0.0002
Silver	53.5	-	0.08	0.02	0.02	5.1	0.5	0.08	0.0009
Acenaphthene	0.3	-	0.002	0.002	0.00009	-	-	-	0.00002
Naphthalene	-	-	0.002	0.002	0.0001	0.3	0.03	0.0007	0.00001
Bis(2-ethylhexyl)phthalate	-	-	0.0008	0.0008	0.000003	0.07	0.1	0.2	0.006
Di-n-butyl phthalate	-	-	0.00003	0.00003	0.0000005	0.8	0.08	0.005	0.0000005
Hazard Index	**58.8**	**8.7**	**10.3**	**9.1**	**0.7**	**18.4**	**1.8**	**0.4**	**0.1**

The HI is the sum of HQs for chemicals with common toxicological endpoints for a given receptor. The HIs for nonradionuclide chemicals are greater than 1.0 for the plant, earthworm, deer mouse, shrew, robin, and kestral and less than 1.0 for the cottontail, kestral with a 100% meat diet, and the red fox. The HIs are driven primarily by the inorganic COPECs, in particular barium and silver, for all but the earthworm, which is driven by copper and mercury. The organic COPECs do not contribute more than 11% to the HIs that are greater than 1.0 and do not present a potential for adverse ecological impacts to the receptors.

The T&E species are potential receptors for exposure to contaminants in this portion of Pueblo Canyon. As previously described, the T&E review of this portion of Pueblo Canyon found that this PRS is within the core area for foraging and nesting habitat for the Mexican spotted owl and the American peregrine falcon. No other T&E species are potentially impacted by the contamination from this PRS. The ecological screening receptor that serves as a surrogate for the owl and falcon in the calculation of screening values is the kestrel with a 100% meat diet. The maximum HQ for this receptor is 0.2 for bis(2-ethyhexyl)phthalate, which contributes 50% of the HI. The HI for the surrogate receptor is 0.4 indicating that there is a no potential for adverse ecological impacts to T&E species outside of the ash debris.

The relatively low HQ and HI values for the nonradionuclide COPECs to the receptors suggest that there is little or no potential for adverse ecological impacts. A visit to the site supports this assumption in that the areas on either side of the ash debris is well vegetated with natural vegetation (dominated by ponderosa pine and shrub oak) and provides excellent habitat for most receptors, including T&E species (Photos 2 and 3). The wildlife receptors have relatively large home ranges as described above, resulting in infrequent or no exposure to the elevated concentrations of COPECs in the areas adjacent to the ash debris. In addition, the surrounding area in the canyon as well as the canyon slope up canyon and downcanyon from the ash debris appears to represent a healthy terrestrial ecosystem. Therefore, the area of contamination appears limited primarily to the ash debris with a small area on either side having elevated concentrations. These lateral areas do not present a potential for adverse ecological impacts as evidenced by the vegetation present. As a result, the canyon slope as a whole is not affected by the ash debris and provides excellent habitat for receptors.

Summary

A comparison of the data from the ash debris to the data for the areas surrounding this site resulted in marked differences in the number of COPECs and the HQ/HI values. In the drainages, only three inorganic chemicals, five organic chemicals, and no radionuclides were included in the ESL comparisons compared to 18 inorganic chemicals, 33 organic chemicals, and six radionuclides in the ash debris analysis (Table 18). Overall, the HI values in the drainages are an order of magnitude or more below the HI values from the ash debris (Table 24). For example, the plant HIs are 1315 and 51.4 for the ash debris versus the drainages and the robin HIs are 618 and 40.5 for the ash debris versus the drainages (Table 24). In addition, the maximum HQs for each COPEC were derived from samples collected in the upper portion of the drainages (approximately 100 to 250 ft below the ash debris). Despite the elevated concentrations of several chemicals in the drainages, the concentrations are markedly less than that detected in the ash debris and appears to be localized to the drainage area just below the ash debris.

Comparable differences were also found in the areas on either side of the ash debris. For these areas, five inorganic chemicals, fourteen organic chemicals, and no radionuclides were included in the ESL comparisons versus 18 inorganic chemicals, 33 organic chemicals, and six radionuclides in the ash debris analysis (Table 18). Overall, the HI values in the areas on either side of the ash debris are an order of magnitude or more below the HI values from the ash debris (Table 24). For example, the plant HIs are 1315 and 58.8 for the ash debris versus the sides of the ash debris and the robin HIs are 618 and 18.4 for the ash debris versus the sides of the ash debris (Table 24). Despite the elevated concentrations of several chemicals in these areas, the concentrations are markedly less than that detected in the ash debris and so to is the potential for adverse ecological impacts. It is assumed that as the distance from the ash debris increased on

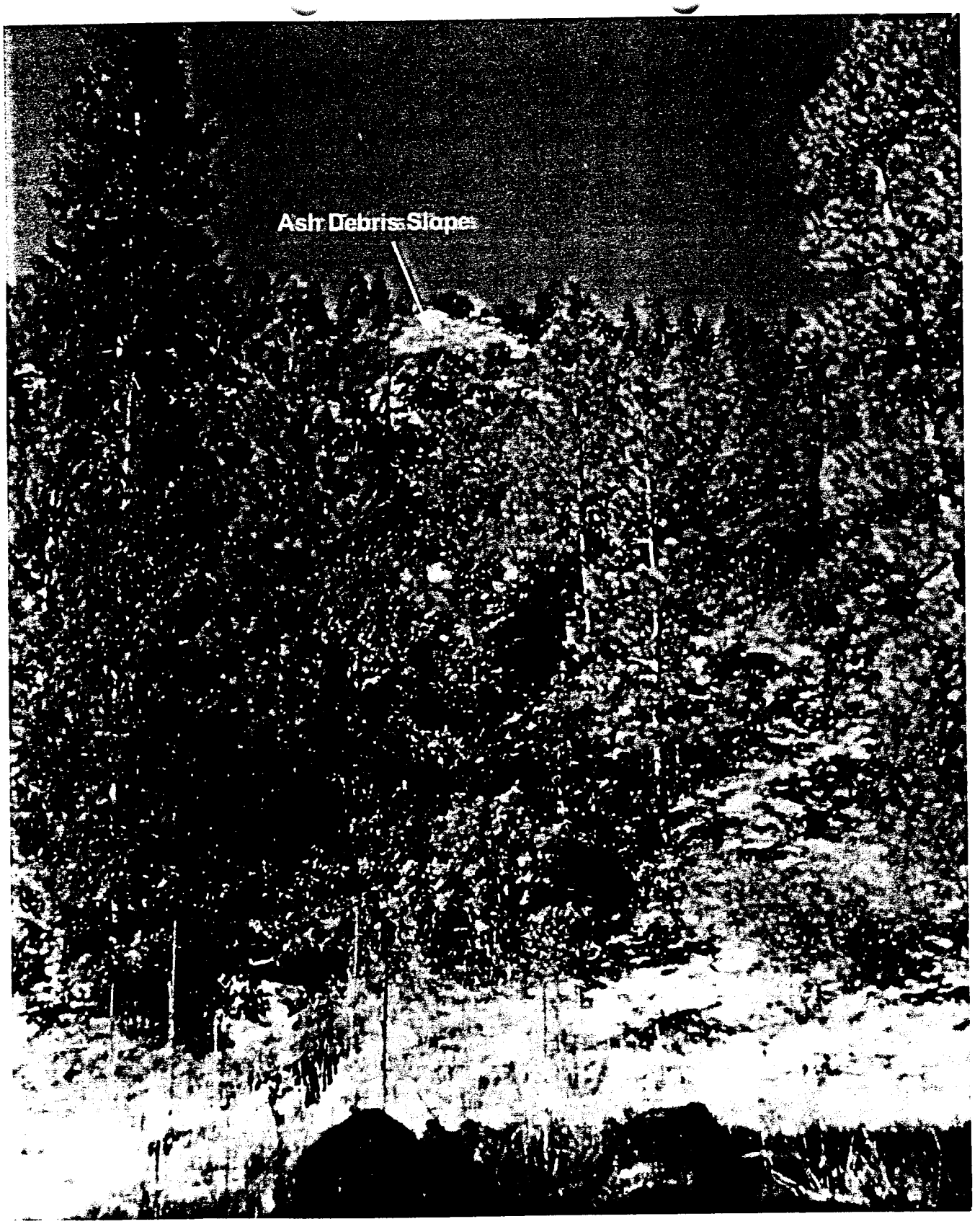

Photo 3: View to south from bottom of Pueblo Canyon.

either side of the site, the concentrations of contaminants would decrease as seen in the drainages.

Based on the observations made during the site visit conducted in conjunction with the completion of the ecological scoping checklist (Attachment 2), the ash debris is vastly different in composition as well as vegetation from the surrounding area (Photos 1, 2, and 3). Based on the site conditions and the preliminary evaluations presented here, the ash debris does pose a potential for adverse ecological impacts to some or all of the receptors. There has been some release of contamination, primarily inorganic chemicals, into the drainages and areas immediately below or adjacent to the ash debris. However, the concentrations of contaminants decreases to below background concentrations or detection limits as the distance from the ash debris increases (Figures 4 and 5). The exceptions to this are zinc, DDT, and DDE, which have not been analyzed in samples collected further down the drainages. In general, the area of the drainages below PRS and the areas adjacent to the PRS along the canyon walls appears to be representative of a healthy terrestrial ecosystem that is commonly encountered in northern New Mexico and have not been adversely impacted by the ash debris (Photo 3).

TABLE 24
SUMMARY OF HAZARD INDEX ANALYSES FOR THE ASH DEBRIS AND SURROUNDING AREAS

ECOLOGICAL SCREENING RECEPTORS	HAZARD INDEX VALUES		
	ASH DEBRIS	DRAINAGES	LATERAL AREAS
Plant	1316	51.4	58.8
Earthworm	352	6.1	8.7
Deer Mouse	270	0.9	10.3
Vagrant Shrew	238	0.4	9.1
Desert Cottontail	21	0.3	0.7
Red Fox	6.6	0.04	0.1
Robin	618	40.5	18.4
Kestral	157	16	1.8
Kestral (with an all meat diet)	199	23.9	0.4

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ATTACHMENT 1

TOXICITY EQUIVALENCY FACTORS

THE US EPA TEF VALUES

The polychlorinated dibenzodioxins (CDDs) include 75 individual compounds, and the polychlorinated dibenzofurans (CDFs) include 135 individual compounds. These individual compounds are technically referred to as congeners. Only 7 of the 75 congeners of CDDs are thought to have dioxin-like toxicity; these are ones with chlorine substitutions in, at least, the 2,3,7,and 8 positions. Only 10 of the 135 possible congeners of CDFs are thought to have dioxin-like toxicity; these also are ones with substitutions in the 2,3,7, and 8 positions. There are 209 PCB congeners, of which only 13 are thought to have dioxin-like toxicity. These are PCBs with 4 or more chlorines with just 1 or no substitution in the ortho position. These compounds are sometimes referred to as coplanar, meaning that they can assume a flat configuration with rings in the same plane. These 30 dioxin-like compounds are often found in complex mixtures. For risk assessment purposes, a toxicity equivalency procedure was developed to describe the cumulative toxicity of these mixtures. This procedure involves assigning individual toxicity equivalency factors (TEFs) to the CDD, CDF, and PCB congeners. These TEF values have had international endorsement (U.S. EPA, 1989; Ahlborg, et.al., 1994). 2,3,7,8-TCDD is assigned a TEF of 1.0. All other congeners have lower TEF values ranging from 0.5 to 0.00001. Generally accepted TEF values for CDD/Fs and PCBs are shown in Table 1. Calculating the toxic equivalency (TEQ) of a mixture involves multiplying the concentration of individual congeners by their respective TEF. The sum of the TEQ concentrations for the individual congeners is the TEQ concentration for the mixture.

Of the 419 dioxin, furan, and PCB congeners, only these 30 are considered to have dioxin like toxicity. The following table lists the Toxic Equivalency Factors, or TEFs, of these congeners.

I. DIOXINs	
2,3,7,8-TCDD	
1,2,3,7,8-PeCDD	1.0
1,2,3,4,7,8-HxCDD	0.5
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.1
1,2,3,4,6,7,8,9-OCDD	0.01
	0.001
II. FURANs	
2,3,7,8-TCDF	
1,2,3,7,8-PeCDF	0.1
2,3,4,7,8-PeCDF	0.05
1,2,3,4,7,8-HxCDF	0.5
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1

2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.1
1,2,3,4,7,8,9-HpCDF	0.01
1,2,3,4,6,7,8,9-OCDF	0.01
	0.001
III. PCBs	
3,3',4,4'-TeCB (PCB 77)	
2,3,3',4,4'-PeCB (PCB 105)	
2,3,4,4',5-PeCB (PCB 114)	
2,3',4,4',5-PeCB (PCB 118)	
2',3,4,4',5-PeCB (PCB 123)	0.0005
3,3',4,4',5-PeCB (PCB 126)	0.0001
2,3,3',4,4',5-HxCB (PCB 156)	0.0005
2,3,3',4,4',5'-HxCB (PCB 157)	0.0001
2,3',4,4',5,5'-HxCB (PCB 167)	0.0001
3,3',4,4',5,5'-HxCB (PCB 169)	0.1
2,2',3,3',4,4',5-HpCB (PCB	0.0005
170)	0.0005
2,2',3,4,4',5,5'-HpCB (PCB	0.00001
180)	0.01
2,3,3',4,4',5,5'-HpCB (PCB	0.0001
189)	0.00001
	0.0001

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BACK TO DIOXIN HOMEPAGE

Last Revised: February 10, 1998
URL: http://www.epa.gov/ncea/dchem.htm

ATTACHMENT 2

ECOLOGICAL SCOPING CHECKLIST

ECOLOGICAL SCOPING CHECKLIST

PART A—SCOPING MEETING DOCUMENTATION

Site ID	PRS 73-002
Form of site releases (solid, liquid, vapor). Describe all relevant known or suspected mechanisms of release (spills, dumping, material disposal, outfall, explosive testing, etc.) and describe potential areas of release. Reference locations on a map as appropriate.	The primary release from this PRS would be the solid waste in the form of the ash from the incinerator disposed of on the canyon slope in back of the incinerator building. A secondary release would have been the liquid waste from the septic tank and wash water discharged via the drain lines that were discharged from outfalls along the rim of the slope above the ash debris pile [PRSs 73-004(a) and 73-006]. The area of release was the canyon slope in back of the incinerator building to the bench located approximately 200 ft below the rim of the canyon.
List of Primary Impacted Media (Indicate all that apply.)	Surface soil – XX – The impacted medium was all surface soil because the incinerator ash was dumped onto the slope and the outfalls discharged at the surface. Surface water/sediment – X – Surface water runoff may have transported ash down the canyon slope and accumulated as sediment below the ash debris pile. Subsurface – Groundwater – Other, explain –
FIMAD vegetation class based on Arcview vegetation coverage (Indicate all that apply.)	Water – Bare Ground/Unvegetated – XX - The area between the building and canyon slope is bare ground and unvegetated due to the disturbance of the area from past and current activities. Spruce/fir/aspen/mixed conifer – Ponderosa pine – XX - The area along the canyon slope on either side of the outfalls is ponderosa pine habitat with shrub oak and woody ground cover. Piñon juniper/juniper savannah – Grassland/shrubland – Developed – XX – Incinerator building is the primary structure and the point from which these PRSs originate.
Is T&E Habitat Present? If applicable, list species known or suspected to use the site for breeding or foraging.	The PRS is entirely within an area of Mexican spotted owl nesting habitat and within an area in which the spotted owl can be conservatively assumed to forage at a medium frequency. It is also in the vicinity of potential peregrine falcon nesting habitat, approximately 1600 ft away, and within an area in which the peregrine falcon can be conservatively assumed to forage at a relatively high frequency. The PRS is within an area in which the bald eagle is conservatively assumed to forage at a relatively low frequency.
Provide list, of Neighboring/ Contiguous/ Upgradient sites, includes a brief summary of COPCs and the form of releases for relevant sites and reference a map as appropriate. (Use this information to evaluate the need to aggregate sites for screening.)	PRS 73-004(b) was a septic tank that received wash water from the steam cleaning facility at PRS 73-003 and had an outfall that terminated in Pueblo Canyon approximately 40-50 ft west of 73-002. The septic tank and associated lines have been removed. The other PRSs in the area are 73-004(a) a septic tank and outfall and 73-006 drainlines from the incinerator building. The outfalls for 73-004(a) and 73-006 terminate within the boundaries of the ash debris pile. Therefore, the outfall areas for these two PRSs should be aggregated with PRS 73-002 and addressed together.
Surface Water Erosion Potential Information Summarize information from SOP 2.01, including the run-off subscore (maximum of 46); terminal point of surface water transport; slope; and surface water runon sources.	PRS 73-002 has an Erosion Matrix Score of 56. The run-off score is 25.5 (visible evidence of runoff (5.0), bench setting (9.5) and rill erosion (11) and the run-on score was 7.0 (structures adversely affecting run-on). The score also reflects the site is within a bench of the canyon (4.0), the ground cover is 25-75% (6.5), and the slope is >30% (13). The terminal point of surface water is the bench on the north-facing slope within Pueblo Canyon.

PART B—SITE VISIT DOCUMENTATION

Site ID	PRS 73-002
Date of Site Visit	5/19/99
Site Visit Conducted by	Richard Mirenda and Steve Calhoun

Receptor Information:

Estimate cover	Relative vegetative cover (high, medium, low, none) = none to medium; not much vegetation in the area between the incinerator building and canyon slope. The upper part of the ash debris slope has little or no vegetation. As one goes further down the slope there is an increase in vegetation in the form of low shrubs that cover the lower part of the slope to the bench. Relative wetland cover (high, medium, low, none) = none Relative structures/asphalt, etc. cover (high, medium, low, none) = low; incinerator building is primary structure and there are cement walkways in the area between the building and the canyon slope.
Field notes on the FIMAD vegetation class to assist in ground-truthing the Arcview information	The area is listed as developed, with the canyon being predominantly ponderosa pine habitat. The PRS is bare ground on the upper 1/5 of the canyon slope and well vegetated with scattered shrubs and grasses along the lower 4/5 of the slope. The vegetation that has established itself on the ash debris pile is different from the native vegetation that is present on either side and in the canyon below this area.
Field notes on T&E Habitat, if applicable. Consider the need for a site visit by a T&E subject matter expert to support the use of the site by T&E receptors.	Pueblo Canyon is within the core area for nesting and foraging for the peregrine falcon and Mexican spotted owl. Habitat for these species may be adequate for these birds. Habitat surveys have not found any nests for the peregrine falcon in the vicinity of the airport.
Are ecological receptors present at the site? (yes/no/uncertain) Describe the general types of receptors present at the site (terrestrial and aquatic), and make notes on the quality of habitat present at the site.	Yes. There is available habitat in the area adjacent to the site. There are scattered grasses, shrubs, and trees at the site. Pueblo Canyon does provide excellent habitat for a variety of terrestrial ecological receptors, including, bird, mouse, and shrew. No aquatic ecological receptors are present anywhere in the area of the PRS.

Contaminant Transport Information:

Surface water transport Field notes on the erosion potential, including a discussion of the terminal point of surface water transport (if applicable).	The terminal point of surface water transport is the bench located approximately 150 ft down the slope in Pueblo Canyon. The runoff in the area of the PRS is primarily rill flow but there are a few vaguely distinct run-off channels where the outfalls used to be. In addition, there is an asphalt drainage ditch that channels run-off from the airport parking lot approximately 10-15 ft west of the incinerator building.
Are there any off-site transport pathways (surface water, air, or groundwater)? (yes/no/uncertain) Provide explanation	Yes. Surface water is the primary off-site transport pathway. There is run-off from the mesa top onto the north-facing slope of Pueblo Canyon. There may be some off-site transport via the air pathway but this is minimal especially on the north-facing slope. Trees and the incinerator building shelter the mesa top area. The slope is vegetated and the nature of the ash on this slope is such that wind erosion is minimal. There is no off-site transport via ground water because ground water is not near the mesa top and there is no hydraulic driver for the subsurface contamination to reach alluvial, perched, or the main aquifer.

Interim action needed to limit off-site transport? **(yes/no/uncertain)** **Provide explanation/ recommendation to project lead for IA SMDP.**	**No. The north-facing slope of Pueblo Canyon below the mesa edge has become vegetated by some woody ground cover. As a result, the slope is stabilized and the erosion potential is minimal. The run-off from the mesa top terminates at the bench approximately 150 ft below. This acts as a natural barrier to further off-site transport.**

Ecological Effects Information:

Physical Disturbance **(Provide list of major types of disturbances, including erosion and construction activities, review historical aerial photos where appropriate.)**	**The area has been disturbed by the sampling activities that have occurred over the last year or so. Also, underground electrical and telephone lines have been installed across the mesa top in back of the incinerator building. A dirt road runs east-west over in the general area where the drain lines and septic tank line were located. These activities are largely responsible for the lack of vegetation on the mesa top behind the incinerator building. The canyon slope has been disturbed by the disposal of the incinerator ash as well as the tin cans that have accumulated along the bench in the canyon.**
Are there obvious ecological effects? **(yes/no/uncertain)** **Provide explanation and apparent cause (e.g., contamination, physical disturbance, other).**	**Yes. The relative lack of and change in the vegetation in this portion of the canyon slope is the most obvious ecological effect. In addition, there are numerous rusted tin cans along the bench below the ash debris pile.**
Interim action needed to limit apparent ecological effects? **(yes/no/uncertain)** **Provide explanation and recommendations to mitigate apparent exposure pathways to project lead for IA SMDP.**	**No. This area is within an active industrial/commercial facility (Los Alamos Airport). Investigations in the area are continuing and activities along the dirt road are ongoing.**

No Exposure/Transport Pathways:

If there are no complete exposure pathways to ecological receptors onsite and no transport pathways to offsite receptors, the remainder of the checklist should not be completed. Stop here and provide additional explanation/justification for proposing an ecological No Further Action recommendation (if needed). At a minimum, the potential for future transport should include likelihood that future construction activities could make contamination more available for exposure or transport. **Not applicable.**

Adequacy of Site Characterization:

Do existing or proposed data provide information on the nature, rate and extent of contamination? **(yes/no/uncertain)** **Provide explanation** **(Consider if the maximum value was captured by existing sample data.)**	**No. Samples have been collected from the surface and subsurface of the ash debris pile so that the nature of the contamination from this PRS is clearly defined. In addition, samples have been collected from the drainages leading from the bench to the floor of Pueblo Canyon. This sampling has delineated the general extent of the contamination originating from the PRS. However, some of the drainages have not been sampled sufficiently to depict extent and some have not been analyzed for all of the analytes detected in the ash.**
Do existing or proposed data for the site address potential transport pathways of site contamination? **(yes/no/uncertain)** **Provide explanation** **(Consider if other sites should aggregated to characterize potential ecological risk.)**	**Yes. See comment above.**

Additional Field Notes:

Provide additional field notes on the site setting and potential ecological receptors.

The outfall areas for PRSs 73-004(a) and 73-006 will be addressed as part of the investigation of PRS 73-002 (ash debris pile) because the discharges from these PRSs are commingled with the as debris pile.

PART C—ECOLOGICAL PATHWAYS CONCEPTUAL EXPOSURE MODEL

Question A:

Could soil contaminants reach receptors via vapors?

- **Volatility of the hazardous substance (volatile chemicals generally have Henry's Law constant $>10^{-5}$ atm-me/mol and molecular weight <200 g/mol).**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: Volatile organic compounds have been detected in the ash debris pile but at very low concentrations (approximately 0.02 mg/kg or less). At these low levels vapors are a concern.

Question B:

Could the soil contaminants reach receptors through fugitive dust carried in air?

- **Soil contamination would have to be on the actual surface of the soil to become available for dust.**

- **In the case of dust exposures to burrowing animals, the contamination would have to occur in the depth interval where these burrows occur.**

Answer (likely/unlikely/uncertain): Likely

Provide explanation: The incinerator ash is on the surface of the canyon slope. This area is exposed to the elements and subject to transport as particulates or dust by the wind. However, the ash is a heavy solidified substance that probably makes this pathway unlikely or minor. There is no evidence of burrowing on this slope.

Question C:

Can contaminated soil be transported to aquatic ecological communities (use SOP 2.01 run-off score and terminal point of surface water runoff to help answer this question)?

- **If the SOP 2.01 run-off score* for each PRS included in the site is equal to zero, this suggests that erosion at the site is not a transport pathway. (* note that the runoff score is not the entire erosion potential score, rather it is a subtotal of this score with a maximum value of 46 points).**

- **If erosion is a transport pathway, evaluate the terminal point to see if aquatic receptors could be affected by contamination from this site.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: The runoff score for this site is 25.5 indicating a good possibility of transport of materials via surface water runoff. However, the slope is relatively stable and there are no aquatic communities located in Pueblo Canyon in the vicinity of the drainage from the ash debris slope.

Question D:

Is contaminated groundwater potentially available to biological receptors through seeps or springs or shallow groundwater?

Known or suspected presence of contaminants in groundwater.

- **The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.**

- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).**

- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: The main aquifer is approximately 1100 ft beneath the mesa top making it unlikely that contaminants from this PRS would reach the aquifer. There are no known seeps or springs in the vicinity of the PRS so the presence of shallow alluvial or perched aquifers so near the canyon appears unlikely.

Question E:

Is infiltration/percolation from contaminated subsurface material a viable transport and exposure pathway?

- **Suspected ability of contaminants to migrate to groundwater.**
- **The potential for contaminants to migrate via groundwater and discharge into habitats and/or surface waters.**
- **Contaminants may be taken up by terrestrial and rooted aquatic plants whose roots are in contact with groundwater present within the root zone (~1 m depth).**
- **Terrestrial wildlife receptors generally will not contact groundwater unless it is discharged to the surface.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: The main aquifer is approximately 1100 ft beneath the mesa top making it unlikely that contaminants from these PRSs would reach the aquifer. There are no known seeps or springs in the vicinity of the PRSs. Also, there is no hydraulic driver to facilitate the movement of contaminants to the ground water.

Question F:

Might erosion or mass wasting events be a potential release mechanism for contaminants from subsurface materials or perched aquifers to the surface?

- **This question is only applicable to release sites located on or near the mesa edge.**
- **Consider the erodability of surficial material and the geologic processes of canyon/mesa edges.**

Answer (likely/unlikely/uncertain): Unlikely

Provide explanation: Because the ash debris pile is located on the canyon slope, mass wasting can be considered a potential, though unlikely, release mechanism. The area is stabilized by vegetation and does not appear to have experienced any massive erosion over the years.

Question G:

Could airborne contaminants interact with receptors through respiration of vapors?

- **Contaminants must be present as volatiles in the air.**
- **Consider the importance of inhalation of vapors for burrowing animals.**
- **Foliar uptake of organic vapors is typically not a significant exposure pathway.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 1

Terrestrial Animals: 1

Provide explanation: The concentration of volatiles in the ash is relatively low (generally 0.02 mg/kg or less). Because of the low levels and the nature of the site, any vapors that may be released are rapidly dispersed. There is no evidence of burrowing activity in the ash debris pile.

Question H:

Could airborne contaminants interact with plants through deposition of particulates or with animals through inhalation of fugitive dust?

- **Contaminants must be present as particulates in the air or as dust for this exposure pathway to be complete.**
- **Exposure via inhalation of fugitive dust is particularly applicable to ground-dwelling species that would be exposed to dust disturbed by their foraging or burrowing activities or by wind movement.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 2

Terrestrial Animals: 2

Provide explanation: Contamination is at or near the surface of the ash debris pile and subject to transport via the wind. However, the ash is a heavy, solidified material that is probably not easily dispersed by wind activity. There is also no evidence of burrowing activity by receptors within the ash debris pile.

Question I:

Could contaminants interact with plants through root uptake or rain splash from surficial soils?

- **Contaminants in bulk soil may partition into soil solution, making them available to roots.**
- **Exposure of terrestrial plants to contaminants present in particulates deposited on leaf and stem surfaces by rain striking contaminated soils (i.e., rain splash).**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 3

Provide explanation: Currently, vegetative cover ranges from little or no vegetation near the mesa top to moderate cover on the lower part of the slope. Because the vegetation consists of grasses and low shrubs, there is the potential for rain splash. The roots of the plants are also in contact with the contamination present in the ash and available for uptake.

Question J:

Could contaminants interact with receptors through food web transport from surficial soils?

- **The chemicals may bioaccumulate in animals.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 3

Provide explanation: There are a number of potential bioaccumulators present in the ash debris pile.

Question K:

Could contaminants interact with receptors via incidental ingestion of surficial soils?

- **Incidental ingestion of contaminated soil could occur while animals grub for food resident in the soil, feed on plant matter covered with contaminated soil or while grooming themselves clean of soil.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 3

Provide explanation: The contaminants are at or near the surface and available to receptors via incidental ingestion.

Question L:

Could contaminants interact with receptors through dermal contact with surficial soils?

- **Significant exposure via dermal contact would generally be limited to organic contaminants that are lipophilic and can cross epidermal barriers.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 2

Provide explanation: Some of the contaminants are lipophilic and can cross the epidermal barrier if exposure would occur.

Question M:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0

Terrestrial Animals: 0

Provide explanation: No gamma emitting radionuclides were detected in the ash debris pile.

Question N:

Could contaminants interact with plants through direct uptake from water and sediment or sediment rain splash?

- **Contaminants may be taken-up by terrestrial plants whose roots are in contact with surface waters.**
- **Terrestrial plants may be exposed to particulates deposited on leaf and stem surfaces by rain striking contaminated sediments (i.e., rain splash) in an area that is only periodically inundated with water.**
- **Contaminants in sediment may partition into soil solution, making them available to roots.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 1

Provide explanation: There are no surface water systems at or near the PRS. The stream channel in the floor of Pueblo Canyon is ephemeral and rarely inundated with water.

Question O:

Could contaminants interact with receptors through food web transport from water and sediment?

- **The chemicals may bioconcentrate in food items.**
- **Animals may ingest contaminated food items.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 1

Provide explanation: There are no surface water systems at or near the PRS. The stream channel in the floor of Pueblo Canyon is ephemeral and rarely inundated with water.

Question P:

Could contaminants interact with receptors via ingestion of water and suspended sediments?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial receptors may incidentally ingest sediments.**
- **Terrestrial receptors may ingest water-borne contaminants if contaminated surface waters are used as a drinking water source.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 1

Provide explanation: There are no surface water systems at or near the PRS. The stream channel in the floor of Pueblo Canyon is ephemeral and rarely inundated with water.

Question Q:

Could contaminants interact with receptors through dermal contact with water and sediment?

- **If sediments are present in an area that is only periodically inundated with water, terrestrial species may be dermally exposed during dry periods.**
- **Terrestrial organisms may be dermally exposed to water-borne contaminants as a result of wading or swimming in contaminated waters.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Animals: 1

Provide explanation: There are no surface water systems at or near the PRS. The stream channel in the floor of Pueblo Canyon is ephemeral and rarely inundated with water.

Question R:

Could contaminants interact with plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma emitting radionuclides.**
- **Burial of contamination attenuates radiological exposure.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Terrestrial Plants: 0

Terrestrial Animals: 0

Provide explanation: There are no surface water systems at or near the PRS. The stream channel in the floor of Pueblo Canyon is ephemeral and rarely inundated with water. No gamma-emitting radionuclides were detected in the ash debris pile.

Question S:

Could contaminants bioconcentrate in free floating aquatic, attached aquatic plants, or emergent vegetation?

- **Aquatic plants are in direct contact with water.**
- **Contaminants in sediment may partition into pore water, making them available to submerged roots.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Plants/Emergent Vegetation: 0

Provide explanation: There are no aquatic communities located at or near the site or in Pueblo Canyon below the drainage from the PRS.

Question T:

Could contaminants bioconcentrate in sedimentary or water column organisms?

- **Aquatic receptors may actively or incidentally ingest sediment while foraging.**
- **Aquatic receptors may be directly exposed to contaminated sediments or may be exposed to contaminants through osmotic exchange, respiration, or ventilation of sediment pore waters.**
- **Aquatic receptors may be exposed through osmotic exchange, respiration, or ventilation of surface waters.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Animals: 0

Provide explanation: There are no aquatic communities located at or near the site or in Pueblo Canyon below the drainage from the PRS.

Question U:

Could contaminants bioaccumulate in sedimentary or water column organisms?

- **Lipophillic organic contaminants and some metals may concentrate in an organism's tissues**
- **Ingestion of contaminated food items may result in contaminant bioaccumulation through the food web.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

Aquatic Animals: 0

Provide explanation: There are no aquatic communities located at or near the site or in Pueblo Canyon below the drainage from the PRS.

Question V:

Could contaminants interact with aquatic plants or animals through external irradiation?

- **External irradiation effects are most relevant for gamma emitting radionuclides.**
- **The water column acts to absorb radiation, thus external irradiation is typically more important for sediment dwelling organisms.**

Provide quantification of exposure pathway (0=no pathway, 1=unlikely pathway, 2=minor pathway, 3=major pathway):

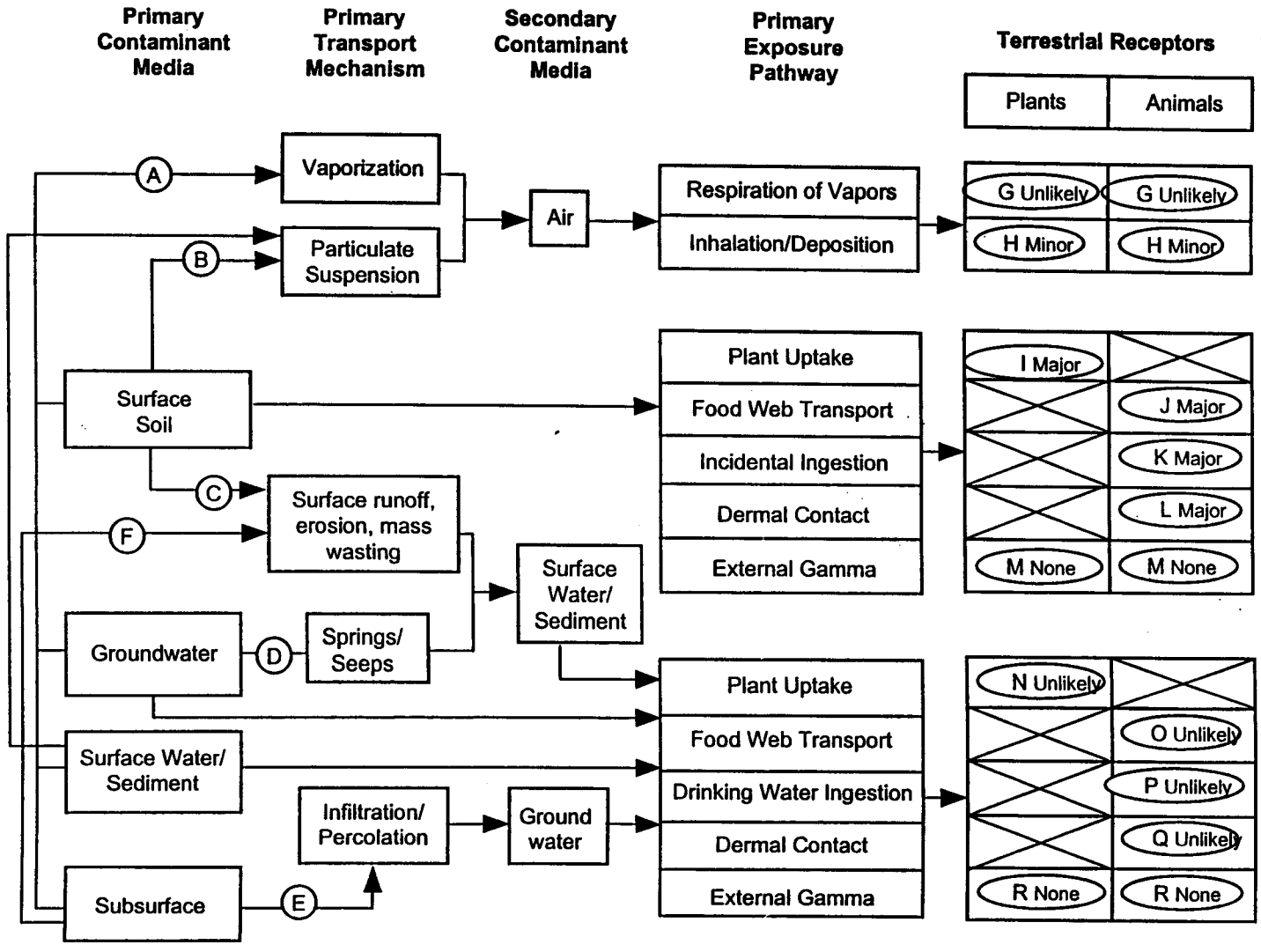
Aquatic Plants: 0

Aquatic Animals: 0

Provide explanation: There are no aquatic communities located at or near the site or in Pueblo Canyon below the drainage from the PRS. No gamma-emitting radionuclides were detected in the ash debris pile.

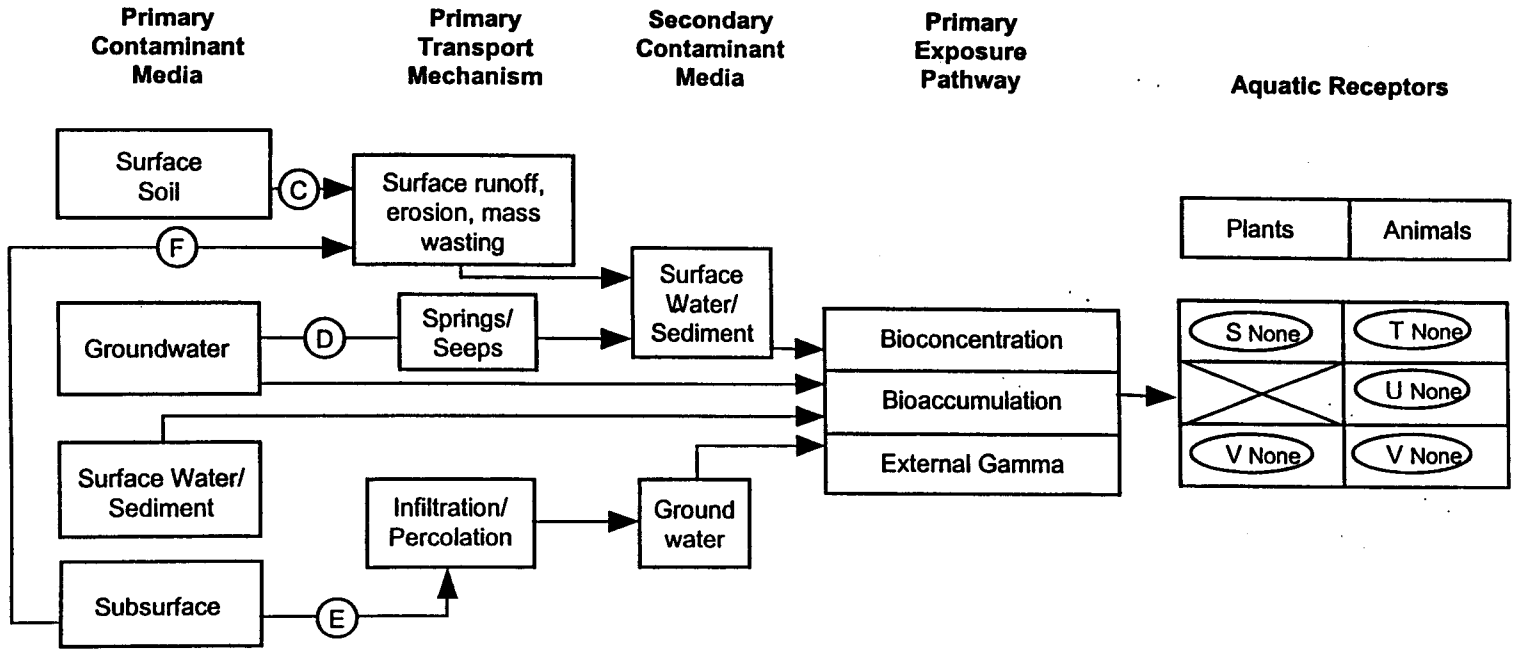
Ecological Scoping Checklist
Terrestrial Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the Scoping Checklist



Ecological Scoping Checklist
Aquatic Receptors
Ecological Pathways Conceptual Exposure Model

NOTE:
Letters in circles refer to questions on the Scoping Checklist



Signatures and certifications:

Checklist completed by (provide name, organization and phone number):

Name (printed): Richard Mirenda, Ph.D.
Name (signature):
Organization: MK/PMC
Phone number: (505)662-1329

Date completed: 6/1/99

Verification by a member of ER Project Ecological Risk Task Team (provide name, organization and phone number):

Name (printed):
Name (signature):
Organization:
Phone number: