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# Post-Cerro Grande Fire Environmental Sampling Data: Baseline Ash and Muck Samples

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**Acronyms**

DOE	US Department of Energy
EPA	US Environmental Protection Agency
ER	environmental restoration
RESRAD	residual radioactive material code
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TEF	toxicity equivalency factor

## 1.0 INTRODUCTION

This report summarizes the analytical results for seven post-Cerro Grande fire baseline ash and muck samples collected in June 2000 from background locations west of Los Alamos National Laboratory (the Laboratory).

## 2.0 SAMPLING AND ANALYSIS

On June 9, 2000, seven samples of ash and muck (flood-reworked ash and very fine sediment) were collected from background locations west of Los Alamos National Laboratory (the Laboratory). The ash samples were collected from upland locations in the upper Pueblo and Los Alamos watersheds. The muck samples were collected from the South Fork of Pajarito Canyon at the culvert west of State Road 501, from Pueblo Canyon at the culvert west of Diamond Drive, and from the bottom of the Los Alamos reservoir in Los Alamos Canyon. Each sample was analyzed for the following chemicals:

- 23 trace metals;
- bicarbonate, bromide, carbonate, chloride, fluoride, pH, and sulfate;
- americium-241;
- gamma-emitting radionuclides;
- isotopic plutonium (plutonium-238 and plutonium-239);
- isotopic thorium (thorium-228, thorium-230, and thorium-232);
- isotopic uranium (uranium-234, uranium-235, and uranium-238);
- strontium-90;
- dioxins and furans;
- semivolatile organic compounds; and
- total organic carbon.

One sample was also analyzed for high explosives.

Chemical data from the ash and muck samples are important for characterizing the concentrations of metals and radionuclides in ashes of plant material and organic compounds resulting from partial combustion of trees, litter, and other plants. The metals found in ash represent plant uptake of naturally occurring metals in rock and soil. The radionuclides are associated with fallout from above-ground nuclear testing conducted primarily during 1950s and 1960s. The baseline ash and muck data support the assessment of potential impacts to the Laboratory and offsite (e.g., the Rio Grande and the Cochiti Reservoir) from fire-related contaminants found in storm runoff.

## 3.0 DATA SUMMARY TABLES

The chemical data for the baseline ash and muck samples are summarized in three tables: one each for inorganic chemicals, radionuclides, and organic chemicals (Tables 3.0-1, 3.0-2, and 3.0-3). Each table

lists the chemical analyte, the number of samples analyzed, the number of detected results, and the minimum, mean, and maximum value for the detected results. The inorganic and radionuclide detected results are compared with the Laboratory-specific background values for canyon-bottom sediments. The background value is a threshold used to identify site sample results that may be greater than background levels. The Laboratory background data are summarized in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory" (Ryti et al. 1998, 59730). The Laboratory Environmental Restoration (ER) Project procedures for using background values are found in ER-SOP-15.12, "Performing Background Value Comparisons for Inorganic Chemicals," and ER-SOP-15.13, "Performing Background Value Comparisons for Radionuclides." There are no background values for organic chemicals.

In the inorganic and organic summary tables (Tables 3.0-1 and 3.0-3), the results are also compared with US Environmental Protection Agency (EPA) Region 6 residential screening levels for soil. The soil screening levels are chemical concentrations that correspond to a fixed level of risk to an individual (i.e., either a one-in-one-million [ $10^{-6}$ ] cancer risk for carcinogens or a hazard quotient of 1.0 for noncarcinogens). The values are derived using the most currently available toxicity information, default toxicity parameters, and equations, and are updated periodically by EPA Region 6. The values, along with the supporting information, are available with a textual discussion on the EPA Region 6 home page at [www.epa.gov/region06/6pd/rcra\\_c/pd-n/screen.htm](http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm). Screening levels are intended to provide an initial generic assessment of potential risk under conservative exposure conditions. The exceedance of the screening level by a chemical does not necessarily mean that immediate action (e.g., remediation) is necessary, only that further evaluation should be undertaken. The evaluation may include additional sample collection leading to a baseline risk assessment or, if enough data are available, evaluating the potential risk under a more realistic context (e.g., more representative exposure conditions). Subsequently, a baseline risk assessment may be warranted to accurately assess the potential risk from exposure.

In the radionuclide data summary table (Table 3.0-2) the sample results are compared with residential soil screening levels. Radionuclide screening levels are calculated using the residual radioactive material computer code (RESRAD) developed by Argonne National Laboratory for use by DOE sites. This model uses standard residential default values for variables that affect risk such as body weight, intake rate, and exposure duration. Doses are summed over multiple pathways, including inhalation, external gamma, soil ingestion, and plant ingestion. The target dose level used for radionuclide screening level calculations is 10 mrem/yr, which is one-tenth of DOE's annual effective dose limit of 100 mrem/yr from all sources (DOE Order 5400.5, "Radiation Protection of the Public and the Environment" [Proposed Rule, 10 CFR 834]).

For the dioxin and furan results reported in the organic summary table (Table 3.0-3), the 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) risk equivalent value was derived using EPA's toxicity equivalency factor (TEF) methodology for dioxin and related compounds. Several dioxin and furan congeners are thought to have dioxin-like toxicity because they have chlorine substitutions in at least the 2, 3, 7, and 8 positions. For risk assessment purposes, a toxicity equivalency procedure has been developed to describe the cumulative toxicity of mixtures of dioxin and furan congeners. The TEFs assigned to the individual congeners are based on 2,3,7,8-TCDD, which has a TEF value of 1.0. The TEF values have had international and national endorsement and are reviewed every five years to account for new toxicity information. In the organic data summary table, the 2,3,7,8-TCDD toxicity equivalency for each sample has been determined by multiplying the concentration of individual congeners by their respective TEFs, and then summing the normalized values. The 2,3,7,8-TCDD toxicity equivalent concentration is compared to the EPA Region 6 soil screening level for 2,3,7,8-TCDD to provide an estimate of potential risk from exposure to dioxin. Further information about the TEF values for dioxin and furans is available at <http://www.epa.gov/nceawww1/dchem.htm>.

#### **4.0 REFERENCES**

Ryti, R. T., P. A. Longmire, D. E. Broxton, S. L. Reneau, and E. V. McDonald, September 1998. "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory," Draft, Los Alamos National Laboratory Report LA-UR-98-4847, Los Alamos, New Mexico. (Ryti et al. 1998, 59730)

**Table 3.0-1  
Baseline Ash and Muck Samples: Data Summary for Inorganics**

Analyte	Number of Analyses	Number of Detects	Minimum of Detects (mg/kg)	Mean of Detects (mg/kg)	Maximum of Detects (mg/kg)	Sediment Background Value <sup>a</sup> (mg/kg)	Frequency of Detects >Background	Residential Screening Level <sup>b</sup> (mg/kg)	Frequency of Detects >Residential Screening Level
Aluminum	7	7	6,700	11,600	17,000	15,400	2/7	78,000	0/7
Antimony	7	5	0.42	0.57	0.68	0.83	0/7	31	0/7
Arsenic	7	7	3.8	4.8	6.6	3.98	6/7	0.39 <sup>c</sup>	7/7
Barium	7	7	160	650	1,300	127	7/7	5,400	0/7
Beryllium	7	7	0.5	0.7	1.0	1.31	0/7	150	0/7
Bicarbonate	7	7	490	890	1,400	na <sup>d</sup>	n/a <sup>e</sup>	na	n/a
Bromide	7	7	0.6	6	14	na	n/a	na	n/a
Cadmium	7	7	0.54	0.69	0.96	0.4	7/7	39	0/7
Calcium	7	7	13,000	45,000	90,000	4,420	7/7	na	n/a
Carbonate	7	0	n/a	n/a	n/a	na	n/a	na	n/a
Chloride	7	7	19	90	180	17.1	7/7	na	n/a
Chromium, total	7	7	5.4	8.5	11	10.5	2/7	30	0/7
Cobalt	7	7	3.8	6.3	8.9	4.73	6/7	3,400	0/7
Copper	7	7	16	26	45	11.2	7/7	2,900	0/7
Fluoride	7	0	n/a	n/a	n/a	n/a	0/7	3,600	0/7
Iron	7	7	10,000	12,600	15,000	13,800	2/7	23,000	0/7
Lead	7	7	40	54	75	19.7	7/7	400	0/7
Magnesium	7	7	2,100	3,700	6,100	2,370	5/7	na	n/a
Manganese	7	7	1,200	3,600	8,200	543	7/7	3,200	3/7

**Table 3.0-1  
Baseline Ash and Muck Samples: Data Summary for Inorganics  
(continued)**

Analyte	Number of Analyses	Number of Detects	Minimum of Detects (mg/kg)	Mean of Detects (mg/kg)	Maximum of Detects (mg/kg)	Sediment Background Value <sup>a</sup> (mg/kg)	Frequency of Detects >Background	Residential Screening Level <sup>b</sup> (mg/kg)	Frequency of Detects >Residential Screening Level
Mercury	7	7	0.003	0.012	0.04	0.1	0/7	23	0/7
Nickel	7	7	5.7	9.1	11	9.38	3/7	1,600	0/7
pH	7	7	7.9	8.2	8.5	na	n/a	na	n/a
Potassium	7	7	2,200	4,500	8,800	2,690	4/7	na	n/a
Selenium	7	5	0.61	2.3	4.7	0.3	5/7	390	0/7
Silver	7	3	0.23	0.44	0.64	1	0/7	390	0/7
Sodium	7	7	150	400	870	1,470	0/7	na	n/a
Sulfate	7	7	190	2,000	4,300	58.2	7/7	na	n/a
Thallium	7	0	n/a	n/a	n/a	0.73	0/7	5.5	0/7
Vanadium	7	7	13	19	25	19.7	2/7	550	0/7
Zinc	7	7	83	118	180	60.2	7/7	23,000	0/7

<sup>a</sup>Laboratory-specific background values for canyon-bottom sediments are found in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory." ER Project procedures for using background values are found in ER-SOP-15.12, "Performing Background Value Comparisons for Inorganic Chemicals," and ER-SOP-15.13, "Performing Background Value Comparisons for Radionuclides."

<sup>b</sup>EPA Region 6 residential screening levels for soils are available at [www.epa.gov/region06/6pd/rcra\\_c/pd-n/screen.htm](http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

<sup>c</sup>Soil screening level is less than Laboratory-specific background value.

<sup>d</sup>na = not available.

<sup>e</sup>n/a = not applicable.

**Table 3.0-2  
Baseline Ash and Muck Samples: Data Summary for Radionuclides**

Analyte	No. Analyses	No. Detects	Minimum of Detects (pCi/g)	Mean of Detects (pCi/g)	Max. Detect (pCi/g)	Sediment Background Value <sup>a</sup> (pCi/g)	Frequency of Detects >Background	Residential Screening Level <sup>b</sup> (pCi/g)	Frequency of Detects >Residential Screening Level
Americium-241	7	7	0.07	0.12	0.203	0.04	7/7	22	0/7
Cesium-134	7	0	n/a <sup>c</sup>	n/a	n/a	na <sup>d</sup>	n/a	1.9	0/7
Cesium-137	7	7	3.18	4.39	5.16	0.9	7/7	5.1	1/7
Cobalt-60	7	0	n/a	n/a	n/a	na	n/a	1.1	0/7
Europium-152	7	0	n/a	n/a	n/a	na	n/a	2.6	0/7
Plutonium-238	7	6	0.019	0.029	0.042	0.006	6/7	27	0/7
Plutonium-239	7	7	0.25	0.37	0.7	0.068	7/7	24	0/7
Ruthenium-106	7	0	n/a	n/a	n/a	na	n/a	13	0/7
Sodium-22	7	0	n/a	n/a	n/a	na	n/a	1.3	0/7
Strontium-90	7	7	1.02	2.08	3.48	1.04	6/7	4.4	0/7
Thorium-228	7	7	1	1.23	1.66	2.28	0/7	1.7	0/7
Thorium-230	7	7	1	1.19	1.32	2.29	0/7	0.18 <sup>e</sup>	7/7
Thorium-232	7	7	0.89	1.07	1.29	2.33	0/7	0.77 <sup>e</sup>	7/7
Uranium-234	7	7	1.14	1.38	1.82	2.59	0/7	13	0/7
Uranium-235	7	7	0.067	0.129	0.178	0.2	0/7	10	0/7
Uranium-238	7	7	1.3	1.84	2.74	2.29	1/7	67	0/7

<sup>a</sup>Laboratory-specific background values for canyon-bottom sediments are found in "Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory." ER Project procedures for using background values are found in ER-SOP-15.12, "Performing Background Value Comparisons for Inorganic Chemicals," and ER-SOP-15.13, "Performing Background Value Comparisons for Radionuclides."

<sup>b</sup>Radionuclide screening levels are calculated using the residual radioactive material computer code (RESRAD) developed by Argonne National Laboratory for use by DOE sites. The target dose level used for radionuclide screening level calculations is 10 mrem/yr, which is one-tenth of DOE's annual effective dose limit of 100 mrem/yr from all sources.

<sup>c</sup>n/a = not applicable.

<sup>d</sup>na = not available.

<sup>e</sup>Soil screening level is less than Laboratory-specific background value.

**Table 3.0-3  
Baseline Ash and Muck Samples: Data Summary for Organics**

Analyte	Number of Analyses	Number of Detects	Frequency of Detects	Minimum of Detects (mg/kg)	Mean of Detects (mg/kg)	Maximum of Detects (mg/kg)	Residential Screening Level <sup>a</sup> (mg/kg)	Frequency of Detects > Residential Screening Level
Benzoic Acid	7	3	3/7	2.10	3.93E+00	5.90E+00	1.00E+05	0/7
Carbon, total organic	7	7	7/7	7.60E+03	2.32E+4	4.60E+4	na <sup>b</sup>	n/a <sup>c</sup>
Dibenzofuran	7	4	4/7	2.10E-01	4.30E-1	7.50E-1	2.30E+02	0/7
Dimethylphenol[2,4-]	7	1	1/7	4.60E-01	4.60E-01	4.60E-01	1.20E+03	0/7
Methylnaphthalene[2-]	7	1	1/7	2.00E-01	2.00E-01	2.00E-01	5.5E+01	0/7
Methylphenol[2-]	7	5	5/7	3.10E-01	6.62E-01	9.60E-01	3.00E+03	0/7
Methylphenol[4-]	7	7	7/7	8.20E-01	1.59E+00	3.00E+00	3.00E+02	0/7
Naphthalene	7	7	7/7	5.80E-01	1.02E+00	1.50E+00	5.5E+01	0/7
Nitrobenzene	1	1	1/1	1.10E-01	1.10E-01	1.10E-01	1.6E+01	0/1
Phenanthrene	7	4	4/7	2.00E-01	4.35E-01	9.80E-01	1.60E+04	0/7
Phenol	7	7	7/7	1.00E-00	2.50E+00	5.40E+00	3.6E+04	0/7
Pyridine	7	7	7/7	1.80E-00	3.79E+00	7.10E+00	6.1E+01	0/7
<b>Dioxins and Furans</b>								
Heptachlorodibenzodioxin[1,2,3,4,6,7,8-]	7	3	3/7	1.59E-06	4.23E-06	7.13E-06	na	n/a
Heptachlorodibenzodioxins (total)	7	7	7/7	1.20E-06	4.66E-06	1.45E-05	na	n/a
Heptachlorodibenzofuran[1,2,3,4,6,7,8-]	7	5	5/7	1.71E-07	6.89E-07	1.46E-06	na	n/a
Heptachlorodibenzofurans (total)	7	5	5/7	1.71E-07	1.32E-06	3.30E-06	na	n/a
Hexachlorodibenzodioxin[1,2,3,6,7,8-]	7	1	1/7	4.44E-07	4.44E-07	4.44E-07	na	n/a
Hexachlorodibenzodioxin[1,2,3,7,8,9-]	7	1	1/7	3.43E-07	3.43E-07	3.43E-07	na	n/a
Hexachlorodibenzodioxins (total)	7	6	6/7	2.50E-07	1.36E-06	3.89E-06	na	n/a

**Table 3.0-3**  
**Baseline Ash and Muck Samples: Data Summary for Organics**  
**(continued)**

Analyte	Number of Analyses	Number of Detects	Frequency of Detects	Minimum of Detects (mg/kg)	Mean of Detects (mg/kg)	Maximum of Detects (mg/kg)	Residential Screening Level <sup>a</sup> (mg/kg)	Frequency of Detects > Residential Screening Level
Hexachlorodibenzofuran[1,2,3,4,7,8-]	7	3	3/7	2.07E-07	2.77E-07	3.3E-07	na	n/a
Hexachlorodibenzofuran[1,2,3,6,7,8-]	7	2	2/7	1.91E-07	2.07E-07	2.22E-07	na	n/a
Hexachlorodibenzofuran[2,3,4,6,7,8-]	7	2	2/7	1.60E-07	1.68E-07	1.76E-07	na	n/a
Hexachlorodibenzofurans (total)	7	6	6/7	1.40E-07	9.39E-07	2.49E-06	na	n/a
Octachlorodibenzodioxin[1,2,3,4,6,7,8,9-]	7	5	5/7	3.50E-06	1.66E-05	3.66E-05	na	n/a
Octachlorodibenzofuran[1,2,3,4,6,7,8,9-]	7	2	2/7	2.14E-06	2.52E-06	2.90E-06	na	n/a
Pentachlorodibenzodioxins (total)	7	1	1/7	2.11E-07	2.11E-07	2.11E-07	na	n/a
Pentachlorodibenzofuran[1,2,3,7,8-]	7	5	5/7	7.40E-08	1.42E-07	2.19E-07	na	n/a
Pentachlorodibenzofuran[2,3,4,7,8-]	7	5	5/7	1.16E-07	1.98E-07	3.11E-07	na	n/a
Pentachlorodibenzofurans (total)	7	6	6/7	5.21E-07	1.51E-06	3.28E-06	na	n/a
Tetrachlorodibenzodioxins (total)	7	7	7/7	1.17E-06	3.62E-06	7.54E-06	na	n/a
Tetrachlorodibenzofuran[2,3,7,8-]	7	7	7/7	1.27E-07	2.28E-07	3.41E-07	na	n/a
Tetrachlorodibenzofurans (totals)	7	7	7/7	1.83E-06	2.88E-06	5.02E-06	na	n/a
<b>Summed 2,3,7,8-TCDD toxicity equivalent<sup>d</sup></b>	n/a	n/a	n/a	1.27E-08	1.68E-07	4.70E-07	3.9E-06	0/7

<sup>a</sup> EPA Region 6 residential screening levels for soils are available at [www.epa.gov/region06/6pd/rcra\\_c/pd-n/screen.htm](http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

<sup>b</sup> na = not available.

<sup>c</sup> n/a = not applicable.

<sup>d</sup> The 2,3,7,8-TCDD toxicity equivalent concentration is determined by multiplying the concentration of individual congeners by their respective TEFs, and then summing the normalized values. Further information about the TEFs for dioxins and furans is available at <http://www.epa.gov/nceawww1/dchem.htm>.