Table 4-36. Summary Data for Site-Related VOCs Detected in Melt-Pour Area Drainage Aggregate Surface Soil[a]

Functional Area		Melt-Pour Area Drainage Ditches Aggregate	Melt-Pour Area Drainage Ditches Aggregate	Melt-Pour Area Drainage Ditches Aggregate	Melt-Pour Area Drainage Ditches Aggregate
Station ID		LL4-013(p2)	LL4-145	LL4-145	LL4sd-051(d)
Sample ID		LL40953	LL40887	LL41137	LL4SD-051(D)-0288-SD
Date		08/11/2001	08/13/2001	08/13/2001	07/30/1996
Depth (ft)		0 - 1	0 - 1	0 - 1	0 - 1
Sample Type		Grab	Grab	Field Duplicate	Grab Composite
Analyte	Units				
Volatile Organics					
Acetone	mg/kg	0.028 UJ	0.0063 J	0.026 UJ	0.006 R

[a] Table presents results for samples collected during the Phase I RI (1996) and the Phase II RI (2001).
ID = Identification.
VOC = Volatile organic compound.
J - Estimated result.
R - Rejected.
U - Not detected.

4.2.6 Summary

Pervasive SRCs in surface soil, occurring across all aggregates at Load Line 4, include inorganic constituents such as barium, cadmium, chromium, copper, lead, thallium, and zinc. SVOCs such as fluoranthene and pyrene were also present in one or more samples from each of the aggregates comprising Load Line 4. Other metals and SVOC were detected in Load Line 4 but were not pervasive throughout the entire AOC. In addition, various volatile organic compounds, PCBs, pesticides, and a few explosive and propellant compounds were detected sporadically.

Based on the evaluation of surface soil data for Load Line 4, the following observations were made.

4.2.6.1 Explosives and propellants

Explosives were detected in surface soil at a few locations in the Explosives Handling Areas Aggregate. 2,4,6-TNT, HMX, and RDX were detected in samples collected around Building G-8. RDX was detected at a concentration of 19 mg/kg in one sample near Building G-8. Nitrocellulose was present in surface soil at one location north of Building G-1A (station LL4-088) in the Preparation and Receiving Areas Aggregate and one location south of Building G-19 (LL4-096) in the Packaging and Shipping Areas Aggregate.

4.2.6.2 Inorganics

In general, metals considered as SRCs were present throughout the AOC, but were most prevalent in the Explosives Handling Areas Aggregate and the Preparation and Receiving Areas Aggregate. Lead, mercury, and zinc were the metals most often detected above background.

4.2.6.3 SVOCs

SVOCs occurring in surface soil at Load Line 4 consist primarily of the PAHs. A far greater number of SVOCs were detected in the Explosives Handling Areas Aggregate than in any other aggregate. Fluoranthene and pyrene were the most frequently detected compounds, but bis(2-ethylhexyl)phthalate and phenanthrene were also detected in at least four of the aggregates. Very few SVOCs were detected in samples from the Preparation and Receiving Areas Aggregate and the Melt-Pour Drainage Area Ditches Aggregate.

4.2.6.4 VOCs

The VOCs detected in surface soil samples from Load Line 4 include acetone, benzene, chloroform, dimethylbenzene, and toluene. Toluene was the most frequently detected compound and was detected in at least one sample from the Explosives Handling Areas Aggregate, the Packaging and Shipping Areas Aggregate, the Change Houses Aggregate, and the Perimeter Area Aggregate.

4.2.6.5 Pesticides/PCBs

Pesticides were most frequently detected in the Explosives Handling Areas Aggregate. A fewer number of pesticides were detected in one sample from the Packaging and Shipping Areas Aggregate. No other occurrences were reported. Similarly, PCB-1254 and PCB-1260 were detected most often in the samples from the Explosives and Handling Areas Aggregate. These compounds were also detected in a few samples from the Preparation and Receiving Areas Aggregate, the Packaging and Shipping Areas Aggregate, and the Change Houses Aggregate.

4.3 SUBSURFACE SOIL

4.3.1 Summary of Phase I Remedial Investigation Data

Subsurface soil characterization was not performed during the Phase I RI.

4.3.2 Geotechnical Results

Thirteen undisturbed subsurface soil samples were collected from proposed monitoring well locations using Shelby tubes during the Phase II RI and submitted for geotechnical analyses. Two samples were collected from separate intervals in five of the monitoring well borings (LL4-193, LL4-194, LL4-195, LL4-199, and LL4-200) and one sample was collected from the remaining three monitoring well borings (LL4-196, LL4-197, and LL4-198). The samples were submitted for analyses of moisture content, Atterberg limits, USCS classification, bulk density, porosity, grain size distribution, hydraulic conductivity, specific gravity, and pH. In borings where two Shelby tube samples were collected, only one of the samples had grain size and hydraulic conductivity analyses. In addition, four grab samples of subsurface soil collected from Test Pit 2 (station LL4-168) and two samples collected from Test Pit 5 (station LL4-171) were submitted for analyses of moisture content, grain size distribution, Atterberg limits, USCS classification, specific gravity, and pH. Table 4-37 provides a summary of the geotechnical data for subsurface soil at Load Line 4.

Sieve analyses and USCS classification identified the samples as ranging from lean clay (CL) to silty sand (SM). Most of the results (10 of 13) for moisture content ranged between 17.9 and 22.1%. Both samples from station LL4-200 were outside of this range; the sample collected from the interval between 5.5 to 6.1 m (18 to 20 ft) bgs in this boring showed a moisture content of 24.1% while the sample collected between 7.0 to 7.3 m (23 to 23 ft, 10 in.) bgs showed a moisture content of 9.2%.

The majority of the samples selected for Atterberg limits analyses were identified as having some degree of plasticity; however, 5 of the 13 samples were determined to be non-plastic (see Table 4-37).

Hydraulic conductivity values ranged from 9.2×10^{-8} cm/sec [4.9 to 5.5 m (16 to 18 ft) bgs at LL4-193] to 7.6×10^{-4} cm/sec [7.0 to 7.3 m (23 to 23 ft, 10 in.) bgs at LL4-200].

Table 4-37. Geotechnical Data for Load Line 4 Subsurface Soil Samples

Station ID	Depth (ft)	Moisture Content (%)	Atterberg Limits			Grain Size (%)				Dry Bulk Density (lb/ft^3)	Hydraulic Conductivity (cm/sec)	pH	Specific Gravity	Porosity	USCS
			LL	PL	PI	Gravel	Sand	Silt	Clay						
LL4-168	2 to 2.5	27.2	44	19	25	0.2	13.9	42.6	43.3	NA	NA	4.02	2.837	NA	Lean clay (CL)
LL4-168	7.0	16.2	35	19	16	2.6	15.0	42.8	39.6	NA	NA	7.81	2.750	NA	Lean clay with sand (CL)
LL4-168	8.5 to 9	14.8	NP	NP	NP	0.9	57.5	32.4	9.2	NA	NA	7.90	2.743	NA	Silty sand (SM)
LL4-168	11	21.4	32	15	17	1.4	12.0	37.7	48.9	NA	NA	7.77	2.843	NA	Lean clay (CL)
LL4-171	3 to 3.5	13.8	NP	NP	NP	0.0	60.5	36.4	3.1	NA	NA	4.93	2.717	NA	Silty sand (SM)
LL4-171	10	23.4	NP	NP	NP	0.0	72.1	27.9	0.0	NA	NA	4.84	2.743	NA	Silty sand (SM)
LL4-193	16 to 18	22.1	28	16	12	2.2	17.8	45.2	34.8	114.8	9.2E-08	7.87	2.767	0.335	Lean clay with sand (CL)
LL4-193	20 to 22	16.9	25	15	10	NA	NA	NA	NA	110.9	NA	7.58	2.817	0.370	Sandy lean clay (CL)
LL4-194	12 to 14	19.4	20	12	8	0.7	19.4	45.5	34.4	113.4	3.1E-07	7.98	2.833	0.359	Lean clay with sand (CL)
LL4-194	16 to 18	22.0	NP	NP	NP	NA	NA	NA	NA	103.4	NA	7.04	2.816	0.412	Poorly graded sand w/silt (SP-SM)
LL4-195	10 to 12	17.9	NP	NP	NP	0.0	62.6	33.8	3.6	110.9	3.8E-04	8.18	2.718	0.346	Silty sand (SM)
LL4-195	14 to 16	18.3	20	13	7	NA	NA	NA	NA	120.7	NA	8.06	2.762	0.300	Silty clayey sand (SC-CM)
LL4-196	18 to 20	17.9	18	13	5	0.0	44.6	48.2	7.2	NA	NA	7.89	2.758	NA	Sandy silty clay (CL-ML)
LL4-197	18 to 20	12.9	26	15	11	2.8	19.7	47.5	30.0	123.3	1.4E-07	7.68	2.790	0.292	Lean clay with sand (CL)
LL4-198	14 to 16	21.2	23	13	10	0.0	3.8	89.0	7.2	109.1	4.5E-05	7.23	2.801	0.376	Lean clay (CL)
LL4-199	18 to 20	19.9	NP	NP	NP	0.0	85.2	11.2	3.6	105.6	7.5E-04	7.60	2.810	0.398	Silty sand (SM)
LL4-199	20 to 22	19.1	NP	NP	NP	NA	NA	NA	NA	NA	NA	7.66	2.754	NA	Poorly graded sand (SP)
LL4-200	18 to 20	24.1	20	16	4	NA	NA	NA	NA	101.0	NA	8.04	2.777	0.417	Silty clayey sand (SC-SM)
LL4-200	23 to 23'10"	9.2	NP	NP	NP	1.2	48.5	47.4	2.9	100.1	7.6E-04	6.88	2.784	0.424	Sandy silt (ML)

ID = Identification.
LL = Liquid limits.
NA = Not analyzed.
NP = Non-plastic.
PI = Plasticity index.
PL = Plasticity limit.
USCS = Unified Soil Classification System.

Porosity values ranged from 0.29 for the lean clay with sand at a depth of 5.5 to 6.1 m (18 to 20 ft) bgs at station LL4-197 to 0.42 for the sandy silt present at the 7.0- to 7.3- m (23- to 23-ft, 10 in.) bgs depth at station LL4-200.

Dry bulk density ranged from 100.1 lb/ft^3 [7.0 to 7.3 m (23 to 23 ft, 10 in.) bgs at LL4-200] to 123.3 lb/ft^3 [5.5 to 6.1 m (18 to 20 ft) bgs at LL4-197].

4.3.3 Explosives and Propellants

Based on surface soil sampling field explosives results, subsurface soil samples were collected from the 1- to 3-ft interval at 11 stations. The field explosives results for these stations were all < 1 mg/kg, except at Station LL4-113 (1.8 mg/kg). The subsurface sample from LL4-113 was submitted for fixed-base laboratory confirmation of explosives; none were detected.

4.3.4 Inorganic Constituents

The distribution of detected inorganics in subsurface soil at each of the Load Line 4 soil aggregates is described below. The distribution of selected inorganics in subsurface soil at Load Line 4 is depicted in Figures 4-18 through 4-27. The inorganics selected for depiction on the figures were those with the highest frequency of detection above background and/or based on process knowledge. The relative concentrations above background were bracketed by non-detects and the MDC, and they were arbitrarily subdivided between the highs and lows.

4.3.4.1 Explosives Handling Areas Aggregate

Subsurface soil samples were collected at four stations (LL4-075, LL4-105, LL4-113, and LL4-142) and analyzed for inorganic elements. A total of 21 metals were detected at least once in the samples collected (Table 4-4). Neither antimony nor silver was detected in any of the samples. Fourteen of the detected metals were eliminated as potential SRCs because they are normally considered essential elements (calcium, iron, magnesium, potassium, and sodium) or there were no detections above the background criteria (aluminum, arsenic, cobalt, copper, manganese, nickel, selenium, thallium, and vanadium). The remaining seven inorganics (barium, beryllium, cadmium, chromium, lead, mercury, and zinc) were classified as SRCs and carried forward to the risk screening (Chapter 6.0); these constituents are summarized in Table 4-38. The distribution and relative concentration of beryllium, copper, lead, manganese, and mercury in subsurface soil at Load Line 4 is shown on Figures 4-18 through 4-27.

Background criteria for all inorganic SRCs were exceeded in the subsurface soil sample from one station, LL4-075, collected on the north side of Building G-9. Background criteria for barium, beryllium, cadmium, lead, and zinc were exceeded in the sample collected at station LL4-113, near the southwest corner of Building G-12A.Cadmium was the only metal detected above background in the sample collected at station LL4-142 (the background criterion for cadmium was set to zero). No metals were detected above background concentrations in the sample collected at station LL4-105, near Building G-15.

4.3.4.2 Preparation and Receiving Areas Aggregate

Subsurface soil samples were collected at three stations (LL4-084, LL4-087, and LL4-088) and analyzed for inorganic elements. A total of 19 metals were detected at least once in the samples collected (Table 4-4). Four metals were not detected in any of the samples (antimony, mercury, silver, and thallium). Eleven of the detected metals were eliminated as potential SRCs because they are normally considered essential elements (calcium, iron, magnesium, potassium, and sodium) or there were no detections above the

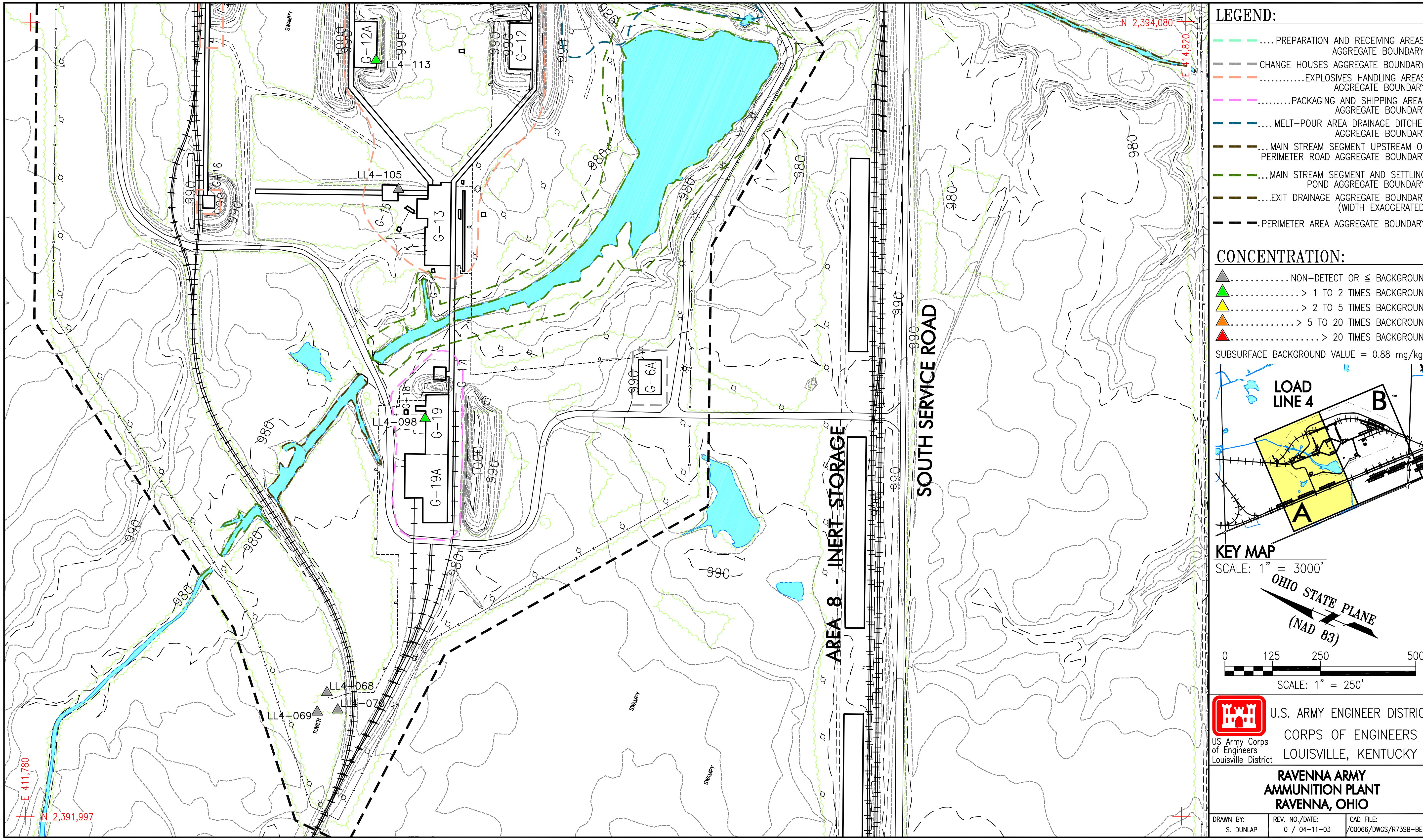

Figure 4-18. Distribution of Beryllium in Subsurface Soil at Load Line 4 - Western Section

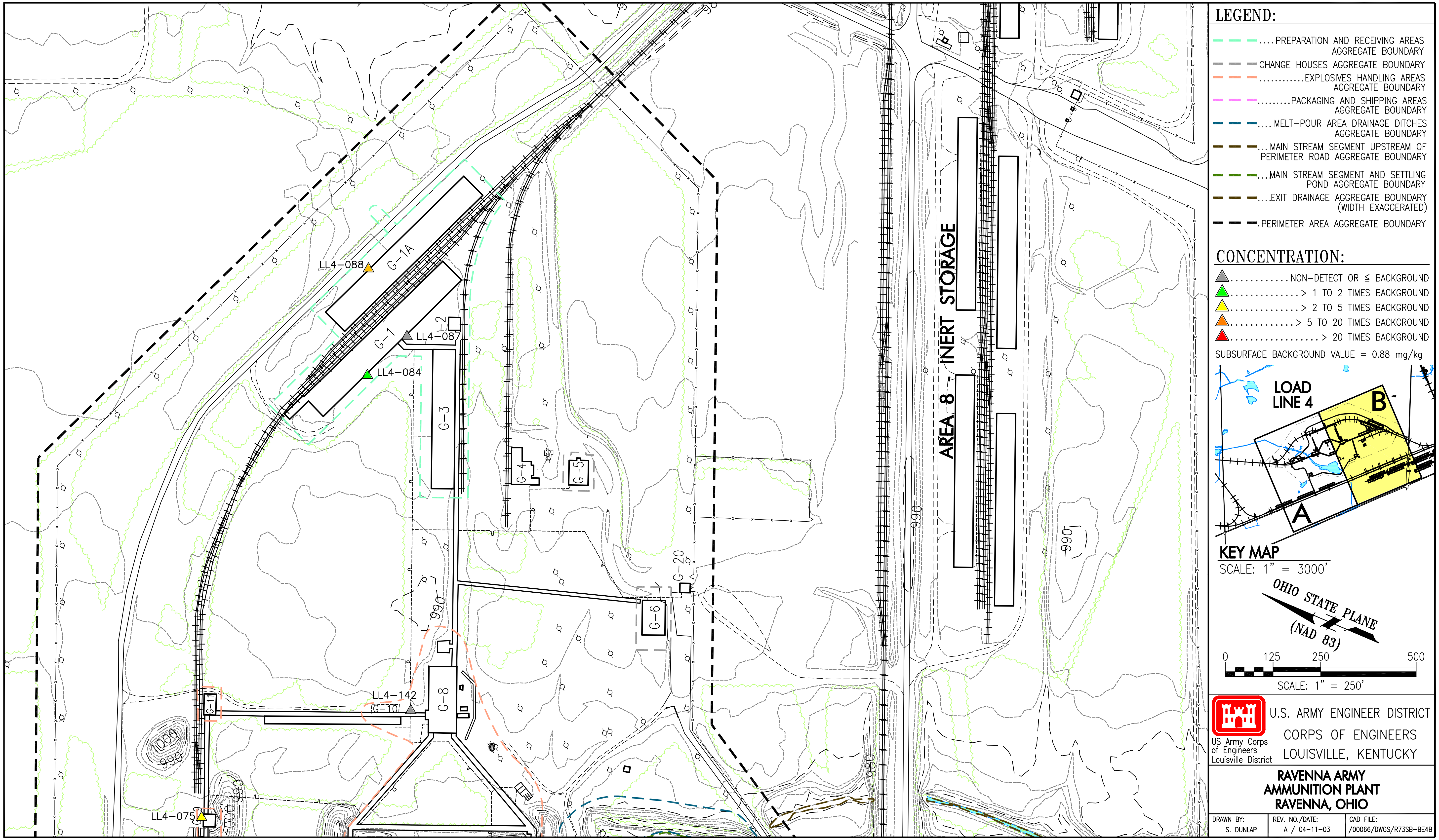

Figure 4-19. Distribution of Beryllium in Subsurface Soil at Load Line 4 - Eastern Section

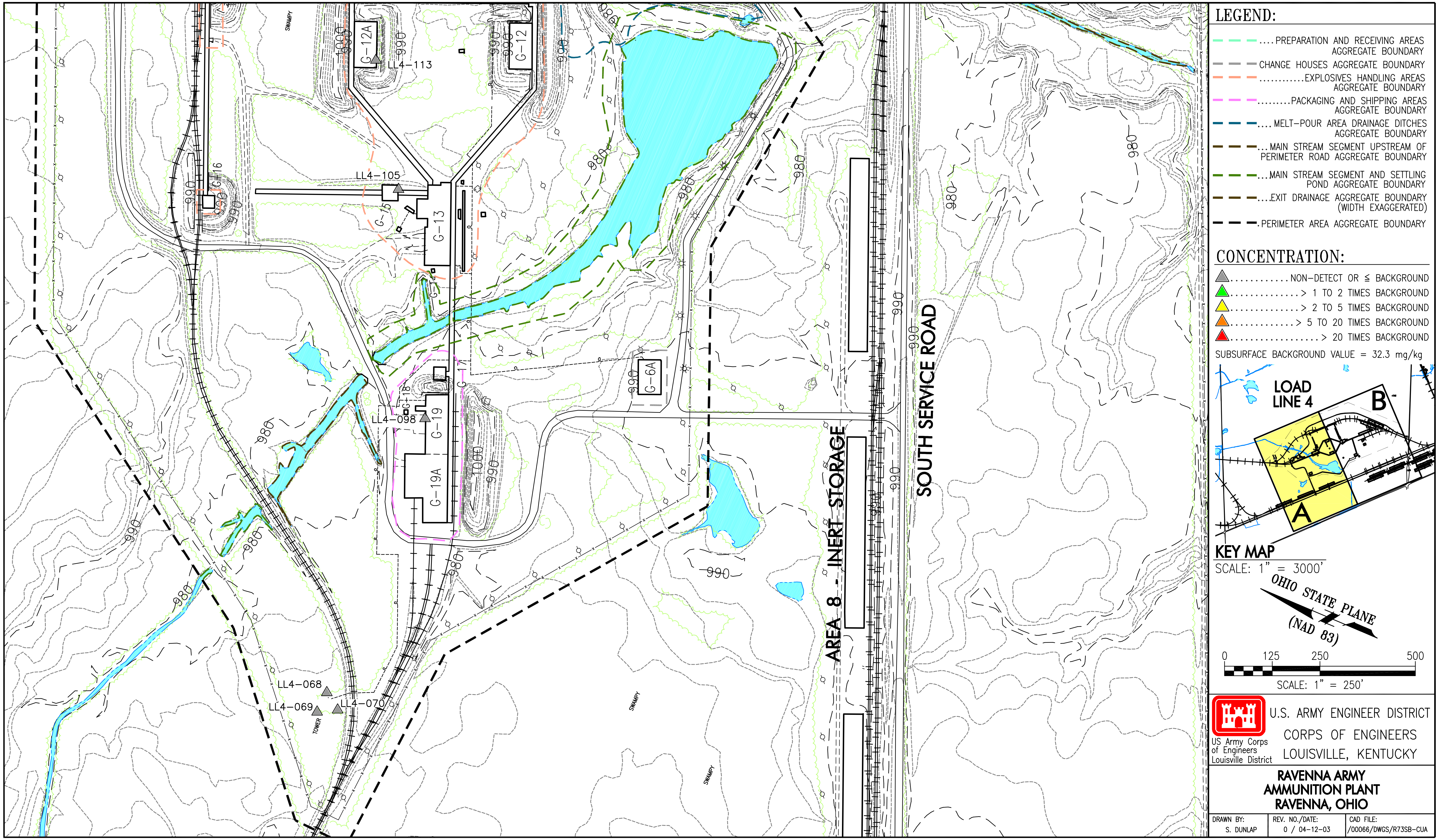

Figure 4-20. Distribution of Copper in Subsurface Soil at Load Line 4 - Western Section

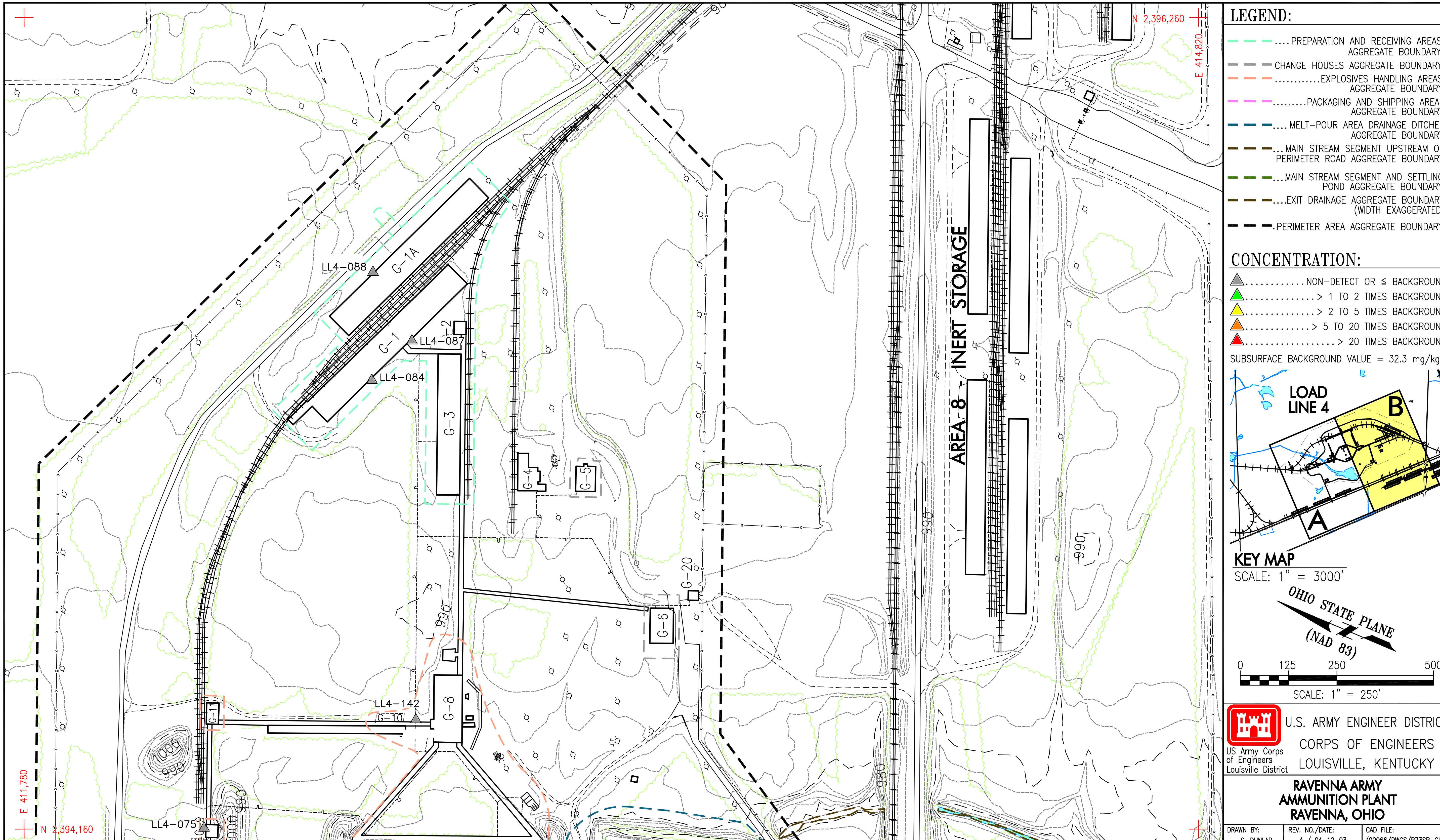

Figure 4-21. Distribution of Copper in Subsurface Soil at Load Line 4 - Eastern Section

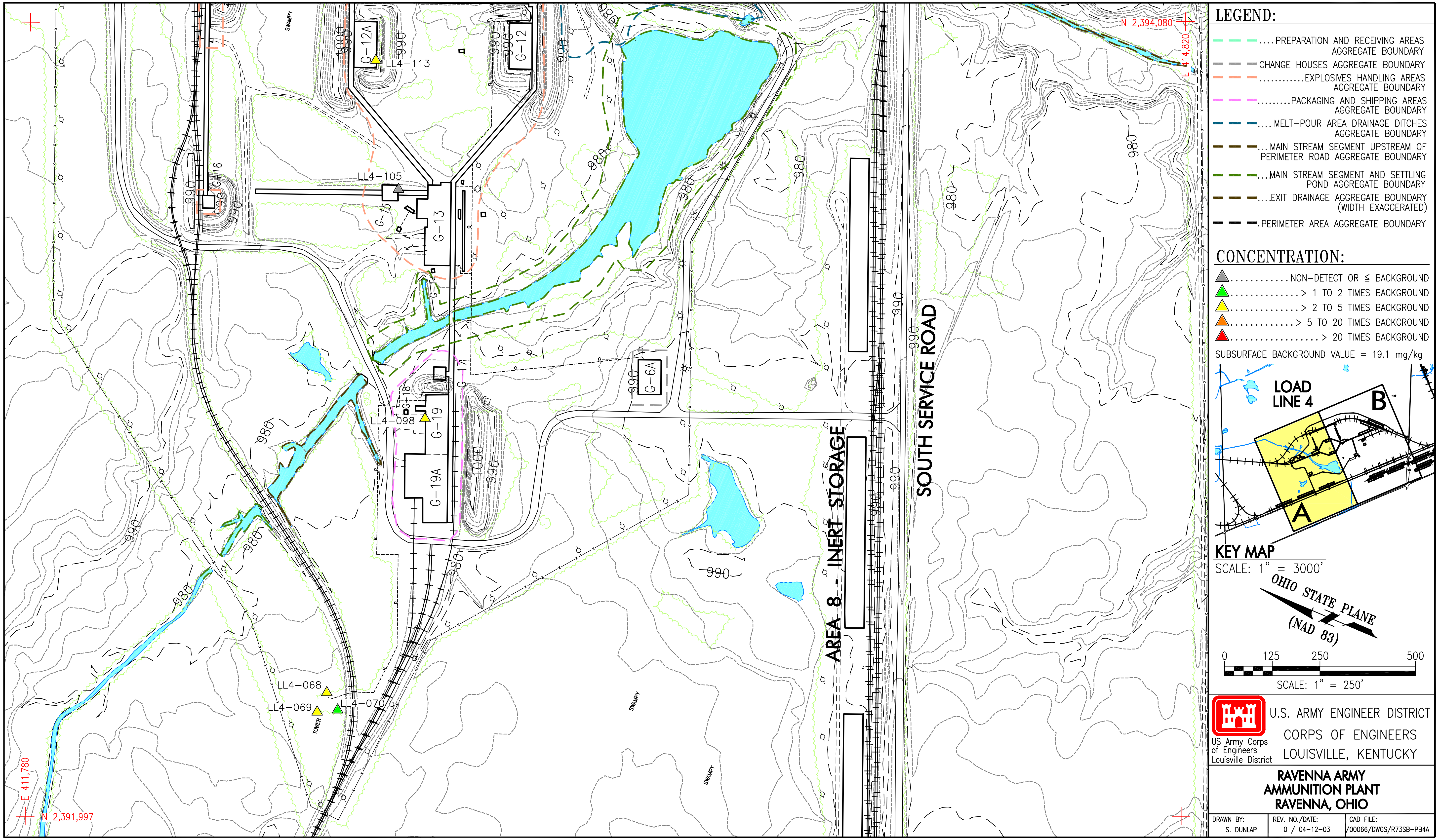

Figure 4-22. Distribution of Lead in Subsurface Soil at Load Line 4 - Western Section

Figure 4-23. Distribution of Lead in Subsurface Soil at Load Line 4 - Eastern Section

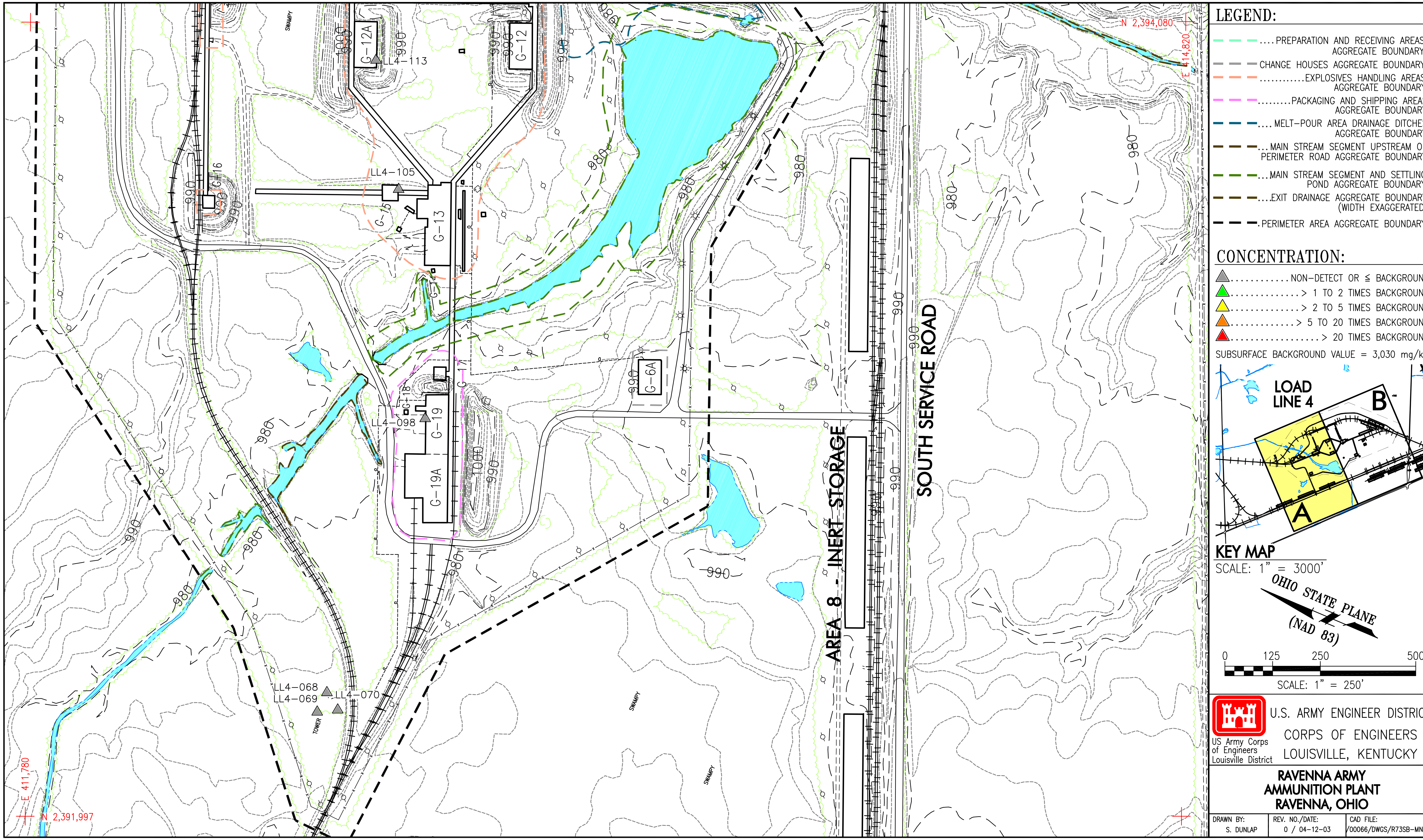

Figure 4-24. Distribution of Manganese in Subsurface Soil at Load Line 4 - Western Section

Figure 4-25. Distribution of Manganese in Subsurface Soil at Load Line 4 - Eastern Section

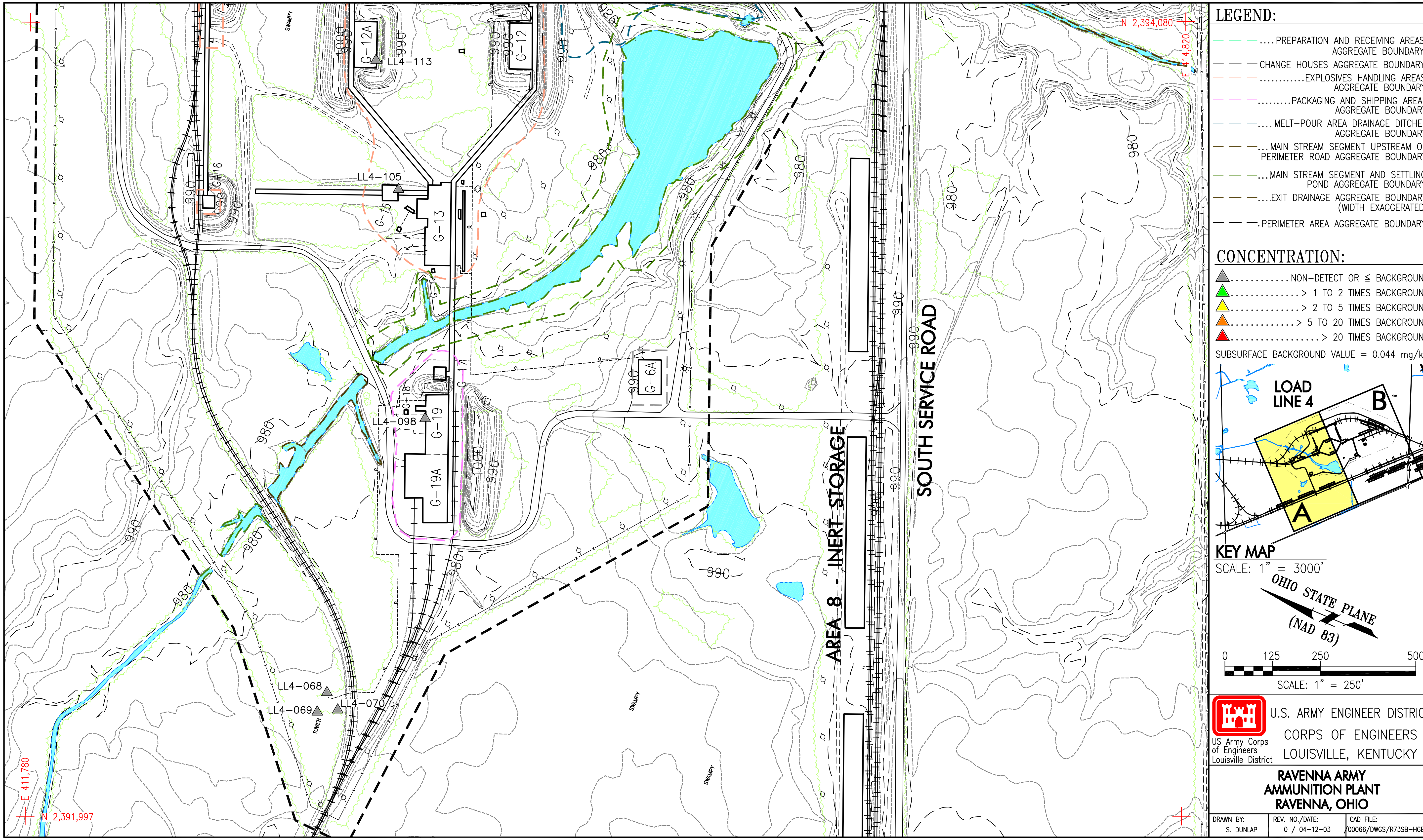

Figure 4-26. Distribution of Mercury in Subsurface Soil at Load Line 4 - Western Section

Figure 4-27. Distribution of Mercury in Subsurface Soil at Load Line 4 - Eastern Section

Table 4-38. Summary Data for Site-Related Inorganics in Explosives Handling Areas Aggregate Subsurface Soil

Functional Area		Explosives Handling Areas Aggregate	Explosives Handling Areas Aggregate	Explosives Handling Areas Aggregate	Explosives Handling Areas Aggregate	Explosives Handling Areas Aggregate
Station ID		**LL4-075**	**LL4-105**	**LL4-105**	**LL4-113**	**LL4-142**
Sample ID		**LL40702**	**LL40788**	**LL41144**	**LL40808**	**LL40879**
Date		**08/23/2001**	**08/23/2001**	**08/23/2001**	**08/23/2001**	**08/25/2001**
Depth (ft)		**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**
Sample Type		**Grab**	**Grab**	**Field Duplicate**	**Grab**	**Grab**
Analyte	**Units**					
Inorganics						
Barium	mg/kg	194 J *	51.1 =	58.6 =	137 = *	54.7 =
Beryllium	mg/kg	2.7 J *	0.62 U	0.65 U	1.5 J *	0.61 U
Cadmium	mg/kg	1.5 J *	0.59 U	0.59 U	1.4 = *	0.29 J *
Chromium	mg/kg	27.8 J *	14.4 =	14.8 =	12.5 =	13.3 =
Lead	mg/kg	137 J *	11.3 =	14.7 =	59.2 = *	14.6 =
Mercury	mg/kg	0.2 J *	0.013 J	0.12 UJ	0.043 J	0.022 U
Zinc	mg/kg	114 J *	58.3 =	62.9 =	130 = *	56.9 =

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
= - Detected result.
J - Estimated result.
U - Not detected.

background criteria (arsenic, chromium, cobalt, copper, nickel, and vanadium). The remaining eight metals (aluminum, barium, beryllium, cadmium, lead, manganese, selenium, and zinc) were classified as SRCs and carried forward to the risk screening (Chapter 6.0); these constituents are summarized in Table 4-39.

Table 4-39. Summary Data for Site-Related Inorganics in Preparation and Receiving Areas Aggregate Subsurface Soil

Functional Area		Preparation and Receiving Areas Aggregate	Preparation and Receiving Areas Aggregate	Preparation and Receiving Areas Aggregate
Station ID		**LL4-084**	**LL4-087**	**LL4-088**
Sample ID		**LL40727**	**LL40736**	**LL40739**
Date		**08/25/2001**	**08/25/2001**	**08/24/2001**
Depth (ft)		**1 - 3**	**1 - 3**	**1 - 3**
Sample Type		**Grab**	**Grab**	**Grab**
Analyte	**Units**			
Inorganics				
Aluminum	mg/kg	12,800 =	10,900 =	36,700 = *
Barium	mg/kg	182 = *	32.4 =	404 = *
Beryllium	mg/kg	1.1 J *	0.33 U	5 J *
Cadmium	mg/kg	0.26 J *	0.64 U	0.42 J *
Lead	mg/kg	42.1 = *	14 =	85.3 = *
Manganese	mg/kg	1,660 =	84.5 =	4,660 = *
Selenium	mg/kg	0.74 J	0.42 J	2.8 J *
Zinc	mg/kg	109 = *	35.7 =	49.2 =

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
= - Detected result.
J - Estimated result.
U - Not detected.

Background criteria for all inorganic SRCs, except zinc, were exceeded in one of the samples collected on the north side of Building G-1A (station LL4-088). Also, background criteria for most of the SRCs were exceeded in the sample collected at station LL4-084 on the south side of Building G-1. No detections above background concentrations were reported in the sample collected at station LL4-087 on the south side of Building G-1. The distribution and relative concentration of beryllium, copper, lead, manganese, and mercury in subsurface soil at Load Line 4 is shown on Figures 4-18 through 4-27.

4.3.4.3 Packaging and Shipping Areas Aggregate

One subsurface soil sample was collected and analyzed for inorganic elements. No other subsurface samples were collected in this aggregate. Twenty metals were detected in this sample (Table 4-4). Three metals were not detected (antimony, silver, and selenium). Fifteen of the detected metals were eliminated as potential SRCs because they are normally considered essential elements (calcium, iron, magnesium, potassium, and sodium) or there were no detections above the background criteria (aluminum, arsenic, chromium, cobalt, copper, manganese, mercury, nickel, thallium, and vanadium). The remaining five inorganic constituents (barium, beryllium, cadmium, lead, and zinc) were classified as SRCs and carried forward to the risk screening (Chapter 6.0); these constituents are summarized by station in Table 4-40.

Table 4-40. Summary Data for Site-Related Inorganics in Packaging and Shipping Areas Aggregate Subsurface Soil

Functional Area		**Packaging and Shipping Areas Aggregate**
Station ID		**LL4-098**
Sample ID		**LL40769**
Date		**08/23/2001**
Depth (ft)		**1 - 3**
Sample Type		**Grab**
Analyte	**Units**	
	Inorganics	
Barium	mg/kg	131 = *
Beryllium	mg/kg	1.1 J *
Cadmium	mg/kg	3.2 = *
Lead	mg/kg	47.8 = *
Zinc	mg/kg	102 = *

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.

Most of the inorganic SRCs in this aggregate only slightly exceeded corresponding background criteria. For example, barium was detected at a concentration of 131 mg/kg, exceeding the established background criterion of 124 mg/kg by less than 6%. Beryllium was detected at an estimated concentration of 1.1 mg/kg, exceeding the background criterion for this constituent by 25%. Lead was the only constituent that showed a comparatively higher exceedance of background (as shown in Table 4-40); this metal was detected at a concentration of 47.8 mg/kg, which is 2.5 times greater than the established background criterion (19 mg/kg) for subsurface soil. The distribution and relative concentration of beryllium, copper, lead, manganese, and mercury in subsurface soil at Load Line 4 is shown on Figures 4-18 through 4-27.

4.3.4.4 Change Houses Aggregate

No subsurface soil samples were collected for analyses of inorganic elements in this aggregate.

4.3.4.5 Perimeter Area Aggregate

Subsurface soil samples were collected at three stations (LL4-068, LL4-069, and LL4-070) from around the WW-23 Water Tower and analyzed for inorganic elements. A total of 17 metals were detected at least once in the samples collected (Table 4-4). Six metals were not detected in any of the samples (antimony, beryllium, selenium, silver, sodium, and thallium). Sixteen of the detected metals were eliminated as potential SRCs because they are normally considered essential elements (calcium, iron, magnesium, and potassium) or there were no detections above the background criteria (aluminum, arsenic, barium, chromium, cobalt, copper, manganese, mercury, nickel, thallium, vanadium, and zinc).

Lead was the only inorganic constituent classified as an SRC and carried forward to the risk screening (Chapter 6.0). The concentration of lead in the samples collected near the water tower ranged from 31.5 to 46.2 mg/kg, exceeding the background concentration (19 mg/kg) by 68 to 142% (Table 4-41). Figures 4-22 and 4-23 show the distribution of lead at Load Line 4.

Table 4-41. Summary Data for Site-Related Inorganics in Perimeter Area Aggregate Subsurface Soil

Functional Area		**Perimeter Area Aggregate**	**Perimeter Area Aggregate**	**Perimeter Area Aggregate**	**Perimeter Area Aggregate**
Station ID		**LL4-068**	**LL4-069**	**LL4-070**	**LL4-070**
Sample ID		**LL40681**	**LL40684**	**LL40687**	**LL41151**
Date		**08/23/2001**	**08/23/2001**	**08/23/2001**	**08/23/2001**
Depth (ft)		**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**
Sample Type		**Grab**	**Grab**	**Grab**	**Field Duplicate**
Analyte	**Units**				
		Inorganics			
Lead	mg/kg	46.2 = *	39.2 = *	31.5 = *	32.8 = *

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.

4.3.4.6 Melt-Pour Area Drainage Ditches Aggregate

Subsurface soil samples were not collected for analyses of inorganic elements in this aggregate.

4.3.5 SVOCs, VOCs, and PCBs

Subsurface soil samples were not analyzed for SVOCs or VOCs.

Samples were collected from the 1- to 3- ft interval at stations LL4-070 (near WW-23 Water Tower in the Perimeter Areas Aggregate) and LL4-105 (near Building G-15 in the Explosives Handling Areas Aggregate) and analyzed for PCBs. PCB compounds were not detected. Pesticide compounds were not analyzed for in these samples.

4.3.6 Summary

Based on the evaluation of the occurrence and distribution of contaminants in subsurface soil at Load Line 4, the following observations were made.

- No explosives or propellants were detected in the subsurface soil at Load Line 4.

- The metals detected at concentrations exceeding their respective background concentration most frequently include barium, beryllium, cadmium, lead, and zinc. Metals above background are most prevalent in subsurface soil in the vicinity of Building G-1A in the Preparation and Receiving Areas Aggregate and Building G-9 in the Explosives Handling Areas Aggregate.

- Based on data from limited samples analyzed, PCBs are generally absent from the subsurface soil at Load Line 4.

- Subsurface soil from Load Line 4 was not analyzed for SVOCs, VOCs, or pesticides; therefore, no direct observations regarding the presence or distribution of these contaminants can be made. If any of these classes of organic compounds are present in the subsurface soil, it is reasonable to expect that the concentrations would be low and the occurrence and distribution would generally coincide with the distribution seen in the overlying surface soil.

4.4 SEDIMENT

Sub-aqueous sediment samples were collected from a total of nine stations at Load Line 4 to quantify risks to human and ecological receptors that may be exposed to sediment. The sampling stations are located along the main stream segment upstream of the Perimeter Road Bridge near Building G-19/-19A, the main stream segment downstream of the Perimeter Road Bridge and the settling pond, and the stream segment downstream of the settling pond to the RVAAP exit point at PF-8 (Figure 3-6). As noted in Section 4.1.2, these sampling stations are divided into three spatial aggregates: Main Stream Segment Upstream of Perimeter Road, Main Stream Segment and Settling Pond, and Exit Drainage.

In addition to these sediment samples, dry sediment samples were collected from five locations along predominantly dry drainage ditches receiving runoff from portions of the explosives handling areas and effluent from the sedimentation basin. These five samples were assigned to the Melt-Pour Areas Drainage Ditches Aggregate and are evaluated in conjunction with surface soil data under that aggregate in Section 4.2. Sediment samples were also collected from the storm and sanitary sewer systems and from sedimentation and washout basins associated with buildings and structures; results from these sampling activities are discussed in Sections 4.7 and 4.8, respectively.

Sediment samples were analyzed for field explosives, explosives, TAL metals, VOCs, SVOCs, pesticides/PCBs, hexavalent chromium, TOC, and grain size distribution. The complete analytical results for sediment samples collected at Load Line 4 are presented by sample aggregate, station, and analyte in Appendix I. Table 4-5 presents the summary statistics and determination of SRCs in sediment.

4.4.1 Summary of Phase I Remedial Investigation Data

Sediments from the main stream and the settling pond were sampled and analyzed for explosive compounds and 11 process-related inorganic analytes. One of the sediment samples was analyzed for a full suite of analytes including TAL metals, cyanide, VOCs, SVOCs, and pesticides/PCBs. TNT was present in sediment upgradient from Load Line 4, where the main stream enters from the west. Pond sediments contained no detectable quantities of TNT or other explosives. Chromium and arsenic were present in pond sediments below background criteria that were established during the background sampling in the Phase I RI. Pond sediments contained comparatively high concentrations of several metals such as cadmium, lead, and zinc. Low concentrations of three VOCs were measured in one sediment sample from the settling pond. No other organic constituents were detected.

4.4.2 Geotechnical Results

Geotechnical samples were collected from at least one sampling station in each of the three sediment aggregates and submitted for analysis of grain size distribution. All of the sediment samples were disturbed (grab) samples. Appendix K contains complete geotechnical laboratory results.

4.4.3 Explosives and Propellants

4.4.3.1 Main Stream Segment Upstream of Perimeter Road Aggregate

Laboratory analyses of the sediment sample collected at station LL4-048 during the Phase I RI indicated the presence of 2,4,6-TNT at a concentration of 0.34 mg/kg. No explosives compounds were detected during field analyses of the sample collected at this station during the Phase II RI; however, the sample was submitted for laboratory analysis for verification. Explosives compounds were not detected in this sample.

4.4.3.2 Main Stream Segment and Settling Pond Aggregate

Laboratory analyses of the sediment sample collected at station LL4sd/sw-049(d) during the Phase I RI indicated the presence of 2,4,6-TNT at a concentration of 0.42 mg/kg. Field analyses of sediment samples collected at stations LL4-053 and LL4-054 during the Phase II RI detected the presence of 2,4,6-TNT at a concentration of 7.8 mg/kg and 2.8 mg/kg, respectively; however, no explosives compounds were detected during subsequent laboratory analyses of these samples. In addition, samples collected from stations LL4-049, LL4-052, and LL4-055 were submitted for laboratory analyses of explosives compounds; none were detected in any of these samples.

4.4.3.3 Exit Drainage Aggregate

Explosives compounds were not detected during field analyses of samples from the two stations in this aggregate (LL4-057 and LL4-058); therefore, and no samples from this aggregate were submitted for laboratory analyses of explosives compounds.

4.4.4 Inorganic Constituents

The distribution of detected inorganics in sediment at each of the Load Line 4 sediment/surface water aggregates is summarized below. The distribution of selected metals in sediment at Load Line 4 is shown in Figure 4-28. Selection of the metals depicted in the figure was based on frequency of detection and magnitude above background.

4.4.4.1 Main Stream Segment Upstream of Perimeter Road Aggregate

A total of 20 inorganic compounds were detected at least once in sediment, 2 of which were identified as SRCs and carried forward to the risk screening process (Chapters 6.0 and 7.0) (Table 4-5). Eighteen of the detected constituents were eliminated as sediment SRCs because they were considered either essential nutrients (calcium, iron, magnesium, and potassium) or the MDC was below the corresponding background criterion (aluminum, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, thallium, vanadium, and zinc). The MDC for beryllium exceeded its respective background criteria and was retained as an SRC. Cadmium was also retained as an SRC because there is no site-related background criteria for this constituent.

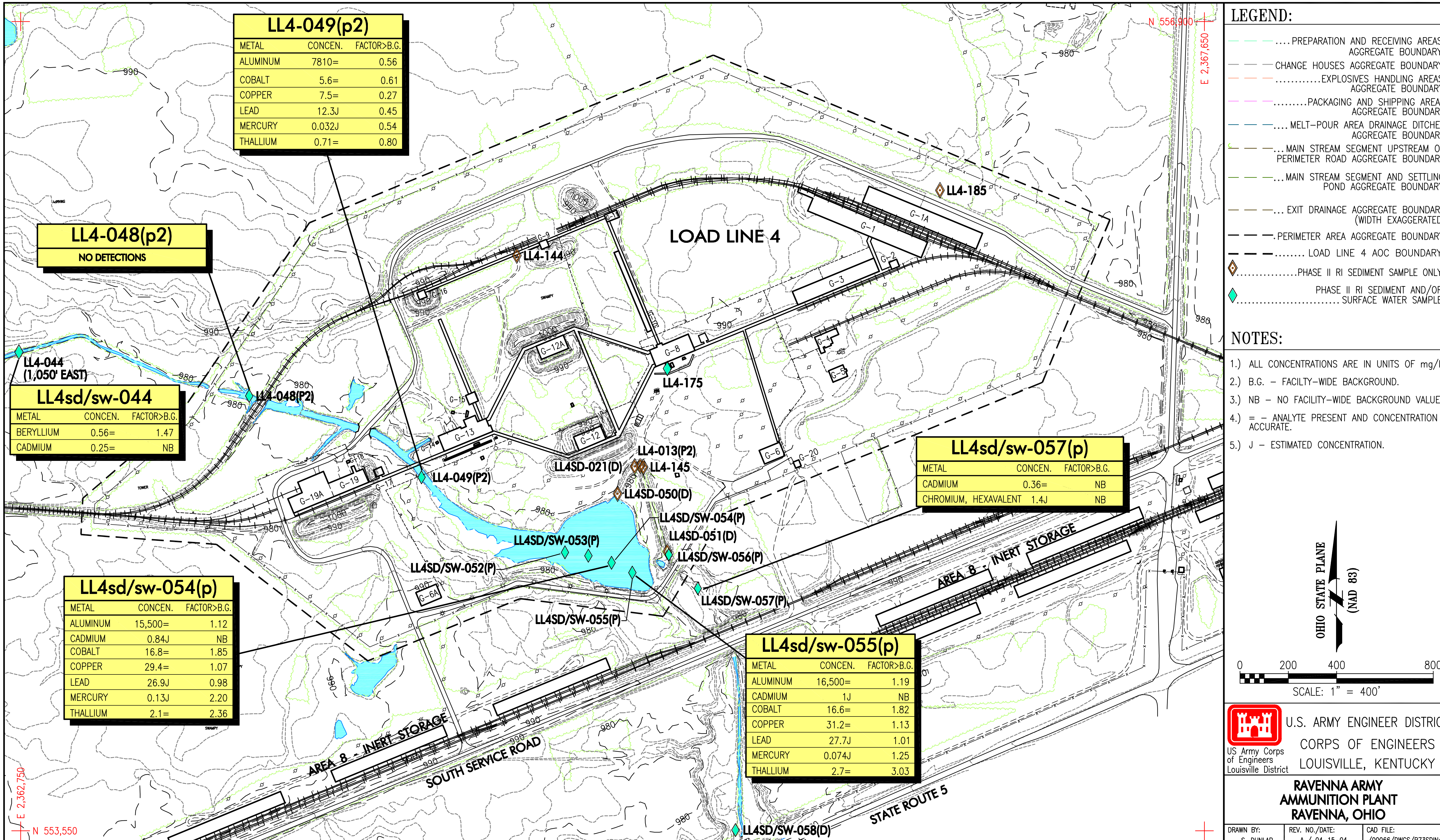

Figure 4-28. Selected Metals in Sediment at Load Line 4

Table 4-42 provides a summary of results by station for inorganic SRCs in sediment for the Main Stream Segment Upstream of Perimeter Road Aggregate. Beryllium was detected at a concentration of 0.56 mg/kg in the sample collected at station LL4sd/sw-044(d), located upstream of the AOC boundary. The concentration present in this sample exceeded the established background criteria for beryllium (0.38 mg/kg) by roughly 50%. Cadmium was detected in two of three samples. No site background has been established for this metal, thus all detected results are considered to exceed background. Cadmium was detected in the sample from station LL4sd/sw-044(d) at a concentration of 0.25 mg/kg and at an estimated concentration of 0.2 mg/kg in a sample collected at station LL4sd/sw-048(d). Figure 4-28 shows the distribution of selected inorganic SRCs in sediment at Load Line 4.

Table 4-42. Summary Data for Site-Related Inorganics in Main Stream Segment Upstream of Perimeter Road Aggregate Sediment

Functional Area		**Main Stream Segment Upstream of Perimeter Road**	**Main Stream Segment Upstream of Perimeter Road**	**Main Stream Segment Upstream of Perimeter Road**	**Main Stream Segment Upstream of Perimeter Road**
Station ID		**LL4-048(p2)**	**LL4sd/sw-044(d)**	**LL4sd/sw-048(d)**	**LL4sd/sw-048(d)**
Sample ID		**LL40957**	**LL40955**	**LL4SD-048(D)-0283-SD**	**LL4SD-048(D)-0284-FD**
Date		**08/20/2001**	**08/13/2001**	**07/30/1996**	**07/30/1996**
Depth (ft)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab**	**Grab Composite**	**Field Duplicate**
Analyte	**Units**				
Inorganics					
Beryllium	mg/kg	0.48 U	0.56 = *	NA	NA
Cadmium	mg/kg	0.17 U	0.25 = *	0.2 J *	0.18 J *

ID = Identification.
NA = Not analyzed.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
= - Detected result.

4.4.4.2 Main Stream Segment and Settling Pond Aggregate

A total of 19 inorganic compounds were detected at least once in the sediment samples from this aggregate, 11 of which were identified as SRCs and carried forward to the risk screening process (Chapters 6.0 and 7.0) (Table 4-5). Eight of the detected constituents were eliminated as sediment SRCs because they were considered either essential nutrients (calcium, iron, magnesium, and potassium) or the MDC was below the corresponding background criterion (arsenic, manganese, selenium, and zinc). The MDC for aluminum, barium, chromium, cobalt, copper, lead, mercury, nickel, thallium, and vanadium exceeded their respective background criteria and were retained as SRCs. Cadmium was also retained as an SRC because the background criteria for this constituent was set to zero.

Table 4-43 provides a summary of results by station for inorganic SRCs in sediment for the Main Stream Segment and Settling Pond Aggregate. For metals with established background concentrations and retained as SRCs in surface soils, aluminum, barium, chromium, cobalt, copper, lead, nickel, thallium, and vanadium were detected in every sample for which those analyses were performed. Cadmium and mercury were detected in all but one of the sediment samples collected in this aggregate.

Generally, detected inorganics were present in concentrations below established background criteria in samples collected upstream of the settling pond (station LL4-049). All inorganics were present at concentrations above background criteria in sediment from at least one sampling station located in the settling pond. Figure 4-28 shows the distribution of selected inorganic SRCs in sediment at Load Line 4.

Table 4-43. Summary Data for Site-Related Inorganics in Main Stream Segment and Settling Pond Aggregate Sediment

Functional Area		Main Stream Segment and Settling Pond	Main Stream Segment and Settling Pond	Main Stream Segment and Settling Pond	Main Stream Segment and Settling Pond	Main Stream Segment and Settling Pond	Main Stream Segment and Settling Pond
Station ID		**LL4-049(p2)**	**LL4sd/sw-049(d)**	**LL4sd/sw-052(p)**	**LL4sd/sw-053(p)**	**LL4sd/sw-054(p)**	**LL4sd/sw-055(p)**
Sample ID		**LL40959**	**LL4SD-049(D)-0286-SD**	**LL40963**	**LL40965**	**LL40967**	**LL40969**
Date		**08/20/2001**	**07/29/1996**	**08/14/2001**	**08/14/2001**	**08/14/2001**	**08/14/2001**
Depth (ft)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab Composite**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	**Units**						
			Inorganics				
Aluminum	mg/kg	7,810 =	6,250 =	14,600 = *	15,000 = *	15,500 = *	16,500 = *
Barium	mg/kg	44.6 =	49.6 =	118 J	140 J *	162 J *	163 J *
Cadmium	mg/kg	0.67 U	0.28 J *	0.88 J *	0.83 J *	0.84 J *	1 J *
Chromium	mg/kg	9.5 =	9.2 =	18.6 J *	19.5 J *	20.2 J *	21.5 J *
Cobalt	mg/kg	5.6 =	NA	13.3 = *	16.3 = *	16.8 = *	16.6 = *
Copper	mg/kg	7.5 =	NA	25.9 =	27 =	29.4 = *	31.2 = *
Lead	mg/kg	12.3 J	13.1 =	23.3 J	25.6 J	26.9 J	27.7 J *
Mercury	mg/kg	0.032 J	0.06 U	0.043 J	0.04 J	0.13 J *	0.074 J *
Nickel	mg/kg	11 J	NA	25 J *	30.5 J *	32.2 J *	33.4 J *
Thallium	mg/kg	0.71 =	NA	1.5 = *	0.99 = *	2.1 = *	2.7 = *
Vanadium	mg/kg	10.5 =	NA	22.3 J	25.4 J	26 J	27 J *

ID = Identification.
NA = Not analyzed.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
= - Detected result.
J - Estimated result.
U - Not detected.

The discussion below is a brief summary of the nature and extent for inorganic SRCs identified as pervasive in the Main Stream Segment and Settling Pond Aggregate.

- Aluminum was detected in all six samples. Concentrations of aluminum in the sediment samples collected above the settling pond were well below the established background criterion. Concentrations of aluminum detected in the samples from the settling pond ranged from 15,000 to 16,500 mg/kg, slightly exceeding the background criterion for this metal (13,900 mg/kg).

- Barium was also detected in all six samples collected from this aggregate. The background criterion (123 mg/kg) was exceeded in three samples, all of which were collected in the settling pond. Concentrations exceeding background ranged from 118.0 mg/kg (estimated) at station LL4sd/sw-052(p) to 163.0 mg/kg (estimated) at station LL4sd/sw-055(p).

- Cadmium was detected in five of six samples. No site background has been established for this metal, thus all detected results are considered to exceed background. Cadmium concentrations ranged from 0.28 (estimated) to 1.0 mg/kg (estimated), with the maximum concentration detected at the most downstream sampling station in the settling pond [LL4sd/sw-055(p)]. Cadmium was not detected in the sample collected at station LL4-049(p2) located above the settling pond.

- Chromium was detected in all six samples and was present at concentrations above background (18.1 mg/kg) in four samples. The highest concentration (21.5 mg/kg, estimated) was reported in the sample collected at station LL4sd/sw-055(p2). Estimated concentrations in other samples collected in the settling pond exceeded the background criterion (18.1 mg/kg) by less than 12%.

- Cobalt was detected in five of five samples, and was present above background in four samples. Concentrations ranged from 5.6 mg/kg at station LL4-049(p2) to 16.8 mg/kg at station LL4sd/sw-054(p). The established background criterion for cobalt in sediment at RVAAP is 9.1 mg/kg.

- Copper was also detected in five of five samples. The background criterion of 27.6 mg/kg was slightly exceeded in the samples collected at stations LL4sd/sw-054(p) and LL4sd/sw-055(p). The remaining detected concentrations were below background.

- Lead was detected in six of six samples but exceeded the established background criterion in only one sample. Lead was detected at an estimated concentration of 27.7 mg/kg in the sample collected at station LL4sd/sw-055(p), slightly exceeding the background criterion of 27.4 mg/kg. The next highest concentration of lead (26.9 mg/kg) was observed in the sample collected at station LL4-sd/sw-054(p).

- Mercury was detected in five of six samples and was present at concentrations above background in two of the samples, LL4sd/sw-054(p) and LL4sd/sw-055(p). Concentrations of mercury at these two stations were 0.13 (estimated) and 0.074 mg/kg (estimated), respectively.

- Nickel was detected in five of five samples and was present at concentrations above background in the four sediment samples collected within the settling pond. Concentrations of nickel in these samples ranged from 25 (estimated) to 33.4 mg/kg (estimated). The established background concentration of nickel in sediment is 17.7 mg/kg.

- Thallium was detected in five of five sediment samples. As with all other detected inorganics in this aggregate, the highest concentrations of thallium were observed in the samples collected from the settling pond. Thallium was detected in the sample collected above the settling pond at a concentration of 0.71 mg/kg (below the established background criterion of 0.89 mg/kg).

- Vanadium was also detected in five of five samples but was present at a concentration above background only in the sample collected from station LL4sd/sw-055(p). The concentration of vanadium in the sample from this station was 27.0 mg/kg (estimated), slightly exceeding the background criterion of 26.1 mg/kg. Concentrations of vanadium in other samples collected from the settling pond were near background.

4.4.4.3 Exit Drainage Aggregate

A total of 19 inorganic compounds were detected at least once in the two sediment samples from this aggregate. Cadmium and hexavalent chromium were identified as SRCs and carried forward to the risk screening process (Chapters 6.0 and 7.0) (Table 4-5). Seventeen of the detected constituents were eliminated as sediment SRCs because they were considered either essential nutrients (calcium, iron, magnesium, and potassium) or the MDC was below the corresponding background criterion (aluminum, arsenic, barium, beryllium, chromium, cobalt, copper, lead, manganese, nickel, thallium, vanadium, and zinc). Cadmium and hexavalent chromium were retained as SRCs because the background criteria for these constituents was set to zero.

Table 4-44 provides a summary of results by station for inorganic SRCs in sediment for the Exit Drainage Aggregate. Both cadmium and hexavalent chromium were detected in the sample collected at station LL4sd/sw-057(p). Cadmium was present at a concentration of 0.36 mg/kg and hexavalent chromium was detected at an estimated concentration of 1.4 mg/kg. Neither of these SRCs were detected in the sample collected at station LL4sd/sw-058(d). Figure 4-28 shows the distribution of selected inorganic SRCs in sediment at Load Line 4.

Table 4-44. Summary Data for Site-Related Inorganics in Exit Drainage Aggregate – Sediment

Functional Area		**Exit Drainage Aggregate**	**Exit Drainage Aggregate**
Station ID		**LL4sd/sw-057(p)**	**LL4sd/sw-058(d)**
Sample ID		**LL40973**	**LL40975**
Date		**08/13/2001**	**08/20/2001**
Depth (ft)		**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab**
Analyte	**Units**		
		General Chemistry	
Chromium, hexavalent	mg/kg	1.4 J	1.3 UJ
		Inorganics	
Cadmium	mg/kg	0.36 = *	0.65 U

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
J - Estimated result.
U - Not detected.

4.4.5 SVOCs, VOCs, and PCBs

Three VOCs and one PCB compound were detected in sediment samples collected at Load Line 4. Pesticides and SVOCs were analyzed for in one sample from each of the three aggregates but none were detected. In addition, TOC was analyzed for in selected samples from each aggregate.

4.4.5.1 Main Stream Segment Upstream of Perimeter Road Aggregate

Acetone, toluene, and 2-butanone were detected in the sediment sample collected at station LL4-048(p2) at estimated concentrations of 0.039, 0.0038, and 0.011 mg/kg, respectively (Table 4-5). The average concentration of TOC in sediment samples from this aggregate was 15,000 mg/kg.

4.4.5.2 Main Stream Segment and Settling Pond Aggregate

Acetone and 2-butanone were detected in a sediment sample collected at station LL4sd/sw-054(p). Acetone was detected at an estimated concentration of 0.41 mg/kg and 2-butanone was present at a concentration of 0.11 mg/kg. TOC in samples from this aggregate ranged from 16,000 to 61,000 mg/kg (Table 4-5).

4.4.5.3 Exit Drainage Aggregate

PCB-1248 was detected in one of two samples from this aggregate (Table 4-5). The compound was present at a concentration of 0.09 mg/kg in the sample collected at station LL4sd/sw-058(d). The average concentration of TOC in samples from this aggregate was 5,100 mg/kg.

4.4.6 Summary

Explosive compounds were detected at concentrations less than 1 mg/kg in sediment samples from the Main Stream Segment Upstream of Perimeter Road Aggregate and the Main Stream Segment and Settling Pond Aggregate.

Cadmium is the only pervasive SRC in sediment occurring across all aggregates at Load Line 4, although all detected concentrations were 1 mg/kg (estimated) or less. Inorganics were most prevalent in sediment samples collected from the settling pond. The maximum concentration for nearly all inorganics was observed in the sample collected at station LL4sd/sw-055(p) in the settling pond. For inorganics with established background concentrations, the maximum concentration for all detected constituents was less than 2 times established background, except for mercury and thallium. The MDC of mercury was 0.13 mg/kg (estimated), 2.2 times background and the maximum concentration of thallium was 2.7 mg/kg, approximately 3 times background.

VOCs and one PCB compound were detected in sediment but these contaminants are present at concentrations of less than 0.5 mg/kg.

4.5 SURFACE WATER

Surface water samples were collected from 10 locations during the Phase II RI to determine the nature and extent of contamination (Figure 3-2). Nine of the surface water samples were co-located with sediment samples in the main stream and the settling pond and, therefore, are assigned to the same three aggregate areas as sediment samples (Main Stream Segment Upstream of Perimeter Road Aggregate, Main Stream Segment and Settling Pond Aggregate, and Exit Drainage Aggregate). Also, as explained in Section 4.1.2, a few miscellaneous surface water samples were collected from ditch lines containing intermittent flow and from the main stream well upstream of Load Line 4. These samples were assigned to a separate aggregate called the Miscellaneous Water Samples Aggregate.

Surface water samples were analyzed for explosives, TAL metals, hexavalent chromium, VOCs, SVOCs, and pesticides/PCBs. In addition, one sample collected at station LL4sd/sw-054 within the Main Stream Segment and Settling Pond Aggregate was analyzed for propellant compounds and cyanide.

The complete analytical results for surface water samples collected at Load Line 4 are presented by sampling aggregate, station, and analyte in Appendix I. Table 4-6 presents the summary statistics and determination of SRCs in surface water. Summary statistics and determination of SRCs in miscellaneous surface water is presented in Table 4-7. The following sections describe the distribution of explosives, propellants, inorganic, and organic SRC constituents in the surface water aggregates.

4.5.1 Explosives And Propellants

All samples from the surface water aggregates at Load Line 4 were analyzed for explosive compounds. The sample collected from station LL4sd/sw-054 within the settling pond was also analyzed for propellants. No explosives or propellant compounds were detected in the surface water samples.

4.5.2 Target Analyte List Metals And Cyanide

The following subsections describe the inorganic constituents that were considered SRCs in each sampling aggregate. The distribution of selected inorganics in surface water at Load Line 4 is shown in Figure 4-29. Selection of the metals depicted on the figure was generally based on frequency of detection and/or magnitude above background.

4.5.2.1 Main Stream Segment Upstream Of Perimeter Road Aggregate

Thirteen inorganics were detected at least once in surface water from this aggregate during the Phase II RI (Table 4-6). Seven of the detected constituents were eliminated as potential SRCs because they were either major geochemical constituents normally considered essential elements (calcium, iron, magnesium, potassium, and sodium) or the MDC was below the corresponding background criterion (aluminum and zinc). The MDCs for arsenic, barium, and manganese exceeded their respective background criteria and were retained as SRCs. Cadmium, mercury, and vanadium were also retained as SRCs because the background criteria for each of these constituents was set to zero.

Table 4-45 provides a summary of results by station for inorganic SRCs in surface water for the Main Stream Segment Upstream of the Perimeter Road. For metals with established background concentrations and retained as SRCs in surface water, arsenic, barium, and manganese were detected in both of the samples analyzed for those constituents. Cadmium, mercury, and vanadium were each detected in one of two samples. The distribution of selected metals in surface water at Load Line 4 is presented on Figure 4-29.

The discussion below is a brief summary of the nature and extent of inorganic SRCs identified in surface water in the Main Stream Segment Upstream of Perimeter Road Aggregate.

- Arsenic was detected at estimated concentrations of 0.007 mg/L in the surface water sample collected at station LL4-048(p2) and 0.0071 mg/L in the sample collected at station LL4sd/sw-044(d) (the most upstream sampling location for surface water at Load Line 4 and a point located upstream of Load Line 4 operational areas). Arsenic in both of these samples exceeded the established background criterion of 0.0032 mg/L.

- Barium was detected in both samples at concentrations exceeding background (0.0475 mg/L). Barium was present in the sample collected at station LL4sd/sw-044 at a concentration of 0.052 mg/L and was present at a slightly higher concentration (0.059 mg/L) in the sample collected at station LL4-048(p2).

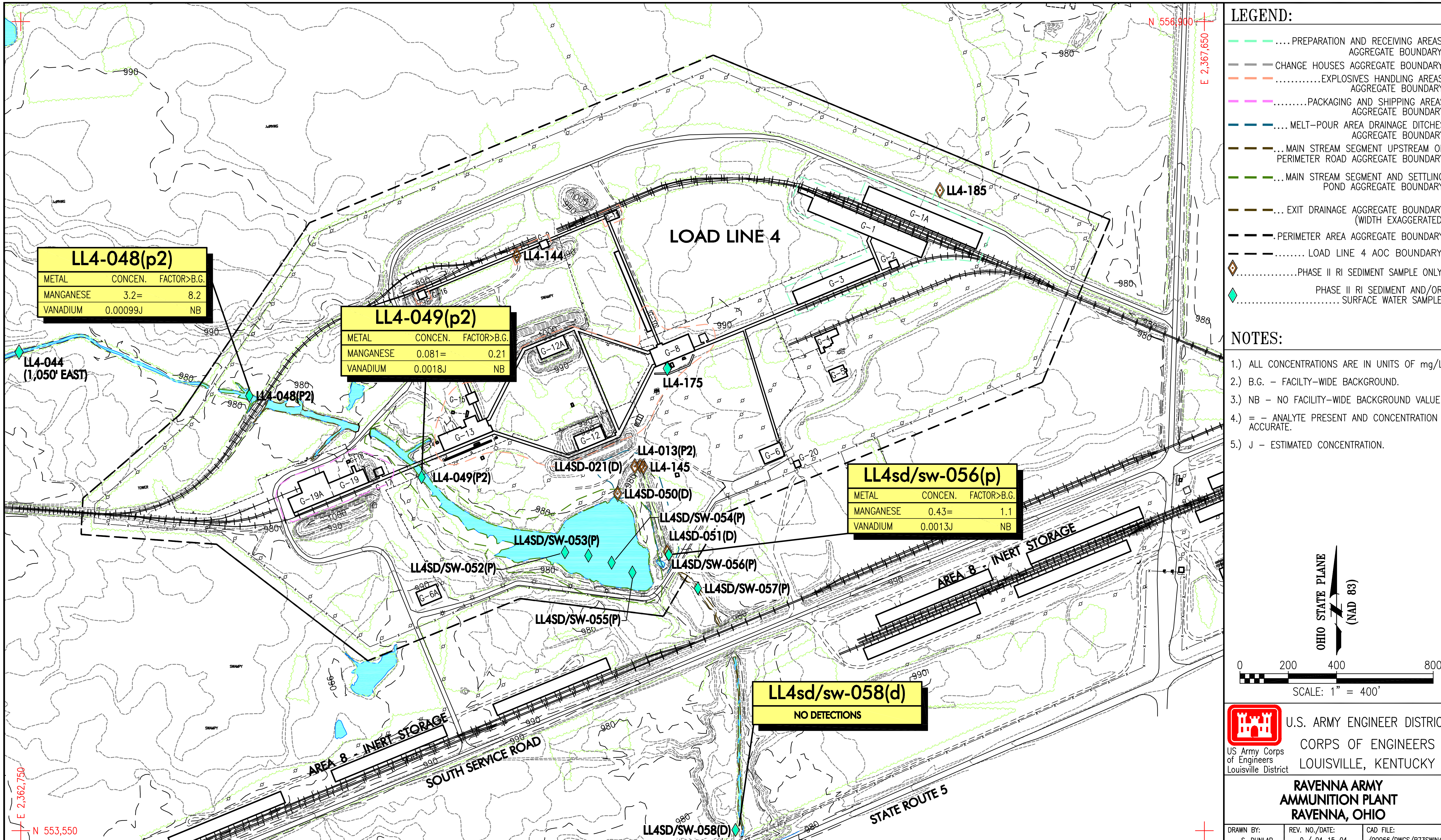

Figure 4-29. Selected Metals in Surface Water at Load Line 4

Table 4-45. Summary Data for Site-Related Inorganics in Main Stream Segment Upstream of Perimeter Road Aggregate – Surface Water

Functional Area		Main Stream Segment Upstream of Perimeter Road	Main Stream Segment Upstream of Perimeter Road
Station ID		LL4-048(p2)	LL4sd/sw-044(d)
Sample ID		LL40958	LL40956
Date		08/20/2001	08/13/2001
Filtered		Total	Total
Sample Type		Grab	Grab
Analyte	Units		
Inorganics			
Arsenic	mg/L	0.007 J *	0.0071 J *
Barium	mg/L	0.059 = *	0.052 = *
Cadmium	mg/L	0.005 U	0.0003 J *
Manganese	mg/L	3.2 = *	3.6 = *
Mercury	mg/L	0.000078 J *	0.0002 U
Vanadium	mg/L	0.00099 J *	0.007 U

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
J - Estimated result.
U - Not detected.

- Cadmium was detected at an estimated concentration of 0.003 mg/L in the sample collected at station LL4sd/sw-044(d). No site background for this metal has been established, thus all detected results are considered to exceed background. Cadmium was not detected in the sample collected from station LL4-048(p2).

- Manganese was detected at concentrations slightly less than 10 times the established background concentration of 0.391 mg/L in both samples. Manganese was present in the sample collected at LL4sd/sw-044(d) at a concentration of 3.6 mg/L. Similarly, manganese was present in the sample collected at station LL4-048(p2) at a concentration of 3.2 mg/L.

- Mercury was detected at an estimated concentration of 0.000078 mg/L in the sample collected at station LL4-048(p2) but was not detected in the sample collected at station LL4sd/sw-044(d). No site background for this metal has been established, thus all detected results are considered to exceed background.

- Vanadium was detected at an estimated concentration of 0.00099 mg/L in the sample collected from LL4-048(p2) but was not detected in the sample collected at station LL4sd/sw-044(d). No site background for this metal has been established, thus all detected results are considered to exceed background.

4.5.2.2 Main Stream Segment And Settling Pond

Eleven inorganics were detected at least once in surface water from this aggregate during the Phase II RI (Table 4-6). Eight of the detected constituents were eliminated as potential SRCs because they were either major geochemical constituents normally considered essential elements (calcium, iron, magnesium, potassium, and sodium) or the MDC was below the corresponding background criterion (aluminum, barium, and zinc). The MDC for manganese exceeded its respective background criteria and was retained as an SRC. Mercury and vanadium were also retained as SRCs because the background criteria for each of these constituents was set to zero.

Table 4-46 provides a summary of results by station for inorganic SRCs in surface water for the Main Stream and Settling Pond Aggregate. For metals with established background concentrations and retained as SRCs in surface water, manganese was detected in every sample (five detections in five samples). Mercury and vanadium were detected in one of five samples. Figure 4-29 shows the distribution of selected metals in surface water at Load Line 4.

Table 4-46. Summary Data for Site-Related Inorganics in Main Stream Segment and Settling Pond Aggregate – Surface Water

Functional Area		**Main Stream Segment and Settling Pond**	**Main Stream Segment and Settling Pond**	**Main Stream Segment and Settling Pond**	**Main Stream Segment and Settling Pond**	**Main Stream Segment and Settling Pond**
Station ID		**LL4-049(p2)**	**LL4sd/sw-052(p)**	**LL4sd/sw-053(p)**	**LL4sd/sw-054(p)**	**LL4sd/sw-055(p)**
Sample ID		**LL40960**	**LL40964**	**LL40966**	**LL40968**	**LL40970**
Date		**08/20/2001**	**08/14/2001**	**08/14/2001**	**08/14/2001**	**08/12/2001**
Filtered		**Total**	**Total**	**Total**	**Total**	**Total**
Sample Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	**Units**					
Inorganics						
Manganese	mg/L	0.081 =	0.2 =	0.35 =	0.46 = *	0.51 = *
Mercury	mg/L	0.000092 J *	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Vanadium	mg/L	0.0018 J *	0.007 U	0.007 U	0.007 U	0.007 U

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
= - Detected result.
J - Estimated result.
U - Not detected.

The discussion below is a brief summary of the nature and extent of inorganic SRCs identified in the Main Stream Segment and Settling Pond Aggregate.

- Manganese was detected in five of five samples and was present at concentrations slightly above background (0.391 mg/L) in two samples. Manganese was present in the sample collected at LL4sd/sw-054(p) at a concentration of 0.46 mg/L and at a slightly higher concentration, 0.51 mg/L, in the sample collected at station LL4sd/sw-055(p).

- Mercury was detected in the sample collected from LL4-049(p2) at an estimated concentration of 0.000092 mg/L, but was not detected in any other surface water sample collected in this aggregate. No site background for this metal has been established, thus all detected results are considered to exceed background.

- Vanadium was also detected only in the sample collected at station LL4-049(p2). Vanadium was detected at an estimated concentration of 0.0018 mg/L at this location. No site background for this metal has been established, thus all detected results are considered to exceed background.

4.5.2.3 Exit Drainage Aggregate

Ten inorganics were detected at least once in surface water from this aggregate during the Phase II RI (Table 4-6). Eight of the detected constituents were eliminated as potential SRCs because they were either major geochemical constituents normally considered essential elements (calcium, iron, magnesium, potassium, and sodium) or the MDC was below the corresponding background criterion (barium, manganese, and zinc). Antimony and vanadium were retained as SRCs because the background criteria for each of these constituents was set to zero. Antimony and vanadium were detected in one of two samples.

Table 4-47 provides a summary of results by station for inorganic SRCs in surface water for the Exit Drainage Aggregate. The discussion below is a brief summary of the nature and extent of inorganic SRCs identified in the Exit Drainage Aggregate. Figure 4-29 shows the distribution of selected metals in surface water at Load Line 4.

- Antimony was detected in the sample collected from LL4sd/sw-057(p) at an estimated concentration of 0.0025 mg/L. No site background for this metal has been established, thus all detected results are considered to exceed background.

Table 4-47. Summary Data for Site-Related Inorganics in Exit Drainage Aggregate Surface Water

Functional Area		**Exit Drainage Aggregate**	**Exit Drainage Aggregate**
Station ID		**LL4sd/sw-057(p)**	**LL4sd/sw-058(d)**
Sample ID		**LL40974**	**LL40976**
Date		**08/13/2001**	**08/14/2001**
Filtered		**Total**	**Total**
Sample Type		**Grab**	**Grab**
Analyte	**Units**		
Inorganics			
Antimony	mg/L	0.0025 J *	0.01 U
Vanadium	mg/L	0.0014 J *	0.007 U

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
J - Estimated result.
U - Not detected.

- Vanadium was also detected in the sample collected at station LL4-057(p). Vanadium was present at an estimated concentration of 0.0014 mg/L at this location. No site background for this metal has been established, thus all detected results are considered to exceed background.

4.5.2.4 Miscellaneous Water Samples Aggregate

Inorganics were detected in one surface water sample collected in this aggregate [station LL4sd/sw-056(p)] (Table 4-7). Detected concentrations of barium, manganese, and zinc in the sample exceeded their respective background criteria and were thus retained as SRCs. Vanadium was also retained as an SRC because the background criteria for this constituent was set to zero.

Table 4-48 provides a summary of results for inorganic SRCs in surface water for the Miscellaneous Water Samples Aggregate. The discussion below is a brief summary of the inorganic SRCs identified in surface water from this aggregate.

- Barium was present in the sample at a concentration of 0.049 mg/L, slightly above the background concentration of 0.0475 mg/L.

- Manganese was detected at a concentration of 0.43 mg/L, slightly above the background concentration of 0.391 mg/L.

Table 4-48. Summary Data for Site-Related Inorganics in Miscellaneous Water Samples Aggregate – Surface Water

Functional Area		**Miscellaneous Water Samples Aggregate**
Station ID		**LL4sd/sw-056(p)**
Sample ID		**LL40972**
Date		**08/13/2001**
Filtered		**Total**
Sample Type		**Grab**
Analyte	**Units**	
Inorganics		
Barium	mg/L	0.049 = *
Manganese	mg/L	0.43 = *
Vanadium	mg/L	0.0013 J *
Zinc	mg/L	0.09 = *

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
= - Detected result.
J - Estimated result.

- Vanadium was detected in the sample at an estimated concentration of 0.0013 mg/L. No site background for this metal has been established, thus all detected results are considered to exceed background.

- Zinc was present in the sample at a concentration of 0.09 mg/L, exceeding the background concentration of 0.042 mg/L by a factor of 2.1.

4.5.3 SVOCs, VOCs, and PCBs

One VOC (acetone) and one pesticide (4,4'-DDT) were detected in the surface water samples collected at Load Line 4 (Table 4-6).

4.5.3.1 Main Stream Segment Upstream of Perimeter Road Aggregate

No SVOCs, VOCs, pesticides, or PCBs were detected in surface water samples from this aggregate.

4.5.3.2 Main Stream Segment and Settling Pond Aggregate

Acetone was detected at an estimated concentration of 0.0031 mg/L in the sample collected at station LL4sd/sw-054(p). The pesticide 4,4'-DDT was detected in this same sample at a concentration of 0.00031 mg/L. No SVOCs or PCBs were detected.

4.5.3.3 Exit Drainage Aggregate

Acetone was detected at an estimated concentration of 0.0012 mg/L in the sample collected at station LL4sd/sw-058(d). No SVOCs, pesticides, or PCBs were detected.

4.5.4 Summary

Based on the evaluation of surface water data for Load Line 4, the following observations were made.

- Surface water at Load Line 4 has not been impacted by explosives and propellants.

- Vanadium is the only inorganic SRC detected at least once in each of the surface water aggregates. Concentrations of this metal range from 0.00099 mg/L, at an upstream surface water sampling station [LL4-048(p2)], to 0.0014 mg/L (estimated) at station LL4sd/sw-057(p) in the Exit Drainage Aggregate. Manganese was detected in surface water at concentrations nearly 10 times background at 2 locations upstream of Perimeter Road. Arsenic was present at concentrations exceeding 2 times background in both samples collected from the Main Stream Segment Upstream of Perimeter Road Aggregate but was not detected in any other Load Line 4 surface water aggregate. Mercury exceeded background in one sample from the main stream segment upstream of Perimeter Road Aggregate and in one sample from the Main Stream Segment and Settling Pond Aggregate. Other SRCs (antimony, barium, cadmium, and zinc) were detected sporadically and at low concentrations.

- VOC and pesticide contamination in surface water at Load Line 4 is isolated; acetone was detected at one location in the holding pond and once in surface water drainage from Load Line 4. The pesticide 4,4'-DDT was detected once in a sample collected from the holding pond.

- No SVOCs or PCBs were detected.

4.6 GROUNDWATER

Groundwater samples were collected from eight new monitoring wells installed at Load Line 4 during the Phase II RI (see Figure 3-3). Wells LL4mw-199 and LL4mw-200 are located near the southern boundary of the AOC to identify possible contamination in groundwater and potential off-AOC transport of contamination to the south. The remaining six wells are located adjacent to known or suspected source areas. Wells were screened within the unconsolidated zone, with most screens either entirely or partially within the silty-sand to sand interval. Groundwater flow patterns have been approximated from water level measurements in the wells (see Figure 2-4). In general, the potentiometric surface is a subdued replica of the topography within the AOC. Shallow groundwater flow is to the south and off of the AOC consistent with surface water drainage.

All groundwater samples were analyzed for explosives, propellants, TAL metals (filtered only), cyanide, VOCs, SVOCs, and pesticides/PCBs. The analytical data are presented in Appendix I. Table 4-8 provides the summary statistics and determination of SRCs for groundwater at Load Line 4. Nature and extent of contamination in groundwater is considered on an AOC-wide basis; therefore, no spatial aggregates have been assigned.

4.6.1 Explosives and Propellants

No explosives or propellants compounds were detected in the groundwater samples collected during the Phase II RI for Load Line 4.

4.6.2 Target Analyte List Metals and Cyanide

Due to the turbidity of the groundwater, filtered groundwater samples were analyzed for TAL metals. Unfiltered groundwater samples were analyzed for cyanide. Facility-wide background criteria for metals were established prior to the Phase II efforts and only detections above background are discussed below. Exceptions to this are aluminum, antimony, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, selenium, silver, thallium, and vanadium, which were not detected in the background data set and are, therefore, automatically considered SRCs if detected at a frequency greater than 5%.

Table 4-49 presents concentrations of the four inorganics that are considered SRCs in groundwater. The most frequently detected metals considered as SRCs were barium (eight detections) and manganese (eight detections). The only other metals SRCs were nickel (five detections) and arsenic (two detections). Distributions of these metals are presented in Figure 4-30. Barium was detected at a concentration of 110 µg/L in the sample from monitoring well LL4mw-198, exceeding the background concentration (82 µg/L) by approximately 34 %. The background concentration of manganese (1,000 µg/L) was exceeded at two locations, LL4mw-194 and LL4mw-197, where it was measured at 2,700 and 1,900 µg/L, respectively. Nickel was detected in the groundwater samples from five of the eight monitoring wells. The highest concentration (16 µg/L) was measured in the sample taken from monitoring well LL4mw-197. Results from the other four locations at which nickel was detected ranged from 2.8 µg/L (LL4mw-195) to 4.8 µg/L (LL4mw-200). Arsenic was detected in the groundwater sample from monitoring well LL4mw-198 at a concentration of 13 µg/L, slightly exceeding the background concentration of 12 µg/L for this metal.

High turbidity readings (> 999 NTUs) remained in wells LLWmw-197 and -198 despite pumping these wells to dryness twice during development. To ensure that representative samples were obtained to the extent possible, general water quality parameters (pH, specific conductance, etc.) were allowed to stabilize prior to sampling collection. The measures appeared to have been successful. Concentrations of SRCs noted in Table 4-49 in these two wells were generally consistent with other wells at Load Line 4, with the possible exception of nickel in LLWmw-197 and barium in LL4mw-198.

Table 4-49. Summary of Site-Related Inorganics in Groundwater

Station Analyte	Units	LL4mw-193	LL4mw-194	LL4mw-195	LL4mw-196	LL4mw-197	LL4mw-198	LL4mw-199	LL4mw-200
Arsenic	µg/L	ND	ND	ND	ND	ND	13 J	6.5 J	ND
Barium	µg/L	22 =	40 =	47 =	42 =	17 =	110 =	44 =	63 =
Manganese	µg/L	540 =	2,700 =	230 =	890 =	1,900 =	830 =	350 =	390 =
Nickel	µg/L	ND	3.5 J	2.8 J	4.1 J	16 J	ND	ND	4.8 J

J - Analyte present but concentration estimated.
ND - Analyte not detected.
= - Analyte present and concentration accurate.

4.6.3 SVOCs, VOCs, and PCBs

One SVOC was detected in the groundwater sample collected from one well during the Phase II RI. Bis(2-ethylhexyl)phthalate was detected at an estimated concentration of 4.4 µg/L at well LL4mw-194. VOCs were detected in groundwater samples collected from two of the monitoring wells, although only one compound was seen in each well. Carbon disulfide was detected at an estimated concentration of 0.2 µg/L in monitoring well LL4mw-200. Chloromethane was detected at 0.13 µg/L in well LL4mw-193. No pesticides or PCBs were detected in the groundwater samples collected at Load Line 4.

4.6.4 Summary

The interpretation of chemical data obtained from Load Line 4 groundwater is summarized as follows.

- Groundwater does not exhibit contamintion associated with explosives, propellants, pesticides, or PCBs.
- Groundwater in all monitoring wells shows low levels of contamination with metals considered to be SRCs; however, exceedances of background concentrations are either slight (as in the case of arsenic in monitoring well LL4mw-198) or sporadic (as in the case of manganese in monitoring wells LL4mw-194 and LL4mw-197).
- SVOCs (one detection) and VOCs (two detections) are minor contaminants in Load Line 4 groundwater.

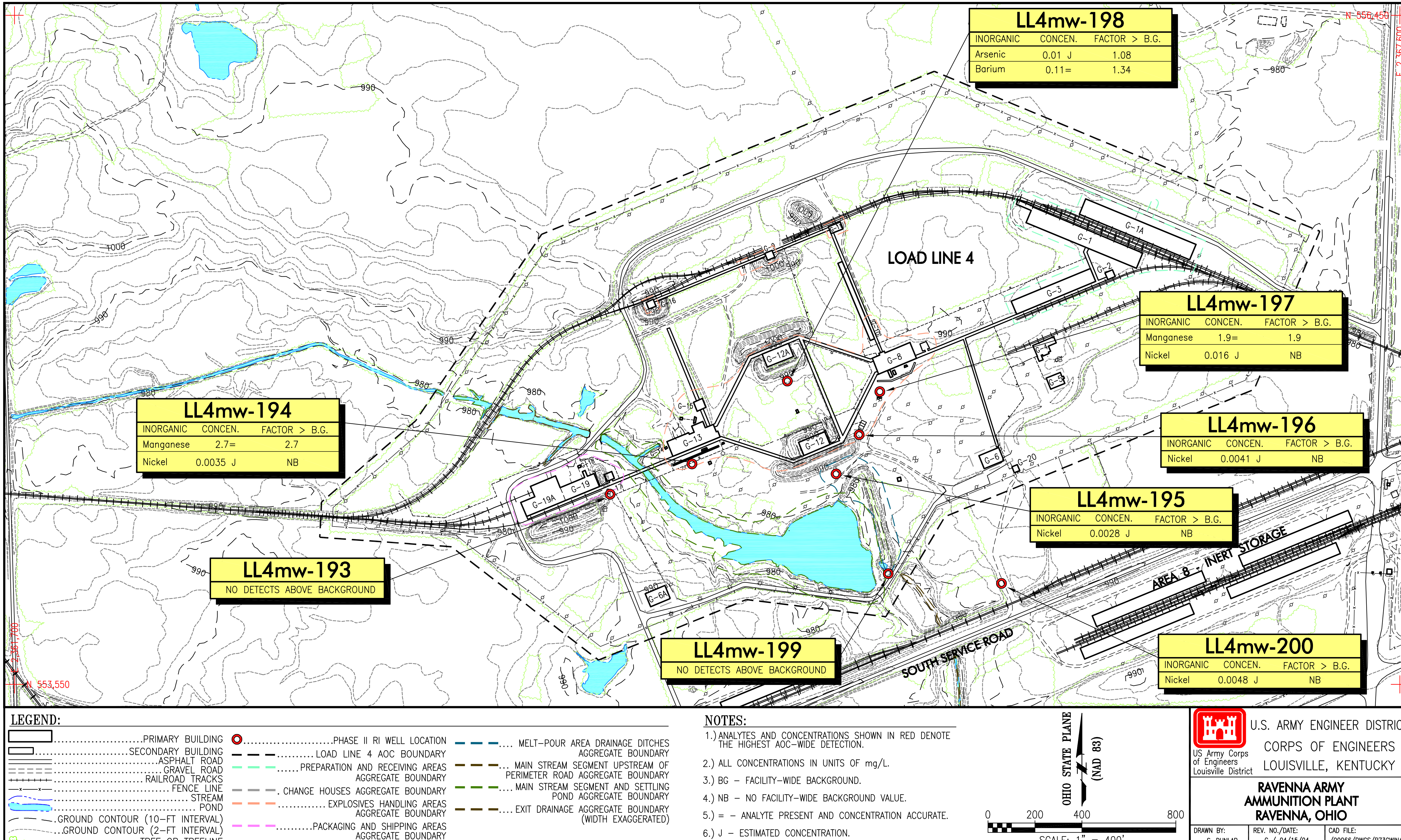

Figure 4-30. Selected Inorganics in Groundwater at Load Line 4

4.7 STORM AND SANITARY SEWERS

4.7.1 Sewer Line Video Survey Results

As discussed in Chapter 3.0, a video survey of the storm and sanitary sewers was conducted at Load Line 4. Approximately 1,500 ft of sewer line was surveyed. The sanitary and storm sewer system was found to be cracked with heavy debris, mineral deposits, and roots throughout. Some portions of the system were flooded and breaks in the connections were noted. The inspection records of the survey are found in Appendix N and are summarized in Table 4-50.

Table 4-50. Summary of Sewer Line Video Survey Results

Manhole	Direction	Condition of Pipe
CB-13	West	Cracks throughout; ends at downstream manhole
	East	Pipe changes to steel
GA-17	East	Good
	West	Good
	North	Crack, ends at upstream manhole
	South	Crack and multiple fractures, ends at downstream manhole
MH-10	South	Multiple cracks and fractures, hole in pipe
MH-9	South	Multiple cracks, inspections ends due to too slick for camera
MH-15	West	Cracks, break in connection
MH-11	to MH-5	Crack
MH-5	to MH-7	Heavy debris
MH-11	to MH12	Break in connection, large rock blocks
W6	to W5	Debris, roots, scale/mineral deposits, ends at downstream manhole
W5	to W4	Light corrosion, heavy deposits could not pass
E4	Southwest	Light roots, debris, blocked by heavy mud
	North	Heavy debris
E2	Northeast	Too dirty
E6	South	Roots
	East	Heavy debris

4.7.2 Storm and Sanitary Sewer Sediment Aggregate

Sediment samples were collected from nine sewer system manholes during the Phase II RI to characterize the nature and extent of contamination. Five sediment samples were co-located with sewer water samples; LL4-180 and LL4-182 contained insufficient sediment to obtain a sample. All nine of the sediment samples were analyzed for field explosives, TAL metals, and PCBs. Based on the results of the field explosives analyses, four sediment samples were sent off-site for explosives analysis. Three samples were analyzed for the full suite of parameters and included analysis of pesticides, SVOCs, and VOCs. Table 4-9 presents summary statistics and determination of SRCs in sanitary sewer system sediment. Tables 4-51 and 4-52 present SRC summary data by station for sewer line sediment samples.

4.7.2.1 Explosives

No explosives compounds were detected in sediment in the sewer system at Load Line 4.

Table 4-51. Summary Data for Site-Related VOCs and SVOCs in Storm Sanitary Sewer Sediment Aggregate

Functional Area		**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**
Station ID		**LL4-187**	**LL4-189**	**LL4-192**
Sample ID		**LL40993**	**LL40997**	**LL41003**
Date		**08/20/2001**	**08/13/2001**	**08/13/2001**
Sample Type		**Grab**	**Grab**	**Grab**
Analyte	**Units**			
Volatile Organics				
2-Butanone	mg/kg	0.054 J	0.027 UJ	0.025 UJ
Acetone	mg/kg	0.23 J	0.027 UJ	0.025 UJ
Toluene	mg/kg	0.0064 J	0.0067 U	0.0063 U
Semivolatile Organics				
Acenaphthene	mg/kg	2.1 UJ	0.16 J	0.41 UJ
Anthracene	mg/kg	0.34 J	0.84 J	0.41 UJ
Benz(*a*)anthracene	mg/kg	3.2 J	1.8 J	0.41 UJ
Benzo(*a*)pyrene	mg/kg	3.5 J	1.3 J	0.41 UJ
Benzo(*b*)fluoranthene	mg/kg	5.5 J	1.7 J	0.41 UJ
Benzo(*g,h,i*)perylene	mg/kg	1.8 J	0.52 J	0.41 UJ
Benzo(*k*)fluoranthene	mg/kg	1.7 J	0.67 J	0.41 UJ
Chrysene	mg/kg	4 J	1.7 J	0.41 UJ
Dibenz(*a,h*)anthracene	mg/kg	0.51 J	0.15 J	0.41 UJ
Fluoranthene	mg/kg	4.4 J	4.4 J	0.41 UJ
Fluorene	mg/kg	2.1 UJ	0.39 J	0.41 UJ
Indeno(1,2,3-*cd*)pyrene	mg/kg	1.8 J	0.51 J	0.41 UJ
Phenanthrene	mg/kg	1.5 J	3 J	0.41 UJ
Pyrene	mg/kg	4.9 J	4.2 J	0.41 UJ

ID = Identification.
SVOC = Semivolatile organic compound.
VOC = Volatile organic compound.
= - Detected result.
J - Estimated result.
U - Not detected.

4.7.2.2 Inorganic constituents

Fourteen TAL metals were detected above background criteria at least once in sediment among the nine sewer stations (Table 4-8). Ten of these metals were detected at every station. Table 4-51 gives the inorganic SRC results by station. The most concentrations above background occurred at LL4-187, near the Load Line 4 Pond. Arsenic was detected at a high concentration of 157 mg/kg, 7.9 times background; beryllium was detected at a high concentration of 2.5 mg/kg, 6.6 times background; and cobalt was detected at 45.6 mg/kg, 5 times background at this station. Figure 4-31 shows the distribution of inorganic SRCs in storm and sanitary sewer sediment at Load Line 4. The selection of particular metals for depiction on the figure is generally based on process knowledge and frequency of detection and/or magnitude above background.

The highest concentrations above background were found in station LL4-186 where manganese was detected at a high concentration of 30,500 mg/kg (15 times background), lead at 251 mg/kg (9.2 times background), and barium at 600 mg/kg (5 times background).

4.7.2.3 SVOCs, VOCs, and Pesticides/PCBs

No organic constituents were detected in LL4-192. Three sediment samples collected at LL4-187, LL4-189, and LL4-192 were submitted for full suite analysis.

Fourteen SVOCs were detected in at least one of two sediment samples submitted for SVOC analysis (Table 4-52). All fourteen SVOCs detected were found at LL4-189. LL4-187 contained 12 SVOCs. The highest concentrations of SVOCs at this station were 5.5 mg/kg of benzo(*b*)fluoranthene, 4.9 mg/kg of pyrene, and 4.4 g/kg of fluoranthene. The highest detected SVOC at LL4-189 was 4.4 mg/kg of fluoranthene. No SVOCs were detected in LL4-192.

Three VOCs were detected at LL4-187. Acetone was detected at a concentration of 0.23 mg/kg, 2-butanone was detected at 0.054 mg/kg, and toluene was detected at 0.064 mg/kg.

Five pesticides were detected in two of the three sediment samples (Table 4-53). LL4-189 contained four pesticides, 4,4-DDE (0.01 mg/kg), dieldrin (0.0081 mg/kg), endrin aldehyde (0.012 mg/kg), and gamma-chlordane (0.0061 mg/kg). Beta-BHC was detected at LL4-187 at a concentration of 0.044 mg/kg.

PCB-1254 was detected at only one station (LL4-189) at a concentration of 0.67 mg/kg. PCB-1260 was detected at LL4-178 and LL4-190 at a high concentration of 0.14 mg/kg at MH-7 (Figure 4-31).

Figure 4-32 shows the distribution of pesticides and PCBs detected in storm and sanitary sewer sediment at Load Line 4.

4.7.3 Storm and Sanitary Sewer Water Aggregate

Water samples were collected from seven sewer system manholes during the Phase II RI to determine whether residual contamination exists within the system and whether the pipelines may be functioning as a preferential migration pathway or source of contaminants to groundwater. Table 4-9 presents summary statistics and determination of SRCs in sanitary sewer system water. Tables 4-54 and 4-55 contain summary data by station for water samples collected from the sewer system. Background values for surface water were used conservatively to screen for SRCs. Water samples were analyzed for explosives, TAL metals, and PCBs; in addition, two of the samples were analyzed for the full suite of parameters.

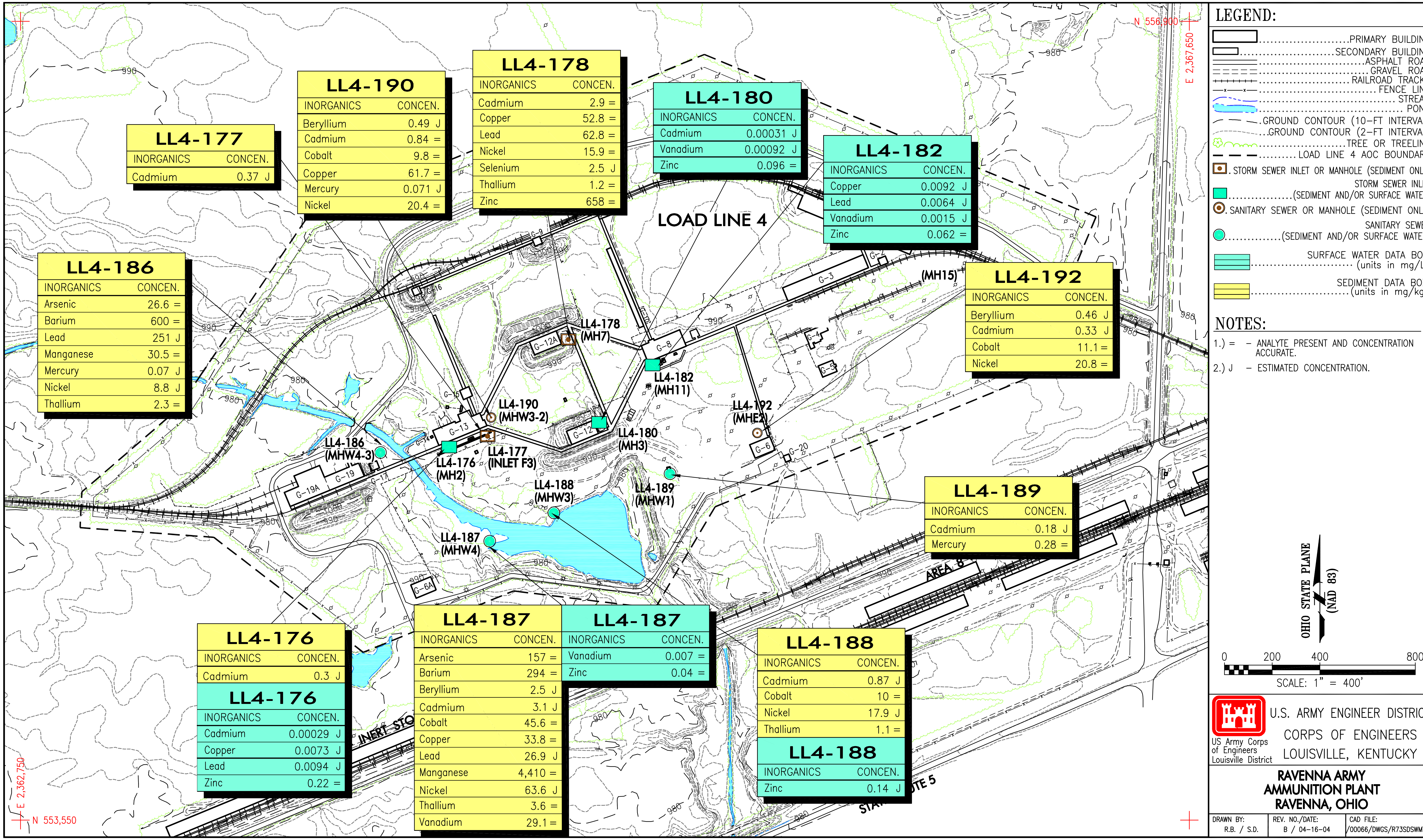

Figure 4-31. Distribution of Selected Inorganics in the Sewer Systems at Load Line 4

Table 4-52. Summary Data for Site-Related Inorganics Storm and Sanitary Sewer Sediment Aggregate

Functional Area		**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**
Station ID		**LL4-176**	**LL4-177**	**LL4-177**	**LL4-178**	**LL4-186**
Sample ID		**LL40977**	**LL40979**	**LL41140**	**LL40980**	**LL40991**
Date		**08/12/2001**	**08/12/2001**	**08/12/2001**	**08/12/2001**	**08/20/2001**
Depth (ft)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab**	**Field Duplicate**	**Grab**	**Grab**
Analyte	**Units**					
				Inorganics		
Arsenic	mg/kg	2.4 =	5.5 =	5.7 =	7.9 =	26.6 = *
Barium	mg/kg	22.3 =	37.3 =	35.6 =	80.3 =	600 = *
Beryllium	mg/kg	0.12 J	0.3 J	0.32 J	0.21 J	0.7 U
Cadmium	mg/kg	0.3 J *	0.37 J *	0.34 J *	2.9 = *	21.5 U
Cobalt	mg/kg	2.4 =	4.7 =	4.8 =	4 =	2.6 =
Copper	mg/kg	7.6 =	20.6 =	21.3 =	52.8 = *	13.5 =
Lead	mg/kg	21.2 =	21.5 =	20.1 =	62.8 = *	251 J *
Manganese	mg/kg	171 =	188 =	206 =	470 =	30,500 = *
Mercury	mg/kg	0.024 J	0.014 J	0.014 J	0.043 J	0.07 J *
Nickel	mg/kg	4.7 =	15.5 =	14 =	15.9 =	8.8 J
Selenium	mg/kg	3 U	2.7 U	2.7 U	2.5 J *	86.1 U
Thallium	mg/kg	0.54 =	0.41 J	0.48 J	1.2 = *	2.3 = *
Vanadium	mg/kg	4.4 =	11.2 =	11.6 =	14.9 =	13.3 =
Zinc	mg/kg	109 =	73.1 =	67.5 =	658 = *	66.1 J

Functional Area		**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**
Station ID		**LL4-187**	**LL4-188**	**LL4-189**	**LL4-190**	**LL4-192**
Sample ID		**LL40993**	**LL40995**	**LL40997**	**LL40999**	**LL41003**
Date		**08/20/2001**	**08/20/2001**	**08/13/2001**	**08/13/2001**	**08/13/2001**
Depth (ft)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	**Units**					
				Inorganics		
Arsenic	mg/kg	157 = *	18.8 =	6.3 =	6.7 =	12.1 =
Barium	mg/kg	294 = *	39.5 =	14.8 =	46.8 =	50.5 =
Beryllium	mg/kg	2.5 J *	0.71 U	0.11 J	0.49 J *	0.46 J *
Cadmium	mg/kg	3.1 J *	0.87 J *	0.18 J *	0.84 = *	0.33 J *
Cobalt	mg/kg	45.6 = *	10 = *	3 =	9.8 = *	11.1 = *
Copper	mg/kg	33.8 = *	27.5 =	4 =	61.7 = *	18 =
Lead	mg/kg	26.9 J	10.9 J	14.2 =	27.4 =	16.9 =
Manganese	mg/kg	4,410 = *	694 =	155 =	714 =	476 =
Mercury	mg/kg	0.65 U	0.2 U	0.28 = *	0.071 J *	0.035 J
Nickel	mg/kg	63.6 J *	17.9 J *	3.9 =	20.4 = *	20.8 = *
Selenium	mg/kg	13 U	4 U	0.44 J	2.7 U	2.5 U
Thallium	mg/kg	3.6 = *	1.1 = *	0.25 J	0.56 =	0.57 =
Vanadium	mg/kg	29.1 = *	10 =	2.9 =	9.5 =	16.4 =
Zinc	mg/kg	431 =	230 =	43.5 =	237 =	55.3 =

*- Exceeds Ravenna Army Ammunition Plant background criteria.
ID = Identification. J - Estimated result.
= - Detected result. U - Not detected.

Table 4-53. Summary Data for Site-Related Pesticides/PCBs in Storm and Sanitary Sewer Sediment Aggregate

Functional Area		**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**
Station ID		**LL4-176**	**LL4-177**	**LL4-177**	**LL4-178**	**LL4-186**
Sample ID		**LL40977**	**LL40979**	**LL41140**	**LL40980**	**LL40991**
Date		**08/12/2001**	**08/12/2001**	**08/12/2001**	**08/12/2001**	**08/20/2001**
Depth (ft)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab**	**Field Duplicate**	**Grab**	**Grab**
Analyte	**Units**					
Pesticides and PCBs						
4,4'-DDE	mg/kg	NA	NA	NA	NA	NA
Dieldrin	mg/kg	NA	NA	NA	NA	NA
Endrin Aldehyde	mg/kg	NA	NA	NA	NA	NA
PCB-1254	mg/kg	0.05 U	0.087 U	0.044 U	0.14 U	0.14 U
PCB-1260	mg/kg	0.05 U	0.087 U	0.044 U	0.14 =	0.14 R
beta-BHC	mg/kg	NA	NA	NA	NA	NA
gamma-Chlordane	mg/kg	NA	NA	NA	NA	NA

Table 4-53. Summary Data for Site-Related Pesticides/PCBs in Storm and Sanitary Sewer Sediment Aggregate (continued)

Functional Area		**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**	**Storm/Sanitary Sewers Sediment Samples Aggregate**
Station ID		**LL4-187**	**LL4-188**	**LL4-189**	**LL4-190**	**LL4-192**
Sample ID		**LL40993**	**LL40995**	**LL40997**	**LL40999**	**LL41003**
Date		**08/20/2001**	**08/20/2001**	**08/13/2001**	**08/13/2001**	**08/13/2001**
Depth (ft)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	**Units**					
Pesticides and PCBs						
4,4'-DDE	mg/kg	0.022 U	NA	0.01 J	NA	0.0021 U
Dieldrin	mg/kg	0.022 U	NA	0.0081 J	NA	0.0021 U
Endrin Aldehyde	mg/kg	0.022 U	NA	0.012 J	NA	0.0021 U
PCB-1254	mg/kg	0.21 U	0.066 U	0.67 J	0.044 U	0.041 U
PCB-1260	mg/kg	0.21 R	0.066 R	0.044 U	0.048 =	0.041 U
beta-BHC	mg/kg	0.044 J	NA	0.0045 U	NA	0.0021 U
gamma-Chlordane	mg/kg	0.022 U	NA	0.0061 J	NA	0.0021 U

BHC = Benzene hexachloride.
DDE = Dichlorodiphenyldichloroethylene.
ID = Identification.
NA = Not analyzed.
PCB = Polychlorinated biphenyl.
= - Detected result.
J - Estimated result.
U - Not detected.
R - Rejected result.

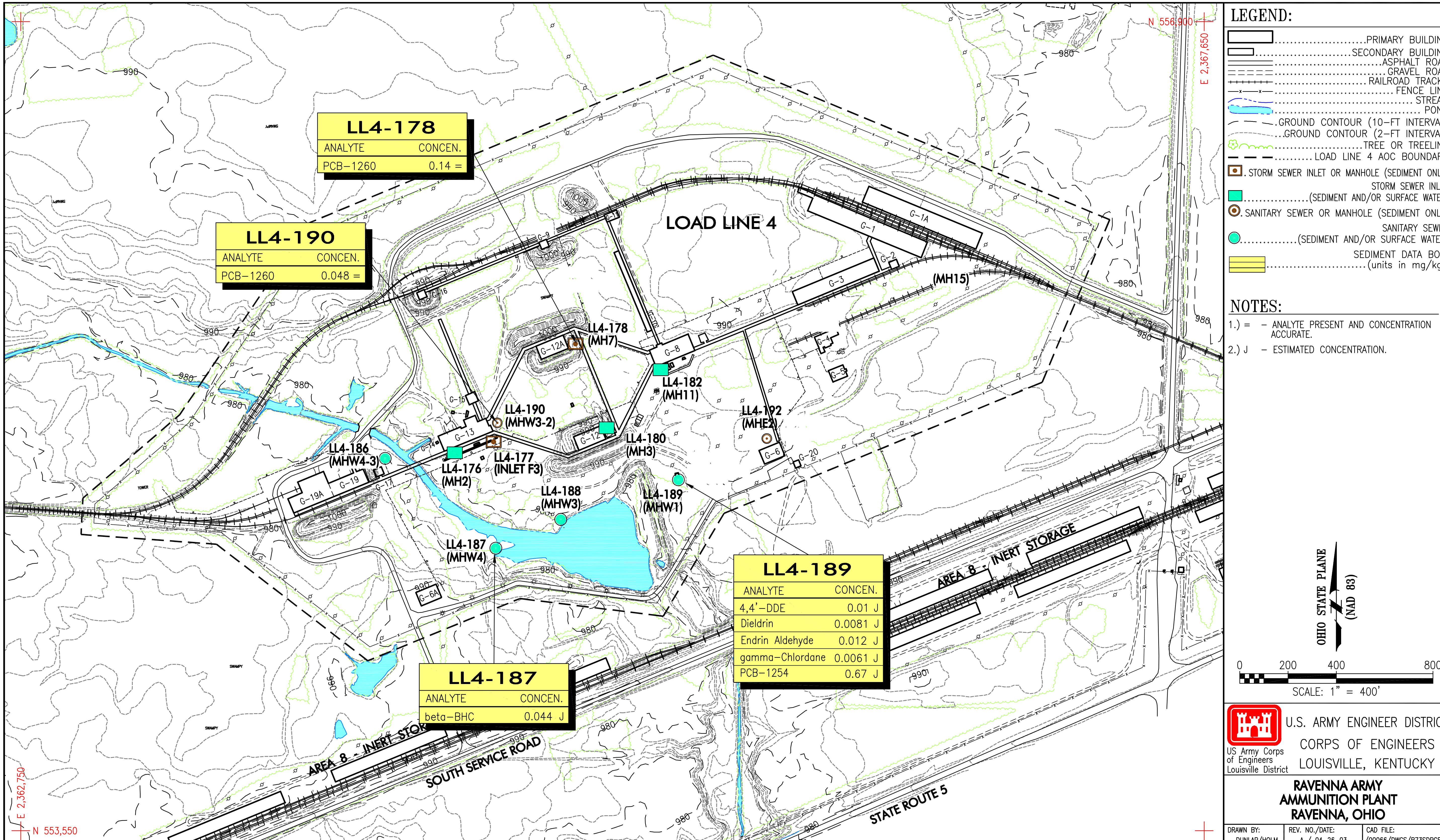

Figure 4-32. Distribution of Detected Pesticides and PCBs in the Storm and Sanitary Sewer System Sediment at Load Line 4

Table 4-54. Summary Data for Site-Related Explosives and VOCs in Storm and Sanitary Sewer Water Aggregate

Functional Area		**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**
Station ID		**LL4-176**	**LL4-180**	**LL4-182**	**LL4-186**
Sample ID		**LL40978**	**LL40983**	**LL40987**	**LL40992**
Date		**08/12/2001**	**08/12/2001**	**08/12/2001**	**08/20/2001**
Sample Type		**Grab**	**Grab**	**Grab**	**Grab**
Analyte	**Units**				
Explosives					
2-Amino-4,6-dinitrotoluene	mg/L	0.0003 =	0.00013 J	0.0002 U	0.0002 U
4-Amino-2,6-dinitrotoluene	mg/L	0.00034 =	0.0003 =	0.0002 U	0.0002 U
RDX	mg/L	0.0005 U	0.0005 U	0.00046 J	0.0005 U
Volatile Organics					
Acetone	mg/L	NA	NA	NA	NA

Functional Area		**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**
Station ID		**LL4-187**	**LL4-188**	**LL4-189**	**LL4-189**
Sample ID		**LL40994**	**LL40996**	**LL40998**	**LL41154**
Date		**08/14/2001**	**08/20/2001**	**08/13/2001**	**08/13/2001**
Sample Type		**Grab**	**Grab**	**Grab**	**Field Duplicate**
Analyte	**Units**				
Explosives					
2-Amino-4,6-dinitrotoluene	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U
4-Amino-2,6-dinitrotoluene	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U
RDX	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U
Volatile Organics					
Acetone	mg/L	0.0009 J	NA	0.0011 J	0.0011 J

ID = Identification.
NA = Not analyzed.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
= - Detected result.
J - Estimated result.
U - Not detected.

Table 4-55. Summary Data for Site-Related Inorganics in Storm and Sanitary Sewer Water Aggregate

Functional Area		**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**
Station ID		**LL4-176**	**LL4-180**	**LL4-182**	**LL4-186**
Sample ID		**LL40978**	**LL40983**	**LL40987**	**LL40992**
Date		**08/12/2001**	**08/12/2001**	**08/12/2001**	**08/20/2001**
Depth (ft)		**0 - 0**	**0 - 0**	**0 - 0**	**0 - 0**
Sample Type		**Grab**	**Grab**	**Grab**	**Grab**
Analyte	**Units**				
Inorganics					
Cadmium	mg/L	0.00029 J *	0.00031 J *	0.005 U	0.005 U
Copper	mg/L	0.0073 J	0.015 U	0.0092 J *	0.015 U
Lead	mg/L	0.0094 J *	0.01 U	0.0064 J *	0.01 U
Vanadium	mg/L	0.002 U	0.00092 J *	0.0015 J *	0.007 U
Zinc	mg/L	0.22 = *	0.096 = *	0.062 = *	0.04 U

Functional Area		**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**	**Storm/Sanitary Sewers Water Samples Aggregate**
Station ID		**LL4-187**	**LL4-188**	**LL4-189**	**LL4-189**
Sample ID		**LL40994**	**LL40996**	**LL40998**	**LL41154**
Date		**08/14/2001**	**08/20/2001**	**08/13/2001**	**08/13/2001**
Depth (ft)		**0 - 0**	**0 - 0**	**0 - 0**	**0 - 0**
Sample Type		**Grab**	**Grab**	**Grab**	**Field Duplicate**
Analyte	**Units**				
Inorganics					
Cadmium	mg/L	0.005 U	0.005 U	0.005 U	0.005 U
Copper	mg/L	0.015 U	0.015 U	0.015 U	0.015 U
Lead	mg/L	0.01 U	0.01 U	0.01 U	0.01 U
Vanadium	mg/L	0.007 =	0.007 U	0.007 U	0.007 U
Zinc	mg/L	0.04 =	0.014 J	0.02 U	0.014 U

ID = Identification.
* - Exceeds Ravenna Army Ammunition Plant background criteria.
= - Detected result.
J - Estimated result.
U - Not detected.

4.7.3.1 Explosives

Three explosives were detected in water from three sampling locations. 2-amino-4,6-DNT and 4-amino-2,6-DNT both were detected in LL4-176 and LL4-180. The highest concentrations of 2-amino-4,6-DNT (0.00034 mg/L) and 4-amino-2,6-DNT occurred (0.0003 mg/L) at LL4-176. RDX was only detected in the sewer water at LL4-182 (0.00046 mg/L).

4.7.3.2 Inorganic constituents

Five SRC inorganic constituents were detected in surface water samples collected at Load Line 4, cadmium, copper, lead, vanadium, and zinc. Four of the SRCs were found at LL4-176 (cadmium, copper, lead, and zinc). This station had the highest concentrations of lead (0.0094 mg/L) and zinc (0.22 mg/L). LL4-182 also had four of the SRCs detected (copper, lead, vanadium, and zinc) and the highest concentrations of copper (0.0092 mg/L) and vanadium (0.0015 mg/L) occurred at this station. Three of the SRCs were detected in LL4-180 (cadmium, vanadium, and zinc) and the highest concentration of cadmium (0.00031 mg/L) was found at this station. Two inorganics (vanadium and zinc) were detected in water at LL4-187. At station LL4-188, only zinc was detected. Inorganic SRCs were not detected in the remaining stations.

4.7.3.3 SVOCs, VOCs, and PCBs/pesticides

No SVOCs and PCBs/pesticides were detected in the sewer system water samples at Load Line 4. Acetone was detected at LL4-187 and LL4-189, the two locations where full suite analysis were collected. The highest acetone concentration of 0.0011 mg/L was detected at LL4-189.

4.8 BUILDINGS AND STRUCTURES AGGREGATE

As described in Section 4.1, samples collected from various buildings and structures included soil beneath building floor slabs, sediment/sludges and accumulated water from sedimentation and washout basins, and floor sweep samples from several former production buildings. Table 4-56 summarizes samples collected from buildings and structures; locations of these samples are shown on Figures 3-1, 3-2, and 3-6. The evaluation of these data is limited in that risk assessments are not conducted for this data aggregate. Comparisons of floor sweep sample TCLP results to their respective hazardous waste criteria are presented in Section 4.8.3.

4.8.1 Building Sub-floor Samples

As noted in Table 4-56, nine samples of soil beneath building floor slabs were collected and analyzed for field explosives, TAL metals, and PCBs. In addition, sample station LL4-124 beneath the Building G-8 floor slab was analyzed for cyanide.

All field results for TNT and RDX were non-detect; thus, no sub-floor soil samples were submitted for fixed-base laboratory analysis of explosives. Table 4-57 presents results for inorganics detected at least once. Table 4-58 presents results for detected organic constituents. TAL metals concentrations in sub-floor soil samples were less than RVAAP background values, with the exception of copper, magnesium, and zinc, which were generally greater than background concentrations. Cyanide and PCBs were not detected in any of the sub-floor soil samples collected.

Table 4-56. Load Line 4 Phase II RI Summary of Samples Collected from Buildings and Structures

Location	Station ID	Sample Type
Building Sub-floor Samples		
G-9 Explosive Screening	LL4-079	Sub-floor
G-15 Explosive Preparation	LL4-108	Sub-floor
	LL4-109	Sub-floor
G-10 Explosive Preparation	LL4-119	Sub-floor
	LL4-120	Sub-floor
G-8 Melt-Pour Building	LL4-123	Sub-floor
	LL4-124	Sub-floor
G-4 Boiler House	LL4-134	Sub-floor
	LL4-135	Sub-floor
Washout Annexes and Sedimentation/Filter Basins		
Sediment Basin North of Building G-16	LL4-144	Sediment within basin
G-8 Melt-Pour Building at Washout Basin	LL4-175	Sediment and water samples
Floor Sweep Samples		
G-19 Packing and Shipping	LL4-099	Floor sweep sample; As^{+3} and TCLP also collected
G-8 Melt-Pour Building	LL4-125	Floor sweep sample; As^{+3} and TCLP also collected
G-3 Inert Storage	LL4-129	Floor sweep sample; As^{+3} and TCLP also collected

RI = Remedial Investigation.
TCLP = Toxicity Characteristic Leaching Procedure.

Table 4-57. Summary Results for Load Line 4 Building Sub-floor Soils – Inorganics

Functional Area		**Soil Beneath Building Floor Slabs Aggregate**	**Soil Beneath Building Floor Slabs Aggregate**	**Soil Beneath Building Floor Slabs Aggregate**	**Soil Beneath Building Floor Slabs Aggregate**	**Soil Beneath Building Floor Slabs Aggregate**
Station ID		**LL4-079**	**LL4-108**	**LL4-109**	**LL4-119**	**LL4-120**
Sample ID		**LL4ss-079-0713-SO**	**LL4ss-108-0796-SO**	**LL4ss-109-0797-SO**	**LL4ss-119-0825-SO**	**LL4ss-120-0826-SO**
Date		**08/22/2001**	**08/13/2001**	**08/13/2001**	**08/21/2001**	**08/21/2001**
Depth (ft)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	**Units**					
Inorganics						
Aluminum	mg/kg	5,660 =	8,350 =	8,570 =	8,410 =	9,070 =
Arsenic	mg/kg	9.5 =	11.1 =	9.5 =	13.6 =	13.5 =
Barium	mg/kg	23.6 J	56.1 =	40.7 =	43 =	41.9 =
Beryllium	mg/kg	0.31 U	0.52 J	0.36 U	0.4 U	0.4 U
Cadmium	mg/kg	0.53 U	0.16 J	0.15 J	0.55 U	0.56 U
Calcium	mg/kg	1,650 =	1,430 =	3,670 =	1,360 =	833 =
Chromium	mg/kg	6.2 J	11.7 J	10.2 J	11 =	10.1 =
Cobalt	mg/kg	5.9 J	8.6 =	6.9 =	8.7 =	7.7 =
Copper	mg/kg	16.6 =	23.3 =	18 =	24.2 =	24.5 =
Iron	mg/kg	14,400 J	23,400 =	18,500 =	19,000 =	20,800 =
Lead	mg/kg	10.9 =	13.3 =	12.4 =	17.9 J	18.1 J
Magnesium	mg/kg	1,720 =	2,600 =	2,610 =	2,090 =	2,260 =
Manganese	mg/kg	350 J	348 =	294 =	562 =	492 =
Mercury	mg/kg	0.022 J	0.12 U	0.022 J	0.02 J	0.021 J
Nickel	mg/kg	12.4 J	21.2 =	16.2 =	18.1 J	19 J
Potassium	mg/kg	747 J	866 =	772 =	765 J	718 J
Sodium	mg/kg	534 U	580 U	596 U	552 U	555 U
Thallium	mg/kg	0.42 UJ	0.26 J	0.25 J	0.73 =	0.71 =
Vanadium	mg/kg	8.3 =	12.7 =	12.8 =	13.4 =	13.9 =
Zinc	mg/kg	59.4 =	69.7 =	56.7 =	81.7 =	82.8 =

Table 4-57. Summary Results for Load Line 4 Building Sub-floor Soils – Inorganics (continued)

Functional Area		**Soil Beneath Building Floor Slabs Aggregate**	**Soil Beneath Building Floor Slabs Aggregate**	**Soil Beneath Building Floor Slabs Aggregate**	**Soil Beneath Building Floor Slabs Aggregate**
Station ID		**LL4-123**	**LL4-124**	**LL4-134**	**LL4-135**
Sample ID		**LL4ss-123-0833-SO**	**LL4ss-124-0834-SO**	**LL4ss-134-0858-SO**	**LL4ss-135-0859-SO**
Date		**08/14/2001**	**08/14/2001**	**08/14/2001**	**08/14/2001**
Depth (ft)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Sample Type		**Grab**	**Grab**	**Grab**	**Grab**
Analyte	**Units**				
		Inorganics			
Aluminum	mg/kg	2,990 =	2,730 =	3,490 =	4,880 =
Arsenic	mg/kg	7.4 J	19 J	8 J	7.7 =
Barium	mg/kg	16.5 J	13.1 J	19.5 J	20.6 =
Beryllium	mg/kg	0.23 U	0.17 U	0.25 U	0.3 U
Cadmium	mg/kg	0.29 J	0.26 J	0.27 J	0.18 J
Calcium	mg/kg	84,000 J	27,900 J	30,500 J	11,700 J
Chromium	mg/kg	4.9 J	4.6 J	7.5 J	7.2 =
Cobalt	mg/kg	8.4 =	6.1 =	5.5 =	6.5 =
Copper	mg/kg	15.2 =	15.7 =	17.1 =	18.5 =
Iron	mg/kg	13,800 J	13,400 J	19,100 J	14,600 =
Lead	mg/kg	7.6 J	10.5 J	8.9 J	10.9 =
Magnesium	mg/kg	7,780 J	3,870 J	6,440 J	3,310 =
Manganese	mg/kg	413 J	433 J	450 J	537 =
Mercury	mg/kg	0.011 J	0.017 J	0.11 U	0.045 J
Nickel	mg/kg	9.2 J	9.7 J	11.2 J	14.8 =
Potassium	mg/kg	564 =	564 =	555 =	531 J
Sodium	mg/kg	55.3 J	531 U	534 U	91.4 J
Thallium	mg/kg	0.46 =	0.46 =	0.39 =	0.43 =
Vanadium	mg/kg	6.8 J	6.1 J	9 J	8.6 =
Zinc	mg/kg	51.5 =	43.8 =	61.5 =	93.2 =

ID = Identification.
= - Detected result.
J - Estimated result.
U - Not detected.

Table 4-58. Summary Sediment Results for Load Line 4 Washout and Sedimentation Basin – Inorganic

Functional Area		Pink Water and Washdown Sedimentation Sumps Aggregate	Pink Water and Washdown Sedimentation Sumps Aggregate	Pink Water and Washdown Sedimentation Sumps Aggregate
Station ID		**LL4-144**	**LL4-175**	**LL4-175**
Sample ID		**LL4sd-144-0884-SD**	**LL4sd-175-0951-SD**	**LL4sd-175-1145-SD**
Date		**08/24/2001**	**08/14/2001**	**08/14/2001**
Sample Type		**Grab**	**Grab**	**Field Duplicate**
Analyte	**Units**			
Inorganics				
Aluminum	mg/kg	6,720 =	5,870 =	5,170 =
Antimony	mg/kg	8.1 R	21.2 J	8.1 J
Arsenic	mg/kg	12.1 U	40 J	36.7 J
Barium	mg/kg	80.6 =	1,180 J	991 J
Beryllium	mg/kg	0.83 U	0.37 J	0.37 U
Cadmium	mg/kg	2.6 J	67.9 J	63 J
Calcium	mg/kg	17,100 =	53,600 J	31,000 J
Chromium	mg/kg	29.5 =	1,430 J	1,540 J
Cobalt	mg/kg	5.6 =	39.8 =	39.3 =
Copper	mg/kg	274 =	488 =	468 =
Iron	mg/kg	26,000 =	331,000 J	325,000 J
Lead	mg/kg	174 =	5,020 J	3,040 J
Magnesium	mg/kg	3,400 J	8,620 J	7,950 J
Manganese	mg/kg	510 =	2,480 J	2,490 J
Mercury	mg/kg	0.29 U	0.32 =	0.44 =
Nickel	mg/kg	39.1 =	305 J	249 J
Potassium	mg/kg	1,520 J	11,100 =	12,100 =
Selenium	mg/kg	3.3 J	28.7 U	13.1 U
Silver	mg/kg	4 U	0.87 J	1.1 J
Sodium	mg/kg	4,040 U	2,920 =	2,900 =
Thallium	mg/kg	1.1 U	1.5 =	1.6 =
Vanadium	mg/kg	12.3 =	20.3 J	20.6 J
Zinc	mg/kg	719 =	2,670 =	2,280 =

ID = Identification.
= - Detected result.
J - Estimated result.
U - Not detected.

4.8.2 Washout Annexes and Sedimentation Basins

One sediment and one water sample were collected from the washout basin located outside of Building G-8 (station LL4-175) (Table 4-56). In addition, one sediment sample was collected from a small sedimentation basin located north of Building G-16, which was a former explosives preparation facility. Sediment from the Building G-8 washout basin was approximately 0.2 ft thick, and consisted of dusky red sludge in the bottom of the sump with lots of metal fragments, paint chips, rust flakes, bolts, pieces of wire, etc. The sample contained high concentrations of chromium, copper, iron, nickel, and zinc (Table 4-58). Results of organic analyses showed the presence of explosives, particularly RDX, and propellants (Table 4-59). PCB-1254 and low levels of chlordane isomers were also present in sediment. A number of SVOCs, primarily PAHs, were detected at low, estimated concentrations. The associated water samples from the washout basin showed detectable concentrations of metals and explosives corresponding to those observed at high concentrations in sediment (Tables 4-60 and 4-61).

The sediment sample from the small basin north of Building G-16 (LL4-144) was collected from approximately 1 in. of sediment and water. The basin contained a snail, frog, grass, and algae. The sediment sample contained substantially lower concentrations of metals than the Building G-8 washout basin (Table 4-58). However, copper and lead were elevated well above any RVAAP background values for soil or sediment. Organic constituents analyzed included explosives and PCBs; none of these classes of compounds were detected.

4.8.3 Floor Sweep Samples

Samples of fine debris material (dirt, dust, paint chips, etc.) were collected from the floor areas inside of Buildings G-19 (station LL4-099), G-8 (station LL4-125), and G-3 (station LL4-129). Sample locations are illustrated on Figures 3-1 and 3-2. These samples were analyzed for explosives, inorganics (including cyanide, Cr+6, and As+3), VOCs, SVOCs, and pesticides/PCBs. Tables 4-62 and 4-63 present results for inorganic and organic constituents, respectively, that were detected in at least one sample.

4.8.3.1 Inorganics

Results of inorganic analyses of floor sweep samples show that a very high percentage of the samples consist of iron, presumably rust. The sample from Building G-3 was slightly more than 40% iron by mass. Elevated concentrations of other metals were detected, including cadmium, chromium, copper, lead, and zinc, in the samples from all three buildings, with Building G-8 containing the highest values. Cyanide was also detected in the sample collected from Building G-8.

4.8.3.2 Organics

Low levels of explosive compounds (TNT, HMX, and RDX) were detected in the samples from Building G-8 and G-19. Pesticides and PCBs (PCBs-1254 and -1260) were detected in all three samples, although at much lower concentrations than observed in the other melt-pour lines. Low, estimated concentrations of a number of PAHs were detected in all of the floor sweep samples. Trace levels of acetone, benzene, and/or toluene were also detected in every sample.

4.8.3.3 TCLP analyses

In addition to direct analyses of floor sweepings, aliquots were collected for TCLP analyses (Table 4-64). Cadmium, chromium, and lead were the only analytes detected in TCLP extracts. No results exceeded their respective maximum concentrations for the toxicity characteristic as specified in 40 *Code of Federal Regulations* 261.24.

Table 4-59. Summary Sediment Results for Load Line 4 Washout and Sedimentation Basin – Organics

Functional Area		**Pink Water and Washdown Sedimentation Sumps Aggregate**	**Pink Water and Washdown Sedimentation Sumps Aggregate**	**Pink Water and Washdown Sedimentation Sumps Aggregate**
Station ID		**LL4-144**	**LL4-175**	**LL4-175**
Sample ID		**LL4sd-144-0884-SD**	**LL4sd-175-0951-SD**	**LL4sd-175-1145-SD**
Date		**08/24/2001**	**08/14/2001**	**08/14/2001**
Sample Type		**Grab**	**Grab**	**Field Duplicate**[a]
Analyte	**Units**			
Explosives				
2,4,6-Trinitrotoluene	mg/kg	0.25 U	310 =	NA
2-Amino-4,6-dinitrotoluene	mg/kg	0.25 U	23 =	NA
HMX	mg/kg	0.5 U	600 =	NA
Nitrocellulose	mg/kg	NA	700 =	NA
RDX	mg/kg	0.5 U	2100 =	NA
Pesticides and PCBs				
PCB-1254	mg/kg	0.27 U	150 =	260 =
alpha-Chlordane	mg/kg	NA	11 =	NA
gamma-Chlordane	mg/kg	NA	10 J	NA
Semivolatile Organics				
2,4-Dinitrotoluene	mg/kg	NA	1.6 J	NA
Benz(*a*)anthracene	mg/kg	NA	0.18 J	NA
Benzo(*a*)pyrene	mg/kg	NA	0.32 J	NA
Benzo(*b*)fluoranthene	mg/kg	NA	1.8 J	NA
Benzo(*g,h,i*)perylene	mg/kg	NA	0.37 J	NA
Benzo(*k*)fluoranthene	mg/kg	NA	0.41 J	NA
Bis(2-ethylhexyl)phthalate	mg/kg	NA	1.9 J	NA
Chrysene	mg/kg	NA	1.1 J	NA
Fluoranthene	mg/kg	NA	1.4 J	NA
Indeno(1,2,3-*cd*)pyrene	mg/kg	NA	0.35 J	NA
Phenanthrene	mg/kg	NA	0.41 J	NA
Pyrene	mg/kg	NA	1 J	NA
Volatile Organics				
Acetone	mg/kg	NA	0.025 J	NA
Toluene	mg/kg	NA	0.0094 J	NA

[a] This duplicate sample was also analyzed for target analyte list metals (Table 4-58). Because only two sedimentation/washout basin samples were collected at Load Line 4 and these data were collected for demolition characterization purposes, a full duplicate sample was not collected.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
ID = Identification.
NA = Not analyzed.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
= - Detected result.
J - Estimated result.
U - Not detected.

Table 4-60. Summary Water Results for Load Line 4 Washout and Sedimentation Basin – Inorganics

Functional Area		**Pink Water and Washdown Sedimentation Sumps Aggregate**
Station ID		**LL4-175**
Sample ID		**LL4sw-175-0952-SW**
Date		**08/14/2001**
Depth (ft)		**0 - 0**
Sample Type		**Grab**
Analyte	**Units**	
Inorganics		
Cyanide	mg/L	0.033 =
Antimony	mg/L	0.023 =
Arsenic	mg/L	0.0068 J
Barium	mg/L	0.054 =
Cadmium	mg/L	0.051 =
Calcium	mg/L	49.6 =
Chromium	mg/L	0.079 =
Cobalt	mg/L	0.031 =
Copper	mg/L	0.89 =
Iron	mg/L	3.5 =
Lead	mg/L	0.2 =
Magnesium	mg/L	28.1 =
Manganese	mg/L	0.18 =
Mercury	mg/L	0.00016 J
Nickel	mg/L	0.15 =
Potassium	mg/L	1140 J
Selenium	mg/L	0.0055 J
Sodium	mg/L	426 =
Vanadium	mg/L	0.0016 J
Zinc	mg/L	1 =

ID = Identification.
= - Detected result.
J - Estimated result.

Table 4-61. Summary Water Results for Load Line 4 Washout and Sedimentation Basin – Organics

Functional Area		Pink Water and Washdown Sedimentation Sumps Aggregate
Station ID		**LL4-175**
Sample ID		**LL4sw-175-0952-SW**
Date		**08/14/2001**
Sample Type		**Grab**
Analyte	**Units**	
Explosives		
2,4,6-Trinitrotoluene	mg/L	0.66 =
2-Amino-4,6-dinitrotoluene	mg/L	0.46 =
4-Amino-2,6-dinitrotoluene	mg/L	0.81 =
HMX	mg/L	0.96 =
RDX	mg/L	4.4 =
Pesticides and PCBs		
PCB-1254	mg/L	0.012 =
Semivolatile Organics		
2,4-Dinitrotoluene	mg/L	0.011 J
2,6-Dinitrotoluene	mg/L	0.013 J
Benzoic Acid	mg/L	0.013 J

HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
ID = Identification.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
= - Detected result.
J - Estimated result.

Table 4-62. Load Line 4 Phase II RI Floor Sweep Samples Results – Inorganics

Functional Area		**Floor Sweep Samples Aggregate**	**Floor Sweep Samples Aggregate**	**Floor Sweep Samples Aggregate**
Station ID		**LL4-099**	**LL4-125**	**LL4-129**
Sample ID		**LL4fs-099d-0771-FS**	**LL4fs-125d-0835-FS**	**LL4fs-129d-0845-FS**
Date		**08/20/2001**	**08/20/2001**	**08/20/2001**
Sample Type		**Grab**	**Grab**	**Grab**
Analyte	**Units**			
General Chemistry				
Arsenic $^{+3}$	µg/g	0.0938 =	0.0866 =	0.0614 =
Chromium, hexavalent	mg/kg	23 J	1.1 UJ	1.1 UJ
Inorganics				
Cyanide	mg/kg	0.51 U	1.4 =	0.55 U
Aluminum	mg/kg	3370 =	3,370 =	2,070 =
Antimony	mg/kg	41.9 =	8.6 J	20 J
Arsenic	mg/kg	29.8 J	37 =	31.8 J
Barium	mg/kg	505 J	1,560 J	401 J
Beryllium	mg/kg	0.19 U	0.25 U	2 J
Cadmium	mg/kg	8.8 =	47.9 =	44.1 =
Calcium	mg/kg	6,120 =	15,200 =	10,300 =
Chromium	mg/kg	463 J	249 J	279 J
Cobalt	mg/kg	27.9 J	43.9 J	35.1 J
Copper	mg/kg	1,740 =	540 =	485 =
Iron	mg/kg	258,000 J	278,000 J	401,000 J
Lead	mg/kg	1,210 =	2,610 =	903 =
Magnesium	mg/kg	1,110 =	1,740 =	962 J
Manganese	mg/kg	1,620 J	1,570 J	3,320 J
Mercury	mg/kg	0.022 J	0.16 =	0.022 J
Nickel	mg/kg	130 J	176 J	165 J
Potassium	mg/kg	2,880 J	8,200 J	14,300 J
Selenium	mg/kg	7.4 J	8.8 J	43.9 U
Silver	mg/kg	0.25 J	0.21 J	0.55 J
Sodium	mg/kg	232 J	1,340 =	1,410 =
Thallium	mg/kg	0.32 J	0.42 J	0.36 J
Vanadium	mg/kg	11.5 =	14.7 =	19.8 =
Zinc	mg/kg	648 =	2,850 =	758 =

ID = Identification.
= - Detected result.
J - Estimated result.
U - Not detected.

Table 4-63. Load Line 4 Phase II RI Floor Sweep Samples Results – Organics

Functional Area		Floor Sweep Samples Aggregate	Floor Sweep Samples Aggregate	Floor Sweep Samples Aggregate
Station ID		**LL4-099**	**LL4-125**	**LL4-129**
Sample ID		**LL4fs-099d-0771-FS**	**LL4fs-125d-0835-FS**	**LL4fs-129d-0845-FS**
Date		**08/20/2001**	**08/20/2001**	**08/20/2001**
Sample Type		**Grab**	**Grab**	**Grab**
Analyte	**Units**			
Explosives				
2,4,6-Trinitrotoluene	mg/kg	0.072 J	1.5 =	0.25 U
HMX	mg/kg	0.5 U	3.6 =	0.5 U
RDX	mg/kg	1.1 =	18 =	0.5 U
Pesticides and PCBs				
4,4'-DDD	mg/kg	0.034 J	0.089 U	0.037 U
4,4'-DDE	mg/kg	0.13 J	0.92 =	0.14 J
Dieldrin	mg/kg	0.034 U	0.089 U	0.15 J
Endrin Aldehyde	mg/kg	0.15 J	1 =	0.26 J
Methoxychlor	mg/kg	0.067 U	0.17 U	0.11 J
PCB-1254	mg/kg	16 =	3.5 U	24 =
PCB-1260	mg/kg	1.7 U	29 =	1.8 U
alpha-Chlordane	mg/kg	0.39 =	0.089 U	0.037 U
beta-BHC	mg/kg	0.037 J	0.089 U	0.037 U
gamma-Chlordane	mg/kg	0.34 J	0.12 J	0.094 J
Semivolatile Organics				
Acenaphthene	mg/kg	0.67 UJ	0.41 J	0.36 UJ
Anthracene	mg/kg	0.22 J	0.68 J	0.36 UJ
Benz(*a*)anthracene	mg/kg	0.44 J	2.1 J	0.36 UJ
Benzo(*a*)pyrene	mg/kg	0.45 J	1.9 J	0.36 UJ
Benzo(*b*)fluoranthene	mg/kg	0.98 J	3.8 J	0.16 J
Benzo(*g,h,i*)perylene	mg/kg	0.26 J	0.94 J	0.36 UJ
Benzo(*k*)fluoranthene	mg/kg	0.4 J	1.4 J	0.36 UJ
Benzoic acid	mg/kg	3.2 UJ	1.8 J	1.9 J
Bis(2-ethylhexyl)phthalate	mg/kg	2.5 J	12 J	4.3 J
Butyl benzyl phthalate	mg/kg	0.78 J	1.7 UJ	0.36 UJ
Carbazole	mg/kg	0.25 J	0.62 J	0.36 UJ
Chrysene	mg/kg	0.68 J	3.8 J	0.36 UJ
Fluoranthene	mg/kg	2.2 J	5.8 J	0.11 J
Fluorene	mg/kg	0.67 UJ	0.57 J	0.36 UJ
Indeno(1,2,3-*cd*)pyrene	mg/kg	0.24 J	0.91 J	0.36 UJ
Phenanthrene	mg/kg	1.1 J	4.5 J	0.36 UJ
Pyrene	mg/kg	0.74 J	6 J	0.059 J
Volatile Organics				
Acetone	mg/kg	0.0068 J	0.021 UJ	0.022 UJ
Benzene	mg/kg	0.0012 J	0.0017 J	0.001 J
Toluene	mg/kg	0.0033 J	0.014 =	0.0017 J

BHC = Benzene hexachloride.
DDD = Dichlorodiphenyldichloroethane.
DDE = Dichlorodiphenyldichloroethylene.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
ID = Identification.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
= - Detected result.
J - Estimated result.
U - Not detected.

Table 4-64. Load Line 4 Phase II RI TCLP Constituents Detected in Floor Sweep Samples

Functional Area		**Floor Sweep Samples Aggregate**	**Floor Sweep Samples Aggregate**	**Floor Sweep Samples Aggregate**
Station ID		**LL4-099**	**LL4-125**	**LL4-129**
Sample ID		**LL4fs-099d-0771-FS**	**LL4fs-125d-0835-FS**	**LL4fs-129d-0845-FS**
Date		**08/20/2001**	**08/20/2001**	**08/20/2001**
Sample Type		**Grab**	**Grab**	**Grab**
Analyte	**Units**			
Cadmium	mg/L	0.16 =	0.36 =	0.95 =
Chromium	mg/L	0.5 U	0.5 U	0.85 =
Lead	mg/L	0.5 U	1.6 =	0.72 =

ID = Identification.
RI = Remedial Investigation.
TCLP = Toxicity Characteristic Leaching Procedure.
= - Detected result.
U - Not detected.

4.9 ORDNANCE AND EXPLOSIVES AVOIDANCE SURVEY SUMMARY

UXO technicians provided OE avoidance training and support during all field operations. The OE avoidance crew cleared all soil, surface water/sediment, and drilling locations within the former operations areas. In addition, they provided clearance for all test pit locations and supported the video survey of sanitary and storm sewer lines. In accordance with technical direction from USACE, OE technicians performed physical water and sediment sampling activities for process effluent collection sumps within the melt-pour buildings in order to ensure worker safety. The OE technicians received training from SAIC staff on the proper sampling protocols prior to these sampling activities. SAIC personnel completed all chain-of-custody and packaging and shipping. No OE was discovered during field reconnaissance and magnetometer surveys of access routes and proposed sampling, drilling, or test pit points. Various debris and metal scrap were encountered throughout Load Line 4 during visual and magnetometer surveys including, metal, rail ties, vitrified clay pipe fragments, rail spikes, and iron pipe. In several instances, subsurface magnetic anomalies resulted in the decision to move pre-planned sample locations short distances to points where no anomalies were observed. Appendix O contains the full OE avoidance report and supporting field logs for the Load Line 4 Phase II RI.

4.10 RADIOLOGICAL SURVEY RESULTS

Radiological surveys of Load Lines 2, 3, and 4 were conducted by USACE, Buffalo District staff to demonstrate that no residual radioactive contamination attributable to RVAAP activities remains within radiography buildings. The surveys were conducted using accepted survey methods for decommissioning. These surveys demonstrate that radiological activity from residual radioactive contamination is below the release criteria (United States Nuclear Regulatory Commission Regulatory Guidance 1.86) for each area surveyed. In addition, records were reviewed to determine if documentation existed to support the proper disposal of the radioactive sources (e.g., cobalt-60 sealed sources) used in the load lines at RVAAP. Radiological survey results indicate that there is no detectable cobalt-60 contamination in the load lines. In addition, records exist that indicate that two of three, sealed cobalt-60 sources (a 500-curie and a 1,000-curie source) used at Load Lines 2, 3, and 4 were shipped off-site in 1971 and 1972 and returned to their licensed owner. A shipping record for a second 1,000-curie cobalt-60 source was not found. A later document indicates all three sources were returned to their licensed owner. Efforts are being taken by the U. S. Army to locate any additional pertinent information regarding the fate of the second 1,000-curie cobalt-60 source. A complete report containing methods and discussion of radiological survey results was prepared by the USACE, Buffalo District and is contained in Appendix S.

4.11 COMPARATIVE EVALUATION OF FIELD AND LABORATORY ANALYSES FOR EXPLOSIVES

This section presents a comparison of the TNT and RDX field screening analysis to values determined by the off-site analytical laboratory.

4.11.1 Field Sampling and Analysis Protocol

Samples were collected from surface, subsurface, and sediment locations in and around Load Line 4. All surface soil (0- to 1-ft depth) samples were composite samples from three individual sampling locations positioned in a 3-ft equilateral triangle pattern in the sampling area. Subsurface samples were collected at discrete locations, but were composited over the associated depth interval.

Field determinations of 2,4,6-TNT and RDX in soil and sediment samples were performed through implementation of colorimetric analyses developed by the USACE Cold Regions Research & Engineering Laboratory (CRREL). The procedure for measuring TNT concentrations in soils involves a liquid extraction of the explosives from the soil matrix with acetone, and formation of a color complex with sodium sulfite and potassium hydroxide. Absorbance is measured at a wavelength of 540 nm. For RDX, all nitrate must be removed from the extract, then glacial acetic acid and zinc powder are added. A complexing agent (NitriVer3) is added to the sample, and absorbance is measured at 507 nm. In both methods, percent absorbance is correlated to concentration.

Off-site laboratory determinations for TNT and RDX were performed by solvent extraction and analysis by liquid chromatographic techniques (SW846-8330).

All surface soil and sediment samples were field analyzed with colorimetric methods for TNT and RDX. The purpose of the analysis was to define the extent of surface soil contamination with respect to these explosive compounds. Field colorimetry was also used as a screening method to reduce the number of samples that required fixed-base laboratory analysis for explosives. The strategy can be summarized as follows.

- If the field method indicated TNT was present at >/= 1 parts per million (ppm), the sample was sent to the off-site laboratory for analysis of explosives and propellants.
- If the concentration of TNT was < 1 ppm, the analysis for RDX was performed.
- If RDX was present at a concentration >/= 1 ppm, the sample was sent to the off-site laboratory for analysis of explosives and propellants.
- In addition, 15% of the samples showing non-detects of TNT or RDX were sent to the off-site laboratory for analysis of explosives.
- All samples collected, regardless of field colorimetry results, were submitted for TAL metals analysis.

4.11.2 Trinitrotoluene Comparison

TNT field screening and laboratory results are presented in Table 4-65. Starting with the premise that the laboratory results are accurate relative to the presence or absence of TNT in the sample, the field screening

Table 4-65. Load Line 4 Laboratory/Field TNT Comparison

Station	Sample No.	Lab Result	Lab Dup Result	Field Result	Units
LL4-048	LL40957	0.25 U		1 U	mg/kg
LL4-068	LL40680	0.25 U		1.8	mg/kg
LL4-069	LL40683	0.25 U		1.5	mg/kg
LL4-070	LL40686	0.25 U		2.8	mg/kg
LL4-071	LL40689	0.096 J		11	mg/kg
LL4-073	LL40695	0.25 U		1 U	mg/kg
LL4-075	LL40701	0.25 U		4.1	mg/kg
LL4-076	LL40704	0.25 U	0.25 U	1 U	mg/kg
LL4-077	LL40707	0.25 U		2.1	mg/kg
LL4-080	LL40714	0.25 U		3	mg/kg
LL4-081	LL40717	0.25 U		1.51	mg/kg
LL4-084	LL40726	0.25 U		5.3	mg/kg
LL4-087	LL40735	0.25 U		2	mg/kg
LL4-088	LL40738	0.25 U		10.3	mg/kg
LL4-089	LL40741	0.25 U		1 U	mg/kg
LL4-094	LL40756	0.25 U		1 U	mg/kg
LL4-095	LL40759	0.25 U		7	mg/kg
LL4-096	LL40762	0.25 U		9.5	mg/kg
LL4-097	LL40765	0.25 U		1.02	mg/kg
LL4-098	LL40768	0.25 U		7.8	mg/kg
LL4-105	LL40787	0.25 U		1.5	mg/kg
LL4-113	LL40807	0.25 U		8.9	mg/kg
LL4-113	LL40808	0.25 U		1.8	mg/kg
LL4-114	LL40810	0.25 U		1 U	mg/kg
LL4-116	LL4-816	0.25 U	0.25 U	1 U	mg/kg
LL4-127	LL40839	0.25 U		1.4	mg/kg
LL4-139	LL40869	0.25 U		1 U	mg/kg
LL4-142	LL40878	0.25 U		1 U	mg/kg
LL4-144	LL40884	0.25 U		1 U	mg/kg
LL4-145	LL40887	0.25 U	0.25 U	1 U	mg/kg
LL4-150	LL40902	0.25 U		1 U	mg/kg
LL4-154	LL40906	0.25 U		1 U	mg/kg
LL4-157	LL40909	0.25 U		1 U	mg/kg
LL4-175	LL40951	310		25	mg/kg
LL4-176	LL40979	0.25 U		1 U	mg/kg
LL4-177	LL41140	0.25 U		1 U	mg/kg
LL4-178	LL40980	0.25 U		1 U	mg/kg
LL4-185	LL40990	0.25 U		1 U	mg/kg
LL4-190	LL40999	0.25 U		1 U	mg/kg
LL4sd/sw-052	LL40963	0.25 U		1 U	mg/kg
LL4sd/sw-053	LL40965	0.25 U		7.8	mg/kg
LL4sd/sw-054	LL40967	0.25 U		2.8	mg/kg
LL4sd/sw-055	LL40969	0.25 U		1 U	mg/kg
LL4sd-051	LL40962	0.25 U		1 U	mg/kg

TNT = Trinitrotoluene.

values provide 0% false negative information and 48% false positive information. Consideration of values less than 2 ppm as equivalent reduces the false positive occurrences to a 30% rate. Statistical correlations of positive TNT data where both laboratory and field screening values were greater than 2 ppm were not feasible due to the low population of positive detections of TNT above 1 ppm.

Review of laboratory results for associated explosive compounds [i.e., trinitrobenzene (TNB), dinitrotoluenes, nitrotoluenes, nitrocellulose, etc.] indicates there were not any impacts on the field screening determinations from these compounds. Elevated levels of nitrocellulose did not appear to influence the TNT screening value. The low levels of other nitro-compounds observed in these samples did not exhibit any impact on the TNT screening levels.

It is possible the field screening data were observing cross-contamination effects or poor colorimetry during the performance of these analyses. The high incidence of false positive results would seem to indicate difficulty in the implementation of field screening relative to other studies conducted at the same location. It is concluded that the field screening provided a poor representation of the presence or absence of TNT below 1 to 2 ppm for this study due to the low population of positive detections available for statistical correlations.

4.11.3 RDX Comparison

RDX field screening and laboratory results are presented in Table 4-66. Starting with the premise that the laboratory results are accurate relative to the presence or absence of RDX in the sample, all field screening values were confirmed to be below 1 ppm, with the exception of one result that was confirmed to be positive. Since insufficient RDX comparison data were above the reporting levels, no correlation coefficient information was feasible. It is believed the field screening has provided a valid representation of the presence or absence of RDX above 1 ppm; however, because of the low population of positive detections, there is not a high level of confidence in the statistical correlations.

Review of laboratory results for associated explosive compounds (i.e. HMX, nitrocellulose, nitroquanidine, etc.) does not indicate any obvious impacts on the field screening determinations from these compounds. Elevated levels of nitrocellulose did not appear to influence the RDX screening value. Low levels of HMX and nitroguanidine observed in these samples did not exhibit an impact on the RDX screening levels.

4.12 SUMMARY OF CONTAMINANT NATURE AND EXTENT

Based on evaluation of data collected during the Phase I and II RIs, the extent and magnitude of contamination at Load Line 4 appears to be much less than compared to the other major melt-pour lines at RVAAP (Load Lines 1 through 3). A brief summary of nature and extent of contamination within each of the environmental media characterized is outlined below.

4.12.1 Surface Soil

Explosive and explosive compounds present in surface soil at Load Line 4 are relatively few in number, concentrations are comparatively low relative to Load Lines 1 through 3, and are limited in extent to the immediate proximity of source areas. Pervasive inorganic SRCs in surface soil include inorganic constituents such as barium, cadmium, chromium, copper, lead, thallium, and zinc. SVOCs, such as fluoranthene and pyrene, were also present in one or more samples from each of the aggregates comprising Load Line 4. Other metals and SVOC were detected in Load Line 4, but were not pervasive throughout the entire AOC. The VOCs detected in surface soil samples from Load Line 4 include acetone, benzene, chloroform, dimethylbenzene, and toluene. In addition, PCBs-1254 and -1260 and some pesticides were detected sporadically.

Table 4-66. Load Line 4 Laboratory/Field RDX Comparison

Station	Sample No.	Lab Result	Lab Dup Result	Field Result	Units
LL4-048	LL40957	0.5 U		1 U	mg/kg
LL4-073	LL40695	0.5 U		1 U	mg/kg
LL4-076	LL40704	0.5 U	0.5 U	1 U	mg/kg
LL4-089	LL40741	0.5 U		1 U	mg/kg
LL4-094	LL40756	0.5 U		1 U	mg/kg
LL4-114	LL40810	0.5 U		1 U	mg/kg
LL4-116	LL40816	0.5 U	0.5 U	1 U	mg/kg
LL4-139	LL40869	0.5 U		1 U	mg/kg
LL4-142	LL40878	19 =		11.5	mg/kg
LL4-144	LL40884	0.5 U		1 U	mg/kg
LL4-145	LL40887	0.5 U		1 U	mg/kg
LL4-150	LL40902	0.5 U		1 U	mg/kg
LL4-154	LL40906	0.5 U		1 U	mg/kg
LL4-157	LL40909	0.5 U		1 U	mg/kg
LL4-176	LL40977	0.5 U		1 U	mg/kg
LL4-177	LL40979	0.5 U	0.5 U	1 U	mg/kg
LL4-178	LL40980	0.5 U		1 U	mg/kg
LL4-185	LL40990	0.5 U		1 U	mg/kg
LL4-190	LL40999	0.5 U		1 U	mg/kg
LL4sd/sw-052	LL40963	0.5 U		1 U	mg/kg
LL4sd/sw-055	LL40969	0.5 U		1 U	mg/kg
LL4sd-051	LL40962	0.5 U		1 U	mg/kg

RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

Based on the evaluation of surface soil data for Load Line 4, the following observations were made.

4.12.1.1 Explosive Handling Areas Aggregate

- Explosives (2,4,6-TNT, HMX, and RDX) were detected in surface soil at some locations in the Explosives Handling Areas Aggregate, although concentrations were generally low and the extent was limited. The maximum concentration for explosives was for RDX (19 mg/kg) near Building G-8.

- Pervasive inorganic SRCs in surface soil in this aggregate include aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, and zinc, which were detected in every sample for which those analyses were performed. Beryllium, mercury, selenium, and thallium are also considered pervasive because they were detected in at least 47% (nearly half) of the samples for which they were analyzed.

- A greater number of SVOCs were detected in the Explosives Handling Areas Aggregate than in any other aggregate at Load Line 4, although overall concentrations were low. The SVOCs most frequently detected were PAHs (fluoranthene, phenanthrene, and pyrene) and bis(2-ethylhexyl)phthalate. The highest values were clustered near Building G-8 and along the walkway between Building G-8 and Building G-12.

- VOCs are generally absent in the Explosives Handling Areas Aggregate. Trace concentrations of acetone and chloroform were observed in four samples.

- Generally low concentrations of PCBs (PCBs-1254 and -1260) and pesticides (primarily gamma-chlordane and 4,4'-DDT) were detected in a number of samples from the Explosives Handling Area Aggregate with the highest levels (up to 28 mg/kg for PCB-1254) clustered in the vicinity of the former production buildings.

4.12.1.2 Preparation and Receiving Areas Aggregate

- Explosives and propellants are generally absent in this aggregate. Positive field TNT and RDX results for a few samples were not confirmed by laboratory analysis. Nitrocellulose was present at low concentrations in surface soil at one location north of Building G-1A (station LL4-088).

- Arsenic, barium, chromium, cobalt, copper, cyanide, lead, manganese, nickel, vanadium, and zinc were detected in every sample within this aggregate. Beryllium, cadmium, mercury, and thallium are also considered pervasive in this aggregate because they were detected in more than 50% of the samples analyzed. Contaminants appear to be clustered with the maximum concentrations of almost all of the SRCs in this aggregate in the sample collected at station LL4-131 on the south side of Building G-4.

- Low concentrations of relatively few SVOCs were detected; most observed detections were clustered near Building G-4.

- VOCs are generally absent in the Preparation and Receiving Areas Aggregate. Low concentrations of acetone, toluene, and 2-butanone were observed in some samples.

- PCB-1254 and/or -1260 were observed in four samples at concentrations up to 48 mg/kg; most PCB detects were clustered near Building G-4. No pesticides were detected in surface soil in this aggregate.

4.12.1.3 Packaging and Shipping Areas Aggregate

- Explosives and propellants were generally absent within this aggregate. Nitrocellulose was present at a low concentration in surface soil at one location south of Building G-19.

- Barium, chromium, copper, lead, manganese, nickel, and zinc were detected in every sample for which those analyses were performed. Cadmium, mercury, and thallium are also considered pervasive in the Packaging and Shipping Areas Aggregate because they were detected in more than 50% of the samples analyzed. Antimony and beryllium were detected less frequently and at concentrations only slightly above established background criteria.

- SVOCs in this aggregate were limited in extent to two surface soil samples; maximum concentrations of all but one compound occurred near Building G-19.

- VOCs were absent in surface soil in this aggregate, with the exception of one estimated detection of toluene.

4.12.1.4 Change Houses Aggregate

- No explosives compounds were detected at a concentration of 1.0 mg/kg or greater during field analyses.

- Few inorganic results exceeded RVAAP background values; the observed exceedances were typically not substantially above background. Lead concentrations were the highest among the inorganics with concentrations up to 397 mg/kg.

- One surface soil sample collected from the east side of Building G-6 was submitted for analyses of SVOCs and VOCs. Low estimated concentrations of 16 PAHs were detected. Trace concentrations of benzene, dimethylbenzene, and toluene were also detected.

- Pesticides were not detected in this aggregate. PCB-1260 was detected once at an estimated concentration of 0.059 mg/kg in a sample collected on the east side of Building G-6.

4.12.1.5 Perimeter Area Aggregate

- Field analyses of three samples collected near the WW-23 Water Tower detected TNT at concentrations up to 2.8 mg/kg. No other samples from this aggregate contained explosive compounds at a concentration greater than 1.0 mg/kg, based on field laboratory results.

- Few background exceedances for inorganics were observed in the Perimeter Area Aggregate. Inorganics greater than background were clustered in the vicinity of the WW-23 Water Tower; maximum concentrations of four metals SRCs (mercury, zinc, chromium, and lead) occurred in samples collected near this structure. Lead exhibited the greatest magnitude of background exceedances with observed concentrations up to 1,340 mg/kg.

- SVOCs were generally absent in this aggregate; however, low, estimated concentrations of several PAHs and bis(2-ethylhexyl)phthalate were detected at station LL4-068, near the WW-23 Water Tower.

- VOCs were absent in surface soil in this aggregate, with the exception of one estimated detection of toluene.

4.12.1.6 Melt-Pour Drainage Area Ditches Aggregate

- No explosives compounds were detected at a concentration of 1.0 mg/kg or greater during field analyses.

- Extent and distribution of inorganic SRCs in this aggregate were limited and maximum concentrations rarely exceeded background values by factors of more than 2 times.

- SVOCs were generally absent in this aggregate; however, low, estimated concentrations of several PAHs were detected in one sample.

- VOCs were absent in surface soil in this aggregate, with the exception of one estimated detection of acetone.

4.12.2 Subsurface Soil

Based on the evaluation of the occurrence and distribution of contaminants in the limited number of subsurface soil samples that were able to be collected at Load Line 4, the following observations were made.

- No explosives or propellants were detected in the subsurface soil at Load Line 4.

- The metals detected at concentrations exceeding their respective background concentration most frequently include barium, beryllium, cadmium, lead, and zinc. Metals above background are most prevalent in subsurface soil in the vicinity of Building G-1A in the Preparation and Receiving Areas Aggregate and Building G-9 in the Explosives Handling Areas Aggregate.

- Subsurface soil from Load Line 4 was not analyzed for VOCs or SVOCs; therefore, no direct observations regarding the presence or distribution of these contaminants can be made. If any organic compounds are present in the subsurface soil, it is reasonable to expect that the occurrence and distribution would generally coincide with the distribution seen in the overlying surface soil.

- Subsurface soil from Load Line 4 was not analyzed for pesticides. As with VOCs and SVOCs, it can be expected that if pesticides are present in the subsurface soil, their distribution would be similar to the distribution of pesticides seen in surface soil at Load Line 4.

4.12.3 Sediment and Surface Water

- Explosive compounds were detected in sediment samples, although at concentrations less than 1 mg/kg. Explosives were not detected in associated water samples.

- Cadmium is a pervasive SRC in sediment, occurring in sediment within all three viable habitat aggregates at Load Line 4, although all detected concentrations were 1 mg/kg (estimated) or less. The number and concentrations of inorganics are greatest in sediment within the settling pond. However, for inorganics with established background concentrations, the maximum concentrations for all detected constituents were only between 2 and 3 times the established background criteria.

- Vanadium is the only inorganic SRC detected across all of the surface water aggregates with concentrations ranging from 0.00099 mg/L at the upstream surface water station to 0.0014 mg/L in the Exit Drainage Aggregate. All other inorganic SRCs were detected sporadically and at low concentrations, except manganese. Manganese was detected in surface water at concentrations nearly 10 times background at the two locations upstream of Perimeter Road.

- Pesticide and PCB contaminants are generally absent within sediment; one PCB compound was detected at concentrations of less than 0.5 mg/kg. Pesticides and SVOCs were not detected in sediment.

- The pesticide 4,4'-DDT was detected in one water sample from the settling pond; no SVOCs or PCBs were detected.

- VOCs were only sporadically detected at low concentrations in sediment and surface water.

4.12.4 Groundwater

Groundwater at Load Line 4 contains few contaminants that can be related to historical operations. The interpretation of chemical data obtained from Load Line 4 groundwater is summarized as follows.

- Groundwater does not exhibit contamination associated with explosives, propellants, pesticides, or PCBs.

- Groundwater in all monitoring wells shows low levels of contamination with metals considered to be SRCs; however, exceedances of background concentrations are either slight (arsenic in monitoring well LL4mw-198) or sporadic (manganese in monitoring wells LL4mw-194 and LL4mw-197).

- SVOCs and VOCs were detected in groundwater samples collected from monitoring wells in Load Line 4.

4.12.5 Storm and Sanitary Sewer System

- Accumulation of explosives in the sanitary sewer system is not evident based on Phase II RI results. No explosives compounds were detected in sediment in the storm and sanitary sewer systems. Trace levels of RDX; 2-amino-4,6-DNT; and 4-amino-2,6-DNT were detected in water collected from three manholes.

- Accumulation of site-related inorganics within the storm and sanitary sewer is evident based on evaluation of sediment data. Collections from several manholes exhibited inorganics (arsenic, barium, beryllium, cobalt, lead, and manganese) at concentrations between 5 and 9 times RVAAP background values for sediment. Associated water samples from several of these manholes detected inorganics that were also elevated in the associated sediment samples.

- Low levels of SVOCs (primarily PAHs), PCBs (PCB-1254 and -1260), and four pesticides were detected in the sewer system sediment samples at Load Line 4. No SVOCs or pesticides/PCBs were detected in the sewer system water samples at Load Line 4.

- VOCs are generally absent in sediment and water within the storm and sanitary sewer systems. Trace levels of acetone, 2-butanone, and/or toluene were detected in sediment at three locations; trace levels of acetone were detected in water samples at two locations.

4.12.6 Buildings and Structures

- Soil beneath building sub-floors is generally uncontaminated, based upon a limited number of samples collected from beneath building floor slabs.

Sediment collected from the Building G-8 washout basin contained elevated levels of metals, explosives, propellants, PCBs, and pesticides. The associated water sample contained elevated levels of many constituents observed at high concentrations in sediment.

- Sediment collected from the Building G-16 sedimentation basin contained elevated concentrations of several metals related to historical processes (chromium, copper, and lead).

- Floor sweep samples contained very high levels of iron and other metals, including copper, cadmium, chromium, and lead. Low levels of explosives were detected in the two former explosives handling buildings sampled (G-8 and G-19). Low concentrations of PCBs, pesticides, and various PAHs were also detected. Cadmium and lead were detected in TCLP extracts; however, no constituent exceeded their respective criteria for characteristically hazardous wastes.