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Soil Sample Report in Support of the Site 300 EWTF Ecological Risk Assessment and Permit Renewal-September 2012

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Environmental Functional Area
Environmental Support and Programmatic Outreach

Soil Sample Report
In Support of the Site 300
Explosives Waste Treatment Facility
Permit Renewal

September 2012

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Lawrence Livermore National Laboratory
Lawrence Livermore National Security, LLC

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EXECUTIVE SUMMARY

LLNL Site 300 has applied to renew the permits for its Explosives Waste Treatment Facility (EWTF), Explosives Waste Storage Facility (EWSF) and Building 883 Storage Facility. As a part of the permit renewal process, the Department of Toxic Substances Control (DTSC) requested LLNL to obtain soil samples in order to conduct a scoping-level ecological risk assessment pursuant to the *Department of Toxic Substances Control, Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part A: Overview, July 4, 1996.* As stated in the guidance document, the scoping-level ecological risk assessment provides a framework to determine the potential interaction ecological receptors and chemicals of concern from hazardous waste treatment operations in the area of EWTF.

Project-specific sampling requirements are outlined in *Soil Sampling Plan in Support of the Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Terusaki, October 2007.*

In addition to soil sampling, LLNL completed a predictive ecological risk assessment which is included in the second part of the *Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Gallegos, Daniels and Wegrecki, October 2007*. The predictive ecological risk assessment and scoping level soil sample report characterize the biology of the hazardous waste facility area, evaluate exposure pathways, identify chemicals of concern and evaluate chemicals of concern concentrations relative to site background concentrations.

Soil samples were obtained and analyzed from four chemical groups: furans, explosives, semi-volatiles and metals. Analytical results for furans, explosives and semi-volatiles indicated the chemicals were not detected; therefore, no further analysis was conducted. Soil samples analyzed for metals were compared to site-wide background levels. Background metal concentrations were developed for site wide cleanup activities pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Total metal concentrations from 28 soil samples obtained in the EWTF area are below background levels. Therefore, following DTSC 1996 guidance, the EWTF hazardous waste treatment units exit the ecological risk evaluation process upon completion of the requirements of a scoping-level assessment report. This soil sample report and the predictive ecological risk assessment provide substantial documentation that exceed the requirements of a scoping-level report.

Soil Sampling - Constituents of Potential Ecological Concern Summary

Soil Samples were obtained following the *Soil Sampling Plan in Support of the Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Terusaki, October 2007*, **Appendix 1**. Soil sampling implementation, quality assurance, quality control, EPA and ASTM analytical methods are provided in **Appendix 2** of this report.

Soil samples were analyzed for the following 21 Constituents of Potential Ecological Concern (CPEC). The CPECs were identified in the *Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Gallegos, Daniels and Wegrecki, October 2007*, **Appendix 3.**

Table 1. Constituents of Potential Ecological Concern

PCDFs (5)	Explosives (3)	Metals (8)	SVOCs (5)
1-4, 6-8 HpCDF	2,4-Dinitrotoluene	Aluminum	2-Chlorophenol
1-4, 7-9 HpCDF	2,6-Dinitrotoluene	Antimony	Diphenylamine
1-4, 7, 8 HxCDF	RDX	Barium	Fluoranthene
1-3, 6-8 HxCDF		Cadmium	Naphthalene
1-9 OCDF		Chromium	Phenol
		Copper	
		Lead	
		Zinc	

EPA Methods and detection limits were chosen for the appropriate soil matrix and to achieve the lowest, reproducible analytical result. The following table provides CPEC name, corresponding Chemical Abstract Services (CAS) number, and a qualitative comparison of Limit of Sensitivity to result.

Table 2. CPEC, CAS Number, Limit of Sensitivity and Result

Matrix: Soil
Analytical Group: Furans

CPEC	CAS Number	Limit of Sensitivity (LOS)	Result
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	10 ng/kg (ppt)	All samples <LOS
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	10 ppt	All samples <LOS

1,2,3,4,7,8- Hexachlorodibenzofuran	70648-26-9	10 ppt	All samples <LOS
1,2,3,6,7,8- Hexachlorodibenzofuran	57117-44-9	10 ppt	All samples <LOS
1,2,3,4,6,7,8,9- Octachlorodibenzofuran	39001-02-0	20 ppt	All samples <LOS

Matrix: Soil
Analytical Group: Explosives

CPEC	CAS Number	Limit of Sensitivity (LOS)	Result
2,4-Dinitrotoluene	121-14-2	0.5 mg/kg (ppm)	All samples <LOS
2,6-Dinitrotoluene	606-20-2	0.5 ppm	All samples <LOS
RDX	121-82-4	0.5 ppm	All samples <LOS

Matrix: Soil
Analytical Group: Heavy Metals

CPEC	CAS Number	Limit of Sensitivity (LOS)	Result
Aluminum	7429-90-5	12 mg/kg (ppm)	All samples >LOS
Antimony	7440-36-0	0.5 ppm	4 samples >LOS, 36 samples <LOS

Barium	7440-39-3	5 or 10 ppm depending on dilution	All samples >10 ppm LOS
Cadmium	7440-43-9	0.25 ppm	All samples >LOS
Chromium	7440-47-3	0.75 or 1.5 ppm depending on dilution	All samples >LOS
Copper	7440-50-8	5 or 10 ppm depending on dilution	All samples >LOS
Lead	7439-92-1	0.25 ppm	All samples >LOS
Zinc	7440-66-6	1.3 or 2.6 ppm depending on dilution	All samples >LOS

Matrix: Soil
Analytical Group: Semi-Volatiles

CPEC	CAS Number	Limit of Sensitivity	Result
2-Chlorophenol	95-57-8	0.5 ppm	All samples <LOS
Diphenylamine	122-39-4	0.5 ppm	All samples <LOS
Fluoranthene	206-44-0	0.5 ppm	All samples <LOS
Naphthalene	91-20-3	0.5 ppm	All samples <LOS
Phenol	108-95-2	0.5 ppm	All samples <LOS

The furans, explosives and semi-volatiles results were all below the limit of sensitivity of the laboratory analytical equipment. Therefore, additional statistical analysis was not performed on the 13 CPECs belonging to the furans, explosives and semi-volatile compound chemical groups.

Aluminum analysis was conducted on all 36 samples. The average concentration was 23,075 mg/kg, or 23%. Aluminum is the most commonly occurring metal in the Earth's crust, with concentration ranging from 1% to 30%. Although the concentration of aluminum is high relative to other metals, aluminum bearing minerals do not start to dissociate until soil pH lowers to 5.5. As the concentration of soluble aluminum increases, the toxicity also increases. However, in neutral soil pH environments, aluminum bearing minerals are stable and therefore do not pose a toxicity hazard. The average pH of 36 samples obtained in the EWTF and Ambient (background) areas is 7.5. Therefore, in this pH neutral to slightly basic environment, aluminum would not be found in the soluble, toxic state.

In order to evaluate the CPECs, background samples were collected as part of the EWTF soil sampling project. Samples were obtained by using the same methodology as EWTF area samples. The sample plan is described in the *Soil Sampling Plan in Support of the Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Terusaki, October 2007.* Soil sampling implementation information is provided in the **Appendix 2** of this report.

The three background sample areas were designated "Ambient" in the sampling. The three areas were upwind of EWTF by 7,000 to 8,000 feet; therefore, it is unlikely that emissions from EWTF affected the background areas. Locations of the background sample areas, as well as the EWTF area samples, are shown in **Appendix 2, Figures 6-1 and 6-2.**

In addition, a much larger background dataset consisting of samples obtained across the entire site was considered, and ultimately accepted as the dataset for comparison to the EWTF area metal levels. This larger dataset was developed for Comprehensive, Emergency Response and Compensation Liability Act (CERCLA) site-wide clean-up activities. The CERCLA soil samples were obtained from locations across the entire site, as shown in the **Figure 1**. EWTF sample locations are also shown in the same figure. The following table shows the number of samples obtained for each CPEC metal.

Table 3. Number of Samples Obtained for Each CPEC Metal

	Antimony	**Barium**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Zinc**
Number of Samples	9	422	79	403	340	194	324

A comprehensive description of the CERCLA background study is provided in **Appendix 4**, *Site-Wide Feasibility Study for LLNL Site 300, Appendix A, November 1999.* This 1999 background data is still used to evaluate analytical data from construction projects, CERCLA background determinations, and is a key reference document in the EPA, DTSC, and RWQCB-approved *Site-Wide Record of Decision, Lawrence Livermore National Laboratory, Site 300, July 2008*.

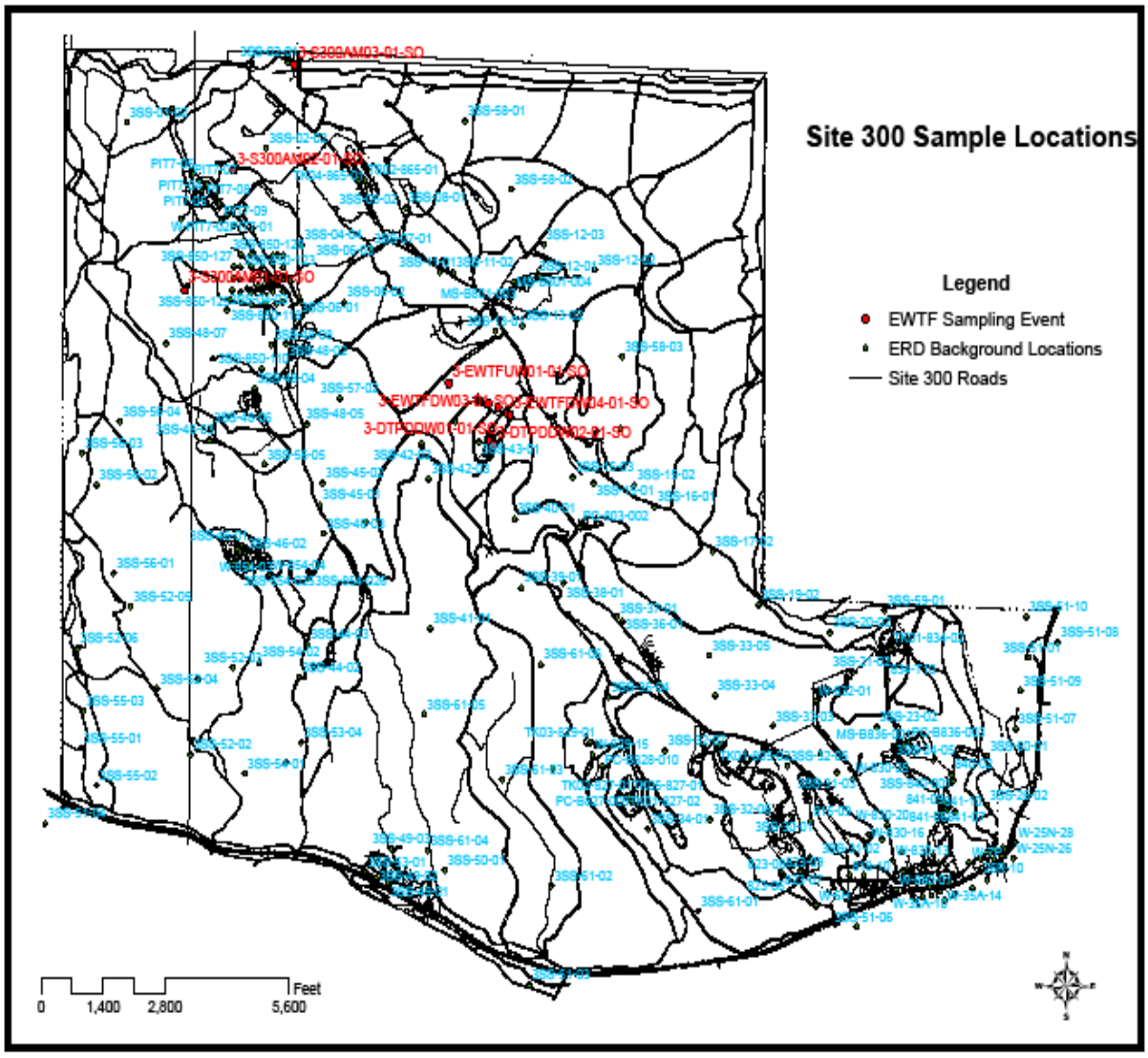

Figure 1. EWTF and CERCLA (ERD) Sample Locations

Soil Sampling - Non-CPEC Summary

Soil particle analysis by ASTM Method D422 was conducted on all soil samples in order to classify the soil texture by standard United States Department of Agriculture (USDA) terminology. The purpose of this test was to ensure consistency of soil sample texture relative to particle size. Soil texture is a qualitative classification tool used in to classify soils based on their physical texture.

Samples obtained in the EWTF area grouped in the middle to bottom middle of the USDA soil texture triangle, **Figure 2**. Samples obtained in the EWTF Ambient (background) areas were more widely distributed. **Table 4** shows the distribution of soil types, location and number of samples in each soil type.

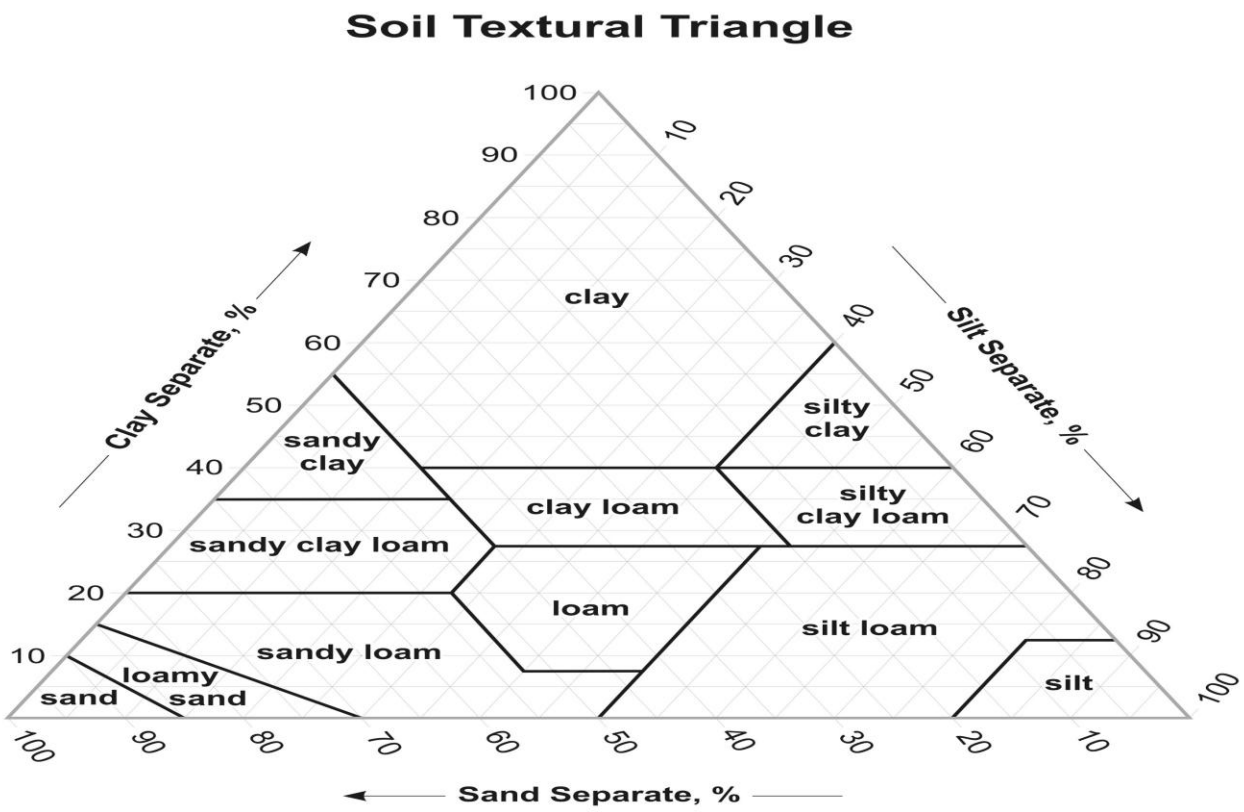

Figure 2. USDA Soil Texture Triangle.

Table 4. EWTF Area and Ambient (Background) Soil Types.

	Loam	Sandy Loam	Silty Clay Loam	Silt Loam	Clay Loam	Silty Clay	Clay	Total Number Samples
EWTF Area	10	1	8	3	6			28
EWTF Ambient (Background)	3	4			1	1	3	12

Total Organic Carbon (TOC) analysis was determined by EPA Method 9060. This test was requested by DTSC in order to identify differences in TOC between the samples. The following table shows the average, maximum, minimum and standard deviation % values for the 28 EWTF area samples and the 12 Ambient (background) area samples. Significant differences are not apparent as shown in **Table 5** below. The TOC analytical data, as well as soil particle size reports and analytical reports for the 21 CPECs is provided in **Appendix 5**.

Table 5. EWTF Area and Ambient (Background) Total Organic Carbon Average, Maximum, Minimum, and Standard Deviation.

	Average %	Maximum %	Minimum %	Standard Deviation %	Total Number Samples
EWTF Area	12.9	17	5.2	2.7	28
EWTF Ambient (Background)	11.3	17	7.6	2.7	12

Statistical Evaluation of Constituents of Potential Ecological Concern

The 95% Upper Confidence Level (95% UCL) was calculated for the seven EWTF area sample locations and the three Ambient (background) locations.

The 95% UCL statistical method was selected as statistical methodology according guidance provided in the *Environmental Protection Agency, Office or Solid Waste and Emergency Response document Calculating Upper Confidence Limits For Exposure Point Concentrations At Hazardous Waste Sites, OSWER 9286.6-10, December 2002*.

The 95% UCL value was calculated for each metal from the seven EWTF areas. Based on the sample strategy, the four EWTF downwind locations, two downwind Detonation Pad locations and the one EWTF upwind location were used for the 95% UCL value. A total of 28 (seven areas with four discrete soil samples per area) sample concentrations were included in the 95% UCL calculation. **Table 6** provides the result for each metal. CERCLA background levels are also included in order to allow direct comparison. All EWTF area levels are below CERCLA background levels.

Table 6. 95% UCL Detonation Pad and Explosives Waste Treatment Facility Levels Compared to CERCLA Background Levels

Sample Location		Sb[1]	Ba[1]	Cd[1]	Cr[1]	Cu[1]	Pb[1]	Zn[1]
Detonation Pad Downwind #01 (DTPD DW01)	Sample #1	1.4	210	1.2	23	45	37	84
	Sample #2	3.2	210	1.4	24	42	37	140
	Sample #3	1.2	230	1.3	25	66	66	150
	Sample #4	2.2	200	1.2	31	89	47	90
Detonation Pad Downwind #02 (DTPD DW02)	Sample #1	0.5	200	1.2	24	24	14	63
	Sample #2	0.5	180	1.2	24	21	12	62
	Sample #3	0.5	180	1.2	23	22	14	59
	Sample #4	0.5	200	1.2	24	22	14	62
Explosives Waste Treatment Facility Downwind #01 (EWTF DW01)	Sample #1	0.5	200	1.1	24	25	11	63
	Sample #2	0.5	220	1.0	23	25	8.6	94
	Sample #3	0.5	160	0.7	20	22	6.3	52
	Sample #4	0.5	190	1.1	26	24	9.8	62
Explosives Waste Treatment Facility Downwind #02 (EWTF DW02)	Sample #1	0.5	200	1.2	26	23	9.9	56
	Sample #2	0.5	180	1.2	26	22	8.2	63
	Sample #3	0.5	180	1.2	31	26	11	62
	Sample #4	0.5	200	1.2	27	23	9.7	58
Explosives Waste Treatment Facility Downwind #03 (EWTF DW03)	Sample #1	0.5	5	0.3	0.8	30	0.3	1.3
	Sample #2	0.5	5	0.3	0.8	29	0.3	1.3
	Sample #3	0.5	5	0.3	0.8	28	0.3	1.3
	Sample #4	0.5	5	0.3	0.8	29	0.3	1.3
Explosives Waste Treatment Facility Downwind #04 (EWTF DW04)	Sample #1	0.5	210	1.7	19	34	14	67
	Sample #2	0.5	170	1.3	16	28	12	54
	Sample #3	0.5	170	1.4	16	28	11	54
	Sample #4	0.5	160	1.2	15	27	11	54
Explosives Waste Treatment Facility Upwind #01 (EWTF UW01)	Sample #1	0.5	190	1.4	35	39	12	79
	Sample #2	0.5	190	1.5	35	37	12	79
	Sample #3	0.5	190	1.5	36	38	12	80
	Sample #4	0.5	190	1.3	36	38	12	79
n		**28**	**28**	**28**	**28**	**28**	**28**	**28**
Mean		**0.7**	**165.4**	**1.1**	**21.9**	**32.4**	**14.7**	**63.3**
Std Dev		**0.6**	**68.6**	**0.4**	**10.4**	**14.7**	**14.7**	**34.6**
UCL 95%[2]		**0.9**	**187.8**	**1.2**	**25.3**	**37.2**	**19.5**	**74.6**
CERCLA Background[3]		**4**	**540**	**1.9**	**122**	**39**	**51**	**110**

[1]Units = mg/kg.

[2]UCL 95 = Mean + (T x StDev)/sqrt (n-1), T=1.701, EPA OSWER 9286.6-10, December 2002.

[3]CERCLA Background from the LLNL Site-Wide Feasibility Study, 1999.

The 95% UCL values were also calculated for the Ambient (background) samples. **Table 7** shows the Ambient (background) levels relative to the CERCLA background levels.

Table 7. 95% UCL Ambient (Background) Levels compared to CERCLA Background Levels

Sample Location		Sb[1]	Ba[1]	Cd[1]	Cr[1]	Cu[1]	Pb[1]	Zn[1]
North Power Station Ambient #01 (AM01)	Sample #1	0.5	180	0.37	30	29	9.6	64
	Sample #2	0.5	160	0.31	27	26	9.4	67
	Sample #3	0.5	160	0.29	27	26	8.7	67
	Sample #4	0.5	150	0.32	26	25	9.3	63
Disposal Site West, Pit 1/7 Area, Ambient #02 (AM02)	Sample #1	0.5	220	1	20	33	9.5	67
	Sample #2	0.5	190	0.63	18	31	9.3	59
	Sample #3	0.5	190	1.1	21	32	9.2	66
	Sample #4	0.5	200	1.1	21	33	9	66
West Observation Post, Ambient #03 (AM03)	Sample #1	0.5	160	1.3	18	21	10	67
	Sample #2	0.5	140	1.3	18	21	9.3	67
	Sample #3	0.5	160	1.3	19	22	9.3	66
	Sample #4	0.5	160	1.3	20	22	9.5	67
n		**12**	**12**	**12**	**12**	**12**	**12**	**12**
Mean		**0.5**	**172.5**	**0.9**	**22.1**	**26.8**	**9.3**	**65.5**
Std Dev		**0.0**	**23.4**	**0.4**	**4.2**	**4.7**	**0.3**	**2.4**
Ambient UCL 95%[2]		**0.5**	**184.5**	**1.1**	**24.3**	**29.2**	**9.5**	**66.7**
CERCLA Background[3]		**4**	**540**	**1.9**	**122**	**39**	**51**	**110**

[1]Units = mg/kg.
[2]Ambient UCL 95 = Mean + (T x StDev)/sqrt (n-1), T=1.701, EPA OSWER 9286.6-10, December 2002.
[3]CERCLA Background from the LLNL Site-Wide Feasibility Study, 1999.

All Ambient (background) 95% UCL levels are below the CERCLA background levels. However, this comparison of Ambient (background) to CERCLA background is of limited value, based on the large difference in dataset size, 256 vs. 12, and the large difference in sample locations. Many more samples would be required over a large area in order to determine if the 95% UCL levels of the Ambient dataset would converge to the CERCLA levels.

According to DTSC guidance provided in the Department of Toxic Substances Control, Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part A: Overview, July 4, 1996, page 13: "If no organic chemicals of ecological concern are present or concentrations of inorganic elements are at or below 'background' concentrations the site or facility exits the risk assessment process upon preparation and acceptance of a minimal scoping assessment report detailing these findings and conclusions."

Based on the non-detect result of the furans, explosives and semi-volatile analyses, the insoluble chemical form of aluminum due to the neutral pH soil environment, and the below background levels of the remaining metals, the EWTF area meets the requirements to exit the ecological risk assessment process as stated in the 1999 DTSC guidance document.

Information provided in this report must be combined with the *Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Gallegos, Daniels and Wegrecki, October 2007; Soil*

Sampling Plan in Support of the Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Terusaki, October 2007; and all referenced documents in order to assess the conclusions in this report.

From this soil report and the *Human Health and Ecological Risk Assessment for the Operation of the Explosives Waste Treatment Facility at Site 300 of the Lawrence Livermore National Laboratory, Gallegos, Daniels and Wegrecki, October 2007*, it is reasonable to conclude that there are no ecological impacts from EWTF operations.