FINAL

PHASE II REMEDIAL INVESTIGATION REPORT

FOR

LOAD LINE 2 AT THE RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

VOLUME 1 – MAIN TEXT

PREPARED FOR

US Army Corps of Engineers®

LOUISVILLE DISTRICT
CONTRACT No. DACA45-03-D-0026
DELIVERY ORDER 0001

July 2004

Shaw® Shaw E & I

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SHAW ENVIRONMENTAL, INC.
AND
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not
be considered eligible contractors for its review.

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Shaw Environmental, Inc. and Science Applications International Corporation (SAIC) have completed the Final Report for the Phase II Remedial Investigation for Load Line 2 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing Corps policy.

Sally Absher, SAIC — 7-29-04 (Date)
Study/Design Team Leader

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Project Manager

Significant concerns and the explanation of the resolution are as follows:

Independent technical review comments are recorded on an SAIC Document Review Record, per SAIC quality assurance procedure QAAP 3.1. This Document Review Record is maintained in the project file. Changes to the report addressing the comments have been verified by the Study/Design Team Leader.

As noted above, all concerns resulting from independent technical review of the project have been considered.

Vice President — 7-29-04
Principal w/ A-E firm — Date

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FIGURES

TABLES

ACRONYMS

ADD	average daily dose
AEC	U.S. Army Environmental Center
amsl	above mean sea level
AOC	Area of Concern
AT123D	Analytical Transient 1- ,2- ,3-Dimensional (groundwater model)
AUF	area use factor
BAF	bioaccumulation factor
bgs	below ground surface
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CMCOC	contaminant migration contaminant of concern
CMCOPC	contaminant migration contaminant of potential concern
COC	chemical of concern
COEC	constitient of ecological concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSF	cancer slope factor
CSM	conceptual site model
CX	Center of Excellence
DAF	dilution attenuation factor
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DLF	dust-loading factor
DNB	dinitrobenzene
DNT	dinitrotoluene
DoD	U.S. Department of Defense
DQA	data quality assessment
DQO	data quality objective
EDQL	Ecological Data Quality Level
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ESV	ecological screening value
EU	exposure unit
FCM	food chain multiplier
FS	Feasibility Study
FWHHRAM	Facility-Wide Human Health Risk Assessor's Manual
GAF	gastrointestinal absorption factor
GPS	global positioning system
GSSL	generic soil screening level
HELP	Hydrologic Evaluation of Landfill Performance (model)
HI	hazard index
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
HVAC	heating, ventilation, and air conditioning

IEUBK	Integrated Exposure Uptake Biokinetic (model)
IDW	investigation-derived waste
ILCR	incremental lifetime cancer risk
IRP	Installation Restoration Program
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level
MDC	maximum detected concentration
MDL	method detection limit
MOA	Memorandum of Agreement
MS	matrix spike
MSD	matrix spike duplicate
NAWQC	National Ambient Water Quality Criteria
NFA	No Further Action
NGB	National Guard Bureau
NOAEL	no observed adverse effect level
NWI	National Wetlands Inventory
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
ODOW	Ohio Department of Wildlife
OE	ordnance and explosives
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
OSC	Operations Support Command
OVA	organic vapor analyzer
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
PEF	particulate emission factor
PF	Parshall flume
ppm	parts per million
PRG	preliminary remediation goal
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDA	recommended daily allowance
RDI	recommended daily intake
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfC	reference concentration
RfD	reference dose
RGO	remedial goal option
RI	Remedial Investigation
RME	reasonable maximum exposure
RRSE	relative risk site evaluation
RTLS	Ravenna Training and Logistics Site
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation

SAP	Sampling and Analysis Plan
SERA	screening ecological risk assessment
SESOIL	Seasonal Soil Compartment (leachate model)
SHHRA	screening human health risk assessment
SRC	site-related contaminant
STL	Severn Trent Laboratories, Inc.
SVOC	semivolatile organic compound
T&E	threatened and endangered
TAL	target analyte list
TCLP	toxicity characteristic leaching procedure
TEF	toxicity equivalency factor
TNB	trinitrobenzene
TNT	trinitrotoluene
TOC	total organic carbon
TRV	toxicity reference value
UCL_{95}	95% upper confidence limit
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
UXO	unexploded ordnance
VOC	volatile organic compound
WBG	Winklepeck Burning Grounds
WOE	weight of evidence
WQS	Water Quality Standard
XRF	X-ray fluorescence

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EXECUTIVE SUMMARY

This Phase II Remedial Investigation (RI) Report characterizes the nature and extent of contamination, evaluates the fate and transport of contaminants, and assesses potential risk to human health and the environment resulting from former operations at Load Line 2 at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio. RVAAP, which consists of approximately 8,668.3 ha (21,419 acres), was constructed in 1940 and 1941 with the primary missions of depot storage and ammunition loading during World War II. Industrial operations at RVAAP consisted of 12 munitions-assembly facilities referred to as “load lines.” In 1992, the status of RVAAP changed from inactive-maintained to modified-caretaker and plans are currently underway to demolish dilapidated buildings and structures at some Areas of Concern (AOCs).

The overall purpose of this Phase II RI Report is to describe the investigation conducted at Load Line 2 to define the vertical and horizontal extent of contamination. The specific objectives of the Phase II RI are as follows.

- Characterize the physical environment of Load Line 2 and surroundings to the extent necessary to define potential contaminant transport pathways and receptor populations.

- Characterize the nature and extent of contamination such that risk evaluations could be conducted and results compared to those from baseline risk assessments at a risk extrapolation reference site [Load Line 1 and Winklepeck Burning Grounds (WBG)]. The risk extrapolation process was developed among the U.S. Army, U.S. Army Corps of Engineers (USACE), and the Ohio Environmental Protection Agency (EPA), and is contained in a draft facility-wide risk assessment work plan, which is currently in review. In addition, a baseline ecological risk assessment (BERA) has been applied, following current U.S. Army and Ohio EPA guidance.

- Identify whether releases of contamination beyond the AOC boundary are occurring by collecting environmental samples (surface water and sediment) downstream of the AOC boundary within exit conveyances and using applicable historical information, including results of the Phase I RI. Data collected prior to the Phase I RI are of limited use due to lack of corresponding quality assurance/quality control data and information on detection limits and any verification/validation processes.

- Characterize the sources of contamination at Load Line 2 sufficient to screen and evaluate remedial alternatives in a subsequent Feasibility Study (FS). Data on source locations, types and concentrations of contaminants, potential release mechanisms, physical and chemical properties of contaminants present, and geotechnical characteristics of environmental media were identified as key data needs.

- Provide recommendations for any additional investigations and/or actions.

In addition to the specific objectives listed above, a key project quality objective for the Phase II RI at Load Line 2 was to develop and document lessons learned so that future projects may benefit from lessons learned and constantly improve data quality and performance. Lessons learned pertaining to project mobilization, analytical interferences, use of field analytical methods, involvement of USACE and regulator staff, investigation-derived waste (IDW) coordination, field facilities, and actions to take in the event of a suspension of operations were developed and documented (see Section 8.4).

This Phase II RI was conducted as part of the U.S. Army’s Installation Restoration Program (IRP) approach to implement the Comprehensive Environmental Response, Compensation, and Liability Act of 1980

(CERCLA) process at RVAAP, which prioritizes environmental restoration at AOCs based on their relative potential threat to human health and the environment. The purpose of the Phase II RI is to determine the nature and extent of contamination in the environmental media so that screening level human health and ecological risk assessments (ERAs) can be performed. Results of the risk assessments will be used to determine whether an AOC requires no further action (NFA) or will be the subject of an FS.

PHYSICAL ENVIRONMENT

Load Line 2 is situated in the southeastern quadrant of the RVAAP facility. The topography within the AOC is characterized as moderately subdued on a re-worked sandstone bedrock surface. In general, the land surface slopes from the center of the load line in all directions, dropping sharply to the south of the AOC in the direction of Kelly's Pond. Cultural features of the AOC consist mainly of asphalt and gravel access roads, man-made ditches, sewerlines, manholes, ballast from old railroad tracks, and buildings/steel buildings frames associated with the load line.

The regional geology at RVAAP consists of horizontal to gently dipping bedrock strata of Mississippian- and Pennsylvanian-age overlain by varying thicknesses of unconsolidated glacial deposits. At Load Line 2, subsurface characterization during the Phase I and II RIs identified bedrock at depths ranging from 1.22 m (4 ft) to 4.88 m (16 ft) below ground surface (bgs) and generally only about 0.3 m (1 ft) in the main production areas. The overlying unconsolidated zone varied widely in character from one area to another due to lateral discontinuity within the glacial till and site disturbances. Some areas have been substantially reworked and contain sandy fill, pea gravel, ballast material, and slag; however, silty clays and silty sands dominate the near surface interval.

Sand and gravel aquifers are present in buried-valley and outwash deposits in Portage County. Recharge of these units comes from surface water infiltration of precipitation and surface streams. Due to the heterogeneous nature of the unconsolidated glacial materials, groundwater flow patterns are difficult to determine. Laterally, most groundwater flow occurs along preferential pathways (sand seams, channel deposits, etc.). A facility-wide water table prepared in August 2001 as part of the Phase II RI shows the water table surface is a subdued representation of the surface topography. The predominant groundwater flow direction is to the east. A significant potentiometric high centered around Load Line 2 is indicated in the southeastern portion of RVAAP, resulting in localized radial flow in this area.

The primary surface water conveyance at Load Line 2 drains to the south, ultimately discharging to Kelly's Pond. Surface water flows through a series of man-made ditches, which flow to the south end of the AOC. Surface water also flows north through a smaller network of ditches to a group of four ponds situated on the northeast corner of Load Line 2; however, the majority of surface water runoff is to the south.

PREVIOUS INVESTIGATIONS

The Phase II RI at Load Line 2 was designed to collect data to supplement information obtained from two previous investigations at the site

- *Preliminary Assessment for the Ravenna Army Ammunition Plant* (USACE 1996a), and
- *Phase I Remedial Investigation of High Priority Areas of Concern at the Ravenna Army Ammunition Plant* (USACE 1998a).

The preliminary assessment of Load Line 2 performed in 1996 included the site within the list of Medium Priority sites based on a relative risk ranking methodology. Evaluation of operational history and the potential for contamination of environmental media resulted in the load line being assigned to a group of 11 high priority AOCs under the RVAAP IRP.

The Phase I RI performed at Load Line 2 in 1996 included sampling and analysis of surface soils, sediment, and groundwater at two monitoring wells and temporary well points. Phase I RI sampling data indicated concentrations of explosives, inorganics, and other organic compounds occurring in soil and sediment, primarily within the former operations areas.

PHASE II RI INVESTIGATIVE APPROACH

The findings and data gaps identified during previous investigations guided the specific objectives and sampling design of the Phase II RI at Load Line 2. As detailed in the *Sampling and Analysis Plan Addendum No.1 for the Phase II RI of Load Lines 2, 3, and 4 at the Ravenna Army Ammunition Plant, Ravenna Ohio* (USACE 2001a), the Phase II RI sampling objectives, by medium, included the following.

Surface Soil and Sediment

- Determining the nature and horizontal extent of contaminations using biased sampling at each area within Load Line 2 having either explosives at concentrations ≥ 1 mg/kg, lead ≥ 100 mg/kg and/or chromium ≥ 35 mg/kg, or polychlorinated biphenyls (PCBs) ≥ 1 mg/kg in surface soil during the Phase I RI. Primary areas of interest include Buildings DB-4/-4A, DA-6/-6A, DB-10, DB-802, and the settling basin. Other areas of interest not characterized during the Phase I RI include the storm and sanitary sewer systems.

- Comparing the surface soil and sediment data to the RVAAP facility-wide background dataset, which characterizes natural facility-wide variability for 23 Target Analyte List (TAL) metals.

- Characterizing large non-production areas by random-grid sampling, using a statistical approach to ensure adequate area coverage and density.

- Assessing the suitability of field-based colorimetric analyses of trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) in soil and sediment samples. Results of these tests will determine the suitability of explosive field data for future environmental investigations and remedial activities.

- Evaluating the relationship between slag and underlying soils.

Subsurface Soil

- Defining the vertical extent of contamination and studying transport pathways through the vadose zone.

Surface Water

- Determining whether runoff from contaminated areas around the former production area may contribute contaminants in dissolved and suspended form to the surface water system at Load Line 2.

- Determining whether drainage conveyances at Load Line 2 allow contaminants to migrate south and north off of RVAAP.

Groundwater

- Characterizing the Load Line 2 hydrogeologic flow system and chemical groundwater quality to identify possible contamination in groundwater and potential off-AOC transport of contamination to the south.

- Comparing groundwater results to the facility-wide background dataset.

These objectives were met through the field activities conducted from July to September 2001 at Load Line 2.

AVAILABLE DATA

Load Line 2 remained relatively undisturbed between the Phase I and Phase II RIs. Demolition of structures was limited to removal of transite siding and roofing material from buildings and walkways; extensive disturbance of soil had not occurred. Soil data obtained during the Phase I RI in 1996 were deemed to still represent current conditions at the AOC, thus these data are incorporated into the appropriate data aggregates and evaluated in conjunction with Phase II data in the contaminant nature and extent evaluation. The Phase I soil data are also included in quantitative analyses (e.g., summary statistics and risk evaluations).

Phase I sediment data are also assumed to be representative of site conditions as they exist today and are included in the Phase II evaluations. Where a Phase I station was re-sampled during the Phase II RI, the latter data were used as the most representative of current conditions in assessment of contaminant nature and extent and risk evaluations. In locations where only Phase I RI data existed, they were used by necessity to provide an overall evaluation of contamination and risk. Phase I RI dry sediment samples from intermittent ditch lines (non-viable habitat), were addressed as soil; these were either assigned to the North Ditches Aggregate or included with the closest relevant soil aggregate (e.g., Explosives Handling Area Aggregate).

Phase I groundwater data were not included for quantitative evaluation purposes because of their age. Phase I samples collected from well points were not used quantitatively due to the fact that they were not obtained from specification monitoring wells. However, Phase I groundwater monitoring well data were used qualitatively to identify and evaluate any contaminant trends over time.

Phase I data are appropriately qualified in the nature and extent and risk evaluations with respect to uncertainties resulting from their age, changes in analytical methods and detection limits, and limited TALs for many samples. However, the Phase I RI data for soil and sediment provide valuable information regarding extent of contamination related to source areas and within exit conveyances from the source areas.

The data collected under this Phase II RI include

- 166 surface soil samples (including 17 collected beneath building floor slabs);
- 31 subsurface soil samples;
- 17 stream, pond, and drainage conveyance sediment samples;
- 5 stream, pond, and drainage conveyance surface water samples;
- 12 groundwater samples;
- 20 storm and sanitary sewer and sump/basin sediment samples;

- 12 storm and sanitary sewer and sump/basin water samples; and
- 3 floor sweep samples (Buildings DB-3, DB-4, and DB-10).

Geological characterization was achieved through the collection of undisturbed and disturbed geotechnical samples from soil sampling stations, piezometer and monitoring well borings, and test pits.

NATURE AND EXTENT

The RI evaluated the nature and extent of contaminated surface soil 0 to 0.3 m (0 to1 ft) bgs, subsurface soil to depths of 2.3 m (7 ft), sediment, surface water, and groundwater. The surface and subsurface soil, sediment, and surface water were divided into spatial aggregates based on former process operations and drainage areas. Surface soil and subsurface soil were divided into six aggregates; those believed to be impacted by process-related activities and those believed to be relatively non-contaminated. Sediment and surface water were grouped by drainage area into two aggregates to facilitate examination of contamination spread by these media and to focus on the receptor exposure points for the screening level human health and ERAs. Groundwater was considered on an AOC-wide basis. Samples from storm and sanitary sewers and buildings and structures are addressed as separate aggregates because these samples do not fit the risk exposure scenarios evaluated in the RI.

Surface Soil

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 site-related contaminants (SRCs) in surface soil include aluminum, arsenic, barium, chromium, lead, manganese, and zinc. Semivolatile organic compounds (SVOCs) detected were primarily polycyclic aromatic hydrocarbons (PAHs), which were observed frequently, although at concentrations generally less than 1 mg/kg. PCBs are widespread, although high concentrations are found in a few sample locations within each aggregate. Pesticides were detected sporadically at typically low estimated concentrations. Few volatile organic compounds (VOCs) were detected 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. The key results for contaminant nature and extent in soil are summarized, by aggregate, below.

Explosives Handling Areas Aggregate

- This exposure unit (EU) 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 melt-pour Buildings DB-4/-4A and explosive preparations Buildings DB-6/-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'dichlorodiphenyldichloroethylene (DDE)] were also consistently detected adjacent to former process buildings.

Preparation and Receiving Areas Aggregate

- Low concentrations of explosive compounds (maximum value 1.2 mg/kg) and nitrocellulose (maximum value 7.2 mg/kg) were detected primarily in the vicinity of Buildings DB-3 and DB-802.

- 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.

- SVOCs (primarily PAHs) were detected at generally low concentrations; the highest concentrations occur in the immediate vicinity of Buildings DB-3 and DB-803. VOCs were sporadically detected at low, estimated concentrations.

- Low concentrations of PCBs (primarily PCB-1254) and pesticides were detected in approximately 30% of the samples collected from this aggregate. The highest concentrations were observed on the eastern side of Building DB-3.

Packaging and Shipping Areas Aggregate

- Low concentrations of explosives (2.6J mg/kg maximum value) were detected primarily along Track DH and near Building DB-13B.

- Inorganic SRCs exhibiting the highest concentrations were antimony, lead, and zinc (11 to 62 times background criteria). Maximum values for inorganic SRCs were clustered at Buildings DB-13, DB-13B, DB-26, and the north side of Building DB-27A.

- SVOCs, primarily PAHs, were detected in multiple samples; however, only one station on the north side, Building DB-27A, had concentrations exceeding 1 mg/kg. VOCs were rarely detected.

- 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. 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. Of the few identified inorganic SRCs, lead and zinc exhibited the highest concentrations (3 and 4 times RVAAP background values).

Perimeter Area Aggregate

- Low concentrations of explosives and nitrocellulose were detected in some samples, primarily along the railroad tracks immediately east of Building DA-21, and at a random grid sample station about 250 ft east of Building DB-3. Low concentrations of 2,4,6-TNT were detected in samples collected from several other stations.

- Concentrations of inorganic SRCs were generally less than 2 times background criteria. At certain locations, very high concentrations of antimony, chromium, copper, lead, and mercury were observed (e.g., drainage swale south of Building DA-5). Elevated inorganics were also observed near Building DA-7 and east of Building DA-21.

- SVOCs were rarely detected. VOCs were not 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. Low concentrations of pesticides were sporadically 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).

Subsurface Soil

Explosives Handling Areas Aggregate

- Explosive compounds occur in subsurface soil in areas with elevated surface soil concentrations, 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.

- Inorganic SRCs include barium, beryllium, chromium, lead, and mercury, with the latter two being the most prevalent. The highest concentrations of inorganics are clustered at Buildings DB-4 and DA-6.

- Organic compounds, other than explosives, 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; concentrations were generally less than 3 times background criteria. Inorganics 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; antimony, arsenic, barium, beryllium, chromium, copper, lead, mercury, and zinc are 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 the two sets of railroad tracks northeast of Building DA-21 (maximum detect of 450 mg/kg for 2,4,6-TNT). No propellants were detected.

- Lead and cadmium were the only SRCs identified in subsurface soils 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).

Sediment

Kelly's Pond and Exit Drainages Aggregate

- Three explosive compounds were detected at low concentrations (less than 1 mg/kg).

- Twelve inorganic SRCs were identified in sediment; detected concentrations were generally less than 2 times available 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.

North Ponds Aggregate

- Explosives were not detected; nitrocellulose was detected once at a low, estimated concentration.

- Inorganic SRCs include lead, nickel, and cadmium. All detected concentrations were low, estimated values less than 2 mg/kg.

- Organic constituents, other than nitrocellulose, were not detected.

Surface Water

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; no other VOCs, SVOCs, PCBs, or pesticides were 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; however, seven of these were retained in absence of facility-wide background values. Four inorganic SRCs (arsenic, barium, manganese, and zinc) were detected at concentrations up to twice background criteria.

Groundwater

- Explosives were detected in two wells (LL2mw-262 and LL2mw-059) at concentrations up to 0.0048 mg/L. Concentrations of explosives in well LL2mw-059 over four sampling events since 1996 do not show clearly increasing or decreasing trends. All explosives concentrations are well below the U.S. Region 9 EPA Tap Water preliminary remediation goals (PRGs).

- Inorganic SRCs include antimony, arsenic, cobalt, manganese, and nickel. The maximum concentrations of most inorganic SRCs were detected in well LL2mw-265, located in the southern exit pathway area of the load line. Concentrations of antimony, cobalt, and nickel are below the EPA Region 9 EPA Tap Water PRGs. Two other wells in this area did not contain inorganic SRCs above background criteria.

- SVOCs were not detected in groundwater. Low levels of four VOCs were sporadically detected; with maximum detected values in well LL2mw-266 installed north of the sedimentation basin.

- Trace levels of heptachlor epoxide and PCB-1242 were sporadically detected, with the highest concentrations in well LL2mw-059.

Sewer System Water and Sediment

Water

- 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.

- Water samples collected from the storm sewer system contained only low concentrations of explosive compounds (maximum detected value of 0.69 mg/L for RDX). 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. Pesticides, PCBs, and SVOCs were not detected.

Sediment

- Limited sediment accumulation within the sanitary sewer system is evident. Only trace concentrations of two explosives were detected in sediment samples obtained from the Ejector Station. 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.

- Explosives compounds were detected in sediment collected from the storm sewer system, although not at very high concentrations or frequencies [up to 25 mg/kg for octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)]. High concentrations of inorganic SRCs were observed in storm sewer sediment samples collected at several locations, with inlet boxes typically having the highest concentrations. Hexavalent chromium was detected at Inlet C-4 at a maximum 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.

Buildings and Structures

- Soil beneath building sub-floors is generally uncontaminated based on a limited number of soil samples collected from beneath building floor slabs (see Section 4.8.1).

- Sediment collected from washout annexes inside of Buildings DB-4 and DB-4A contained high concentrations of metals (cadmium, chromium, copper, and 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 of cadmium, chromium, copper, lead, silver, and zinc. Low levels of nitroguanidine, 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 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 all floor sweep samples at concentrations up to 160 mg/kg for 2,4,6-TNT 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 toxicity characteristic leaching procedure (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.

FATE AND TRANSPORT ANALYSIS

Contaminant fate and transport modeling performed as part of the Phase II RI included leachate modeling [Seasonal Soil Compartment (SESOIL)] at the source area within Load Line 2 demonstrating the highest levels of process-related contaminants (Building DB-4 vicinity). Groundwater modeling [Analytical Transient 1-, 2-, 3-Dimensional (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 (1) the AOC boundary at its closest point downgradient of the source area, (2) Kelly's Pond and exit drainages at the closest point downgradient of the source, and (3) the RVAAP facility boundary at its closest point downgradient of the source.

SESOIL Modeling

Antimony, arsenic, cadmium, chromium, mercury, and RDX were identified as contaminant migration contaminant of potential concern (CMCOPCs) based on the leachability analysis for the selected source area. The SESOIL modeling results indicate that these six constituents may leach from surface soil to groundwater with concentrations beneath the source area above groundwater maximum contaminant levels (MCLs) or risk-based criteria (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-dinitrotoluene (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 identified 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. RDX was the only constituent predicted to reach each of the selected receptor locations with peak concentrations in excess of RBCs at the AOC boundary in 37 years, at Kelly's Pond in 169 years, and the RVAAP boundary in 214 years. Accordingly, RDX was identified as a CMCOPC.

SCREENING HUMAN HEALTH RISK ASSESSMENT

A screening human health risk assessment (SHHRA) was conducted to identify chemicals of concern (COCs) and remedial goal options (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 chemicals of potential concern (COPCs);
- calculation of exposure point concentrations (EPCs) for COPCs;
- calculation of screening RGOs at a chemical hazard index (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 ES-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).

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.

Surface Water and Sediment

Exposure to surface water and sediment 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 Load Line 2: antimony for the Resident Farmer (adult and child). Three PAHs were identified as sediment COCs for the Resident Farmer (adult and child) scenario only: benzo(*a*)pyrene, benzo(*b*)fluoranthene, and dibenz(*a,h*)anthracene.

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.

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) below ground surface (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),

Table ES-1. Chemicals Exceeding RGOs (COCs) by Receptor/Medium/Exposure Unit Combinations at Load Line 2[a]

	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 ES-1. Chemicals Exceeding RGOs (COCs) by Receptor/Medium/Exposure Unit Combinations at Load Line 2[a] (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-triaxine.
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.

Hunter/Trapper/Fisher (shallow surface soil), and Resident Farmer (adult and child) (shallow surface 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 ES-1). Multiple shallow surface soil COCs were identified for the Security Guard/Maintenance Worker, the Resident Farmer Adult, and the Resident Farmer Child. Only one COC was identified each for the Fire/Dust Suppression Worker and the Hunter/Trapper/Fisher. The number of shallow surface soil COCs identified for each EU also varied, ranging from 15 for the Preparation and Receiving Areas Aggregate to 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 ranging from six COCs for both the Explosives Handling Areas and Preparation and Receiving Areas Aggregates to no COCs 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 Explosives Handling Areas, Perimeter Area, and Packaging and Shipping Areas Aggregates had several identified COCs each. No COCs were identified 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).

SCREENING AND BASELINE ECOLOGICAL RISK EVALUATION

Load Line 2 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 screening ERA (SERA) was performed. The SERA was performed in accordance with written guidance from USACE, Louisville District and Ohio EPA and also utilized Ohio's water quality standards. Following the SERA, there was a baseline risk assessment (BERA; Ohio EPA Level III) performed on the preliminary COPECs. The methods followed the Army and Ohio EPA protocols and resulted in chemicals of ecological concern (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.

Soil

Risks were evaluated for five EUs for surface soil based on historical use and geographic proximity. At all EUs, except the Melt-Pour Area Drainage Ditches Aggregate, chemicals of potential ecological concern (COPECs) were identified primarily by comparing the maximum detected value for a constituent to ecological screening values (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 hazard quotients (HQs) calculated. BERA activities depended on the following ecological receptors: vegetation, soil invertebrates, cottontail rabbits, shrews, 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. BERA activities reduced the number of COPECs in every location. The Explosives Handling Area Aggregate had 8 COECs (down from 15 COPECs), the Preparation and Receiving Area Aggregate showed 7 (down from 10), and the Packaging and Shipping Area 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).

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 three 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 persistent, bioaccumulative, and toxic compounds (PBT). All of these preliminary COPECs were further evaluated by having screening HQs calculated. 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 COPECs) and at the North Pond Aggregate there are 2 (down from 3).

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. 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 three COPECs to two COECs.

CONCEPTUAL SITE MODEL

The conceptual site model (CSM) 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.

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.

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 the storm drainage network (ditches and storm sewers) and numerical modeling of soil leaching processes in addition to sampling of groundwater monitoring wells. 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 precludes any substantial dispersion of contaminants via air dispersion pathways.

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 (Section 4.7) 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 in 214 years.

Measured contaminant concentrations in groundwater do not indicate widespread contamination to this point in time and suggest 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 sampling results indicate the presence of contaminants in wells in the southern portion of the AOC near Kelly's Pond.

Given that a portion of the storm and sanitary sewer systems at Load Line 2 contain 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. However, the sanitary sewer system contained very little sediment, is a closed system, and contaminant concentrations were not grossly elevated, thus it is not considered a primary source to groundwater or migration pathway.

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 contamination 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.

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. A summary of the results of the human health RGO comparisons is provided in Chapter 6.0.

Surface and Subsurface Soil

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 decreased 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 Building DB-4 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. 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.

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 decreased 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. Six COCs were identified for deep surface soil for the National Guard Trainee. No COCs were identified for the Resident Farmer scenario in subsurface soil. Multiple metals, PCB-1254, and PAHs are COECs in surface soil.

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 decreased 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. 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.

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 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.

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. Five deep surface soil COCs were identified for the National Guard trainee. The subsurface soil COCs were identified for the Resident Farmer (adult and/or child). Multiple metals are COECs in surface soil.

North Ditches Aggregate

Surface soil in this EU 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. Subsurface soil was not collected in this aggregate. Zinc was identified as a COPEC.

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 identified as a 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 quantitively 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).

Groundwater

Groundwater within the AOC did not exhibit evidence of widespread contamination. Explosives were detected only sporadically, with the highest concentrations present at one well 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 Areas 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).

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 characteristics of the sanitary sewer system and the fact that contaminant concentrations were not grossly elevated; it is not considered a primary source to groundwater or migration pathway.

Buildings and Structures

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

Any future demolition of the Buildings 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. Arsenic^{+3} was speciated from total arsenic in the nine floor sweeps samples and was shown to be a very small percent of total arsenic. 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.

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

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 were integrated under a single sampling and analysis plan (SAP), quality assurance project plan, and health and safety plan addendum. Preparation for field efforts, including logbook preparation, sampling database 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 data quality objectives and sampling procedures.

- The Phase II RI efforts for Load Lines 2, 3, and 4 were the first conducted by Science Applications International Corporation (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 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:

    1. Communication of events and planned actions to the appropriate SAIC, USACE, and RVAAP management personnel.

    2. Removal of environmental samples that were in refrigerated storage in order to deliver these to analytical laboratories.

    3. Inspection and securing of IDW containers to ensure safe and compliant storage.

    4. Removal of rental vehicles and rented field equipment.

    5. 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.

RECOMMENDATIONS

To provide decision makers with the information necessary to evaluate remedial alternatives to reduce or eliminate potential risks to human and/or ecological receptors, it is recommended that Load Line 2 proceed to the FS phase under the RVAAP CERCLA process. It is recommended that the FS phase employ a streamlined remedial alternatives evaluation process based on the most likely land use assumptions and evaluate a range of effective alternatives and technologies and associated costs. The intent of this strategy is to accelerate site-specific analysis of remedies by focusing the FS efforts to appropriate remedies that have been evaluated at other sites with operational histories similar to Load Line 2.

The future land uses and controls envisioned for Load Line 2 should be determined prior to selection of the path forward for the site. Establishment of the most likely land use scenario(s) will allow decision makers the initial information necessary to determine the correct remedial action, such as source removal, land use controls, and/or continued monitoring, to achieve requisite protection of human health and the environment. The envisioned future use of the AOC, or a portion of the AOC, is an important consideration in determining the extent of remediation necessary to achieve the required degree of protectiveness. For example, a residential versus a National Guard land use scenario influences how much cleanup is needed to lower the risk to protective levels. Establishment of land use will also allow for streamlined evaluation of remedies and will be necessary for documentation in a remedial decision.

Areas having the same projected land use within Load Line 2 (and at other melt-pour lines at RVAAP) will incorporate the same RGOs into remedial alternative development. Also, the FS should consider potential future separate actions related to surface water systems and recognize the connection of surface water exit pathways among the four major melt-pour lines (Load Lines 1 through 4), as well as Load Line 12. The FS should apply results of the ecological field truthing effort at the WBG (pending agreement by Ohio EPA) to remedial goal development for Load Line 2 to the extent practicable.

Key data uncertainties have been identified in the RI to help guide any future sampling efforts. Details of additional nature and extent assessment, as needed to fill any remaining data gaps in order to evaluate remedial alternatives, are deferred to the FS planning stage. The following components may be necessary for a thorough FS evaluation or may be considered under a separate remedial action process for integrator media, such as surface water or groundwater.

- Refinement of EU boundaries, if remedial decisions by EU are considered most feasible by decision makers. Such a delineation would allow:

    1. Prioritization of EUs or areas from highest potential risk to lowest potential risk.

    2. Selection of cleanup actions and exit strategies per EU and/or per buildings in each EU, (e.g., certain areas may remediated by soil removal, whereas remediation of other areas, such as a process building vicinity, may require an alternate approach).

    3. Potential elimination of all or portions of certain EUs from additional investigation or further action, such as portions of the Perimeter Area Aggregate, thus reducing the footprint of the AOC.

- Assessment of shallow groundwater at Load Line 2 indicated some contamination related to historical process operations. Subsurface soil data at Load Line 2 indicated the presence of explosives and metals SRCs above levels of concern. Although definitive evidence of vertical migration of contaminants does not exist, assessment of deep groundwater at the site has not been performed and may be a potential data gap. Characterization or monitoring of deeper groundwater may be necessary to evaluate certain potential remedial actions or support future resource use decisions.

- Sediment in the Kelly’s Pond and Exit Drainages Aggregate, the North Ponds Aggregate and dry conveyances in the North Ditches Aggregate, and south of Building DB-802 was characterized to typical depths of 0.15 m (0.5 ft). Characterization of deeper sediment in ponds and drainage conveyances is a potential data gap and additional sampling at deeper intervals may be necessary to evaluate potential remedial actions or support future resource use decisions.

- Requirements of the Toxic Substances Control Act should be evaluated to determine if they may be an applicable or appropriate and relevant requirements for future remedial actions involving soil or sediment containing PCBs above certain threshold criteria.