8.0 SUMMARY AND CONCLUSIONS

The Load Line 2 Phase II RI Report presents a detailed analysis of the environmental data collected during the Phase I and II RI field efforts. The following sections present an overview of the major findings of the nature and extent of contamination, modeling of contaminant fate and transport, and human health and ERAs. A revised CSM is presented to integrate results of the evaluations presented in this report. The CSM denotes, based on available data, where source areas occur, the mechanisms for contaminant migration from source areas to receptor media (e.g., streams and groundwater), and exit pathways from the AOC. The conclusions of the Phase II RI are presented by media, with an emphasis on the degree of contamination and the potential risks to human receptors.

8.1 SUMMARY

8.1.1 Contaminant Nature and Extent

The Phase II RI evaluated the nature and extent of contamination in surface soil from 0 to 0.3 m (0 to 1 ft) bgs, subsurface soil below 0.3 m (1 ft) bgs, sediment, surface water, groundwater, storm and sanitary sewers, and selected buildings and structures.

8.1.1.1 Data aggregates/exposure units and data reduction

Surface and subsurface soil, sediments, and surface water were further divided into spatial aggregates based on AOC operational history, proximity of sampling stations to source areas, drainage patterns, and viability of aquatic habitat. These aggregates form the basis for EUs evaluated in the human health and ecological risk evaluations (Chapters 6.0 and 7.0, respectively). Surface soil and subsurface soil were divided into six aggregates based on the criteria above. The aggregates demarcate areas believed to be impacted by different process-related activities, as well as areas believed to be relatively non-contaminated.

Sediment and surface water were grouped based on drainage patterns (e.g., upstream versus downstream) and to focus on the receptor exposure points for the human health and ecological risk evaluations. Sediments collected from intermittent, primarily dry drainage conveyances were addressed as surface soil media in the nature and extent evaluation and risk evaluations. Surface water samples collected from intermittent ditches or puddles were considered as non-viable ecological habitat and addressed as a separate miscellaneous surface water aggregate. Groundwater was evaluated on an AOC-wide basis. Storm and sanitary sewer systems, and samples from buildings and structures, were also considered separately in the nature and extent evaluation; these samples were not subjected to risk evaluations, as they are not representative of the exposure scenarios (e.g., recreational, NGB, or residential) evaluated in this RI.

Summary statistics for data within each aggregate were calculated for the purposes of identifying SRCs. SRCs were identified by screening data against frequency of detection criteria, essential human nutrient criteria, and RVAAP facility-wide background values for inorganics. The nature and extent evaluation focused on only those constituents identified as site-related.

8.1.1.2 Surface soil

A total of 149 surface soil samples from 0- to 0.3-m (0- to 1-ft) depth were collected for the purpose of determining nature and extent of surface soil contamination across Load Line 2. Within the production area of the load line, sampling locations were biased to the building perimeters and drainage conveyances where contaminants most likely would have accumulated over time. Random grid sampling was applied in non-production areas (Perimeter Area Aggregate).

Explosive and propellant compounds are present in surface soil at Load Line 2 with the highest concentrations observed in the immediate proximity of source areas. Pervasive inorganic SRCs in surface soil include aluminum, arsenic, barium, chromium, lead, manganese, and zinc. SVOCs detected in surface soil were primarily PAHs, which were observed frequently, although at concentrations generally less than 1 mg/kg. PCBs are widespread contaminants in surface soils, and high concentrations are found in a few sample locations within each aggregate. Pesticides tend to be more sporadic in their occurrence and are generally detected in low estimated concentrations. Few VOCs were detected in surface soil samples from Load Line 2 and concentrations were generally low. Almost all stations with higher concentrations and/or a number of SVOCs, PCBs/pesticides, and VOCs occurred in the immediate vicinity of the process buildings, or along the railroad tracks connecting the process areas to one another.

Explosives Handling Areas Aggregate

This exposure unit contained the highest concentrations and most extensive SRCs within Load Line 2. Explosive and propellant compounds are common in surface soil in this aggregate with maximum concentrations up to 17,000 mg/kg for 2,4,6-TNT and 93.5 mg/kg for nitrocellulose, respectively. The highest overall concentrations occur in the near vicinity of the melt pour buildings (DB-4 and 4A) and the explosive preparations buildings (DB-6 and DB-6A). Numerous inorganic SRCs were identified in this aggregate; aluminum, arsenic, barium, chromium, lead, and zinc were most pervasive. The highest concentrations and largest numbers of inorganic SRCs were clustered in the vicinity of the former production buildings, similar to the distribution observed for explosive compounds. SVOCs were detected frequently, although almost all concentrations were less than 1 mg/kg. VOCs are generally absent in this aggregate. PCB-1254 was commonly detected, along with PCB-1256 and PCB-1260 at lower frequencies of detection. The highest values were observed in the vicinity of Buildings DB-4 and DB-10. Low levels of pesticides (primarily 4,4'DDE) were also consistently detected adjacent to former process buildings.

Preparation and Receiving Areas Aggregate

Low concentrations of explosive compounds (1.2 mg/kg) and nitrocellulose (7.2 mg/kg) were detected in surface soil primarily in the vicinity of Buildings DB-3 and DB-802. Inorganic SRCs in this aggregate had the highest observed concentrations at Load Line 2. The inorganic SRCs occurring at the highest concentrations were antimony, chromium, copper, lead, mercury, and zinc, with concentrations ranging from 66 to 688 times background criteria. Hexavalent chromium was detected in only 1 of 13 samples at an estimated concentration of 81.9J mg/kg. PAHs and other SVOC compounds were detected in surface soils from this aggregate at generally low concentrations; the highest concentrations occur in the immediate vicinity of Buildings DB-3 and DB-803. Low concentrations of PCBs (primarily PCB-1254) and pesticides were detected in approximately 30% of the samples collected from this aggregate, with the highest concentrations observed on the eastern side of Building DB-3. Four VOCs were sporadically detected at low, estimated concentrations.

Packaging and Shipping Areas Aggregate

Low concentrations of explosives (2.6J mg/kg maximum value) were detected in surface soils, primarily along Track DH and near Building DB-13B. Numerous inorganic SRCs were detected; however, over 60% of the detected values were less than 2 times background values. Maximum values for inorganic SRCs were clustered at Buildings DB-13, DB-13B, DB-26, and the north side of Building DB-27A. Maximum observed inorganic SRCs include antimony, lead, and zinc at concentrations ranging from 11 to 62 times background criteria. PAHs were detected in multiple samples; however, only one station on the north side Building DB-27A had concentrations exceeding 1 mg/kg. PCB-1254 and PCB-1260 were commonly detected in surface soil, although concentrations greater than 1 mg/kg were limited to the vicinity of Buildings DB-13 and DB-13B. VOCs and pesticides were rarely detected.

Change Houses Aggregate

Surface soil in this EU is relatively uncontaminated. Explosives, propellants, SVOCs, VOCs, PCBs, and pesticides were not detected in this aggregate. Few inorganic SRCs were detected at more than twice RVAAP background values; only lead and zinc were between 3 and 4 times background values. The maximum concentration for all SRCs, except copper, occurred at Building DB22-02.

Perimeter Area Aggregate

Low concentrations of explosives and nitrocellulose were detected in some surface soil samples in the Perimeter Area Aggregate, primarily along the railroad tracks immediately east of Building DA-21 and at a random grid sample location (LL2-204) located about 250 ft east of Building DB-3. Low concentrations of 2,4,6-TNT were detected in samples collected from several other stations. The distribution of inorganic SRCs in this aggregate is highly sporadic. Maximum values of most SRCs were less than 2 times background criteria. However, at specific locations, very high concentrations of antimony, chromium, copper, lead, and mercury were observed. Maximum concentrations of the 12 of the 16 SRCs for this aggregate were in a dry sediment sample collected from a drainage swale south of Building DA-5. Elevated inorganics were also observed adjacent to Building DA-7 and east of Building DA-21. Low concentrations of pesticides were sporadically detected. PCB-1254 was detected in four samples collected near Buildings DA-7 and DA-21 and in the aforementioned drainage swale south of Building DA-5. SVOCs were rarely detected. VOCs were not detected.

North Ditches Aggregate

Explosives compounds are generally absent in this aggregate; only 2,4,6-TNT was detected once at a low, estimated concentration. Propellants were not detected. Six inorganic SRCs were identified, but usually at concentrations at or only slightly above the site-related background level. SVOCs, PCBs, and pesticides were not detected. Acetone was the only detected VOC at less than 0.1 mg/kg.

8.1.1.3 Subsurface soil

Explosives Handling Areas Aggregate

Explosive compounds were detected in subsurface soil samples, although the lateral extent and concentrations were lower than in surface soil. 2,4,6-TNT was the most commonly detected explosive with concentrations up to 240 mg/kg. The highest concentrations of explosives in subsurface soil corresponded to high concentrations observed in overlying soils. Barium, beryllium, chromium, lead, and mercury were identified as SRCs in subsurface soil. Lead and mercury were the most prevalent, with the highest concentrations clustered at Buildings DB-4 and DA-6. Organic compounds, other than explosives (discussed in Section 4.3.3), were not detected.

Preparation and Receiving Areas Aggregate

Explosives were not detected in subsurface soils in this aggregate. Antimony, cadmium, copper, lead, and zinc were identified as SRCs in subsurface soil in this aggregate. Maximum concentrations of these metals (less than 3 times background criteria) were clustered along the railroad tracks west of Buildings DB-802 and DB-3. Low, estimated concentrations of a few SVOCs and VOCs were sporadically detected.

Packaging and Shipping Areas Aggregate

Explosives, SVOCs, PCBs, and pesticides were not detected in subsurface soils in this aggregate. Eleven inorganic SRCs were identified; with antimony, arsenic, barium, beryllium, chromium, copper, lead, mercury, and zinc being the most persistent. Distribution of inorganics was highly variable and maximum detected values for all but one inorganic SRC were limited to one sample station along the railroad tracks west of Building BD-13. A few VOCs were detected at low estimated concentrations less than 0.1 mg/kg.

Perimeter Area Aggregate

Three explosive compounds were detected at one sampling station located between two sets of railroad tracks northeast of Building DA-21. The maximum detected value was 450 mg/kg (2,4,6-TNT). No propellants were detected. Lead and cadmium were the only SRCs identified in subsurface soils (1 to 3 ft bgs) in this aggregate; maximum lead concentrations also occurred at the sample station northeast of Building DA-21 where explosives were detected. PCB-1260 was detected once at a low concentration (0.64J mg/kg).

8.1.1.4 Sediment and surface water

Kelly's Pond and Exit Drainages Aggregate

Three explosive compounds were detected at low concentrations in sediments from the Kelly's Pond and Exit Drainages aggregate. Nine inorganic SRCs were identified; beryllium, chromium, cobalt, copper, lead, and nickel exceeded the background values in at least one sample. In almost all cases, detected concentrations were less than twice the background criteria. Antimony, cadmium, and silver were also considered to be SRCs in absence of background criteria. Pesticides and SVOCs (primarily PAHs) were detected in sediment samples with most detected values clustered at stations LLs-182 and LL2sd/sw-053(p), at concentrations less than 1 mg/kg. PCBs and VOCs were not detected in sediment in the Kelly's Pond and Exit Drainages Aggregate.

Four explosive compounds were detected in surface water at one sample station; all concentrations were less than 0.01 mg/L. Antimony, cadmium, and vanadium were detected at concentrations <0.01 mg/L in surface water and were considered as SRCs in absence of available background criteria. Trace quantities of carbon disulfide were detected in one surface water sample.

North Ponds Aggregate

Surface water in the North Ponds Aggregate was not characterized. Explosives were not detected in sediment; nitrocellulose was detected once at a low, estimated concentration. Inorganic SRCs identified in sediment are lead, nickel, and cadmium. All detected concentrations were low, estimated values less than 2 mg/kg. Organic constituents, other than nitrocellulose, were not detected.

Miscellaneous Water Samples Aggregate

Explosives, SVOCs, and PCBs/pesticides were not detected in the two miscellaneous water samples collected from drainage ditches southeast of Building DB-802. Eleven metals were identified as SRCs in the Miscellaneous Water Samples Aggregate; however, seven metals were detected that do not have site-related background values and, thus were retained as SRCs. Four additional inorganic SRCs (arsenic, barium, manganese, and zinc) were detected at concentrations up to 2 times greater than background criteria.

8.1.1.5 Groundwater

One explosive compound (RDX at 0.18J mg/L) was detected in well LL2mw-262 in the southern portion of the AOC. Five explosive compounds were detected in LL2mw-059, also in the southern portion of the AOC; the maximum detected value was 0.0048 mg/L for 1,3,5-TNB. Concentrations of explosives measured over four sampling events since 1996 are variable depending on the constituent; clearly increasing or decreasing trends are not evident. Inorganic SRCs detected above RVAAP background values include antimony, arsenic, cobalt, manganese, and nickel. The maximum concentrations of all inorganic SRCs, except antimony, were detected in well LL2mw-265, located in the southern exit pathway area of the load line. Two other wells in this area did not contain inorganic SRCs above background criteria. The maximum concentration of antimony (0.008 mg/L) was detected in LL2mw-266, located in the Explosives Handling Areas Soil Aggregate.

SVOCs were not detected in groundwater samples collected during the Phase II RI. Trace levels of heptachlor epoxide and PCB-1242 were sporadically detected; the highest concentrations for both compounds were observed in well LL2mw-059. Low levels of four VOCs were sporadically detected; all four constituents and maximum detected values occurred in well LL2mw-266 installed north of the sedimentation basin.

8.1.1.6 Storm and sanitary sewer system

Limited sediment accumulation within the sanitary sewer system is evident. Accumulation of explosives in sediment is minor based on limited Phase II RI data (samples could be obtained only from the Ejector Station). Samples collected from the Ejector Station showed trace quantities of two explosive compounds. Inorganic SRCs, in particular silver (393 mg/kg) and lead (148 mg/kg), were detected at the Ejector Station. Low levels of SVOCs were detected. No VOCs were detected. Two pesticides were detected at trace concentrations.

Analysis of water from the sanitary sewer Ejector Station showed very low concentrations (<0.001 mg/L) of four explosive compounds. Inorganics did not exceed RVAAP surface water background values. Pesticides, PCBs, or SVOCs were not detected. A trace concentration of trichloroethene was detected.

Explosives compounds were detected in sediment collected from the storm sewer system, although not at very high concentrations or frequencies. Stations MH-B2 and Inlet DB-11, near Building DB-4, contained the highest number and concentrations of explosive compounds (up to 25 mg/kg for HMX). Explosives or propellants compounds were not detected in 7 of the 12 total sewer line sediment samples collected. In the remaining five samples, concentrations of explosives ranged from 0.1 to 25 mg/kg . High concentrations of inorganic SRCs were observed in storm sewer sediment samples collected at several locations, with inlet boxes typically having the highest concentrations. Inlet DB-20, adjacent to Building DB-2, contains very high levels of chromium, lead, mercury, antimony, and other metals. Hexavalent chromium was detected at Inlet C-4 at a concentration of 1.4 mg/kg. PCBs were detected in 10 of the 12 storm sewer sediment samples at concentrations up to 31 mg/kg at Inlet DB-11.

Three water samples collected from the storm sewer system (MH-B1, MH-B2, and MH-304) contained low concentrations of six explosive compounds; the maximum detected value (RDX at 0.69 mg/L) occurred at MH-B1. Lead (maximum detect of 0.12 mg/L) and nickel (maximum detect of 0.0061 mg/L) were the most frequently detected inorganics above background. Antimony and silver were also detected at MH-304. Pesticides, PCBs, and SVOCs were not detected in the storm sewer water samples.

8.1.1.7 Buildings and structures

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

Sediment collected from washout annexes inside of Buildings DB-4 and DB-4A contained high concentrations of metals (cadmium, chromium, copper, lead) as well as detectable quantities of several explosive and propellant compounds. PCB-1254 was detected at concentrations up to 3,200 mg/kg. PAHs were prevalent in basin sediments. Corresponding water samples from the washout annex basins showed detectable concentrations of metals and explosives corresponding to those observed at high concentrations in sediment.

Sediment samples collected from the covered sedimentation basin located north of Building DB-4 contained elevated levels cadmium, chromium, copper, lead, silver, and zinc. Low levels of nitroguanidine and nitrocellulose, pesticides, and PCBs were also detected. Trace levels of SVOCs and VOCs were also detected. Water samples from the sedimentation basin contained detectable concentrations of metals and explosives corresponding to those observed at high concentrations in sediment.

Floor sweep samples contained very high concentrations of multiple metals, including cadmium, chromium, and lead. Low concentrations of cyanide and As^{+3} were detected in the samples collected from all three buildings sampled. Explosive compounds were detected in each of the floor sweep samples, with maximum levels (2,4,6-TNT at 160 mg/kg) observed in Building DB-3. Low, estimated concentrations of SVOCs, pesticides, and VOCs were detected in all of the floor sweep samples. PCB-1254 was detected in all floor sweep samples at similarly elevated concentrations (690 to 790 mg/kg). Cadmium and lead concentrations in floor sweep TCLP samples collected from Building DB-10 and Building DB-3 exceeded criteria for the toxicity characteristic.

Ballast and slag samples contained elevated concentrations of major geochemical elements; one sample (LL2-177) contained anomalously high concentrations of cadmium, copper, lead, nickel, and zinc as compared to other ballast samples. Vertical profiles for inorganics in soil beneath the ballast samples suggest that these materials may contribute to some contamination of underlying soil, but the effect rapidly diminishes with depth.

8.1.2 Contaminant Fate and Transport

Contaminant fate and transport modeling performed as part of the Phase II RI included leachate modeling (SESOIL) at the source area within Load Line 2 demonstrating the highest levels of process-related contaminants (Building DB-4 vicinity). Groundwater modeling (AT123D) was conducted from this source to selected receptors or exit points from the AOC. The receptor and exit points selected for groundwater transport modeling included the AOC boundary at its closest point downgradient of the source area and Kelly's Pond and exit drainages at the closest point downgradient of the source. In addition, groundwater transport modeling from the source area to the RVAAP facility boundary was conducted to evaluate the potential for off-site migration of any identified CMCOPCs.

SESOIL Modeling

Antimony, arsenic, cadmium, chromium, mercury, and RDX were identified as CMCOPCs based on source loading predicted by the leachability analysis near the selected primary source (Building DB-4 vicinity). The SESOIL modeling results indicate that these six constituents may leach from surface soil to groundwater with concentrations beneath the source area above groundwater MCLs or RBCs. The timeframe for the metals constituents to reach peak concentrations in groundwater beneath the source ranged from 149 to 647 years. The projected timeframe for RDX to achieve peak concentrations is 3 years, suggesting that such leaching has already occurred. The leaching modeling is conservative and migration of these constituents may be attenuated because of moderate to high retardation factors for these constituents. However, the presence of antimony, arsenic, 2,4-DNT, and RDX in groundwater within the Explosives Handling Areas Aggregate indicates leaching processes are ongoing near the source areas.

AT123D Modeling

Modeling of contaminant transport in shallow groundwater was conducted for nine CMCOPCs from the Building DB-4 source area to the three endpoints noted above. Six of these nine CMCOPCs were identified from SESOIL modeling and the remaining three were identified based on observed groundwater concentrations. No inorganics, pesticides, or PCBs were predicted to reach any receptor points at concentrations greater than MCLs or RBCs within the 1,000-year modeling period, thus they were eliminated as CMCOCs. RDX was the only constituent predicted to reach each of the selected receptor locations at concentrations exceeding its RBC. Peak RDX concentrations were predicted to occur at the AOC boundary in 37 years, at Kelly's Pond in 169 years, and the RVAAP boundary at 214 years. Accordingly, RDX was identified as a CMCOC.

8.1.3 Human Health Risk Evaluation

The SHHRA identified COCs and RGOs for contaminated media at Load Line 2 for three potential future use scenarios: National Guard use, recreational use, and residential use. Results have been presented for all scenarios and exposure pathways. The following steps were used to generate conclusions regarding human health risks and hazards associated with contaminated media at Load Line 2:

- identification of COPCs;
- calculation of EPCs for COPCs;
- calculation of screening RGOs at a chemical HI of 0.1 or risk level of 10^{-6} for all identified COPCs;
- identification of COCs by comparing COPC concentrations against screening RGOs; and
- calculation of risk-based RGOs (HI of 1 or risk level of 10^{-5}) to move forward to the FS.

COCs were identified for National Guard receptors (Trainee, Security Guard/Maintenance Worker, and Fire/Dust Suppression Worker), recreational receptors (Hunter/Trapper/Fisher), and residential receptors (Resident Subsistence Farmer Adult and Child). A COC summary is presented in Table 8-1, with results discussed below for each medium. Risk-based RGOs were calculated for all chemicals identified as COCs (see Chapter 6.0) for any medium or receptor (e.g., antimony is identified as a COC in surface water for the resident farmer only; however, risk-based RGOs are calculated for this metal for all receptors exposed to surface water).

8.1.3.1 Groundwater

Two COCs (arsenic and heptachlor epoxide) were identified for the National Guard Trainee exposed via potable use of groundwater. Arsenic, heptachlor epoxide, manganese, 2,4-DNT, PCB-1242, and benzene were identified for the On-Site Residential Farmer scenarios. For these groundwater COCs, ratios of EPCs to RGOs indicate that most estimated cancer risks would be close to 10^{-6} for the National Guard Trainee; the one exception is for arsenic, with an estimated risk of greater than 10^{-5}. For the residential farmer scenarios, most estimated cancer risks would be between 10^{-6} and 10^{-5}, with the exception of arsenic (greater than 10^{-4}) and heptachlor epoxide (slightly greater than 10^{-5}). These are hypothetical future scenarios; no receptors are currently using groundwater from the AOC for any purpose.

Table 8-1. Chemicals Exceeding RGOs (COCs) by Receptor/Medium/Exposure Unit Combination at Load Line 2

	Groundwater			Surface Water					Sediment				
COC	National Guard Trainee	Resident Farmer Adult	Resident Farmer Child	Dust/Fire Control Worker	National Guard Trainee	Hunter/ Trapper	Resident Farmer Adult	Resident Farmer Child	Dust/Fire Control Worker	National Guard Trainee	Hunter/ Trapper	Resident Farmer Adult	Resident Farmer Child
Inorganics													
Aluminum													
Antimony							KP	KP					
Arsenic	LL2	LL2	LL2										
Cadmium													
Chromium, hexavalent													
Copper													
Manganese		LL2	LL2										
Thallium													
Organic Explosives													
2,4,6-Trinitrotoluene													
2,4-Dinitrotoluene		LL2											
RDX													
Organic Pesticides													
Dieldrin													
Heptachlor Epoxide	LL2	LL2	LL2										
Organic PCBs													
PCB-1242		LL2	LL2										
PCB-1254													
PCB-1260													
Organic Semivolatiles													
Benz(*a*)anthracene													
Benzo(*a*)pyrene												KP	KP
Benzo(*b*)fluoranthene												KP	
Dibenz(*a,h*)anthracene												KP	
Indeno(1,2,3-*cd*)pyrene													
Benzene		LL2											

Table 8-1. Chemicals Exceeding RGOs (COCs) by Receptor/Medium/Exposure Unit Combination at Load Line 2 (continued)

	Shallow Surface Soil					Deep Surface Soil	Subsurface Soil	
COC	Security Guard/ Maintenance Worker	Dust/Fire Control Worker	Hunter/ Trapper	Resident Farmer Adult	Resident Farmer Child	National Guard Trainee	Resident Farmer Adult	Resident Farmer Child
Inorganics								
Aluminum					EH,PA,PR,PS	EH,PA,PR,PS		EH
Antimony	PA			PA,PR	EH,ND,PA,PR,PS	PA		EH,PS
Arsenic	EH,PA,PR,PS			EH,PA,PR,PS	EH,PA,PR,PS	EH,PA,PR,PS	EH,PS	EH,PS
Cadmium					PR			
Chromium, hexavalent						PR		
Copper					PR			
Manganese					EH,PA,PR,PS	EH,PA,PR,PS		
Thallium					EH,PR			
Organic Explosives								
2,4,6-Trinitrotoluene	EH,PA	EH,PA	PA	EH,PA	EH,PA	EH,PA	EH,PA	EH,PA
2,4-Dinitrotoluene				PA	PA		EH,PA	EH,PA
RDX	EH			EH	EH	EH		
Organic Pesticides								
Dieldrin	PR			PR	PR			
Heptachlor Epoxide								
Organic PCBs								
PCB-1242								
PCB-1254	EH,PA,PR,PS			EH,PA,PR,PS	EH,PA,PR,PS	PR		
PCB-1260	PR			EH,PR	EH,PR		PA	PA
Organic Semivolatiles								
Benz(*a*)anthracene	EH,PR			EH,PR	EH,PR			
Benzo(*a*)pyrene	EH,PR,PS			EH,PR,PS	EH,PR,PS	EH,PR		
Benzo(*b*)fluoranthene	PR			EH,PR	PR			
Dibenz(*a,h*)anthracene	EH,PR			EH,PR,PS	EH,PR			
Indeno(1,2,3-*cd*)pyrene	EH,PR			EH,PR	EH,PR			
Benzene								

[a]COCs are shown for each medium/receptor/area of concern combination. Chemicals whose exposure point concentration exceeds its screening risk-based RGO are COCs. Area of concern codes are as follows:

LL2 = Load Line 2. ND = North Ditches Aggregate. PR = Preparation and Receiving Areas Aggregate.
KP = Kelly's Pond Aggregate. PA = Perimeter Area Aggregate. PS = Packaging and Shipping Areas Aggregate.
EH = Explosives Handling Areas Aggregate.

COC = Chemical of concern. PCB = Polychlorinated biphenyl. RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

RGO = Remedial goal option. Screening risk-based RGOs are based on a cancer risk level of 10^{-6} or a hazard level of 0.1 (whichever is smaller) and are shown in Tables Q-10 through Q-15. Screening of Load Line 2 data to determine COCs is shown in Tables Q-16 through Q-21.

8.1.3.2 Surface water and sediment

Exposure to surface water in Kelly's Pond and sediment in Kelly's Pond and the North Ponds was evaluated for five receptor scenarios: National Guard Fire/Dust Suppression Worker, National Guard Trainee, Hunter/Trapper/Fisher, and Resident Farmer (adult and child). Only one COC was identified in surface water at Kelly's Pond: antimony for the Resident Farmer (adult and child). Three PAHs were identified as sediment COCs in Kelly's Pond for the Resident Farmer (adult and/or child) scenarios: benzo(*a*)pyrene, benzo(*b*)fluoranthene, and dibenz(*a,h*)anthracene. Nitrocellulose was identified as a COPC in sediment in the North Ponds; however, it does not have approved toxicity values and was not evaluated quantitatively in the SSHRA.

Ratios of EPCs to RGOs provide an indication of the estimated cancer risks. Estimated cancer risks for surface water would be below 10^{-6} for all five receptors. Estimated cancer risks for sediment risks would be less than 10^{-6} for the two National Guard receptors and the Hunter/Trapper/Fisher, but between 10^{-6} and 10^{-5} for the resident farmer scenarios.

8.1.3.3 Soil

Soil was evaluated at six EUs defined on the basis of Load Line 2 operational history and site characteristics. Three vertical aggregations of the soil column were evaluated depending on the receptor scenario:

- shallow surface soil from 0 to 0.3 m (0 to 1 ft) bgs as applied to all receptors, except the National Guard Trainee;
- deep surface soil from 0 to 1.3 m (0 to 4 ft) bgs, as applied only the National Guard Trainee; and
- subsurface soil defined as all soil deeper than 0.3 m (>1 ft) bgs for the Resident Farmer adult and child only.

Direct contact (ingestion, dermal contact, and inhalation) with surface and subsurface soils was evaluated for six receptors: National Guard Security Guard/Maintenance Worker (shallow surface soil), National Guard Fire/Dust Suppression Worker (shallow surface soil), National Guard Trainee (deep surface soil), Hunter/Trapper/Fisher (shallow surface soil), and Resident Farmer (adult and child) (shallow surface soil and subsurface soil). The following summarizes the resulting COCs in soil at Load Line 2.

Shallow Surface Soil

Eighteen Load Line 2 COCs were identified for shallow surface soil (Table 8-1). The number of shallow surface soil COCs varied for each receptor, with only 1 COC for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher, 12 COCs for the Security Guard/Maintenance Worker, 13 COCs for the Resident Farmer Adult, and 18 COCs for the Resident Farmer Child. The number of shallow surface soil COCs identified for each EU also varied: 15 for the Preparation and Receiving Areas Aggregate, 14 for the Explosives Handling Areas Aggregate, 7 for both the Packaging and Shipping Areas and Perimeter Area Aggregates, 1 for the North Ditches Aggregate, and none for the Change Houses Aggregate.

Ratios of EPCs to RGOs provide an indication of estimated cancer risks. All estimated risks for shallow surface soil COCs would be less than 10^{-6} for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher. For the Security Guard/Maintenance Worker, most COCs would produce a cancer risk at or slightly above 10^{-6}, with the following exceptions, where the estimated cancer risk would be slightly larger than 10^{-5}:

- 2,4,6-TNT in the Explosives Handling Areas and Perimeter Area Aggregates;
- RDX in the Explosives Handling Areas Aggregate;
- PCB-1254 in the Preparation and Receiving Areas Aggregate; and
- benzo(*a*)pyrene in the Explosives Handling Areas and Preparation and Receiving Areas Aggregates.

For the resident farmer scenarios, estimated cancer risks would exceed 10^{-5} for several shallow surface soil COCs, including:

- arsenic in the Explosives Handling Areas, Preparation and Receiving Areas, Packaging and Shipping Areas, and Perimeter Area Aggregates;
- 2,4,6-TNT in the Explosives Handling Areas and Perimeter Area Aggregates;
- RDX in the Explosives Handling Areas Aggregate;
- PCB-1254 in the Preparation and Receiving Areas Aggregate; and
- benzo(*a*)pyrene and dibenz(*a,h*)anthracene, both in the Explosives Handling Areas and Preparation and Receiving Areas Aggregates.

Deep Surface Soil

Nine COCs were identified for the National Guard Trainee exposed to deep surface soil at Load Line 2 [aluminum; antimony; arsenic; hexavalent chromium; manganese; 2,4,6-TNT; RDX; PCB-1254; and benzo(*a*)pyrene]. The number of deep surface soil COCs identified for each EU varied: six for both the Explosives Handling Areas and Preparation and Receiving Areas Aggregates, five for the Perimeter Area Aggregate, three for the Packaging and Shipping Areas Aggregate, and none for the Change Houses and North Ditches Aggregates.

Ratios of EPCs to RGOs indicate that estimated cancer risks would be at or slightly above 10^{-6} for most deep surface soil COCs. One deep surface soil COC (hexavalent chromium in the Perimeter Area Aggregate) would result in cancer risk to the National Guard Trainee of slightly larger than 10^{-5}.

Subsurface Soil

Six COCs were identified for the Resident Farmer (adult and child) exposed to subsurface soil at Load Line 2 (aluminum; antimony; arsenic; 2,4,6-TNT; 2,4-DNT; and PCB-1260). The number of subsurface soil COCs identified for each EU included: five for the Explosives Handling Areas Aggregate; three for the Perimeter Area Aggregate; two for the Packaging and Shipping Areas Aggregate; and none for the Preparation and Receiving Areas, Change Houses, and North Ditches Aggregates.

Ratios of EPCs to RGOs provide an indication of the estimated cancer risks. Estimated risks that would be greater than 10^{-5} for the resident farmer include arsenic (at the Explosives Handling Areas and Packaging and Shipping Areas Aggregates), as well as 2,4,6-TNT (at the Explosives Handling Areas and Perimeter Area Aggregates).

8.1.4 Ecological Risk Evaluation

The Load Line 2 site contains sufficient terrestrial and aquatic (surface water and sediment) habitat to support various classes of ecological receptors, such as vegetation, small and large mammals, and birds. Due to the presence of suitable habitat and observed receptors at the site, a SERA was performed. The SERA was performed in accordance with written guidance from the USACE, Louisville District and Ohio EPA and also utilized Ohio's water quality standards. Following the SERA, there was a BERA (Ohio EPA Level III) performed on the preliminary COPECs. The methods followed the Army and Ohio EPA protocols and resulted in COECs. Groundwater was not evaluated considering that direct exposure to receptors would be expected to occur as discharge to surface water features. Soil deeper than 0.3 m (1 ft) was also not evaluated considering that contaminant concentrations in surface soil represent the probable worst-case exposures for most contaminants.

8.1.4.1 Soil

Risks were evaluated for five EUs for surface soil based on historical use and geographic proximity, as described in Section 4.1.2 and Chapter 7.0. At all EUs, except the Melt-Pour Area Drainage Ditches Aggregate, COPECs were identified primarily by comparing the maximum detected value for a constituent to ESVs. One constituent (PCB-1254) was identified as a COPEC in absence of an ESV at three of the four EUs. One analyte, benzoic acid, was identified as unique to Load Line 2 as compared to Load Line 1; this compound was also identified as a preliminary COPEC. Preliminary COPECs whose maximum detected values exceeded ESVs and those without ESVs were further evaluated by having screening HQs calculated. BERA activities depended on the following ecological receptors: vegetation, soil invertebrates, cottontail rabbits, shrew, foxes, and hawks.

The Explosives Handling Areas Aggregate contained the most preliminary COPECs for soil (15 metals, 2 pesticides, and 1 PCB), whereas the North Ditches Aggregate had the fewest preliminary COPECs for soil (3 metals). The Packaging and Shipping Areas Aggregate had the second highest number of preliminary COPECs (11 metals and 1 PCB). The Preparation and Receiving Areas Aggregate had nine metals, one explosive, one PCB, and one SVOC that were preliminary COPECs. The Perimeter Area Aggregate had five metals that were identified as preliminary COPECs. At all EUs, except the North Ditches Aggregate, most preliminary COPECs were identified because the maximum detection exceeded the ESV. For the North Ditches Aggregate, all three preliminary COPECs were identified as such because the Load Line 2 mean concentrations were > Load Line 1 mean concentrations per t-tests and the spatial distribution evaluation. A summary of the Load Line 2 soil preliminary COPECs, organized by EUs, and the rationales for why the analytes were preliminary COPECs is presented in Chapter 7.0, Table 7-8. BERA activities reduced the number of COPECs in every location. The Explosives Handling Areas Aggregate had 8 COECs (down from 15), the Preparation and Receiving Areas Aggregate showed 7 (down from 10), and the Packaging and Shippping Areas Aggregate had 9 (down from 12). The North Ditches Aggregate remained the lowest one with only one COEC (down from three) and the Perimeter Area Aggregate was intermediate with four (down from five). A summary of Load Line 2 soil COECs is provided in Chapter 7.0, Table 7-11.

8.1.4.2 Sediment and surface water

Sediment

The Kelly's Pond and Exit Drainages Aggregate contained the most preliminary COPECs for sediment (7 metals, 4 pesticides, 4 explosives, and 13 semivolatiles), whereas the North Ponds Aggregate had only 3 preliminary COPECs for sediment (2 metals and 1 explosive). Most of the sediment preliminary COPECs (16 of 28) were identified by virtue of having a maximum detect exceeding the ESV.

Approximately one-third of the preliminary COPECs for sediment were selected by virtue of having no ESVs. Only five sediment analytes were preliminary COPECs solely by virtue of being PBT compounds. All of these preliminary COPECs were further evaluated by having screening HQs calculated. A summary of the Load Line 2 sediment preliminary COPECs, organized by the two EUs, and the rationales for why the analytes were preliminary COPECs is presented in Chapter 7.0, Table 7-9. BERA activities utilized the following ecological receptors: benthic invertebrates, riparian herbivores (muskrats and mallards), and riparian carnivores (mink and herons). BERA activities reduced the number of COPECs in every location. For example, at the Kelly's Pond and Exit Drainage Aggregate there are 18 COECs (down from 28) and at the North Pond Aggregate there are two (down from three). A summary of Load Line 2 sediment COECs in provided in Chapter 7.0, Table 7-12.

Surface Water

Four preliminary COPECs (three metals and one SVOC) were identified at the Kelly's Pond and Exit Drainages Aggregate. Two COPECs (calcium and magnesium) were identified by virtue of having no ESV. The remaining two COPECs [cadmium and bis(2-ethylhexyl)phthalate] were identified as COPECs by virtue of being PBT compounds. All of these preliminary COPECs were further evaluated by having screening HQs calculated. A summary of the Load Line 2 surface water preliminary COPECs and the rationales for why the analytes were preliminary COPECs is presented in Chapter 7.0, Table 7-10. BERA activities used the following ecological receptors: aquatic life, riparian herbivores (muskrats and mallards), and riparian carnivores (mink and herons). BERA activities further screened the four COPECs to two COECs.

8.2 CONCEPTUAL SITE MODEL

The preliminary Load Line 2 CSM, developed as part of the Phase II RI SAP Addendum, was summarized in Chapter 2.0. A revised CSM is presented in this section that incorporates Phase II RI data and the results of contaminant fate and transport modeling and risk evaluations. Elements of the CSM include

- primary contaminant source areas and release mechanisms,
- contaminant migration pathways and exit points, and
- data gaps and uncertainties.

An illustrated version of the revised CSM is provided in Figure 8-1 to assist in visualizing the concepts discussed below.

8.2.1 Source-Term and Release Mechanisms

Results of the Phase II RI soil sampling indicate that the Explosives Handling Areas Aggregate, particularly areas surrounding Buildings DB-4, DB-4A, DA-6, DA-6A, and DB-10, generally contain the greatest numbers and concentrations of contaminants. Metals, explosives, PAHs, and PCBs/pesticides are present in soil in these areas at concentrations greater than background or risk screening criteria. Other source areas defined by Phase II RI data (primarily elevated inorganics) include the vicinity of Buildings DB-3 and DB-802 (primarily elevated inorganics), Buildings DB-13 and DB-13B, Building DB-26, and Building DB-27A. Inorganic contaminants and SVOCs were observed in other locations; however, their distribution is sporadic.

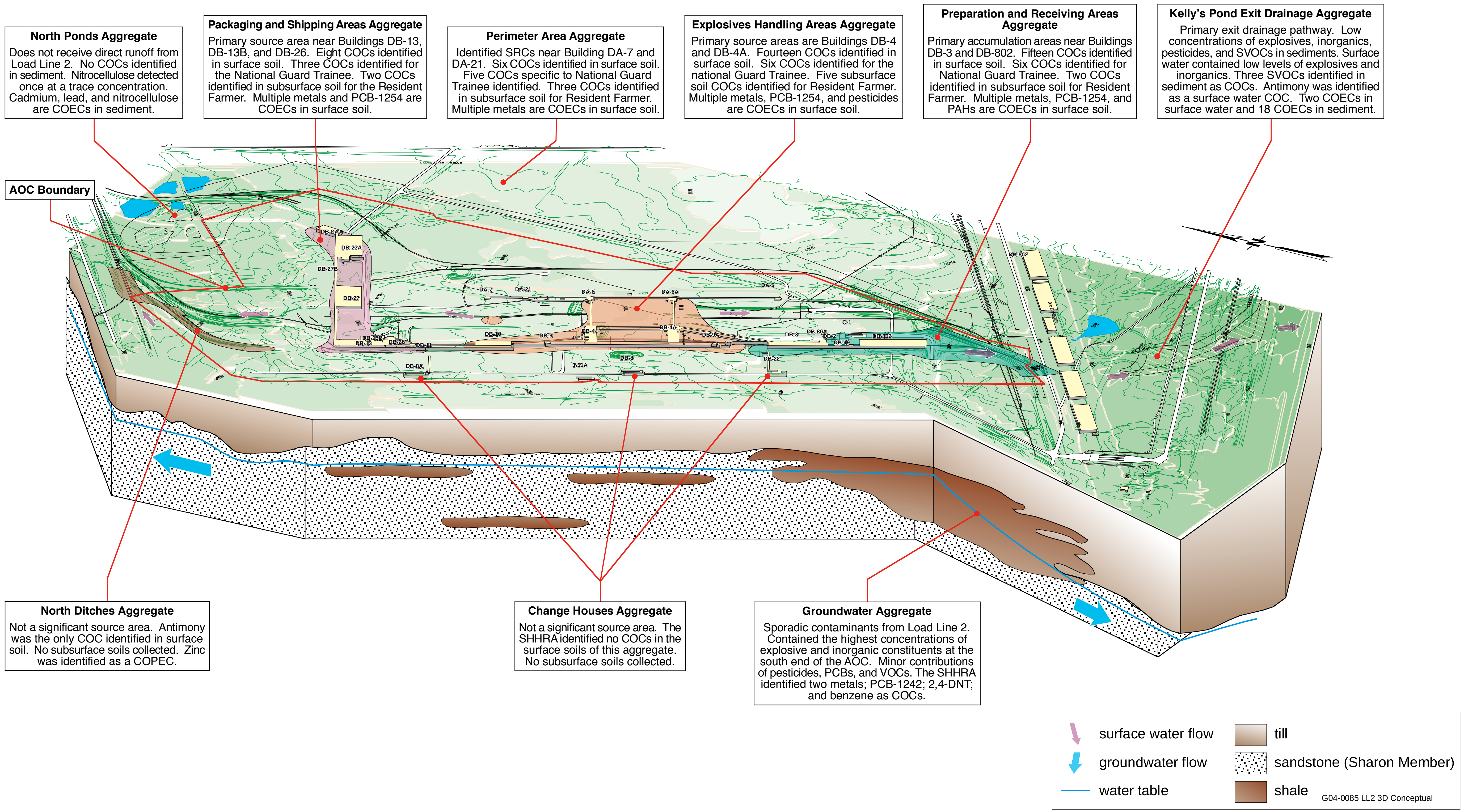

Figure 8-1. Conceptual Site Model for Load Line 2

The majority of soil contamination at Load Line 2 is within the surface soil interval less than a depth of 0.3 m (1.0 ft). Explosives detected in subsurface soil were more limited in extent and concentrations were typically lower than in corresponding surface soil. Most subsurface soil contamination was observed in the areas surrounding the major production buildings noted above.

Two primary mechanisms for release of contaminants from the source areas are identified (1) erosional and/or dissolved phase transport of contaminants from soil sources with transport into the storm drain network or drainage ditches, and (2) leaching of constituents to groundwater via infiltration of rainwater through surface and subsurface soils. Evaluation of these release mechanisms was done through sampling of storm drainage network (ditches and storm sewers) and numerical modeling of soil leaching processes. Discussion of the results of evaluation of data for preferred contaminant migration pathways and exit points is presented below. Airborne dispersion of contaminants was not quantified or modeled. The chemical characteristics of the SRCs present, high annual precipitation levels, and heavy vegetation cover at Load Line 2 likely preclude any substantial dispersion of contaminants via air dispersion pathways.

8.2.2 Contaminant Migration Pathways and Exit Points

Surface Water Pathways

Migration of contaminants from soil sources via surface water occurs primarily by (1) movement of particle-bound (e.g., clays or colloids) contaminants in surface water runoff, and (2) transport of dissolved constituents in surface water. Surface runoff is directed to drainage ditches and the storm drainage network, which terminate at drainage conveyances on the north and south ends of the load line.

Upon reaching quiescent portions of surface water conveyances, flow velocities decrease and particle-bound contaminants are expected to settle out as sediment accumulation. Sediment-bound contaminants may be re-mobilized during storm events. Sediment-bound contaminants may also partition to surface water and be transported in dissolved phase. Sampling of the dry sediment from the North Ditches and drainage ditches southeast of Building DB-802 indicate minimal contaminant accumulation from the major production areas.

Results of sediment and water sampling from the storm sewer network indicate accumulation of low levels of explosives in sediment in some locations with corresponding low concentrations in water. Substantial concentrations of inorganics were evident in some storm sewer inlets. Detectable PCBs have also accumulated throughout the storm sewer network. Inorganics and low levels of explosives appear to be partitioning from sediment to water. The sanitary sewer system contains accumulated metals; however, it is a closed system and is not open to receiving substantial surface water runoff, except potentially through cracks in piping.

Substantial contaminant accumulation within the Kelly's Pond and exit conveyances is not evident based on Phase I and II RI data. Accumulated explosive compounds were detected at low concentrations. Inorganic contaminants were typically detected at concentrations less than twice background criteria. SVOCs and pesticides were detected at concentrations typically less than 1 mg/kg. PCBs and VOCs were not detected in pond and exit drainage sediment. Some partitioning from sediment to water appears to be occurring; however, detected explosive and inorganic compounds were all at concentrations less than 0.01 mg/L and are considered as SRCs in absence of available background criteria.

Leaching and Groundwater Pathways

Theoretical numerical modeling of leaching potential for soil source areas indicates that antimony, arsenic, cadmium, chromium, mercury, and RDX may be expected to leach from the contaminated surface soil into the groundwater and reach concentrations exceeding groundwater MCLs or RBCs. The presence of some of these constituents in groundwater at Load Line 2 suggests that leaching processes are ongoing near the source areas. Timeframes for leaching of the explosive compounds are relatively short (3 to 16 years), indicating that leaching is ongoing and that peak concentrations in groundwater beneath the source areas may have already passed. Timeframes to attain predicted peak concentrations for metals are much longer (approximately 150 to 650 years), indicating that concentrations may increase in the future.

Shallow groundwater flow follows stream drainage and topographic patterns with flow from the center of the load lines to south toward the AOC and RVAAP boundaries and toward the northwest following regional topography. Modeling of contaminant transport in shallow groundwater was conducted for the nine constituents from the Building DB-4 source area to the AOC boundary, Kelly's Pond, and the RVAAP boundary. Results show that none of the metals were predicted to reach any receptor points at concentrations greater than MCLs or RBCs within the 1,000-year modeling period. RDX was predicted to reach each of the selected receptor locations at concentrations exceeding its RBC. Peak RDX concentrations were predicted to occur at the AOC boundary in 37 years, at Kelly's Pond in 169 years, and the RVAAP boundary at 214 years. Measured contaminant concentrations in groundwater do not indicate widespread contamination to this point in time and suggests that the conservative modeling results do not fully represent retardation and attenuation effects in the subsurface. Also, not every source area was modeled and the presence of contaminants in wells in the southern portion of the AOC near Kelly's Pond indicate flux of contaminants from some source area within the AOC, potentially residual contaminants from the pond itself.

Given that a portion of the storm and sanitary sewer systems at Load Line 2 contains water, these utility networks may serve as preferential conduits for shallow groundwater movement. These systems were evaluated to determine if they facilitate transport of contaminants dissolved in groundwater or function as sources of dissolved phase contaminants to groundwater. As noted above, the storm drain network contains some accumulated explosive, inorganics, and PCBs that appear to be partitioning to water at low levels, although concentrations are not grossly elevated relative to background values. Accordingly, the storm drain network may act as a minor source of contaminant flux to groundwater and likely facilitates the movement of shallow groundwater in the vicinity of cracked or broken pipes where inflow or outflow may occur. The sanitary sewer system at Load Line 2 contains accumulated inorganics and may contribute some level of contaminant flux to groundwater. Considering the relative lack of data and the characteristics of the sewer systems, it is not conclusive if these systems are a primary source to groundwater or migration pathway.

8.2.3 Uncertainties

The CSM is developed based on available site characterization and chemical data. Uncertainties are inherent in the CSM where selected data do not exist or are sparse. The uncertainties within the CSM for Load Line 2 include the following.

- Groundwater monitoring wells installed during the Phase II RI targeted the water table interval only. The observed extent and magnitude of contamination in shallow groundwater do not indicate substantial contamination of groundwater within the AOC. Conservative modeling results suggest that off-AOC migration of contaminants may occur in the future. Groundwater within deeper flow zones was not characterized and conclusions regarding groundwater contaminant transport are representative of only the source areas modeled and hydrostratiographic intervals that were characterized.

- The exact source(s) of PAHs at Load Line 2 is unknown, although they may be anthropogenic combustion products derived from coal and/or fuel oil-fired power and boiler plant emissions.

- Leachate and transport modeling is limited by uncertainties in the behavior and movement of contaminants in the presence of multiple solutes. In addition, heterogeneity, anisotropy, and spatial distributions of more permeable zones (e.g., fractures) could not be fully characterized during the field investigation nor addressed in the modeling. Therefore, effects of these features on contaminant transport at Load Line 2 are uncertain and modeling results are considered as conservative representations.

- The exact source(s) of some inorganics (e.g., manganese and arsenic) in soil and sediment in the AOC is unknown. Data evaluated in the nature and extent and risk evaluations address all constituents measured within the load line whether from natural or anthropogenic sources. Results of the evaluations may reflect, in part, contributions from sources other than Load Line 2 operations (e.g., slag or pre-RVAAP activities).

- Limited data collected from beneath building floor slabs indicate no substantial contaminantion of subfloor soils. However, additional data may be required to further characterize such soils if building floor slabs are removed as part of a future action.

8.3 CONCLUSIONS

The conclusions presented below, by medium, combine the findings of the contaminant nature and extent evaluation, fate and transport modeling, and the human health and ecological risk evaluations. To support remedial alternative selection and evaluation in future CERCLA documents (e.g., FS), RGOs were developed for identified COCs in surface soil, subsurface soil, surface water, sediment, and groundwater at Load Line 2 at an HI of 1 or risk level of 10^{-5}. A summary of the results of the human health RGO comparisons are provided in Chapter 6.0.

8.3.1 Explosives Handling Areas Aggregate

The primary identified source areas in the Explosives Handling Areas Aggregate include Buildings DB-4, DB-4A, DA-6, DA-6A, and DB-10. Metals, explosives, PAHs, and PCBs represent the most pervasive SRCs in the former production areas. The spatial distribution and concentrations of contaminants were concentrated in the vicinities of these former production buildings. With respect to vertical distribution, the numbers and concentrations of SRCs in subsurface soil at these source areas deceased relative to surface soil.

Theoretical numerical modeling of leaching potential for soil source areas indicates that antimony, arsenic, cadmium, chromium, mercury, and RDX near Building DB-4 may be expected to leach from the contaminated surface soil into the groundwater and reach concentrations exceeding groundwater MCLs or RBCs. Migration of RDX from the source area to the AOC boundary, Kelly's Pond, and the RVAAP boundary was predicted to occur within timeframes ranging from 37 to 214 years. Metals were not predicted to reach the AOC boundary at concentrations above MCLs or RBCs within the 1,000-year modeling period. Migration of most of the constituents is expected to be attenuated because of moderate to high retardation factors, as well as degradation of organic compounds; these processes are not reflected in the conservative modeling results.

Comparison of concentrations of Load Line 2 COPCs in shallow surface soil to screening RGOs shows that a total of 14 chemicals exceed the RGOs for at least one receptor scenario (Section 6.5.2.4).Six deep surface soil COCs were identified for the National Guard Trainee. Five subsurface soil COCs were identified for the Resident Farmer scenario (adult and/or child). Multiple metals, PCB-1254, and pesticides are COECs in surface soil.

8.3.2 Preparation and Receiving Areas Aggregate

The primary identified source areas in the Preparation and Receiving Areas Aggregate include Buildings DB-3 and DB-802. Metals, PAHs, and PCBs represent the most pervasive SRCs in these areas. The spatial distribution and concentrations of contaminants were highly variable. Buildings DB-3 and C-1 exhibit the highest levels of SVOCs within the aggregate. With respect to vertical distribution, the numbers and concentrations of SRCs in subsurface soil at these source areas deceased substantially relative to surface soil.

Comparison of concentrations of Load Line 2 COPCs in shallow surface soil to screening RGOs shows that a total of 15 chemicals exceed the RGOs for at least one receptor scenario (Section 6.5.2.4). Six COCs were identified for deep surface soil for the National Guard Trainee. No COCs were identified for the Resident Farmer in subsurface soil. Multiple metals, PCB-1254, and PAHs are COECs in surface soil.

8.3.3 Packaging and Shipping Areas Aggregate

The primary identified source areas in the Packaging and Shipping Areas Aggregate are along Track DH and Buildings DB-13, DB-13B, DB-26, and the north side of Building DB-27A. Metals are the most pervasive SRCs in these areas; low concentrations of explosives, PAHs, and PCBs were detected sporadically. The spatial distribution and concentrations of contaminants were highly variable. With respect to vertical distribution, the numbers and concentrations of SRCs in subsurface soil at these source areas deceased substantially relative to surface soil.

Comparison of concentrations of Load Line 2 COPCs in shallow surface soil to screening RGOs shows that a total of eight chemicals exceed the RGOs for at least one receptor scenario (Section 6.5.2.4). Three deep surface soil COCs were identified for the National Guard Trainee. Two COCs were identified for the subsurface soil aggregate for the Resident Farmer (adult and/or child). Multiple metals and PCB-1254 are COECs in surface soil.

8.3.4 Change Houses Aggregate

Surface soil in this EU is relatively uncontaminated. Few inorganic results exceeded RVAAP background values; the distribution of exceedances was very sporadic. Explosive compounds greater than 1 mg/kg were not detected during field analyses. Accordingly, subsurface soil samples were not collected. SVOCs, VOCs, and PCBs/pesticides were not detected in surface soil. Maximum levels of SRCs were detected in the vicinity of Building DB22-02. No human health COCs were identified in soil for this aggregate.

8.3.5 Perimeter Area Aggregate

Overall, SRC concentrations in this aggregate were low; however, at specific sample stations, high levels of inorganics were observed. Specifically, high concentrations of inorganics were observed at station LL2-248 within a drainage swale south of Building DA-5. Elevated inorganics were also observed adjacent to Building DA-7 and east of Building DA-21. Explosive and propellant compounds were also detected along the railroad tracks east of Building DA-21 and east of Building DB-3. Explosive compounds were also detected in the subsurface soil sample collected along the railroad tracks east of Building DA-21; lead and cadmium were also identified as SRCs at this sampling station.

Comparison of concentrations of Load Line 2 COPCs in shallow surface soil to screening RGOs shows that a total of six chemicals exceed the RGOs for at least one receptor scenario (Section 6.5.2.4). Five deep surface soil COCs were identified for the National Guard Trainee. Three subsurface soil COCs were identified for the Resident Farmer (adult and child). Multiple metals are COECs in surface soil.

8.3.6 North Ditches Aggregate

Surface soil in this EU unit exhibited little contamination. Trace concentrations of 2,4,6-TNT were detected. Inorganic SRCs rarely exceeded background values by factors of more than 2 times. Propellants, SVOCs, PCBs, and pesticides were not detected. Subsurface soil samples were not collected from this aggregate due to the lack of detectable field explosives in surface soil.

Comparison of concentrations of Load Line 2 COPCs in shallow surface soil to screening RGOs shows that antimony exceeds its RGO for the On-Site Resident Farmer (child) receptor (Section 6.5.2.4). No COCs in deep surface soil were identified in the aggregate. Subsurface soil was not collected in this aggregate. Zinc was identified as a COPEC.

8.3.7 Sediment and Surface Water

Sediment and surface water were characterized in the Kelly's Pond and Exit Drainages Aggregate. Only sediment was characterized in the North Ponds Aggregate.

Sediment in Kelly's Pond and Exit Drainages

Detectable explosive compounds occur in sediments in this aggregate. Inorganic SRCs were identified, although concentrations rarely exceeded more than twice their respective background criteria, if available. Pesticides and SVOCs were detected in sediment at concentrations less than 1 mg/kg. PCBs and VOCs were not detected.

Three sediment human health COCs were identified for the Resident Farmer scenario (adult): benzo(*a*)pyrene, benzo(*b*)fluoranthene, and dibenz(*a,h*)anthracene. Benzo(*a*)pyrene was also an identified COC for the Resident Farmer (child).

Sediment in the North Ponds Aggregate

Nitrocellulose was detected once at a low, estimated concentration. This constituent was identified as a COPC, but was not evaluated quantitatively due to the lack of approved toxicity values. Inorganic SRCs identified in sediment in this aggregate (lead, nickel, and cadmium) were all detected at low concentrations less than 2 mg/kg; none of these were identified as COPCs.

Surface Water in Kelly's Pond and Exit Drainages

Four explosive compounds were detected in surface water at one sample station; all concentrations were less than 0.01 mg/L. Antimony, cadmium, and vanadium were detected at concentrations <0.01 mg/L in surface water and were considered as SRCs in absence of available background criteria. Trace quantities of carbon disulfide were detected in one surface water sample. Of the identified SRCs in surface water, only antimony was identified as a COC (Resident Farmer adult and child only).

8.3.8 Groundwater

Groundwater within the AOC did not exhibit evidence of widespread contamination. Explosives were detected only sporadically, with the highest and most consistent concentrations present in the southern portion of the load lines near Kelly's Pond. Inorganic SRCs were identified in most wells, with maximum concentrations in the southern portion of the AOC (well LL2mw-265) and in the Explosives Handling Area Aggregate (well LL2mw-266). SVOCs were not detected. Trace levels of one PCB, pesticides, and VOCs were sporadically detected in groundwater.

The Load Line 2 groundwater aggregate was evaluated to identify COCs. Comparisons of Load Line 2 COCs in groundwater to screening RGOs show that arsenic and heptachlor epoxide exceed RGOs for the National Guard Trainee and On-Site Resident Farmer (adult and child) receptors. Manganese; PCB-1242; 2,4-DNT; and benzene were also identified as COCs for the Resident Farmer (child and/or adult)..

8.3.9 Storm and Sanitary Sewers

Some inlets in the storm sewer system contained high concentrations of inorganics. The storm sewer system contains low levels of accumulated explosives based on Phase II RI sampling results, as well as PAHs, PCBs, and pesticides. Some partitioning to water appears to be occurring at low concentrations. The storm drain network may act as a minor source of contaminant flux to groundwater and likely facilitates the movement of shallow groundwater in the vicinity of cracked or broken pipes where inflow or outflow may occur.

The sanitary sewer system does not contain substantial quantities of accumulated sediment. Concentrations of accumulated explosives were low based on Phase II RI sampling results; however, accumulated inorganics are present at high concentrations. Some partitioning of explosives to water appears to be occurring at low concentrations. The sanitary sewer system does not receive large influxes of storm runoff and is largely a closed system, except where pipes may be cracked. Considering the relative lack of data and the characteristics of the sewer systems; it is not conclusive if these systems are a primary source to groundwater or migration pathway.

8.3.10 Buildings and Structures

Data collected during the Phase II RI indicate an overall absence of contamination in soil beneath building sub-floors. However, this is based on a limited number of samples collected from beneath building slabs.

Any future demolition of the Building DB-4 and DB-4A washout basins should consider that sediment in these structures contained elevated levels of metals, explosives, propellants, PCBs, and pesticides. The associated water sample contained elevated levels of many constituents that were detected at high concentrations in sediment.

Any future demolition of the covered sedimentation basin north of Building DB-4 should consider that sediment in this structure contained elevated concentrations of several metals related to historical processes (chromium, copper, and lead), as well as detectable propellants, pesticides, PCBs, SVOCs, and VOCs. The associated water sample contained elevated levels of several contaminants that were detected in sediment.

Floor sweeping samples collected from Buildings DB-3, DB-10, and DB-4 contained very high concentrations of multiple metals, including cadmium, chromium, and lead. Explosive compounds were detected in each of the floor sweep samples at concentrations up to 160 mg/kg. PCBs were present in all floor sweep samples at concentrations from 690 to 790 mg/kg. Cadmium and lead concentrations in floor sweep TCLP samples collected from Buildings DB-10 and DB-3 exceeded criteria for the toxicity characteristic.

8.4 LESSONS LEARNED

A key project quality objective for the Phase II RI at Load Line 2 is to document lessons learned so that future projects may benefit from lessons learned and constantly improve data quality and performance. Lessons learned are derived from process improvements that were implemented or corrective measures for nonconformances. The Phase II RIs for Load Lines 2, 3, and 4 were planned and implemented under one mobilization; therefore, the key lessons learned discussed below are applicable to all of the investigations conducted in 2001.

- The Phase II RI for Load Lines 2, 3, and 4 was integrated under a single SAP, QAPP, and Health and Safety Plan Addendum. Preparation for field efforts, including logbook preparation, sampling data base prepopulation, readiness reviews, and personnel training assignments were conducted under one combined mobilization. Field sampling operations for all three load lines were coordinated under one Field Operations Manager, Site Health and Safety Officer, and Sample Manager and utilized the same sampling teams. Set up and operation of the field laboratory was likewise done once for all three investigations. The integrated effort allowed subcontractors (drilling, test pit excavation, video camera surveys, concrete coring, etc.) to conduct their operations under one mobilization. This integrated effort for multiple sites eliminated redundant startup operations, compressed the field investigation schedules, reduced costs, and improved data quality by utilizing staff familiar with the project DQOs and sampling procedures.

- The Phase II RI efforts for Load Lines 2, 3, and 4 were the first conducted by SAIC at RVAAP to designate a formal IDW Compliance Officer. A single person with waste operations and management experience was designated to coordinate the packaging, labeling, tracking, and disposition of all project IDW. This person reported directly to the Field Operations Manager and SAIC Project Manager. Implementation of this position resulted in greater efficiencies in IDW management and no compliance issues related to IDW during the course of the project.

- Analytical difficulties were encountered for some floor sweep and other sample types collected within or near buildings and railroad tracks were encountered due to the suspected presence of paint chips, creosotes, or other materials. Prior notification to the analytical laboratory is advised when such unusual samples may be collected so that they can adjust extraction or analytical protocols as needed to avoid gross contamination or even damage to instrumentation and to improve overall data quality.

- Use of field portable X-ray fluorescence (XRF) analyses for metals was not employed to help guide the placement of sampling locations, although the method may have provided useful information regarding the distribution of inorganic contaminants. Re-evaluation of previous applications of XRF at RVAAP are to be conducted, including implementation of a revised analytical method. Upon completion of the evaluation and testing of the new method(s), use of field XRF to help guide characterization sampling activities or conduct remediation verification sampling should be considered.

- Incorporation of undesignated contingency samples into the project planning provides a useful tool and flexibility to sample additional locations based on field observations. Examples of the application of contingency samples include small sedimentation basins discovered at Load Lines 3 and 4 near explosives preparation buildings and collection of Cr^{+6} at multiple stations at Load Line 2.

- The presence of Ohio EPA and USACE staff on-site during field operations was beneficial in that potential changes to the project work plan due to field conditions could be quickly discussed, resolved, and implemented.

- The availability of on-site facilities for use as a field staging area and to house the field explosives laboratory was extremely beneficial. Having high quality shelter facilities for sample storage and management operations, equipment decontamination, and the field laboratory improves sample quality and project efficiency. The facility provides a central and secure location to store equipment and supplies, as well as to conduct safety meetings and other site-specific training.

- Field operations were temporarily suspended for 5 days beginning September 12, 2001, due to RVAAP security measures in response to the terrorist attacks of September 11, 2001. As a result, field operations were placed in a safe and compliant standby condition including:

  – Communication of events and planned actions to the appropriate SAIC, USACE, and RVAAP management personnel;

  – Removal of environmental samples that were in refrigerated storage in order to deliver these to analytical laboratories;

  – Inspection and securing of IDW containers to ensure safe and compliant storage;

  – Removal of rental vehicles and rented field equipment; and

  – Sealing of project field records in coolers and securing of the field staging building.

Future SAP Addenda for investigations at RVAAP may include a section containing instructions for unplanned events resulting in the immediate suspension of field operations.