FINAL

PHASE I REMEDIAL INVESTIGATION REPORT

FOR THE

NACA TEST AREA AT THE
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

Prepared for

US Army Corps
of Engineers®

U.S. Army Corps of Engineers – Louisville District
Contract No. DACA62-94-D-0029
Delivery Order 0077

December 2001

SAIC®

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LIST OF ACRONYMS

amsl	above mean sea level
AOC	Area of Concern
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chain-of-custody
COCs	chemicals of concern
COPCs	chemicals of potential concern
DA1	Demolition Area 1
DAF	dilution attenuation factor
DNT	dinitrotoluene
DoD	U.S. Department of Defense
DQOs	data quality objectives
EDQLs	Ecological Data Quality Levels
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
IRP	Installation Restoration Program
MCL	maximum contaminant level
MCLG	maximum containment level goal
MCX	Mandatory Center of Expertise
MS	matrix spike
MSD	matrix spike duplicate
NACA	National Advisory Committee on Aeronautics
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NT	nitrotoluene
NTA	NACA Test Area
OE	ordnance and explosive
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
OSC	Operations Support Command
PAH	polycyclic aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PRG	preliminary remedial goal
PSV	preferred sediment value
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QCSR	Quality Control Summary Report
RBSC	risk-based screening criteria
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RRSE	relative risk site evaluation
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation

SAP	Sampling and Analysis Plan
SCM	site conceptual model
SRC	site-related contaminant
SVOC	semivolatile organic compound
TAL	Target Analyte List
TEL	Threshold Effects Level
TNT	trinitrotoluene
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
UXO	unexploded ordnance
VOC	volatile organic compound
WBG	Winklepeck Burning Grounds

EXECUTIVE SUMMARY

This Phase I remedial investigation (RI) report characterizes the occurrence and distribution of contamination in soil, sediment, and surface water and evaluates potential risk to human health and the environment resulting from operations at the National Advisory Committee on Aeronautics (NACA) Test Area (NTA) at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio. Additionally, one groundwater screening sample was obtained using direct-push boring techniques to provide a general indication of whether source contamination has leached to the groundwater. The NTA, designated as Area of Concern (AOC) RVAAP-038, was in operation from 1947 to 1953 and consists of an area of approximately 27.9 hectares (69 acres) located in the southwestern quadrant of the facility. The NTA is located adjacent to Demolition Area 1 (DA1) (AOC number RVAAP-003). The site was used to conduct experimental crash tests of excess military aircraft in order to develop explosion-proof fuel tanks and fuel for aircraft (AGOH 1997; NACA 1953).

HISTORY AND CURRENT SITE CONDITIONS

The AOC consists of an east–west trending runway or crash strip measuring approximately 495 meters (1,625 feet) long; the crash area at the east end of the strip, measuring about 244 × 244 meters (800 × 800 feet); the plane burial area upslope (east) of the crash area; and the plane storage area, which surrounds and overlaps DA1 (RVAAP-03). Although the concrete runway and pad are still present, other infrastructure has been removed. Water lines or other utilities are possibly still buried beneath the crash area. A small reservoir was excavated for water, presumably for fire control, southeast of the former crash barrier. An out-of-service water well, enclosed in a concrete pit, is located immediately northeast of the reservoir. Wetland areas exist partly within the AOC boundary north of the crash area. Seasonal wetland areas are evident along the southern boundary of the crash area.

Excess airplanes were flown to RVAAP under their own power, taxied along installation roads, and staged at the NTA. Seventeen excess aircraft were used during NTA operations. The planes were fueled, propelled under their own power on a guide monorail, and crashed into a concrete barrier at speeds from 80 to 105 miles per hour. During the tests, high-speed films were made to study fuel spillage, generation of ignition sources, flame front progression, and toxic gas generation, among other parameters. Fluids from the burning airplanes were generally found in a fan-shaped area beginning at the crash barrier and extending out in front of the airplane up to 122 meters (400 feet). The majority of the damaged aircraft were removed from the site following testing. However, some aircraft were bulldozed into an area at the northeast end of the AOC and buried. Debris protrudes from the soil at some locations within this former burial area.

Since 1969, the Ohio Army National Guard (OHARNG) has used a large portion of the NTA for dismounted troop training, bivouac (temporary encampment), and vehicle parking. Firing of small (7.62 millimeter and smaller) blank ammunition is permitted within the training area as approved by the Training Site Commander. The area has also been used as a helicopter landing zone. Guard personnel periodically mow a large portion of the AOC.

Original sources of contamination include 100/130 octane aviation fuels, low-volatility fuel, flame retardants, lubricating oil, coolant compounds, hydraulic fluids, alcohol, and brake fluid. Estimates of aviation fuel consumed are approximately 17,850 gallons. However, the amounts of other liquids potentially released are not known (AGOH 1997). The principal sources of contaminants are volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals associated with burned or partly combusted fuels, deicing compounds, lubricants, hydraulic fluids, as well as fire extinguishing agents, specifically bromochloromethane (AGOH 1997; NACA 1953). Because of the proximity of DA1 to the NTA, explosives and propellants are also considered to be potential contaminants, especially in the southern portion of the crash strip area.

OBJECTIVES

The overall purpose of the Phase I RI is to assess the occurrence, distribution, and potential risk from contamination in soil to a depth of 1.5 meters (5 feet), sediment, and surface water. The specific objectives of the Phase I RI are to

- determine the potential types and sources of contamination using historical process information and previous sampling data;
- 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;
- perform a screening risk evaluation to determine if additional investigation is warranted; human health and ecological risk screening will be used to determine the potential magnitude of risk associated with any contamination detected; and
- provide preliminary recommendations for any additional investigations and/or actions.

PAST AND CURRENT INVESTIGATIONS

Previous studies at NTA consist of collection and analyses of five surface soil samples and one sediment sample as part of a relative risk site evaluation (RRSE) in 1996 (USACHPPM 1996). Data from the Water Quality Surveillance Program (USATHAMA 1980-1992) obtained at monitoring station HC-2 at the southern installation boundary along Hinkley Creek, which drains NTA, DA1, and a large surrounding area, also are relevant to this investigation. Small quantities of metals and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) on one occasion were observed at HC-2. A number of potential site-related contaminants (SRCs) were identified in sediment and soil. Most detections were below the RRSE risk-based evaluation criteria. However, these data were insufficient for determining the occurrence and distribution of contamination or for evaluating potential risk. Additionally, annual storm water sampling is conducted each fall at three facility outfalls, including HC-2. The samples are tested for toxicity to *Ceriodaphnia dubia* (water fleas) and *Pimephales promelas* (fathead minnow) larvae. Analyses for explosives and metals are also conducted. The most recent data (August 2000) show no toxicity or detectable explosives at HC-2. Arsenic, chromium, and magnesium were detected above background.

The following data quality objectives (DQOs) were identified to guide the implementation of the Phase I RI and to help ensure that data needs for the project were met.

Source Area Soil. Previous analytical evidence for source contamination (i.e., soil) is inconclusive and incomplete for NTA. Available data show potential impacts due to metals (barium, cadmium, and chromium) within the crash area. The crash strip and plane storage areas were not sampled prior to this Phase I RI. Subsurface soil was not sampled within the AOC prior to the current investigation. Based on the available operational information, all sub-areas within the NTA were deemed in need of characterization. A grid sampling approach was selected as the best method to adequately characterize soil. Contingency samples were selected for biased sampling in areas of bare soil or in locations having visible debris.

Sediment. Low-lying areas were identified as the most likely sites for contaminant accumulation due to transport of eroded soil in storm water runoff. Also, sediment may function as a transport mechanism because contaminants adsorbed to particulates can be mobilized by surface water flow. Runoff from the AOC generally travels south, beginning with a wetland/pond north of the crash area that drains through two 20-inch-diameter culverts beneath the runway that feed an unnamed tributary located south of the runway. The wetland area north of the runway is fed by a culvert that drains a portion of the area along the north side of Demolition Road. An upgradient sample was collected at this culvert as well as in a separate ditch north of the AOC. The tributary draining the AOC to the south flows into Hinkley Creek, where a biased sample was collected to determine if contaminant migration to Hinkley Creek has occurred. Station HC-2 on Hinkley Creek at the facility boundary was sampled as part of the concurrent DA1 Phase I RI to provide data on potential impacts to sediment at the facility exit point.

Surface Water. Historical surface water sampling of Hinkley Creek and its tributaries in the vicinity of the NTA has not been performed. As denoted for sediment above, the most likely points to observe surface water contamination are within the tributary to Hinkley Creek south of the NTA. All of these areas were targeted for surface water sampling provided sufficient water was available. Also, surface water was sampled at station HC-2 to provide current data on surface water quality downstream of DA1 and the NTA.

Groundwater. Analytical evidence for substantial source area (soil) contamination did not exist for NTA. Potential SRCs based on operations history (e.g., inorganics, SVOCs, and VOCs) are readily attenuated or have low mobility in groundwater. Therefore, investigation of potential impacts to groundwater was limited in the Phase I RI until more source area data were collected. One groundwater screening sample from a deep soil boring in the central portion of the crash area was collected to provide a general indication of whether leaching of soil contaminants has occurred at the AOC. The potential for leaching to groundwater is also evaluated in this Phase I RI report using conservative migration to groundwater screening criteria from the U.S. Environmental Protection Agency (see Chapter 5.0).

AVAILABLE DATA

The environmental database for the NTA Phase I RI includes only data obtained from the field activities conducted in 1999. Historical data did not have sufficient quality documentation for use in this Phase I RI. The data collected under this Phase I RI include

- 99 surface soil samples,
- 21 subsurface soil samples,
- 6 sediment samples,
- 5 surface water samples, and
- 1 groundwater sample.

DISTRIBUTION AND OCCURRENCE OF CONTAMINATION

The RI evaluated the occurrence and distribution of contamination in five media: surface soil [from 0 to 0.3 meter (0 to 1 foot) below ground surface (bgs)]; subsurface soil [from 0.3 to 1 meter (1 to 3 feet), 1 to

1.6 meters (3 to 5 feet), and 2 to 2.6 meters (6 to 8 feet)]; sediment; surface water; and groundwater. The results of this evaluation are summarized by medium.

Surface Soil

- Sporadic detections of 2,4,6-trinitrotoluene (TNT); 2,4-dinitrotoluene (DNT); and nitrocellulose were identified in surface soil. No apparent pattern of distribution was noted for this class of SRCs.

- The principal inorganic SRCs in surface soil include barium, copper, mercury, and zinc, which exceeded background in 20 percent or more of the sample population. Inorganics above background occurred throughout the AOC, but the highest concentrations of metals occurred along the crash strip and in the northeast portion of the plane burial area in association with observed surface debris and suspected subsurface debris.

- Bis(2-ethylhexyl)phthalate and polycyclic aromatic hydrocarbon (PAH) compounds were detected in some combination in approximately one-third of all samples analyzed. Bis(2-ethylhexyl)phthalate was the most widespread SVOC, with detected values at 18 sample stations. The majority of the detected PAH values occurred within the plane refueling/crash strip area. The maximum detected value for each of the PAHs occurred at station NTA-088 in the western-most portion of the plane refueling/crash strip area.

- The VOCs, dimethylbenzene, methylene chloride, and toluene were each detected in from six to nine samples. VOCs were concentrated in the center of the crash area and on the perimeter of the plane burial area.

- Polychlorinated biphenyls (PCBs) were not detected in any surface soil samples.

Subsurface Soil

- Explosives, propellants, and PCBs were not detected in subsurface soil.

- Aluminum, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc were detected in all subsurface soil samples, but they only rarely exceeded their background criteria. Almost all exceedances of background occur in the northeastern corner of the plane burial area in association with observed surface debris and suspected subsurface debris.

- Thirteen PAHs were detected in the sample from station NTA-083 in the plane refueling area. Bis(2-ethylhexyl)phthalate was detected at eight different stations scattered across the AOC. Eight of the PAHs at station NTA-083 were retained as SRCs based on weight-of-evidence evaluation, despite only being detected once in 21 samples.

- In general, the average and maximum detected concentrations for inorganic SRCs in subsurface soil were less than the corresponding values in surface soil.

- Three VOC compounds (methylene chloride, styrene, and toluene) were detected in more than 5 percent of the subsurface soil samples. The maximum detected values for these three VOCs occurred at stations NTA-067 and NTA-073 in the plane burial area.

Sediment

- Low levels of nitrocellulose and the maximum detected values for all of the inorganic sediment SRCs occurred at stations NTA-101 in the well pit and NTA-104 north of NTA along Demolition Road. Because of the presence of paint chips and abundant rust fragments in the well pit at NTA-101 and the fact that NTA-104 lies upgradient (upstream) of the NTA drainage area, these results do not reflect impacts related to former NTA operations. Concentrations of all detected inorganics decreased along the tributary to Hinkley Creek between stations NTA-103 and NTA-106. The consistency of the observed decrease among the inorganics suggests some observable impacts to the tributary from site runoff; however, background values are not exceeded at the confluence with Hinkley Creek.

Surface Water

- The majority of constituents above background levels in surface water occurred at the two stations located north and upgradient (upstream) of NTA (NTA-104 and NTA-105). No impacts to the tributary draining NTA or to Hinkley Creek can be ascertained. The water reservoir also does not appear to have been impacted by former NTA operations.

Groundwater

- Only arsenic and barium concentrations in the filtered sample collected from NTA-038 exceeded background criteria. Based on these screening data, no clear evidence exists that leaching to groundwater has occurred at station NTA-038. These limited data do not necessarily represent conditions in other portions of the AOC.

HUMAN HEALTH RISK EVALUATION

A screening-level human health risk evaluation was performed using conservative assumptions and screening criteria for each of the five media sampled. The selection of chemicals of potential concern (COPCs) is based on comparisons of maximum contaminant concentrations to the screening criteria. Screening criteria do not exist for every constituent; where no criterion is available, the constituent is retained as a COPC. Results from the groundwater sample collected from the piezometer at station NTA-038 were not screened in the risk evaluation. The following points summarize the results of the risk evaluation as presented in Chapter 5.0.

Surface Soil

- Aluminum, arsenic, chromium, lead, and manganese were detected at levels above both their respective residential and industrial screening values.

- Cadmium and copper were detected above their residential screening levels but below their industrial screening levels.

- Nitrocellulose is retained as a COPC in the absence of a screening criterion for comparison. This constituent was detected at scattered locations across the AOC at low (usually estimated) concentrations.

- Eleven SVOCs are identified as surface soil COPCs. The SVOCs consist of two groups of chemicals: bis(2-ethylhexyl)phthalate and 10 PAH compounds. Bis(2-ethylhexyl)phthalate was detected above residential screening levels, but below industrial screening levels, at scattered locations across the AOC. PAH compounds were concentrated in the plane storage and crash strip area; most exceeded both residential and industrial screening levels.

- Summary results of the surface soil data screening against the soil leaching screening criteria [dilution attenuation factor (DAF)=1] show that three metals (arsenic, cadmium, and chromium) identified as COPCs exceed their respective leaching criteria. Three COPCs (aluminum, lead, and manganese) do not have leaching criteria available for comparison. Seven PAHs identified as COPCs exceed their respective leaching criteria. The explosive 2,4-DNT did not exceed its residential soil screening criterion (i.e., it was not a COPC), but it did exceed its migration to groundwater criterion, indicating a need for further analysis in groundwater.

Subsurface Soil

- Three metals (lead, cadmium, and copper) are identified as subsurface soil COPCs at only one sampling station (NTA-073 in the plane burial area). Of these, only lead exceeded its industrial screening value.

- Four SVOCs (all PAH compounds) are identified as subsurface soil human health COPCs at only station NTA-083 in the plane refueling/crash strip area. All of these PAHs exceeded both residential and industrial screening levels. One SVOC, benzo(g,h,i)perylene, was retained as a COPC in absence of screening criteria.

- Summary results of the subsurface soil data screening against the soil leaching screening criteria (DAF=1) show that only cadmium exceeds its leaching criterion. Four of the five SVOCs identified as subsurface soil COPCs exceed their respective leaching criteria.

Sediment

- Chromium, lead, and manganese are identified as human health COPCs in sediment above both residential and industrial screening values.

- Cadmium is identified as a human health COPC in sediment and exceeded only residential screening values.

- Nitrocellulose (detected in the well pit and at ambient station NTA-104) is retained as a COPC in absence of screening criteria.

Surface Water

- Antimony, cadmium, manganese, zinc, bis(2-ethylhexyl)phthalate, and 2,4-DNT at upstream station NTA-104 are identified as human health surface water COPCs in excess of tap water screening criteria. Lead is retained as a COPC in absence of a screening criterion.

SCREENING ECOLOGICAL RISK EVALUATION

The screening level ecological risk evaluation was performed using conservative assumptions to estimate risk in surface water and sediment. Suitable ecological screening criteria do not exist for soils. Maximum concentrations of constituents were compared to the ecological screening criteria. The following points summarize the results of the ecological risk evaluation presented in Chapter 5.0.

Sediment

- Nitrocellulose (11 mg/kg) is retained as a sediment ecological COPC in absence of an available screening values for comparison.

- Eight inorganics are identified as sediment ecological COPCs primarily due to elevated concentrations observed in the well pit sample (cadmium, copper, cyanide, iron, lead, manganese, nickel, and zinc). Five additional inorganics (barium, beryllium, calcium, magnesium, and selenium) are retained as sediment ecological COPCs in absence of available ecological screening values.

Surface Water

- Eight metals are identified as surface water ecological COPCs, including barium, cadmium, cobalt, iron, lead, manganese, nickel, and zinc. Calcium, magnesium, and potassium are retained as ecological COPCs in absence of available screening values for comparison.

- Bis(2-ethylhexyl)phthalate was detected once at a concentration of 3.2 µg/L, which exceeds its surface water screening value of 2.1 µg/L.

SITE CONCEPTUAL MODEL

Information gathered during the NTA Phase I RI was used to develop a site conceptual model (SCM) for NTA. The elements of the SCM include source term definition and contaminant release mechanisms, contaminant migration pathways and exit points, and uncertainties.

Source Areas and Release Mechanisms

The primary mechanisms for releases of contaminants from the source areas include (1) spills, leaks, and releases of fluids (fuels, oil, hydraulic fluid, etc.) directly onto the ground surface; (2) leaching of constituents from residual debris in the plane burial area onto soil; and (3) erosion of contaminated soil and redeposition along the drainageways exiting the site (i.e., tributary to Hinkley Creek). The results of Phase I RI soil sampling indicate that the plane refueling/crash strip area and the northeastern quadrant of the plane burial area are the portions of NTA with the greatest number and concentration of contaminants. The majority of contamination is restricted to the surface soil interval less than 0.3 meter (1.0 foot deep). Based on the Phase I RI data, surface soil within the areas noted above is considered to be a residual or secondary source of contamination. Overall, substantially fewer inorganic and organic COPCs and lower overall concentrations were observed in subsurface soil as compared to surface soil. These factors, combined with the small number of soil locations with concentrations above leaching criteria, suggest that, overall, soil leaching to groundwater is a minor release mechanism.

Contaminant Migration Pathways and Exit Points

The primary identified contaminant exit pathway at NTA is the tributary to Hinkley Creek, which is fed by a number of small drainage ditches and conveyances draining portions of the crash strip, the crash area, and the southern portion of the plane burial area. In addition, surface water runoff from areas north of NTA are directed through a wetland and ultimately are directed to the tributary. Sampling data do not provide conclusive evidence that Hinkley Creek has received significant contamination related to former NTA operations.

Additional accumulation areas for contaminants in surface water exist along the shallow ditch lines in the western and southwestern portions of the crash area and in the small water reservoir. Within the plane refueling/crash strip and plane burial areas, no clearly defined surface water conveyances exist, and runoff occurs primarily as diffuse overland flow. A wetland along the southern boundary of the crash and plane burial areas represents a collection point for some of the overland flow in the southern half of the site. The wetland north of the AOC receives runoff from areas north of Demolition Road as well as from the northern portion of the crash area. The Phase I data do not demonstrate that these surface water features or sediment have received significant contamination related to former NTA operations.

Uncertainties

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

- Contaminant migration from source areas to groundwater via leaching or surface water infiltration is an unknown element of the conceptual model at present. A number of contaminants identified as COPCs also exceeded conservative soil leaching screening criteria. Observed vertical distribution of soil contamination did not indicate significant leaching from surface soil to subsurface soil.

- In the northeast quadrant of the plane burial area, areas having observed debris at the surface extend laterally at least a short distance beyond the area characterized by the Phase I RI sampling. In particular, debris were noted along a former service road leading east from the plane burial area. Therefore, the lateral distribution of debris zones and associated inorganic SRCs may not be fully characterized.

- At least one suspected debris burial site was observed in the northeastern quadrant of the plane burial area (station NTA-073 vicinity). Subsurface soil in the vicinity of the suspected burial site was characterized to depths of 1.5 meters (5 feet), which indicated the occurrence of COPCs in subsurface soil. Therefore, some uncertainty exists as to the full vertical extent of contamination in association with the suspected burial site.

CONCLUSIONS

The Phase I RI at NTA identified site-related contamination in soil at NTA. These contaminants, primarily metals and SVOCs, were subjected to a preliminary risk evaluation to determine whether further action or investigation is warranted. Screening of chemical data against risk-based soil criteria shows the presence of human health and ecological COPCs. Constituents identified above background criteria in sediment and surface water and classified as human health or ecological COPCs are not conclusively related to former NTA operations.

Surface Soil

- Trace levels of explosives were detected at only three stations within the NTA; none of the concentrations exceeded human health residential risk screening criteria. Nitrocellulose was retained as a COPC in absence of available screening criteria but was detected at low levels at only three stations. On this basis, historical NTA operations did not result in impacts to surface soil related to explosives or propellants.

- For inorganic constituents, the greatest exceedances of human health risk-based screening criteria are clustered primarily along the crash strip and the northeastern quadrant of the plane burial area in association with areas having surface debris. Other scattered locations within the crash area have inorganic constituents above risk-based screening levels; most of these occur in the western portion of the crash area.

- For the 10 PAH compounds identified as COPCs, the highest concentrations occur within the plane refueling/crash strip area and near the former crash barrier in the western-most portion of the crash area. Bis(2-ethylhexyl)phthalate values above residential risk-based standards occurred only at station NTA-007. The identified PAHs may reflect more recent, frequent use of the AOC for training purposes (i.e., vehicle and equipment drips and leaks) rather than historical NTA operations.

- VOCs and PCBs are not COPCs in surface soil.

Subsurface Soil

- Lead, cadmium, and copper were identified as human health COPCs in subsurface soil only at station NTA-073 (suspected burial site). Five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene] were identified as COPCs only at station NTA-083 (plane refueling/crash strip area).

- In general, concentrations of inorganic SRCs in subsurface soil are substantially lower than those in surface soil.

- Explosives/propellants, VOCs, and PCBs were not identified as COPCs in subsurface soil.

Sediment and Surface Water

- Nitrocellulose (no screening criterion), chromium, lead, manganese, and cadmium are identified as sediment human health COPCs. The maximum detected concentrations of these COPCs occurred at stations NTA-101 (well pit) and NTA-104 (north and outside of the NTA). The maximum concentrations of metals were detected within the well pit and likely reflect paint chips and metal from the heavily corroded, painted steel lid of the well pit.

- Nitrocellulose (no screening criterion) and 13 inorganics are identified as sediment ecological COPCs. As noted above, all of the maximum detected values for these constituents occurred in stations NTA-101 to NTA-104 and do not appear to be related to NTA operations.

- The explosive 2,4-DNT, five metals, and bis(2-ethylhexyl)phthalate are identified as human health surface water COPCs. The maximum detected values for all of the COPCs, except aluminum and bis(2-ethylhexyl)phthalate, occurred at upgradient (upstream) stations NTA-104 and NTA-105, both of which are north of the AOC and reflect potential sources other than NTA operations. The maximum values for aluminum (station NTA-106) and bis(2-ethylhexyl)phthalate (station NTA-103) may or may not be related to NTA.

- Eleven metals and bis(2-ethylhexyl)phthalate are identified as surface water ecological COPCs. As noted above, the maximum detected values for a large majority of these COPCs occurred at stations NTA-104 and NTA-105 upstream of NTA.

- The data collected during the Phase I RI indicate that sediment and surface water in Hinkley Creek have not received significant levels of contamination related to former operations at NTA.

Groundwater

- Based on the available limited screening data, leaching of contaminants from soil to shallow groundwater in the vicinity of station NTA-038 has not occurred. These data from NTA-038 do not necessarily represent conditions in other portions of the AOC.

RECOMMENDATIONS

Based on the human health and ecological screening risk evaluations, human health COPCs were identified for surface soil at NTA. The principal COPCs are inorganics. Subsurface soil COPCs were very limited in extent to a suspected burial site in the northeastern portion of the plane burial area. Considering the high degree of current site use for OHARNG training and the projected land use for the AOC, a potential exists for exposure of human receptors to debris and associated inorganic surface soil contaminants within the NTA. Therefore, current site conditions do not support a “no further action” decision. Additional characterization and a baseline risk assessment are recommended under the auspices of a combined NTA/DA1 Phase II RI. Specific recommendations include

- Human health and ecological COPCs were identified for sediment and surface water collected during the Phase I RI; however, no definitive evidence exists correlating the COPCs identified in the Hinkley Creek main stem to NTA. Subsequent investigation of NTA is recommended in context of a combined NTA/DA1 exposure unit for surface water and sediment within streams and ditches in the AOC and downstream to the confluence with Hinkley Creek. Confirmation of the presence of constituents at HC-2 and within the Hinkley Creek main stem above background criteria will be addressed under a separate investigation.

- Because of the comprehensive characterization of surface soil during the Phase I RI and limited extent and number of COPCs identified in subsurface soil, the lateral and vertical extent of soil contamination has been largely determined. A focused investigation of only the northeastern quadrant of the plane burial area is recommended to characterize any additional debris disposal areas, as follows:

    - thorough visual survey of the area east of the plane burial area, particularly along the former service road, to identify potential debris disposal areas;

    - additional surface and subsurface soil investigation as required to characterize any newly identified debris disposal areas; and

    - specific horizontal and vertical characterization of the suspected burial site at station NTA-073.

- As noted in the DQOs presented in the NTA Phase I RI Sampling and Analysis Plan Addendum, collection of site-specific hydrogeologic data is indicated because soil constituents exceeded migration to groundwater criteria. Collection of these data is recommended in context of a combined NTA/DA1 groundwater exposure unit. Based on the observed vertical distribution of soil contaminants and high likelihood of attenuation within the vadose zone, the scope of these efforts should be limited in extent and should target only shallow groundwater in the unconsolidated zone immediately downgradient of and within the principal source areas. Deeper groundwater may be evaluated if shallow groundwater is found to be contaminated.

- Upon collection of groundwater characterization data, chemical fate and transport modeling and finalization of the SCM are recommended as necessary to identify contaminant migration potential within this medium and to facilitate the decision-making process for any necessary remedial actions.

- A screening ecological risk assessment will address soil, sediment, and surface water media, considering that sufficient quantity and quality of habitat are present. Sediment and surface water data will be grouped inside the combined AOC to the confluence with Hinkley Creek. The screening ERA using hazard quotients for specific receptors will be preceded by a pre-screen using ecological survey values. Thus, a tiered approach will be followed.

- A baseline human health risk assessment will address soil, surface water, and sediment and, if warranted based on additional characterization, a groundwater exposure unit for the combined exposure units described above.

- Plugging and abandonment of the former production well, removal of well pit sediment, and infilling of the well pit are recommended primarily to eliminate potential physical hazard but also to eliminate a potential contamination migration pathway. Geophysical logging of the well may be considered prior to abandonment to obtain subsurface geologic data.

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1.0 INTRODUCTION

This report documents the results of the Phase I remedial investigation (RI) at the National Advisory Committee on Aeronautics (NACA) Test Area at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio (Figures 1-1 and 1-2). The Phase I RI was conducted for the U.S. Army Operations Support Command (OSC) under the U.S. Department of Defense (DoD) Installation Restoration Program (IRP) by Science Applications International Corporation (SAIC) and its subcontractors, under contract number DACA62-94-D-0029, Delivery Order No. 0077, with the U.S. Army Corps of Engineers (USACE), Louisville District. The Phase I RI was conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 following work plans reviewed and commented on by the Ohio Environmental Protection Agency (Ohio EPA).

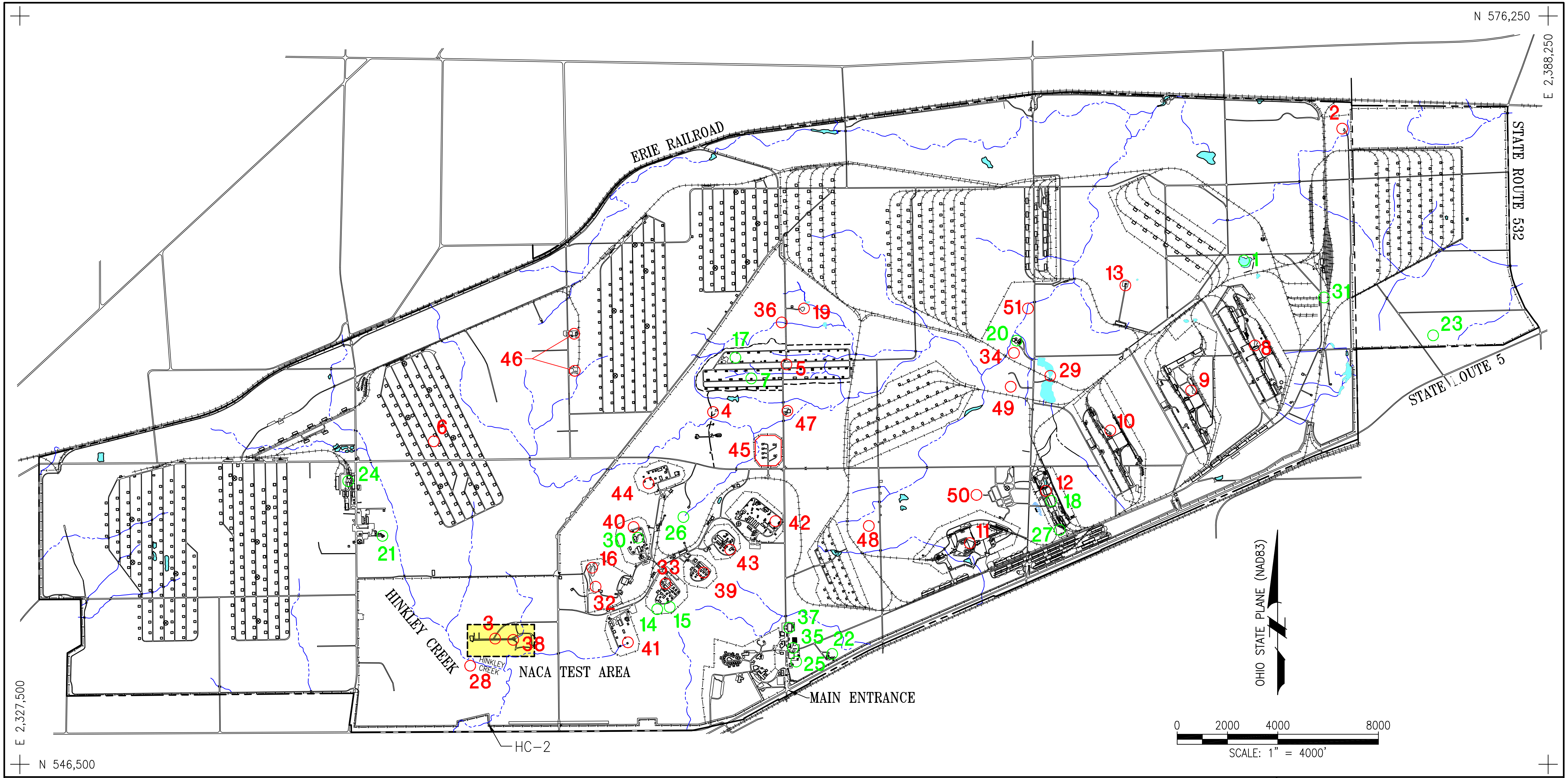
This document summarizes the results of the Phase I RI field activities conducted in October and November 1999 at the NACA Test Area (NTA). The field program, environmental setting, and distribution and occurrence of contamination are discussed. Human health and ecological screening risk evaluations were performed as part of the Phase I RI. Results of the contaminant occurrence and distribution and risk evaluations are used to develop a site conceptual model (SCM) for the NTA that summarizes the results of the investigation, presents conclusions, and forms the framework for decisions regarding future IRP actions at NTA.

1.1 PURPOSE AND SCOPE

Figure 1-3 presents the approach to implementing the CERCLA process under the guidance of the IRP. Priorities for environmental investigation and possible restoration at areas of concern (AOCs) at RVAAP are based on their relative potential threat to human health and the environment, derived from relative risk site evaluations (RRSEs) conducted by the U.S. Army. Thirty-eight AOCs originally were identified at RVAAP in the *Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996a). Thirteen new AOCs were identified in 1998 as a result of additional records searches and site walkovers. The AOCs were ranked by the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) and entered into an OSC database. Those AOCs ranked as high-priority sites (i.e., those with high RRSE scores) are targeted first for Phase I RIs. Because of its current and likely future use, NTA is considered a high-priority site. Medium- and low-priority sites will be characterized in Phase I RIs following completion of the RIs for high-priority AOCs. Investigations and remedial actions under the CERCLA process are implemented at the AOCs in order of priority as funding is available or unless other priorities surface, such as land use needs.

The objective of a Phase I RI for any AOC at RVAAP is to determine whether environmental contamination is present in all relevant media, to identify source areas, and to evaluate the general distribution and occurrence of contaminants sufficient to support a preliminary risk evaluation. The evaluation of risk determines whether a more specific investigation of the AOC (Phase II RI) is warranted. The purpose of the Phase II RI is to determine the nature and extent of contamination so that quantitative human health and ecological risk assessments can be performed. Depending upon the outcome of the risk assessments, an AOC will either require no further action or will be the subject of a feasibility study (FS) to evaluate potential remedies and future actions.

Figure 1-1. General Location and Orientation of RVAAP



LEGEND OF SITES:

1	RAMSDELL QUARRY LANDFILL
2	ERIE BURNING GROUNDS
3	DEMOLITION AREA 1
4	DEMOLITION AREA 2
5	WINKLEPECK BURNING GROUNDS
6	C BLOCK QUARRY
7	BLDG 1601 HAZARDOUS WASTE STORAGE
8	LOAD LINE 1 AND DILUTION/SETTLING POND
9	LOAD LINE 2 AND DILUTION/SETTLING POND
10	LOAD LINE 3 AND DILUTION/SETTLING POND
11	LOAD LINE 4 AND DILUTION/SETTLING POND
12	LOAD LINE 12 AND DILUTION/SETTLING POND
13	BLDG 1200 AND DILUTION/SETTLING POND
14	LOAD LINE 6, EVAPORATION UNIT
15	LOAD LINE 6, TREATMENT PLANT
16	QUARRY LANDFILL/FORMER FUZE & BOOSTER BURNING PITS
17	DEACTIVATION FURNACE
18	LOAD LINE 12 PINK WASTE WATER TREATMENT
19	LANDFILL NORTH OF WINKLEPECK BURNING GROUNDS
20	SAND CREEK SEWAGE TREATMENT PLANT
21	DEPOT SEWAGE TREATMENT PLANT
22	GEORGE ROAD SEWAGE TREATMENT PLANT
23	UNIT TRAINING SITE WASTE OIL TANK
24	RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK
25	BLDG 1034 MOTOR POOL WASTE OIL TANK
26	FUZE BOOSTER AREA SETTLING TANKS
27	BLDG 854–PCB STORAGE
28	MUSTARD AGENT BURIAL SITE
29	UPPER AND LOWER COBBS POND COMPLEX
30	LOAD LINE 7 PINK WASTEWATER TREATMENT PLANT
31	ORE PILE RETENTION POND
32	40– AND 60–MM FIRING RANGE
33	FIRESTONE TEST FACILITY
34	SAND CREEK DISPOSAL ROAD LANDFILL
35	1037 BUILDING–LAUNDRY WASTEWATER SUMP
36	PISTOL RANGE
37	PESTICIDE STORAGE BUILDING T–4452
38	**NACA TEST AREA**
39	LOAD LINE 5 / FUZE LINE 1
40	LOAD LINE 7 / BOOSTER LINE 1
41	LOAD LINE 8 / BOOSTER LINE 2
42	LOAD LINE 9 / DETONATOR LINE
43	LOAD LINE 10 / PERCUSSION ELEMENT
44	LOAD LINE 11 / ARTILLERY PRIMER
45	WET STORAGE AREA
46	BUILDINGS F–15 AND F–16
47	BUILDING T–5301 DECONTAMINATION
48	ANCHOR TEST AREA
49	CENTRAL BURN PITS
50	ATLAS SCRAP YARD
51	DUMP ALONG PARIS–WINDHAM ROAD
○ XX	CERCLA
○ XX	RCRA
○ XX	OTHER REGULATORY

US Army Corps
of Engineers
Louisville District

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO
FACILITY MAP

DRAWN BY:	REV. NO./DATE:	CAD FILE:
R. BEELER	REV. C / 06–04–01	/99039/DWGS/J16RVAP1

Figure 1–2. RVAAP Installation Map

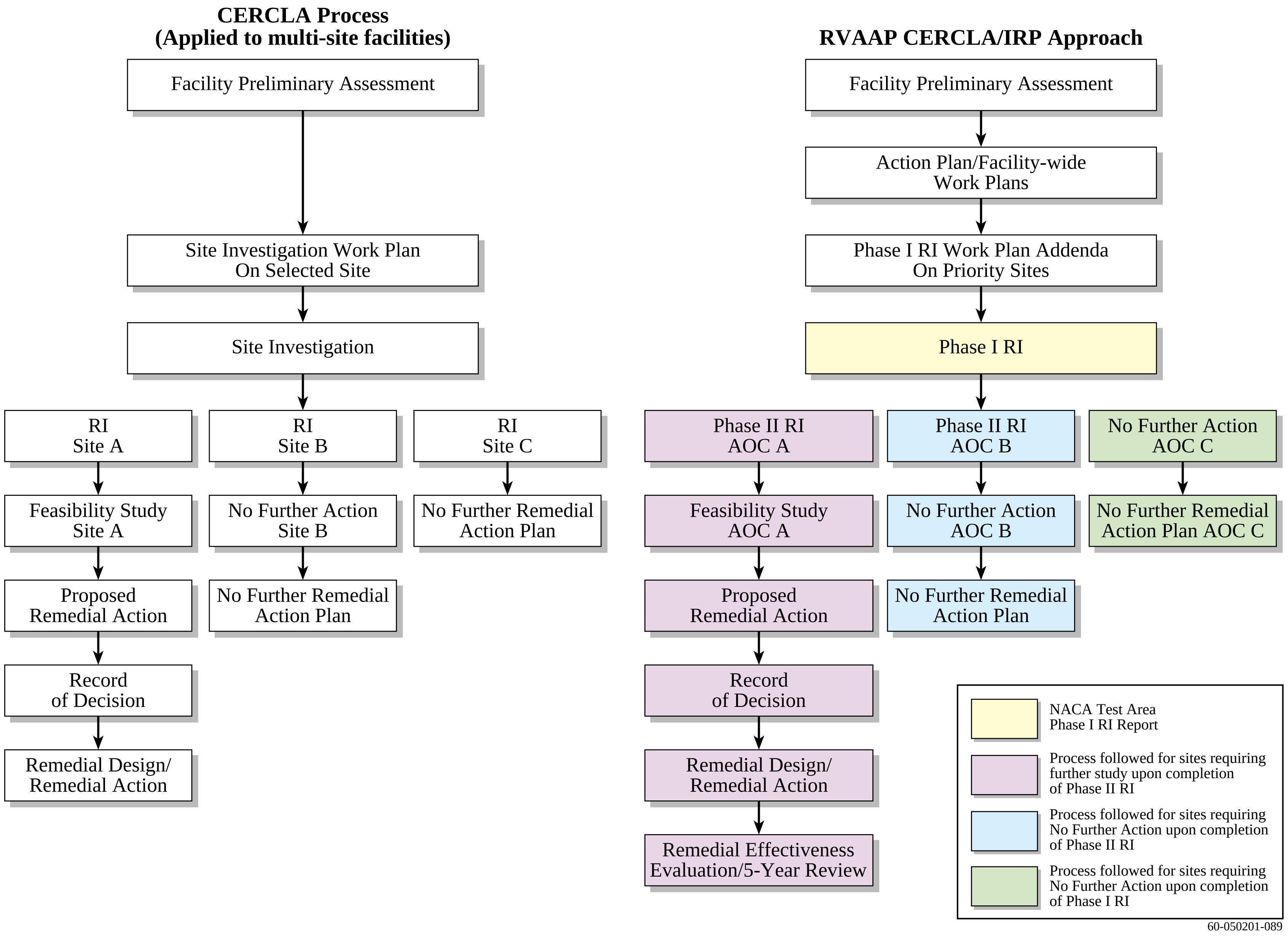


Figure 1-3. CERCLA Approach at RVAAP

Under the RVAAP CERCLA process, the primary project objectives for the Phase I RI of NTA are to

- determine the potential types and sources of contamination using historical process information and previous sampling data;
- 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;
- perform a screening risk evaluation to determine if additional investigation is warranted; human health and ecological risk screening will be used to determine the potential magnitude of risk associated with any contamination detected; and
- provide preliminary recommendations for any additional investigations and/or actions.

To meet the primary project objectives, investigation-specific data quality objectives (DQOs) were developed using the approach presented in the *Facility-Wide Sampling and Analysis Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996b), hereafter referred to as the Facility-Wide Sampling and Analysis Plan (SAP). The DQOs specific to the NTA Phase I RI are discussed in Section 1.3.5. In addition, data collected during the concurrent Phase I RI at Demolition Area 1 (DA1), which adjoins NTA to the south, are used as needed to achieve the primary project objectives.

The investigation approach to the Phase I RI at NTA involved a combination of field and laboratory activities to characterize the AOC. Field investigation techniques included soil boring and sampling as well as sampling of surface water and sediment. Geoprobe techniques were employed to obtain one groundwater screening sample for qualitative evaluation of groundwater quality conditions. The field program was conducted in accordance with the Facility-Wide SAP and the *SAP Addendum No. 1 for the Phase I Remedial Investigation of the NACA Test Area at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999a).

1.2 GENERAL FACILITY DESCRIPTION

1.2.1 Historical Mission and Current Status

RVAAP is a government-owned, contractor-operated OSC facility. RVAAP is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (3 miles) east–northeast of the town of Ravenna and approximately 1.6 kilometers (1 mile) northwest of the town of Newton Falls. The installation consists of 8,668.3 hectares (21,419 acres) contained in a 17.7-kilometer- (11-mile)-long, 5.6-kilometer- (3.5-mile)-wide tract bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garrettsville and Berry roads on the west; and the CONRAIL Railroad on the north (see Figures 1-1 and 1-2). The installation is surrounded by several more populous communities: Windham on the north, Garrettsville [9.6 kilometers (6 miles)] to the northwest, Newton Falls [1.6 kilometers (1 mile)] to the east, Charlestown to the southwest, and Wayland [4.8 kilometers (3 miles)] to the southeast.

Industrial operations at RVAAP consisted of 12 munitions assembly facilities referred to as “load lines.” Load Lines 1 through 4 were used to melt and load trinitrotoluene (TNT) and Composition B into large-caliber shells and bombs. The operations on the load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically, the floors and walls would be cleaned with water and steam. The liquid, containing TNT and Composition B, was known as “pink water” for its characteristic color. Pink water was collected in concrete holding tanks, filtered, and pumped into unlined ditches for transport to earthen settling ponds. Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Potential contaminants in these load lines include lead compounds, mercury compounds, and explosives. Load Line 12 was used to produce ammonium nitrate for explosives and fertilizers prior to its use as a weapons demilitarization facility.

Several areas of RVAAP were used for the burning, demolition, and testing of munitions. These burning grounds consist of large parcels of open land or abandoned quarries. Potential contaminants at these AOCs include explosives, propellants, metals, waste oils, and sanitary waste.

RVAAP has been inactive since 1992. The only activities still being carried out from the wartime era are the storage of bulk explosives and the infrequent demolition of unexploded ordnance (UXO) found at the installation. The Army is also overseeing the reclamation of railroad track, telephone line, and steel for reuse or recycling. The Army has begun the demolition of excess buildings at several load lines, which includes the removal of friable asbestos. Building demolition at Load Lines 1 and 12 has been completed. Demolition at Load Line 2 is ongoing.

1.2.2 Demography and Land Use

Census figures for 2000 list the total populations of Portage and Trumbull counties at 152,061 and 225,116, respectively. Population centers closest to RVAAP are Ravenna, with a population of 11,771, and Newton Falls, with a population of 5,002.

The RVAAP facility is located in a rural area and is not close to any major industrial or developed areas. Approximately 55 percent of Portage County, in which the majority of RVAAP is located, consists of either woodland or farmland acreage. The Michael J. Kirwan Reservoir (also known as West Branch Reservoir) is the closest major recreational area and is located adjacent to the western half of RVAAP south of State Route 5.

Until May 1999, about 1,010 hectares (2497 acres) of land and some existing facilities at RVAAP were used by the National Guard Bureau for training purposes administered by the Ohio Army National Guard (OHARNG). Training and related activities include field operations and bivouac training, convoy training, equipment maintenance, and storage of heavy equipment. In May 1999, about 6,544 ha (16,164 acres) of land at RVAAP was transferred from the Army OSC to the National Guard Bureau for expanded training missions. The OHARNG is currently preparing a comprehensive Environmental Assessment and an Integrated Natural Resources Management Plan, which will address future uses of the property. These uses include two live-fire rifle ranges, hand grenade practice and qualification ranges, a light demolition range, and two armored vehicle maneuver areas. Additional field support and cantonment facilities will be constructed to support future training. The Ohio Air National Guard and the U.S. Air Force Reserve plan to partner with the OHARNG in construction of a 1,219-m (4,000-ft) unpaved tactical runway. Currently, much of the property within the NTA is used by the OHARNG for bivouac training.

1.3 NACA TEST AREA SITE DESCRIPTION

A detailed history of process operations and waste processes for the original 38 identified AOCs at RVAAP, including NTA, is presented in the Preliminary Assessment for RVAAP (USACE 1996a). The following is a summary of the history and related contaminants for NTA.

1.3.1 Operational History

NTA, designated as AOC RVAAP-38 (Figure 1-2), was in operation from 1947 to 1953 and consists of an area of approximately 27.9 hectares (69 acres). The AOC is located in the southwestern quadrant of RVAAP. The site was used to conduct experimental crash tests of excess military aircraft in order to develop explosion-proof fuel tanks and fuel for aircraft (AGOH 1997; NACA 1953). Figure 1-4 depicts the cultural landmarks and other reference points within NTA that will be mentioned throughout this report. Access to the site is by Demolition Road. The AOC consists of an east–west trending runway or crash strip, measuring approximately 495-meters (1,625-feet) long; the crash area at the east end of the strip, measuring about 244 × 244 meters (800 × 800 feet); the plane burial area upslope (east) of the crash area; and the plane storage area, which surrounds and overlaps DA1 (RVAAP-03). Although the concrete runway and pad are still present, the crash barrier, timing poles, utilities, buildings, and other infrastructure have been removed. Water lines or other utilities are possibly still buried beneath the crash area. A small reservoir was excavated for water, presumably for fire control, southeast of the former crash barrier. An out-of-service water well, enclosed in a concrete pit, is located immediately northeast of the reservoir. An access road (slag or compacted soil) makes a loop around the crash area. Wetland areas exist partly within the AOC boundary north of the crash area. Along the southern boundary of the crash area, seasonal wetland areas are evident.

Excess airplanes were flown to RVAAP under their own power, taxied along installation roads, and staged at NTA. The planes were fueled and then propelled under their own power on a guide monorail. The planes were then crashed into a concrete barrier at speeds from 80 to 105 miles per hour. During the tests, high-speed films were made to study fuel spillage, generation of ignition sources, flame front progression, and toxic gas generation, among other parameters. Fluids from the burning airplanes were generally found in a fan-shaped area beginning at the crash barrier and extending out in front of the airplane up to 122 meters (400 feet).

Seventeen excess aircraft were used during NTA operations. Some were completely consumed by fire. Those that were significantly damaged during testing were stripped of instrumentation and salvageable parts, and the majority were removed from the site. However, some aircraft were bulldozed into an area at the northeast end of the AOC and buried. Debris protrudes from the soil at some locations within this former burial area.

Since 1969, the OHARNG has used a large portion of NTA for dismounted troop training, bivouac, and vehicle parking. The area has also been used as a helicopter landing zone. Training activities are restricted as follows (1) parking and vehicle traffic are limited to the concrete runway and established trails; (2) digging of soil is prohibited; (3) disposal of trash is prohibited, other than in designated above-ground receptacles; and (4) disposal of gray water is prohibited. Fires or the firing of live ammunition is prohibited. Firing of small (7.62 millimeter and smaller) blank ammunition is permitted within the training area as approved by the Training Site Commander. Guard personnel periodically mow or clear the site.

Combustible liquids involved in testing activities included 100/130 octane aviation fuels, low-volatility fuel, flame retardants, lubricating oil, coolant compounds, hydraulic fluids, alcohol, and brake fluid. Estimates of aviation fuel consumed are approximately 17,850 gallons. However, the amounts of other liquids potentially released are not known (AGOH 1997). The principal sources of contaminants are volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals associated with burned or partly combusted fuels, deicing compounds, lubricants, hydraulic fluids, as well as fire extinguishing agents, specifically bromochloromethane (AGOH 1997; NACA 1953). Minor amounts of polychlorinated biphenyls (PCBs) may be present from previous spills or leaks from equipment. The central portion of NTA along the crash strip may be contaminated with explosive residues, propellants,

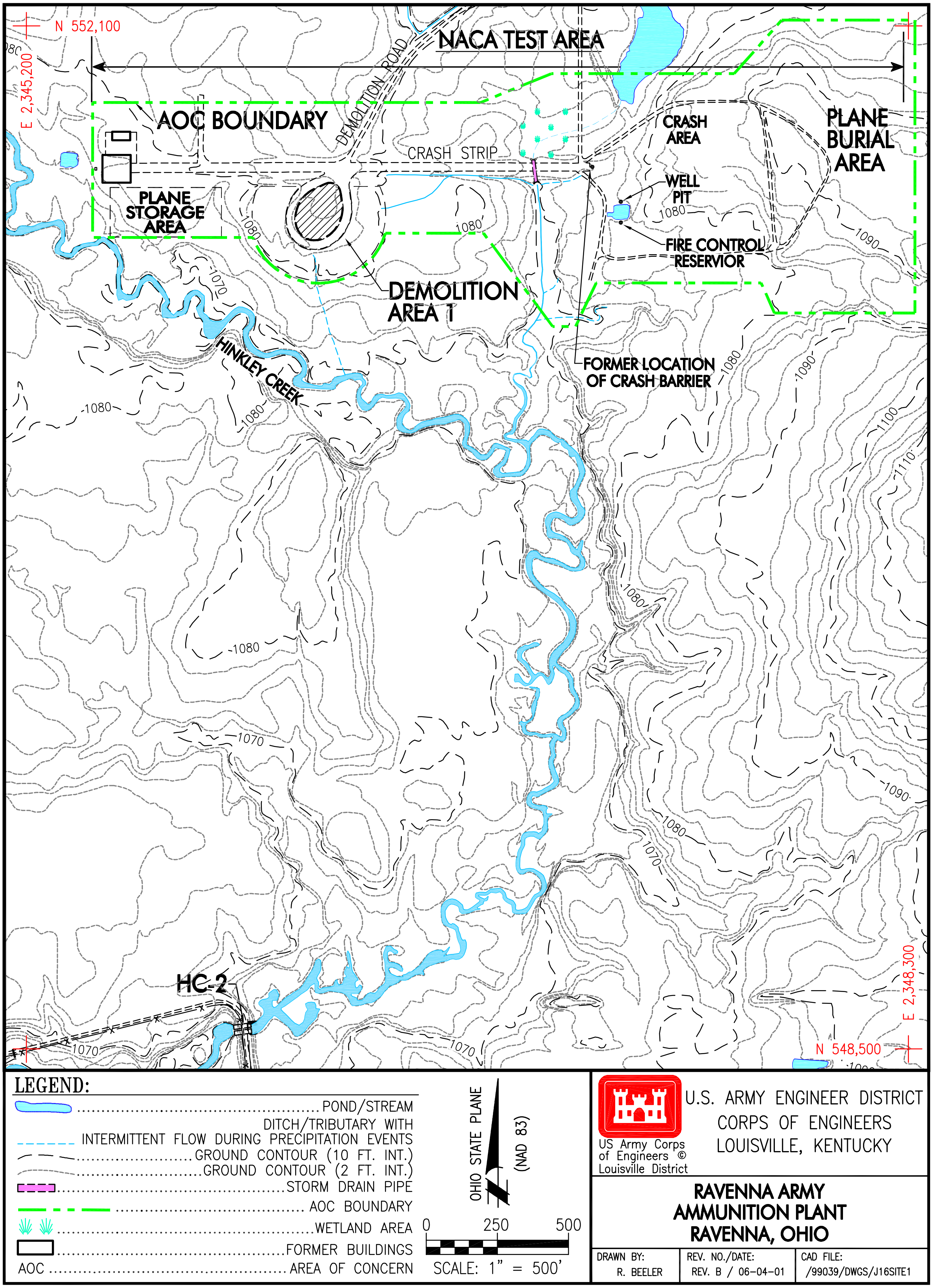


Figure 1-4. NACA Test Area Site Map

and metals from the adjacent DA1, which was in use before NTA was established. A Phase I RI for DA1 is being conducted concurrently with that for NTA.

1.3.2 Regulatory Status

NTA is currently considered a high-priority AOC for remedial investigation and possible cleanup, based upon current land use considerations (OHARNG training activities) and preliminary evidence of soil contamination discovered in the RRSE (USACHPPM 1996), as described in Section 1.3.3 below. Identification of a relative human health risk of “medium” to “high” at NTA and the need for less restricted land use are the bases for performing a Phase I RI. No other regulations [e.g., Resource Conservation and Recovery Act (RCRA), National Pollutant Discharge Elimination System (NPDES), etc.] pertain to past waste disposal and potential contamination at this AOC.

1.3.3 Previous Investigations at the NACA Test Area

Table 1-1 presents a summary of the results from previous investigations performed at NTA. As originally discussed in the Phase I RI SAP Addendum for NTA (USACE 1999a), two previous investigations have been conducted. These investigations include data from the Water Quality Surveillance Program (USATHAMA 1980-1992) and the RRSE (USACHPPM 1996). No groundwater sampling has been conducted prior to the Phase I RI. Figure 1-5 illustrates the locations and media sampled during these investigations.

The Water Quality Surveillance Program collected samples at nine locations throughout RVAAP. The data most relevant to NTA was collected from a large gauging station along Hinkley Creek downstream of the drainage area of NTA and DA1 at the southern RVAAP boundary (station HC-2; see Figure 1-4). All surface water that exits NTA intercepts Hinkley Creek and passes through station HC-2. However, the drainage from a large area in addition to NTA is added to the flow system prior to exiting through this station. Copper, chromium, hexavalent chromium, lead, zinc, 2,4,6-TNT, and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) were monitored annually in surface water between 1980 and 1992. Cadmium was added to the annual list of metal analytes between 1988 and 1992. Indicator parameters, such as pH, temperature, specific conductance, dissolved oxygen, oil and grease, total suspended solids, fecal coliform, and biochemical oxygen demand, were monitored quarterly. Total organic carbon (TOC), total Kjehldal nitrogen, nitrate, nitrite, and phosphorus were analyzed semiannually. Samples collected from HC-2 during the sampling period showed low concentrations of zinc, copper, and RDX on one occasion. Detection limits and analytical methods employed by this program changed over time. Therefore, results must be interpreted cautiously, particularly for older samples.

The RRSE for NTA included collection and evaluation of data from five soil samples and one sediment sample. These samples were collected in the crash area. It is not known whether these locations were biased to areas of obvious contamination. Samples were analyzed for VOCs, SVOCs, and metals. Many potential contaminants were identified in sediment, with fewer in the soils. However, most detections were below the RRSE risk-based evaluation criteria. Because no engineering or access controls were in place, exposure of potential human receptors was noted in the RRSE. On this basis, the overall relative risk attributed to surface soil was determined to be “medium.” Sediments were identified as a “moderate” risk.

Additionally, annual storm water sampling is conducted under an NPDES permit each fall at three facility outfalls, including HC-2 (Outfall 903). The samples are tested for toxicity to *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow) larvae. In addition, samples for chemical analyses for the following constituents are collected: (1) total metals (arsenic, barium, cadmium, chromium, lead, selenium, silver, magnesium, and mercury); (2) dissolved magnesium; (3) cyanide; (4) explosives; and

Table 1-1. Summary of Results of Previous Investigations at the NACA Test Area

Parameter	HC-2 Water Quality Surveillance (water, µg/L)[a]	RRSE (sediment, mg/kg)[b]	RRSE (soil, mg/kg)[b]
Arsenic	ND	3.9	12.7
Barium	ND	67.6	179
Cadmium	ND	<0.65	46
Chromium	ND	20.3	48.3
Copper	11	4.95	13.4
Zinc	31	44.2	53
RDX	4.8	NA	NA
Phenol	NA	3.8	<0.4
2-Chlorophenol	NA	3.6	<0.4
4-Chloro-3-methylphenol	NA	4	<0.4
1,3-Dichlorobenzene	NA	2	<0.4
1,4-Dichlorobenzene	NA	1.9	<0.4
2-Methylnaphthalene	NA	1.6	<0.4
Methylene chloride	NA	<0.005	12
n-Nitroso-di-n-proplyamine	NA	2.3	<0.4
1,2,4-Trichlorobenzene	NA	2.1	<0.4
Acenaphthene	NA	2	<0.4
2,4-Dinitrotoluene	NA	2.2	<0.4
4-Nitrophenol	NA	3.9	
Pentachlorophenol	NA	4.4	<0.81
Pyrene	NA	2.2	<0.4

[a] *Source*: USATHAMA (1980-1992). Values are maximum detected concentrations. Detection limits varied over time.

[b] *Source*: USACHPPM (1996). Values are maximum detected concentrations. Non-detects represent the lowest value among the sample population for each medium.

NA = Not analyzed.
ND = Not detected.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RRSE = Relative risk site evaluation.

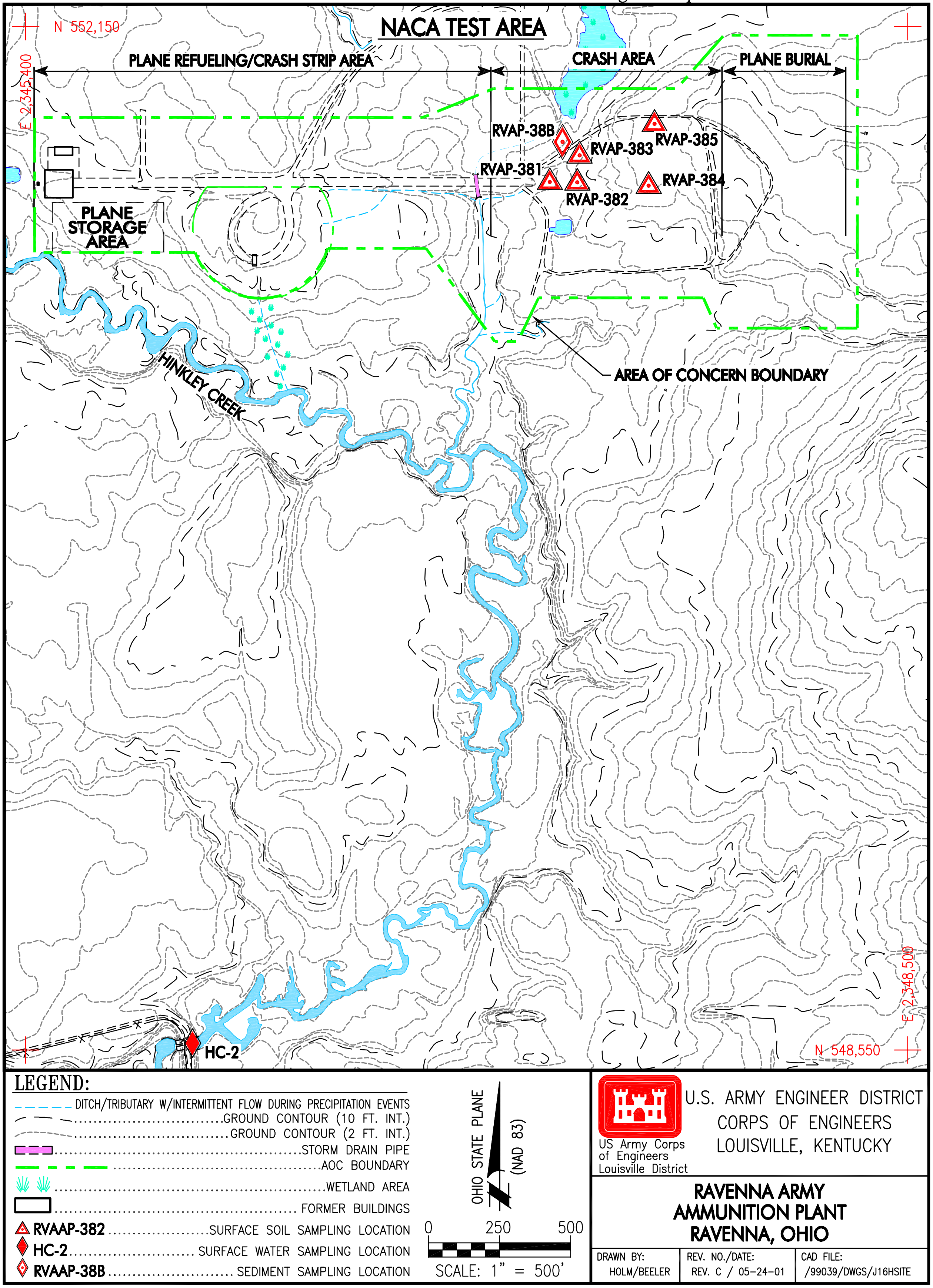


Figure 1-5. Historical Sampling Locations for the NACA Test Area

(5) selected anions and nonspecific indicator parameters (pH, oil and grease, chemical oxygen demand, total nitrogen, total organic carbon, and total dissolved solids).

Results of the most recent annual sampling event (August 2000) at Outfall 903 show that storm water toxicity endpoints all passed. No explosives were detected. The detected metals included arsenic (9.0 µg/L), barium (38 µg/L), chromium (6.8 µg/L), and magnesium (total result = 14,000 µg/L). Of these four detected metals, arsenic and magnesium exceeded their respective facility-wide background criteria (3.2 µg/L and 10,800 µg/L, respectively). Chromium was not detected in the facility-wide background data set; therefore, any detected values are considered to be above background.

1.3.4 Chemicals of Potential Concern

Based on available process knowledge and previous investigation results, the anticipated primary chemicals of potential concern (COPCs) include inorganics (metals), SVOCs, and VOCs. Explosives, such as TNT, and associated degradation products (e.g. 2,4-DNT) and propellants are not directly related to past operations of NTA, but they may exist along a portion of the crash strip due to previous operations at DA1. Operational data suggest that the anticipated primary COPCs may include those shown in Table 1-2. These COPCs represent constituents encountered in the burning of fossil fuels and associated aircraft fluids and components. Explosives and propellants are denoted due to the demolition and thermal treatment of explosives and explosive wastes in the adjacent DA1. From the COPCs identified in this Phase I RI, a subset of chemicals of concern (COCs) may be developed based on the human health and ecological risk screening evaluations.

1.3.5 NTA Phase I RI Data Quality Objectives

Process knowledge, historical records, and previous investigation results were used to design the Phase I RI effort using the DQO approach presented in the Facility-Wide SAP. The DQOs were presented in detail in the Phase I RI SAP Addendum for NTA (USACE 1999a). A summary of the DQOs is presented below for reference purposes in this report.

1.3.5.1 Source area soil

Previous analytical evidence for source contamination (i.e., soil) is inconclusive and incomplete for NTA. Available data show potential impacts due to metals (barium, cadmium, and chromium) within the crash area. The crash strip and plane storage areas were not sampled prior to this Phase I RI. Subsurface soil was not sampled within the AOC prior to the current investigation. Based on the available operational information, all sub-areas within NTA were deemed in need of characterization. A grid sampling approach was selected as the best method to adequately characterize soil. Contingency samples were selected for biased sampling in areas of bare soil or in locations having visible debris.

1.3.5.2 Sediment

Low-lying areas were identified as the most likely sites from contaminant accumulation due to transport of eroded soil in storm runoff. Also, sediment may function as a transport mechanism because contaminants adsorbed to particulates can be mobilized by surface water flow. Most of the AOC is slightly elevated relative to its immediate surroundings. Drainage within the AOC generally flows south, beginning with a wetland area/pond north of the crash area, which drains through two 20-inch diameter culverts beneath the runway that feed an unnamed tributary located south of the runway (Figure 1-4). The wetland area north of the runway is fed, in part, by a culvert draining a portion of the area along the north side of Demolition Road. An upgradient (upstream) sample was collected at the culvert, as well as within the drainage ditch along the north side of Demolition Road. The tributary draining the AOC to the south

Table 1-2. Chemicals of Potential Concern at the NACA Test Area

Chemical Group	Chemical	Rationale
Explosives	TNT	Munitions explosive
	DNT	Munitions explosive
	RDX	Munitions explosive
	HMX	Munitions explosive
	Trinitrobenzene	Associated with explosives
	Dinitrobenzene	Associated with explosives
	Nitrobenzene	Associated with explosives
	Nitrotoluene	Associated with explosives
Propellants	Nitroglycerine	Associated with explosives
	Nitroguanidine	Associated with explosives
	Nitrocellulose	Associated with explosives
Metals[a]	Arsenic	Previously detected
	Aluminum	Munitions booster cups; common fuze casings are made of aluminum
	Barium	Previously detected
	Cadmium	Previously detected; plating of many small metallic munitions components and all metallic shipping components for rust prevention
	Chromium	Common to munitions processing; previously detected
	Copper	Previously detected; common munitions (propellant) casings are made of brass (69 percent copper, 30 percent zinc)
	Lead	Common to munitions processing; previously detected at other AOCs
	Manganese	Previously detected at other AOCs
	Mercury	Previously detected at other AOCs
	Selenium	Previously detected at other AOCs
	Silver	Common to munitions processing
	Zinc	Previously detected
VOCs	---	Associated with aircraft releases; previously detected
	Bromochloromethane	Fire suppression agent
SVOCs	PAHs	Associated with aircraft releases; previously detected
PCBs	---	Associated with aircraft components
Pesticides	---	Associated with industrial processes

[a] Most common projectile casings are made of steel.
AOC = Area of concern.
DNT = Dinitrotoluene.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
PAH = Polynuclear aromatic hydrocarbon.
PCB = Polychlorinated biphenyls.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
SVOC = Semivolatile organic compound.
TNT = Trinitrotoluene.
VOC = Volatile organic compound.

flows into Hinkley Creek. This tributary, which also receives a portion of the drainage from the DA1 vicinity, was sampled at its confluence with Hinkley Creek. Runoff in the eastern-most portion of the AOC drains directly into Hinkley Creek. A biased sample was collected from Hinkley Creek at about 122 meters (400 feet) south of the AOC as part of the DA1 Phase I RI to determine if contaminant migration to this receptor has occurred. Station HC-2 on Hinkley Creek at the facility boundary was sampled as part of the DA1 Phase I RI to provide current data on potential impacts to sediment at the facility exit point.

1.3.5.3 Surface water

Historical surface water sampling of tributaries and Hinkley Creek in the vicinity of NTA has not been performed. As denoted for sediment above, the most likely points to observe surface water contamination are within the tributary to Hinkley Creek south of the NTA. All of these areas were targeted for surface water sampling, provided sufficient water was available. Also, surface water was sampled at station HC-2 to provide current data on surface water quality downstream of DA1 and NTA.

1.3.5.4 Groundwater

Analytical evidence for source area (soil) contamination was obtained during the RRSE. However, potential site-related contaminants (SRCs) based on operations history (e.g., inorganics, SVOCs, and VOCs) are readily attenuated or have low mobility in groundwater. Therefore, the investigation of potential impacts to groundwater was limited in the Phase I RI until more source area data were collected. One groundwater screening sample from a deep soil boring in the central portion of the crash area was identified to provide a general indication of whether leaching of soil contaminants has occurred at the AOC. The potential for leaching to groundwater is also evaluated in this Phase I RI Report using conservative soil leaching screening criteria from the U.S. Environmental Protection Agency (EPA) (see Chapter 5.0).

1.4 REPORT ORGANIZATION

This Phase I RI is organized to meet Ohio EPA requirements in accordance with CERCLA and USACE guidance. The report consists of an Executive Summary, Chapters 1.0 through 7.0, and supporting appendices. Chapter 1.0 describes the purpose, objectives, and organization of this report and provides a description and history of NTA. Chapter 2.0 describes the environmental setting at RVAAP and NTA, including the geology, hydrogeology, climate, population, and ecological resources. Chapter 3.0 describes the specific Phase I RI methods used for field data collection and describes the approach to analytical data management and laboratory programs. Chapter 4.0 presents the data generated during the Phase I RI and discusses the occurrence and distribution of contamination at the NTA. Chapter 5.0 includes the methodology and results of the human health and ecological risk evaluations. Chapter 6.0 summarizes the results and conclusions of this study. Chapter 7.0 provides a list of referenced documents used to support this Phase I RI.

Appendices (A through I) to the Phase I RI for NTA contain supporting data collected during the Phase I RI. These appendices consist of soil and Geoprobe groundwater sampling logs, sediment and surface water sampling logs, a project quality assurance summary, data quality assessment, analytical results, a topographic survey report, ordnance and explosive (OE) avoidance survey report, investigation-derived waste management report, and geotechnical laboratory data, respectively.

2.0 ENVIRONMENTAL SETTING

This section describes the physical characteristics of NTA and the surrounding environment that are important for understanding the potential contaminant transport pathways, risk receptors, and exposure scenarios. Site-specific data collected during the Phase I RI and observations made in the field, as well as local and regional information, are used to refine the SCM, the basic framework of which was presented in the SAP Addendum for the NTA Phase I RI (USACE 1999a). The refined SCM, containing interpretive conclusions, is presented in Chapter 6.0.

2.1 PHYSIOGRAPHIC SETTING

RVAAP is located within the Southern New York Section of the Appalachian Plateaus physiographic province (USGS 1968). This province is characterized by elevated uplands underlain primarily by Mississippian- and Pennsylvanian-age bedrock units that are horizontal or gently dipping. The province is characterized by its rolling topography with incised streams having dendritic drainage patterns. The Southern New York Section has been modified by glaciation, which rounded ridges, filled major valleys, and blanketed many areas with glacially derived unconsolidated deposits (e.g., sand, gravel, and finer-grained outwash deposits). As a result of glacial activity in this section, old stream drainage patterns were disrupted in many locales, and extensive wetland areas developed.

2.2 SURFACE FEATURES AND SITE TOPOGRAPHY

NTA is situated in the southwestern quadrant of the RVAAP facility, as shown in Figure 1-2. The topography of NTA was mapped by the USACE in 1998 on a 0.6-meter (2-foot) contour interval, with an accuracy of 0.006 meter (0.02 foot), from aerial photographs taken in 1997. This survey is the basis for the topographic features presented in the figures in this Phase I RI Report. Elevations vary from approximately 326 meters (1,070 feet) on the west to approximately 333 meters (1,094 feet) above mean sea level (amsl) on the east end of the AOC. Topographic relief at the NTA is low, with most of the relief [from 333 to 372 meters (1,072 to 1,094 feet)] occurring at the east end of the AOC in the crash and plane burial areas (Figure 1-4). The area occupied by the crash strip is level. Low-lying wetland areas exist both to the north between the crash area and Demolition Road and along the south edge of the plane burial area. An upland area to the southeast of the plane burial area rises to an elevation of about 335 meters (1,100 feet) amsl. Figure 2-1 illustrates site conditions at the time of NTA operations. Figure 2-2 illustrates conditions at the time of the Phase I RI field effort in October – November 1999.

Remaining cultural features at NTA consist only of the concrete crash strip and footings of the former operations buildings at the western end of the crash strip. A concrete-walled well pit and small surface water reservoir exist immediately southeast of the terminus of the crash strip. The former steel-cased production well within the well pit was open at the time of the Phase I RI investigation. The depth of the well was estimated in the field at about 23.8 meters (78 feet); the depth to water was 3.35 meters (11.0 feet) below ground surface (bgs). Other than the wetland areas noted above, mature hardwood forest surrounds most of the AOC. Some dense scrub vegetation exists in the eastern-most portion of the plane burial area, as well as along the southern access road in the crash area.

Surface water drainage within most of the NTA converges toward the center of the AOC and exits to the south via a tributary to Hinkley Creek. In the western-most portion of the AOC, surface runoff flows directly toward Hinkley Creek, which intersects the southwest corner of the former refueling/catapult

Figure 2-1. Photo of NTA Operations
(Photo of fuel tank test in progress, circa 1947-1953)

area. Along the northernmost portion of the crash area and plane burial area, drainage is toward the wetland north of the crash area and ditch lines along Demolition Road. Hinkley Creek exits RVAAP at the south perimeter fence, about halfway between Greenleaf Road and Route 80. Although the exit point and Hinkley Creek are not within the AOC boundary proper, they are included in the Phase I RI in order to determine whether potential contamination is migrating beyond the AOC boundary.

2.3 SOIL AND GEOLOGY

2.3.1 Regional Geology

Regional geology in the vicinity of RVAAP consists of horizontal to gently dipping sedimentary rocks of Mississippian- to Pennsylvanian-age, overlain by varying thicknesses of unconsolidated Pleistocene glacial deposits. Both the bedrock and glacial geology at RVAAP and geology specific to NTA are presented in this section.

Figure 2-2. Photo of Current NTA Site Conditions (October 1999)
(View of the crash strip to the east. Crash area is the open, grass-covered area in the background.)

2.3.1.1 Soil and glacial deposits

Bedrock at RVAAP is overlain by deposits of the Wisconsin-age Lavery Till in the western portion of the facility and the younger Hiram Till and associated outwash deposits in the eastern portion (ODNR 1982). Unconsolidated glacial deposits vary considerably in their character and thickness across RVAAP. In the suspected buried bedrock valley that trends northeast–southwest through the installation (Figure 2-3), the thickness of the glacial deposits may exceed 45 meters (150 feet).

Thin coverings of glacial materials have been completely removed as a consequence of human activities at many locations, such as Ramsdell Quarry and Load Line 1 (USACE 1999b). Where these glacial materials are present, their distribution and character indicate their origin as ground moraine. These tills consist of laterally discontinuous assemblages of yellow-brown, brown, and gray silty clays to clayey silts with sand and rock fragments. Deposits from standing water bodies may also have been encountered in the form of >15-meter- (50-foot)-thick deposits of uniformly light gray silt (USACE 1999c).

According to ODNR 1982, NTA is situated near the approximate eastern limit of Lavery Till surficial deposits. A suspected pre-glacial bedrock valley may lie in the vicinity of NTA. On this basis, glacial materials in the AOC are suspected to be very thick. The Lavery Till is a clayey silty till; in general, it contains about 28 percent sand and 30 percent clay, but the percentages vary. The Lavery Till contains

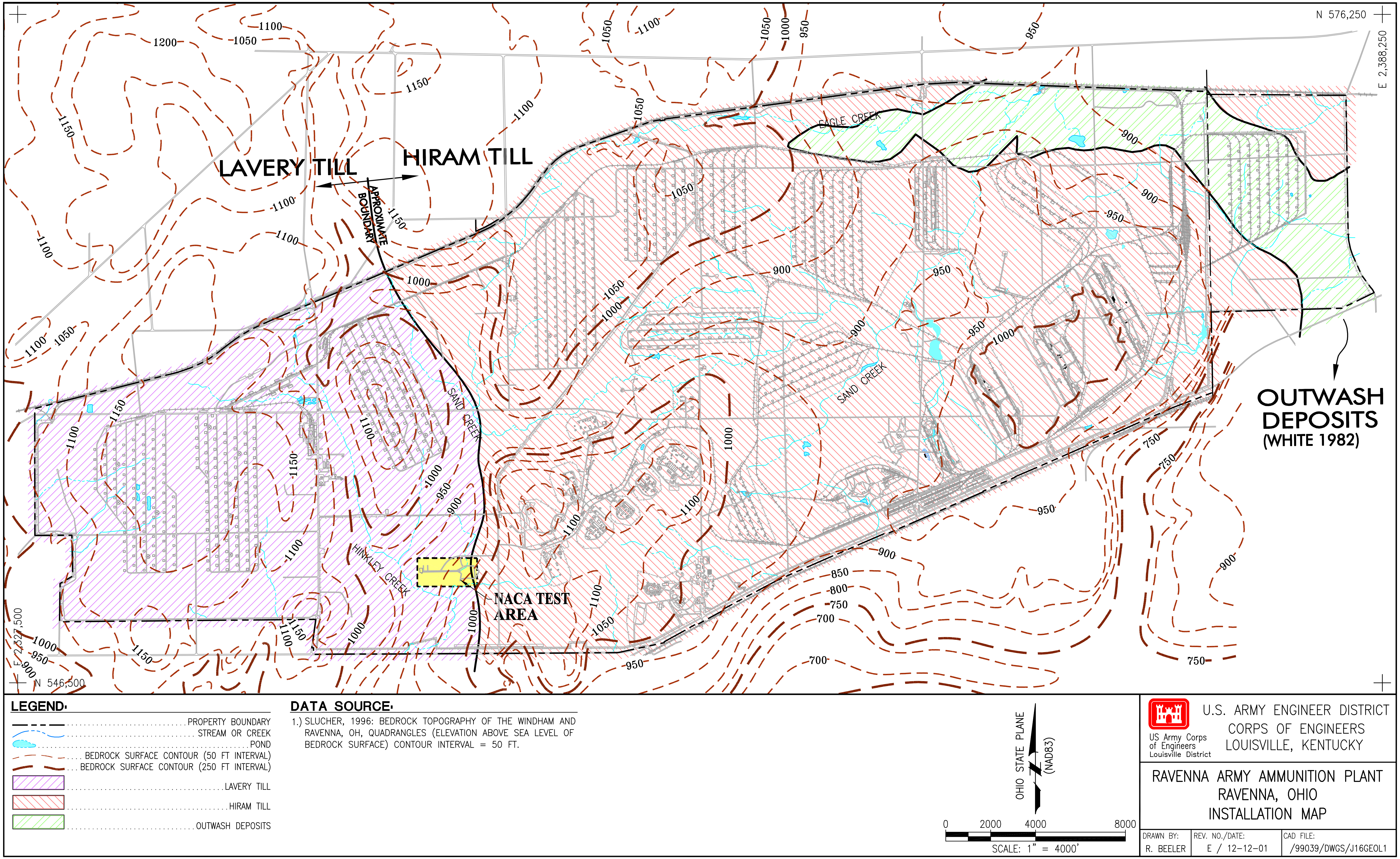


Figure 2-3. Geologic Map of Unconsolidated Deposits on RVAAP, Superimposed on Bedrock Surface Map

only a few cobbles and boulders. Pebbles in the Lavery Till are flat angular pieces of shale and siltstone. The till is rich in calcium. Unweathered Lavery Till is dark gray, and it weathers to dark brown. Surficial weathering of the till results in a very pebbly, almost gravely material.

Soil at RVAAP is generally derived from the silty clay glacial till that overlies bedrock. Distributions of soil types are discussed and mapped in the *Soil Survey of Portage County, Ohio* (USDA 1978). According to this survey, the major soil types found in the high-priority AOCs are silt or clay loams with permeabilities ranging from 6.0×10^{-7} to 1.4×10^{-3} cm/s.

2.3.1.2 Bedrock stratigraphy

The Pennsylvanian Pottsville Formation unconformably overlies the eroded Cuyahoga Formation throughout RVAAP. The Connoquennessing, Mercer, and Homewood Members of the Pottsville Formation are known to underlie the western half of the installation. The Sharon Member is not present in this area.

The Connoquennessing Member is a coarse, gray sandstone with thin interbeds and partings of sandy shale. The Mercer Member overlies the Connoquennessing and consists of silty to carbonaceous shale with thin, discontinuous sandstone lenses. The Homewood Member, which unconformably overlies the Mercer Member, consists of coarse-grained, cross-bedded sandstone.

2.3.2 Geologic Setting of the NACA Test Area

More than 100 soil and sediment boring locations were sampled as part of the Phase I RI of NTA. Information from these borings is used to characterize the surface and subsurface geology of NTA and to develop a conceptual site model. The limitations of these data for this purpose are as follows.

- Minimal geologic information was collected below a depth of 0.9 meter (3 feet) bgs. Unconsolidated zone stratigraphic data were obtained from one Geoprobe boring installed to a depth of 9.14 meters (30 feet) in the central portion of the crash area.

- It is assumed that surface soil was substantially reworked in the course of preparing the site for use as crash test area and during the removal or burial of damaged airframes.

- Bedrock was not penetrated in any of the soil borings.

2.3.2.1 Soil

At NTA, soil of the Mahoning series is dominant. These soil types consist of deep, somewhat poorly drained, nearly level to gently sloping soil that formed in silty clay loam or clay loam glacial till (USDA 1998). The permeabilities of these soil types were measured in the laboratory and range from 6.56×10^{-5} cm/sec to 1.41×10^{-3} cm/sec (0.6 to 2.0 in./hr) in the upper 23 centimeters (9 inches) to 2.19×10^{-5} to 6.56×10^{-5} cm/sec (0.2 to 0.6 in/hr) below 23 centimeters (9 inches). In addition, soil of the Fitchville Series silt loam (FcB) exists along the southern portion of the crash strip at DA1. The *Soil Survey of Portage County, Ohio* (USDA 1978) describes this soil type as gently sloping, somewhat poorly drained, and formed from silty, water-deposited sediment. This soil type typically exhibits low strength, is soft and compressible when wet, and has low permeability similar to that of the Mahoning series.

Based on Phase I RI field data, the typical soil types encountered at NTA are silts and lean clays that contain varying proportions of sand. Silt containing organic matter and sand was commonly observed in the top 0.46 to 0.61 meter (1.5 to 2.0 feet) of the soil column. Gravel and debris fragments encountered in this interval suggest that the area has been extensively reworked. Lean clays with infrequent pebbles and mottled zones were encountered below 0.61 meter (2 feet) bgs. The area near the end of the crash strip and the area immediately to the south are poorly drained; soil in this area is yellowish-brown clay. Geotechnical data for soil and sediment collected during the Phase I RI are presented in Chapter 4.0 and Appendix F of this report.

2.3.2.2 Bedrock geology

Bedrock elevations in the vicinity of NTA are unknown. No outcrops were observed at NTA or in nearby Hinkley Creek during the Phase I RI, and no soil borings penetrated rock in situ. Determination of depth to bedrock and bedrock lithology was not part of the scope of this Phase I RI.

2.4 HYDROLOGY

2.4.1 Regional Hydrogeology

Sand and gravel aquifers are present in the buried-valley and outwash deposits in Portage County as described in the *Phase I Remedial Investigation Report for 11 High-Priority Sites at RVAAP* (USACE 1997). Generally these saturated zones are too thin and localized to provide large quantities of water for industrial or public water supplies. However, they are sufficient for residential water supplies. Lateral continuity of these aquifers is not known. Recharge of these units comes from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at RVAAP have not been delineated.

Hydraulic conductivity measurements (slug tests or pump tests) were not collected during the Phase I RI at NTA. The closest sites to NTA having hydraulic data include Winklepeck Burning Grounds (WBG) and Load Line 1 in the central and eastern portions of RVAAP, respectively. Data from these two sites show moderately high, horizontal hydraulic conductivities within the unconsolidated materials. Hydraulic conductivities measured during the Phase II RI at WBG range from 3.87×10^{-2} to 5.65×10^{-4} cm/sec. However, these values may not be representative of the facility as a whole.

2.4.2 NACA Test Area Hydrogeologic Setting

Characterization of the groundwater regime through monitoring well installation and sampling was not part of the scope of this Phase I RI. Subsurface hydrogeologic conditions at NTA are inferred from surface topography, surface water flow, and soil conditions. The depth to the water table was measured at 5.1 meters (16.6 feet) within a geoprobe boring (NTA-38) installed in the central portion of the crash area. Groundwater was encountered in this piezometer within an unconsolidated sandy silt, which persisted at least to a depth of 7.3 meters (24 feet) bgs. The water table surface was also measured in the former production well at about 3.35 meters (11.0 feet) bgs. The depth to the water table in a piezometer installed at DA1 (station DA1-27) about 427 meters (1,400 feet) west of NTA-038 was 4.83 meters (15.85 feet). Using approximate ground elevation data from the topographic base map, the corresponding water table elevations decrease from about 325.8 meters (1,069 feet) in the crash area to about 324.6 meters (1,065 feet) at the well pit and DA1. The southward-flowing drainage swale (topographic low) between the crash area and DA1 may constitute a minor groundwater divide.

In general, shallow groundwater in the unconsolidated glacial material is suspected to flow across the AOC from north–northeast to south–southwest, following the surface water and topographic trends. However, other factors may have a greater influence on groundwater movement (e.g., confining units, recharge areas, etc.). Because of the potential presence of a regional buried bedrock valley beneath the

AOC, it is likely that multiple deeper saturated zones are present in the glacial materials. Any deeper groundwater is likely to flow down the buried valley, i.e., to the southwest, and off the RVAAP property. However, it is unknown whether permanent saturated zones are present or continuous across the AOC.

2.5 CLIMATE

RVAAP has a humid continental climate characterized by warm, humid summers and cold winters. Precipitation varies widely throughout the year. The driest month is, on average, February, and the wettest month is July. Data from the National Weather Service compiled over the past 47 years indicate that the average rainfall for the area is 0.98 millimeter (38.72 inches) annually. The average snowfall is 1.1 millimeters (43.4 inches) annually. Severe weather, in the form of thunder, hail, or snow storms, is common in summer and winter. Tornadoes are infrequent in Portage County.

The Phase I RI was conducted after an extremely dry summer that was part of a prolonged dry period in northeastern Ohio. Therefore, groundwater and surface water conditions encountered during the RI are suspected to be lower than those under normal conditions.

2.6 POTENTIAL RECEPTORS

This Phase I RI includes an evaluation of potential risks to human receptors from exposure to contaminants in surface soil, subsurface soil, sediment, and surface water. Risks to ecological receptors from exposure to sediment and surface water are also evaluated (Chapter 5.0). This section describes potential receptor populations in the NTA vicinity based on current land use and site conditions.

2.6.1 Human Receptors

RVAAP is located in a primarily rural area. Based on data from the 1990 U.S. Census and the Portage County Soil and Water Conservation District Resource Inventory (1985), approximately 55 percent of Portage County, in which the majority of the RVAAP acreage lies, consists of either woodland or farmland. The population centers located closest to RVAAP include the city of Ravenna (2000 population 11,771), located about 3.2 kilometers (3 miles) from the western boundary in Portage County, and the city of Newton Falls (2000 population 5,002), located about 1.6 kilometers (1 mile) from the southeastern site boundary in Trumbull County. The Michael J. Kirwan Reservoir (also known as the West Branch Reservoir) is the closest major recreational area and is located adjacent to the western half of RVAAP south of State Route 5.

RVAAP is not accessible to the general public. The facility is completely fenced and patrolled by security personnel. Approximately 14 OSC and full-time operating contractor staff (i.e., security, grounds, and maintenance workers) are located on-site. Additional subcontractor staff are on-site for varying periods of time, ranging from several weeks to more than 12 months to complete specific demolition/ decommissioning projects. Training activities under the OHARNG involve an average of 4,500 personnel during the course of a month, who are typically on-site for periods of two weeks (annual training) or three days (inactive duty or weekend training).

Potential human receptors at NTA include OHARNG personnel, maintenance workers, security staff, and infrequent trespassers. The AOC is categorized as restricted entry. The DA1 boundary, contained within NTA, is marked with Seibert stakes. No physical barriers (i.e., fencing or gates) block access. The site is off-limits to recreational users such as hunters. There are no residents at the site or within 914 meters (3,000 feet) of the site. OHARNG personnel conduct limited dismounted training within the AOC boundary of NTA as described in Chapter 1.0 of this RI Report. Groundskeeping is limited to periodic mowing (tractor-mounted equipment) and hand-clearing of the open areas. Security activities consist primarily of drive-through surveillance.

2.6.2 Ecological Receptors

The dominant types of vegetative cover at RVAAP, including NTA and its immediate surroundings, are forests and old fields of various ages. More than 80 percent of RVAAP is now in forest. Most of the old field cover is the result of earlier agricultural practices that left these sites with poor topsoil, which limits forest regeneration. Several thousand acres of agricultural fields were planted in trees during the 1950s and 1960s, but these plantings were not successful in areas with poor topsoil. Some fields, leased for cattle grazing during the same time period, were delayed in their reversion to forest. A few fields have been periodically mowed, maintaining them as old field, and 36 hectares (90 acres) are leased as hay fields (Morgan 1999). DA1 is covered with grass that is periodically mowed as part of routine maintenance activities.

From one-half to two-thirds [4,046 to 6,070 hectares (10,000 to 15,000 acres)] of RVAAP's land area meets the regulatory definition of jurisdictional wetland. Wetland areas at RVAAP include seasonally saturated wetlands, wet fields, and forested wetlands. Most of these wetlands exist because of the presence of poorly drained and hydric soils. Beaver impoundments contribute to wetland diversification in some parts of the site. Some wetland areas exist within the NTA boundary, and a forested wetland area occurs south of the AOC within the headwaters of the tributary draining to Hinkley Creek.

The flora and fauna present at RVAAP are varied and widespread. No federal threatened or endangered or candidate threatened or endangered species have been observed on RVAAP. A list of state endangered, state threatened or potentially threatened, and state special interest species confirmed to be on RVAAP is provided on Table 2-1 (Morgan 2000). Additionally, five rare plant communities/significant natural areas have been identified on RVAAP, including the northern woods, Wadsworth Glenn, Group 3 woods, B&O Wye Road area, and South Patrol Road swamp forest.

Restricted land use and sound forest management practices have preserved and enabled large forest tracts to mature. Habitat conversion at RVAAP, unlike most other habitat conversions occurring nationwide, has been toward restoration of the forests that covered the area prior to its being cleared for agriculture. The reversion of these agricultural fields to mature forest provides a diversity of habitats from old field through several successional stages. Overall, the trend toward forest cover enhances the area for use by forest species, both plant and animal. There are no federal, state, or local parks or protected areas on RVAAP property.

Table 2-1. RVAAP Rare Species List as of April 19, 2000

A. State Endangered
  1. Northern harrier, *Circus cyaneus*
  2. Common barn owl, *Tyto alba*
  3. Yellow-bellied sapsucker, *Sphyrapicus varius*
  4. Mountain brook lamprey, *Ichthyomyzon greeleyi*
  5. Graceful underwing, *Catocala gracilis*
  6. Ovate spikerush, *Eleocharis ovata* (Blunt spike-rush)
  7. Lurking leskea, *Plagiothecium latebricola*
  8. Northern river otter, *Lutra canadensis*
  9. Little blue heron, *Egretta caerulea* (suspected)
  10. American bittern, *Botaurus lentiginosu* (migrant)
  11. Canada warbler, *Wilsonia canadensis* (migrant)
  12. Osprey, *Junco hyemalis* (migrant)
  13. Trumpeter swan, *Cygnus buccinator* (migrant)
  14. Little blue heron, *Egretta caerulea* (migrant)

B. State Threatened
  1. Simple willow-herb, *Epilobium strictum*

C. State Potentially Threatened
  1. Gray birch, *Betula populifolia*
  2. Round-leaved sundew, *Drosera rotundifolia*
  3. Closed gentian, *Gentiana clausa*
  4. Butternut, *Juglans cinerea*
  5. Blunt mountain-mint, *Pycnanthemum muticum*
  6. Northern rose azalea, *Rhododendron nudiflorum* var. *roseum*
  7. Large cranberry, *Vaccinium macrocarpon*
  8. Hobblebush, *Viburnum alnifolium*
  9. Long beech fern, *Phegopteris connectilis*
  10. Woodland horsetail, *Equisetum sylvaticum*
  11. Weak sedge, *Carex debilis* var. *debilis*
  12. Straw sedge, *Carex straminea*
  13. Water avens, *Geum rivale*
  14. Tall St. John’s wort, *Hypercium majus*
  15. Swamp oats, *Sphenopholis pensylvanica*
  16. Shining ladies’-tresses, *Spiranthes lucida*

D. State Special Interest
  1. Sora, *Porzana carolina*
  2. Virginia rail, *Rallus limicola*
  3. Four-toed salamander, *Hemidactylium scutatum*
  4. Smooth green snake, *Opheodrys vernalis*
  5. Woodland jumping mouse, *Napaeozapus insignis*
  6. Sharp-shinned hawk, *Accipiter striatus*
  7. Solitary vireo, *Vireo solitarius*
  8. Pygmy shrew, *Sorex hoyi*
  9. Star-nosed mole, *Condylura cristata*
  10. Red-shouldered hawk, *Buteo lineatus*
  11. Henslow’s sparrow, *Ammodramus henslowii*
  12. Cerulean warbler, *Dendroica cerulea*
  13. Common moorhen, *Gallinula chloropus*
  14. Eastern box turtle, *Carolina carolina*
  15. *Capperia evansi* (moth)
  16. *Zanclognatha martha* (moth)
  17. *Oligia bridghami* (moth)
  18. *Chaetaglaea sericea* (moth)
  19. *Sutyna privata* (moth)
  20. *Homorthodes frufurata* (moth)

Source: Morgan (2000).

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3.0 STUDY AREA INVESTIGATIONS

This chapter presents information on locations and rationale of samples collected during the field effort and provides a synopsis of the sampling methods employed during the investigation. Field activities were conducted from October 18 to November 4, 1999. Specific notation is made where site conditions required a departure from planned activities in the NTA Phase I RI SAP Addendum. Information regarding field decontamination methods, sample container types, preservation techniques, sample labeling, chain of custody, and packaging and shipping requirements implemented during the field investigation may be found in the Facility-wide SAP and the NTA Phase I RI SAP Addendum.

In order to organize and track sampling efforts for the Phase I RI at NTA, the AOC was separated into eight functional areas based on site characteristics, operational data, available maps, and historical aerial photographs. These functional areas and a summary of the environmental matrices that were sampled within each are listed in Table 3-1 and illustrated on Figure 3-1. Investigation of former plane storage areas near DA1, and of DA1 itself, were conducted under the separate, concurrent Phase I RI for that AOC.

Table 3-1. Phase I RI Functional Areas at the NACA Test Area

Area No.	Description	Sample Matrices
1	Crash Area	Surface soil
2	Plane Burial Area	Surface soil/subsurface soil
3	Plane Refueling/Crash Strip Area	Surface soil/subsurface soil
4	Ditches Flowing from the Crash Area	Surface soil (dry sediment)
5	Crash Area Well Pit	Sediment and surface water
6	Crash Area Reservoir	Sediment and surface water
7	Headwaters of Tributary to Hinkley Creek	Sediment and surface water
8	Drainage Conveyances North (Upstream) of NTA	Sediment and surface water
9	Tributary Junction at Hinkley Creek	Sediment and surface water

Functional areas 1 through 3 were sampled to characterize potential residual sources resulting from former site operations and disposal of aircraft debris on-site. Additionally, selected samples were analyzed for explosives and propellants considering the potential for dispersion of this class of contaminants beyond the immediate boundary of DA1, which is within the former operational area of NTA. Functional area 4 was sampled to evaluate potential accumulation of contaminants within the ditch lines draining the lowest lying portions of the crash strip and crash area near the former aircraft impact barrier. The crash area well pit and reservoir were sampled to evaluate potential accumulation of contaminants from inflow of storm runoff. Area 8 was sampled to provide representation of ambient conditions along the surface water conveyance traversing the central portion of NTA from north to south. Samples collected along the tributary to Hinkley Creek that drains NTA and flows south (Areas 7 and 9) provided characterization of the principal surface water exit pathway from the site.

3.1 TOPOGRAPHIC SURVEY

A topographic survey was conducted between November 1 and November 5, 1999, by Adams Craft Herz Walker, Inc. to locate all soil and sediment/surface water sampling points at NTA. All stations except one were located with traditional survey methods. Station NTA-106 was located directly with Global Positioning System technology. Horizontal and vertical controls were based on existing benchmarks

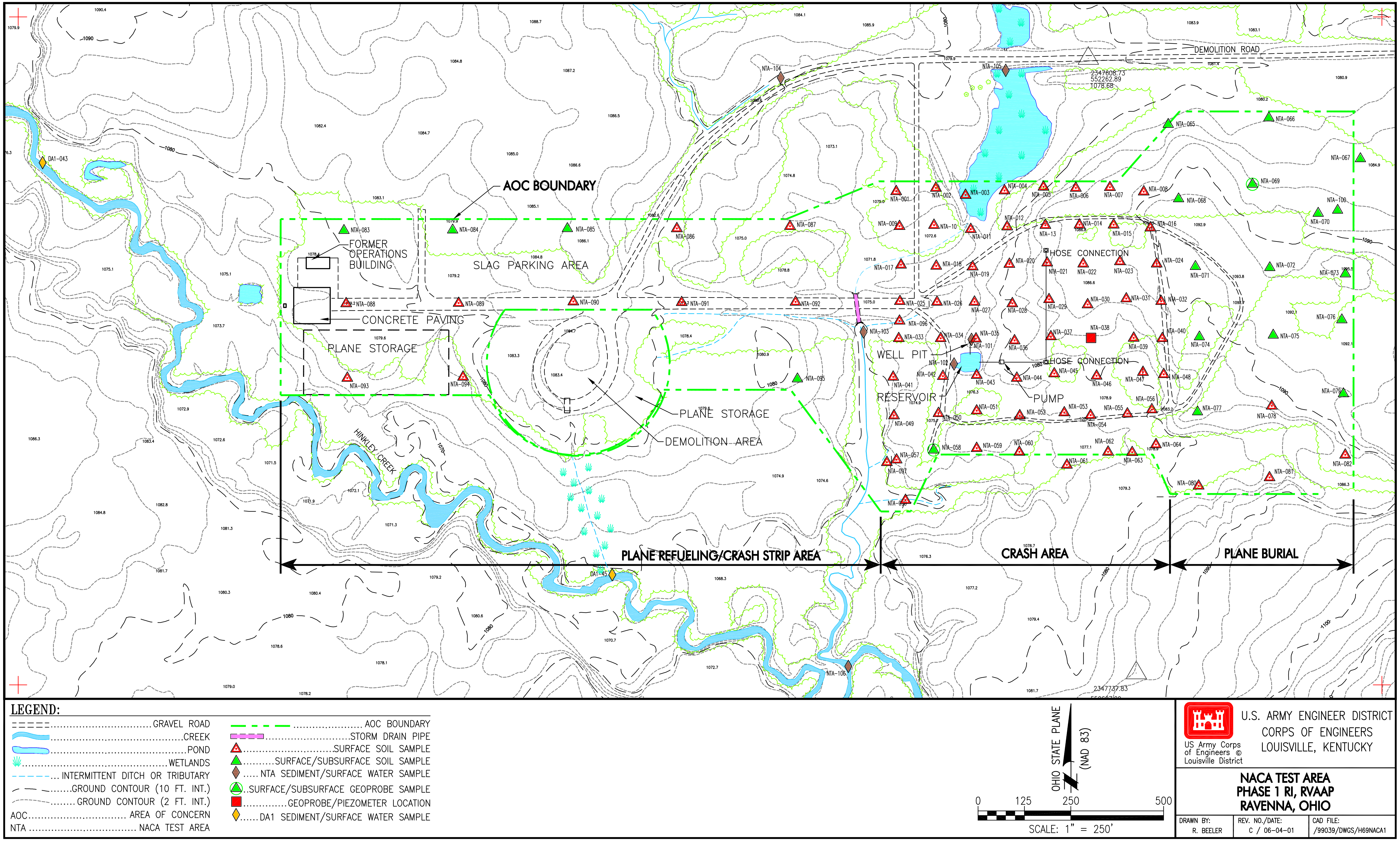

Figure 3-1. NACA Test Area Phase I RI Sampling Locations

RAV 4 and RAV 5, for which coordinates and elevations were provided by the USACE. All supporting documentation for the topographic survey can be found in Appendix F.

3.2 OE AVOIDANCE AND FIELD RECONNAISSANCE

OE technicians were required only for sampling within the plane refueling/crash strip area due to the proximity to DA1. The OE Team Leader led an initial safety briefing to train all field personnel to recognize and avoid propellants and OE. Daily tailgate safety briefings included reminders regarding OE avoidance. Site visitors were briefed on OE avoidance prior to being permitted into the AOC.

Prior to the start of sampling activities, access routes to all soil sample locations within the plane refueling/crash strip area were cleared for potential OE. Clearance was done using visual surveys and hand-held magnetometers. The OE team, accompanied by the USACE technical representative and SAIC technical manager, verified that the proposed sample location was anomaly-free, using a magnetometer. A steel pin flag with the sample station identification number was placed at the sample point approved by the OE technician.

An OE technician remained with the sampling crew as work progressed. At stations where subsurface soil samples were to be collected from the 0.3- to 0.9-meter (1- to 3-foot)-depth interval, the magnetometer tip was lowered into the borehole to screen for subsurface magnetic anomalies at the top of the subsurface interval. No sampling was conducted at depths greater than 0.9 meter (3 feet) bgs in the plane refueling/crash strip area.

3.3 SOIL AND VADOSE ZONE SAMPLING

Soil samples were collected from a total of 99 stations. A total of 100 stations were originally planned; however, samples from one planned contingency station were reassigned as additional subsurface samples at two stations having suspected contamination. Surface soil samples were collected at all 99 stations. Subsurface soil samples were specified for 21 stations, and all were collected as planned. Figure 3-1 illustrates the locations for surface soil and subsurface soil sampling. Table 3-2 lists the soil stations sampled during the Phase I RI field effort.

3.3.1 Rationale

Surface soil samples were collected during the Phase I RI to identify impacted areas within NTA resulting from spills and dispersal of petroleum hydrocarbons. Additionally, the soil samples provided data to identify the potential for contaminant migration by leaching or erosion from surface soil sources to receptor media, such as sediment and surface water. The analytical results from soil samples were also used to identify whether potential leaching to groundwater may occur by comparing results to EPA Soil Screening Guidance Criteria (see Section 4.1 and Chapter 5.0).

The sampling locations were selected on the bases of operational records, project DQOs as discussed in Section 1.3.5, and analytical results from previous sampling events. A combination of grid and biased sampling approaches were employed to maximize the potential to identify contamination and to obtain data representative of site conditions. Grid sampling was tailored to the size and characteristics of each functional area (Figure 3-1). Grid nodes were spaced about 30.5 meters (100 feet) apart in the crash area (Area 1), where operational history suggested contamination was most likely to be present. Grid nodes in the plane refueling/crash strip area (Area 3) were spaced about 91.5 meters (300 feet) apart in the east–

Table 3-2. Sample List and Rationale, NACA Test Area Phase I RI

Functional Area	No. Sample Stations	Sample Station ID	Location Description	Sample Station Rationale	Sample ID	Depth (feet)	Sample Collected (Yes/No)	Comments
Surface and Subsurface Soil Samples								
Crash Area	**64**	NTA-001	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-001-0001-SO	0 - 1	Yes	
		NTA-002	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-002-0002-SO	0 - 1	Yes	
		NTA-003	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-003-0003-SO	0 - 1	Yes	
		NTA-004	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-004-0004-SO	0 - 1	Yes	
		NTA-005	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-005-0005-SO	0 - 1	Yes	
		NTA-006	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-006-0006-SO	0 - 1	Yes	
		NTA-007	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-007-0007-SO	0 - 1	Yes	
		NTA-008	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-008-0008-SO	0 - 1	Yes	
		NTA-009	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-009-0009-SO	0 - 1	Yes	
		NTA-010	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-010-0010-SO	0 - 1	Yes	
		NTA-011	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-011-0011-SO	0 - 1	Yes	
		NTA-012	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-012-0012-SO	0 - 1	Yes	
		NTA-013	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-013-0013-SO	0 - 1	Yes	

Table 3-2. Sample List and Rationale, NACA Test Area Phase I RI (continued)

Functional Area	No. Sample Stations	Sample Station ID	Location Description	Sample Station Rationale	Sample ID	Depth (feet)	Sample Collected (Yes/No)	Comments
Crash Area (continued)	**64 (continued)**	NTA-014	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-014-0014-SO	0 - 1	Yes	
		NTA-015	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-015-0015-SO	0 - 1	Yes	
		NTA-016	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-016-0016-SO	0 - 1	Yes	
		NTA-017	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-017-0017-SO	0 - 1	Yes	
		NTA-018	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-018-0018-SO	0 - 1	Yes	
		NTA-019	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-019-0019-SO	0 - 1	Yes	
		NTA-020	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-020-0020-SO	0 - 1	Yes	
		NTA-021	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-021-0021-SO	0 - 1	Yes	
		NTA-022	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-022-0022-SO	0 - 1	Yes	
		NTA-023	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-023-0023-SO	0 - 1	Yes	
		NTA-024	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-024-0024-SO	0 - 1	Yes	
		NTA-025	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-025-0025-SO	0 - 1	Yes	
		NTA-026	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-026-0026-SO	0 - 1	Yes	
		NTA-027	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-027-0027-SO	0 - 1	Yes	

Table 3-2. Sample List and Rationale, NACA Test Area Phase I RI (continued)

Functional Area	No. Sample Stations	Sample Station ID	Location Description	Sample Station Rationale	Sample ID	Depth (feet)	Sample Collected (Yes/No)	Comments
Crash Area (continued)	**64 (continued)**	NTA-028	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-028-0028-SO	0 - 1	Yes	
		NTA-029	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-029-0029-SO	0 - 1	Yes	
		NTA-030	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-030-0030-SO	0 - 1	Yes	
		NTA-031	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-031-0031-SO	0 - 1	Yes	
		NTA-032	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-032-0032-SO	0 - 1	Yes	
		NTA-033	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-033-0033-SO	0 - 1	Yes	
		NTA-034	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-034-0034-SO	0 - 1	Yes	
		NTA-035	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-035-0035-SO	0 - 1	Yes	
		NTA-036	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-036-0036-SO	0 - 1	Yes	
		NTA-037	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-037-0037-SO	0 - 1	Yes	
		NTA-038	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-038-0038-SO	0 - 1	Yes	Geoprobe station – converted to a piezometer
			Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAso-038-0039-SO	1 - 3	Yes	Geotech only
		NTA-039	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-039-0040-SO	0 - 1	Yes	
		NTA-040	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-040-0041-SO	0 - 1	Yes	

Table 3-2. Sample List and Rationale, NACA Test Area Phase I RI (continued)

Functional Area	No. Sample Stations	Sample Station ID	Location Description	Sample Station Rationale	Sample ID	Depth (feet)	Sample Collected (Yes/No)	Comments
Crash Area (continued)	**64 (continued)**	NTA-041	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-041-0042-SO	0 - 1	Yes	
		NTA-042	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-042-0043-SO	0 - 1	Yes	
		NTA-043	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-043-0044-SO	0 - 1	Yes	
		NTA-044	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-044-0045-SO	0 - 1	Yes	
		NTA-045	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-045-0046-SO	0 - 1	Yes	
		NTA-046	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-046-0047-SO	0 - 1	Yes	
		NTA-047	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-047-0048-SO	0 - 1	Yes	
		NTA-048	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-048-0049-SO	0 - 1	Yes	
		NTA-049	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-049-0050-SO	0 - 1	Yes	
		NTA-050	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-050-0051-SO	0 - 1	Yes	
		NTA-051	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-051-0052-SO	0 - 1	Yes	
		NTA-052	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-052-0053-SO	0 - 1	Yes	
		NTA-053	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-053-0054-SO	0 - 1	Yes	
		NTA-054	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-054-0055-SO	0 - 1	Yes	

Table 3-2. Sample List and Rationale, NACA Test Area Phase I RI (continued)

Functional Area	No. Sample Stations	Sample Station ID	Location Description	Sample Station Rationale	Sample ID	Depth (feet)	Sample Collected (Yes/No)	Comments
Crash Area (continued)	**64 (continued)**	NTA-055	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-055-0056-SO	0 - 1	Yes	
		NTA-056	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-056-0057-SO	0 - 1	Yes	
		NTA-057	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-057-0058-SO	0 - 1	Yes	
		NTA-058	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-058-0060-SO	0 - 1	Yes	
			Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAso-058-0059-SO	1 - 3	Yes	Geotech only
		NTA-059	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-059-0061-SO	0 - 1	Yes	Wetland area
		NTA-060	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-060-0062-SO	0 - 1	Yes	Wetland area
		NTA-061	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-061-0063-SO	0 - 1	Yes	Wetland area
		NTA-062	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-062-0064-SO	0 - 1	Yes	Wetland area
		NTA-063	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-063-0065-SO	0 - 1	Yes	Wetland area
		NTA-064	Grid station inside of crash area	Residual contaminants from aircraft impact/fuel tank ruptures	NTAss-064-0066-SO	0 - 1	Yes	Wetland area
Plane Burial Area	**19**	NTA-065	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-065-0067-SO	0 - 1	Yes	
					NTAso-065-0068-SO	1 - 3	Yes	
		NTA-066	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-066-0069-SO	0 - 1	Yes	
					NTAso-066-0070-SO	1 - 3	Yes	
		NTA-067	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-067-0071-SO	0 - 1	Yes	
					NTAso-067-0072-SO	1 - 3	Yes	
		NTA-068	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-068-0073-SO	0 - 1	Yes	
					NTAso-068-0074-SO	1 - 3	Yes	
		NTA-069	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-069-0075-SO	0 - 1	Yes	
					NTAso-069-0076-SO	1 - 3	Yes	
					NTAso-069-0077-SO	1 - 3	Yes	Geotech only

Table 3-2. Sample List and Rationale, NACA Test Area Phase I RI (continued)

Functional Area	No. Sample Stations	Sample Station ID	Location Description	Sample Station Rationale	Sample ID	Depth (feet)	Sample Collected (Yes/No)	Comments
Plane Burial Area (continued)	**19 (continued)**	NTA-070	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-070-0078-SO	0 - 1	Yes	Surface debris noted at station
					NTAso-070-0079-SO	1 - 3	Yes	
					NTAso-070-0120-SO	3 - 5	Yes	
		NTA-071	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-071-0080-SO	0 - 1	Yes	
					NTAso-071-0081-SO	1 - 3	Yes	
		NTA-072	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-072-0082-SO	0 - 1	Yes	
					NTAso-072-0083-SO	1 - 3	Yes	
		NTA-073	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-073-0084-SO	0 - 1	Yes	Surface debris noted at station
					NTAso-073-0085-SO	1 - 3	Yes	
					NTAso-073-0121-SO	3 - 5	Yes	
		NTA-074	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-074-0086-SO	0 - 1	Yes	
					NTAso-074-0087-SO	1 - 3	Yes	
		NTA-075	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-075-0088-SO	0 - 1	Yes	
					NTAso-075-0089-SO	1 - 3	Yes	
		NTA-076	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-076-0090-SO	0 - 1	Yes	
					NTAso-076-0091-SO	1 - 3	Yes	
		NTA-077	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-077-0092-SO	0 - 1	Yes	Old service road
					NTAso-077-0093-SO	1 - 3	Yes	
		NTA-078	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-078-0094-SO	0 - 1	Yes	Old service road
		NTA-079	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-079-0095-SO	0 - 1	Yes	
					NTAso-079-0096-SO	1 - 3	Yes	
		NTA-080	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-080-0097-SO	0 - 1	Yes	
		NTA-081	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-081-0098-SO	0 - 1	Yes	
		NTA-082	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-082-0099-SO	0 - 1	Yes	
		NTA-100	Grid station inside of plane burial area	Possible source area due to buried and surface debris	NTAss-100-0122-SO	0 - 1	Yes	Old service road. Surface debris noted at station
					NTAso-100-0123-SO	1 - 3	Yes	
Plane Refueling/ Crash Strip Area	**13**	NTA-083	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-083-0100-SO	0 - 1	Yes	
					NTAso-083-0101-SO	1 - 3	Yes	
		NTA-084	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-084-0102-SO	0 - 1	Yes	
					NTAso-084-0103-SO	1 - 3	Yes	
		NTA-085	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-085-0104-SO	0 - 1	Yes	
					NTAso-085-0105-SO	1 - 3	Yes	
		NTA-086	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-086-0106-SO	0 - 1	Yes	

Table 3-2. Sample List and Rationale, NACA Test Area Phase I RI (continued)

Functional Area	No. Sample Stations	Sample Station ID	Location Description	Sample Station Rationale	Sample ID	Depth (feet)	Sample Collected (Yes/No)	Comments
Plane Refueling/ Crash Strip Area (continued)	**13 (continued)**	NTA-087	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-087-0107-SO	0 - 1	Yes	
		NTA-088	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-088-0108-SO	0 - 1	Yes	Slag present at surface
		NTA-089	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-089-0109-SO	0 - 1	Yes	Slag present at surface
		NTA-090	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-090-0110-SO	0 - 1	Yes	Slag present at surface
		NTA-091	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-091-0111-SO	0 - 1	Yes	Slag present at surface
		NTA-092	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-092-0112-SO	0 - 1	Yes	Slag present at surface
		NTA-093	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-093-0113-SO	0 - 1	Yes	
		NTA-094	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-094-0114-SO	0 - 1	Yes	
		NTA-095	Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAss-095-0115-SO	0 - 1	Yes	
			Grid station inside of plane refueling/crash strip area	Residual contaminants from aircraft fluid leaks/spills	NTAso-095-0116-SO	1 - 3	Yes	
Ditches flowing from the NACA Test Area	**3**	NTA-096	Dry ditch near former impact barrier	Sediment accumulation area near impact barrier	NTAss-096-0117-SO	0 - 1	Yes	
		NTA-097	Dry ditch at southwest corner of crash area	Sediment accumulation area from crash area	NTAss-097-0118-SO	0 - 1	Yes	
		NTA-098	Dry ditch at southwest corner of crash area	Sediment accumulation area from crash area	NTAss-098-0119-SO	0 - 1	Yes	
TOTALS		**99 Stations**			**123 Samples**			

Table 3-2. Sample List and Rationale, NACA Test Area Phase I RI (continued)

Functional Area	No. Sample Stations	Sample Station ID	Location Description	Sample Station Rationale	Sample ID	Depth (feet)	Sample Collected (Yes/No)	Comments
Sediment and Surface Water Samples								
Well Pit	**1**	NTA-101	Former water supply well, concrete-lined well pit	Accumulation point for sediment/runoff from crash area	NTAsd-101-0124-SD	0-0.5 ft	Yes	
					NTAsw-101-0130-SW	NA	No	Dry
Reservoir	**1**	NTA-102	Former fire water supply surface impoundment	Accumulation point for sediment/runoff from crash area	NTAsd-102-0125-SD	0-0.5 ft	Yes	
					NTAsw-102-0131-SW	NA	Yes	
Tributary to Hinkley Creek	**1**	NTA-103	Tributary headwaters	Principal exit pathway	NTAsd-103-0126-SD	0-0.5 ft	Yes	
					NTAsw-103-0132-SW	NA	Yes	
Drainages north of NACA	**2**	NTA-104	Ditch line north of Demolition Road	Ambient surface water	NTAsd-104-0127-SD	0-0.5 ft	Yes	
					NTAsw-104-0133-SW	NA	Yes	
		NTA-105	Inlet to wetland north of crash area	Ambient surface water	NTAsd-105-0128-SD	0-0.5 ft	Yes	
					NTAsw-105-0134-SW	NA	Yes	
Hinkley Creek south of NACA	**1**	NTA-106	Tributary at junction with Hinkley Creek	Principal exit pathway	NTAsd-106-0129-SD	0-0.5 ft	Yes	
					NTAsw-106-0135-SW	NA	Yes	
TOTALS		**6 Stations**			**6 sed / 5 sw**			
Groundwater Screening Samples								
Crash Area	**1**	NTA-038	Crash Area		NTAso-038-0136-GW	NA	Yes	Geoprobe
TOTALS		**1 Station**			**1 Sample**			

west direction and 61 meters (200 feet) in the north–south direction. Grid nodes were spaced about 61 meters (200 feet) apart in the plane burial area (Area 2) to provide sufficient sample density to characterize suspected sources in this area. Biased sampling was conducted within the ditches draining the crash area to evaluate potential contaminant accumulation within these drainage features. A synopsis of soil sampling efforts for each of the four functional areas, as executed in the field, is presented below:

- In the crash area, surface soil samples were collected at 64 stations as planned. Subsurface samples were not collected in this area, with the exception of two Shelby tube samples at stations NTA-038 and NTA-058 from the 0.3- to 0.9-meter (1- to 3-foot) interval for geotechnical analysis.

- Within the plane burial area, 18 surface and 14 subsurface soil samples [0.3- to 0.9-meter (1- to 3-foot) depth interval] were collected as planned from 18 stations (Table 3-2). One Shelby tube sample was collected at station NTA-069 from the 0.3- to 0.9-meter (1- to 3-foot) depth interval for geotechnical analysis. One of two planned contingency stations (station NTA-100) was placed in the northwest corner of this area at a location along a former service road containing abundant metallic surface debris. Also, two samples from the remaining planned contingency station (NTA-099) were reassigned as 0.9- to 1.5- meter (3- to 5-foot) subsurface soil samples at stations NTA-070 and NTA-073. These two stations were located in potential burial areas based on the presence of mounded soils with surface debris; thus, reassignment of the samples was done to increase the depth of characterization.

- In the plane refueling/crash strip area, 13 surface and 4 subsurface soil samples were collected as planned from all 13 stations.

3.3.2 Surface Soil Field Sampling Methods

3.3.2.1 Sampling techniques

A decontaminated bucket hand auger was used to collect surface soil samples at each station. Where required, a clean, unpainted spade was used initially to remove heavy vegetative debris or gravel and slag cover where present. Where explosives and propellant analyses were not specified, a single boring was hand augered at the approved locations, and all sample aliquots were obtained from this single boring. Soil from the sample interval was placed into a stainless steel bowl, homogenized, and placed into sample containers. Soil for VOC analyses was placed directly into sample jars from the auger bucket.

Where composite samples for explosives and propellant analyses were specified, three soil borings were hand augered in an equilateral triangle pattern measuring about 0.9 meter (3 feet) on a side. Soil from the three subsamples was placed into a large, decontaminated stainless steel bowl, homogenized, and placed into sample containers. Composite sampling has been shown to reduce statistical sampling errors in surface soil data from sites with a history of explosives contamination (Jenkins et al. 1996). Composite sampling data for explosives analysis are considered acceptable for use in risk assessments (EPA 1996) where concentrations throughout a study area are expected to be variable. Samples for inorganic constituents (metals and cyanide), SVOCs, VOCs, and PCBs were collected from a boring located in the center of the equilateral triangle as described above.

After completion, each soil boring was filled with granular bentonite, staked with a 0.6-meter (2-foot) rebar stake, and labeled with a steel pin flag marked with the station number. The sample locations were later surveyed by a licensed surveyor. Excess soil from each borehole was placed in lined, labeled 242-liter (55-gallon) drums that were sealed after each use and staged at Building 1036. Investigation-derived waste disposal for all media are discussed in Appendix H.

3.3.2.2 Field and laboratory analyses

Field classification of soil was performed and the data recorded in the project logbooks in accordance with Section 4.4.2.3 of the Facility-wide SAP as specified in the NTA Phase I RI SAP Addendum. Headspace gases were not screened in the field for organic vapors. Organic vapor measurements were made in the breathing zone during sampling and at the top of the boring and recorded in the field logbooks.

All surface soil samples collected during the Phase I RI were analyzed for Target Analyte List (TAL) metals, cyanide, VOCs, and SVOCs. Eleven samples from selected locations in the four functional areas were also analyzed for explosives, propellants, and PCBs. The analytical results are presented in Appendix F of this RI.

Disturbed (grab) geotechnical samples were collected at six selected stations and analyzed for Atterberg limits and USCS classification. These samples were collected from the crash area (stations NTA-015, NTA-028, and NTA-047), plane burial area (stations NTA-069 and NTA-078), and plane refueling/crash strip area (station NTA-090). Results of the geotechnical analyses are presented in Appendix I of this RI.

3.3.3 Subsurface Soil Sampling Methods

3.3.3.1 Sampling techniques

To collect subsurface samples, a decontaminated bucket auger was used to deepen the surface soil boring over the required depth interval. At locations where composite sampling was performed for explosives and propellant analysis, subsurface samples were obtained by deepening the surface soil boring located in the center of the equilateral triangle. When necessary, due to obstructions by gravel or fill material, a hand-operated power auger was used to overdrill and advance the boring to the top of the subsurface interval; a hand auger was then used to collect the soil from the prescribed depths. Overall, site conditions allowed sample crews to use only the hand augers to complete the borings. However, at a few sampling locations, refusal of either the hand or power auger prevented the sample crews from reaching the full target depth. In such cases, the samples were collected from the deepest subsurface interval achieved. All VOC samples were collected as discrete aliquots from the middle of the interval without homogenization. Following collection of the VOC sample, the remainder of the soil from the subsurface interval was placed into a stainless steel pan or bowl and homogenized, and representative aliquots for the remaining analyses were placed into the appropriate sample containers.

A van-mounted Geoprobe rig was used to collect undisturbed geotechnical samples at stations NTA-038, NTA-058, and NTA-069. Following geotechnical sample collection at station NTA-038, the Geoprobe rig was used to advance a 5-centimeter (2-inch)-diameter steel core tube fitted with an acetate liner to collect lithologic cores to a projected maximum depth of 9.1 meters (30 feet). Silts and clays containing fine sands and gravel were encountered from 0.3 to 6.0 meters (1 to 20 feet) bgs. The unconsolidated materials became saturated at a depth of 5.0 meters (16.6 feet) bgs and remained saturated to a depth of 7.3 meters (24 feet). The target depth of 9.1 meters (30 feet) could not be achieved because of borehole collapse.

This direct-push boring was converted to a piezometer as discussed in Section 3.5 below.

3.3.3.2 Field and laboratory analyses

Field classification of the soils was performed, and the results were recorded in the project logbooks in accordance with Section 4.4.2.3 of the Facility-wide SAP as specified in the Phase I RI SAP Addendum, with the following exception. Headspace gases were not screened in the field for organic vapors. Organic vapor measurements were made in the breathing zone during sampling and at the top of the boring and recorded in the field logbooks.

All subsurface soil samples were analyzed for TAL metals, cyanide, VOCs, and SVOCs. Two samples from the plane burial area were also analyzed for explosives, propellants, and PCBs. The analytical results are presented in Appendix F of this RI Report.

One disturbed geotechnical subsurface soil sample was collected at station NTA-069 [0.2- to 0.9-meter (1- to 3-foot)-depth interval] and analyzed for Atterberg limits and USCS classification. Undisturbed geotechnical samples were collected from 0.3- to 0.9-meter (1- to 3-foot)-depth intervals at stations NTA-038, NTA-058, and NTA-069 in the crash and plane burial areas. Undisturbed samples were collected using the direct-push (Geoprobe) rig and conventional 7.6-centimeter (3.0-inch) diameter, 0.91-meter- (36-inch)-long Shelby tubes. These samples were analyzed for an expanded list of geotechnical parameters including grain size, soil pH, redox potential, organic carbon content, bulk density, specific gravity, soil permeability, moisture content, and Atterberg limits in order to estimate dilution attenuation factors (DAF) for NTA (Section 4.6). The results of these analyses are presented in Appendix I of this RI report.

3.4 SEDIMENT SAMPLING

Six sediment samples were collected in conjunction with the Phase I RI at NTA (Table 3-2, Figure 3-1). Sediment stations were located both outside of the AOC boundary (exit points or ambient conditions) and within the AOC (potential accumulation areas).

3.4.1 Rationale

Runoff from contaminated soil within NTA may contribute contaminants in dissolved and suspended form to the surface water system that drains NTA. The pit surrounding the out-of-service water well (NTA-101) and the reservoir in the crash area (NTA-102) were sampled to assess potential contaminant accumulation. Sediment sampling was conducted to evaluate the surface water exit pathway and to characterize ambient conditions in the wetland area and surface water conveyances north of the AOC (stations NTA-104 and NTA-105). Two samples were collected along the principal tributary draining NTA, which flows to the south toward Hinkley Creek; these include one sample at the headwaters (NTA-103) and one at the confluence with Hinkley Creek (NTA-106).

In addition, characterization data for Hinkley Creek sediment and surface water, obtained during the concurrent Phase I RI at DA1, are referenced in this report to support assessment of contaminant distribution and occurrence (USACE 2000). Relevant samples from the DA1 Phase I RI include station DA1-043 (upstream of both DA1 and NTA to characterize ambient conditions) and station DA1-046 [along Hinkley Creek at the RVAAP exit point (HC-2) to assess potential contaminant migration off of the installation from both DA1 and the NTA].

3.4.2 Sediment Field Sampling Methods

Sediment stations were located along the nearshore area of surface water impoundments or, for stream channels, where water was pooled or ponded. All sediments were collected as discrete (grab) samples. All sediment samples were collected from a 0- to 0.015-meter (0- to 0.5-foot) interval below the sediment-water interface. Samples were collected using either a bucket hand auger or a stainless steel scoop or trowel, as described in Section 4.2.2 of the NTA Phase I RI SAP Addendum. The VOC fraction was collected directly from the first materials obtained from the sample interval. The remaining sediment samples were homogenized in a stainless-steel bowl before being placed into sample jars.

Visual classification of sediment materials according to the USCS was noted in the field logbooks. All samples were screened with an organic vapor analyzer in the field.

All sediment samples were analyzed for explosives, propellants, TAL metals, cyanide, VOCs, SVOCs, and PCBs. In addition, six samples were collected for the determination of grain size distribution and TOC.

3.5 SURFACE WATER SAMPLING

Co-located surface water samples were collected from five of the six sediment stations described in Section 3.3.1 (stations NTA-102, NTA-103, NTA-104, NTA-105, and NTA-106).

3.5.1 Rationale

Sampling of surface water was conducted because this medium represents the primary contaminant transport pathway within and off of the AOC (either in dissolved phase or adsorbed to particulates and sediment that are mobilized by runoff). As noted for sediment, surface water data from station NTA-102 represent a potential accumulation area (reservoir). Characterization data for ambient conditions north of the AOC are provided by stations NTA-104 and NTA-105. Characterization data for the principal exit pathway are provided by stations NTA-103 and NTA-106. As noted for sediment, concurrent data collected in Hinkley Creek upstream of NTA and DA1 (station DA1-043) and at the facility exit point (DA1-046) are referenced to assess potential impacts at the facility exit point at HC-2 due to former NACA operations.

3.5.2 Surface Water Field Sampling Methods

Hand-held bottles were used to collect surface water samples. Each container was submerged into the water with the cap in place. The cap was removed, and the container was allowed to fill slowly and continuously using the cap to regulate the rate of sample entry into the container. Samples for VOC analysis were collected first. The filled container was slowly removed from the water with minimal disturbance to the sample.

In all cases, the sediment sampling was conducted after the surface water sample had been collected to minimize the amount of suspended solids in the surface water samples. Surface water sampling began at the sampling point furthest downstream in the channel, and proceeded upstream, to further minimize the effects of sediment turbidity on surface water quality. Field measurements performed during sample collection included pH, conductivity, temperature, and dissolved oxygen content.

All surface water samples were analyzed for explosives, propellants, TAL metals, cyanide, VOCs, SVOCs, and PCBs. Filtered samples were not collected during the Phase I RI. Analytical results for surface water are presented in Appendix F of this RI report.

3.6 GROUNDWATER SAMPLING

A groundwater sample was collected from the piezometer installed at sample location NTA-038 (Figure 3-1) in the crash area. This station was selected to represent conditions within the most likely potential source area. Because the sample was collected from a temporary piezometer, the data are considered qualitative and not sufficient to be incorporated into the human health risk evaluation. The objective for installation of the piezometer and collection of a groundwater screening sampling were to

- evaluate whether contamination is present in groundwater and whether leaching of contaminants to groundwater near the source area is a potential problem; and

- collect preliminary hydrogeologic information (water levels) for future characterization of this area, if necessary.

A van-mounted Geoprobe rig was used to advance a direct-push boring for lithologic characterization using a macrocore and acetate liners as described in Section 3.2.3 above. The probe assembly was advanced in 1.2-meter (4-foot) sections by adding lengths of push rods. Upon completion of each 0.9-meter (3-foot) advance, the core tube was removed from the boring and the liner containing a soil core was extracted. Groundwater was encountered at a depth of 5.0 meters (16.6 feet) bgs, and the boring was extended to a depth of 7.3 meters (24 feet) bgs, where borehole collapse prevented further advancement. Upon completion of lithologic logging, the sampling crew inserted a 3-meter (10-foot)-long, slotted, 4.4-centimeter (1.75-inch)-diameter polyvinyl chloride (PVC) screen and riser pipe to create a temporary piezometer approximately straddling the water table interface. Medium-grained sand was poured into the annular space between the PVC pipe and the borehole to act as a filter for incoming groundwater.

Groundwater was collected using a peristaltic pump and flexible tubing to lift water from the piezometer. Low permeability in the saturated zone resulted in slow recharge to the borehole. Therefore, the piezometer was pumped and allowed to recover over several cycles to obtain sufficient sample volume for all required analyses.

The groundwater sample was analyzed for VOCs, SVOCs, explosives, propellants, TAL metals, PCBs, and cyanide. An ample volume of groundwater was collected so that both filtered (0.45 micron) and unfiltered specimens could be analyzed for dissolved and total metals, respectively. The fraction of the groundwater sample designated for TAL metals analysis was filtered in the field prior to analysis. Readings of pH, conductivity, and temperature were recorded in the project logbooks at the time the sample was collected.

3.7 ANALYTICAL PROGRAM OVERVIEW

Specific analyses conducted for each of the environmental media sampled are discussed in Sections 3.2 through 3.5 above. Sections 3.6.1 and 3.6.2 provide additional information regarding the laboratory analytical program.

3.7.1 Laboratory Analyses

All analytical laboratory procedures were completed in accordance with applicable professional standards, EPA requirements, government regulations and guidelines, and specific project goals and requirements. All samples collected during the investigation were analyzed by Quanterra Laboratories, Inc. (now known as Severn-Trent Laboratories, Inc.). The majority of analyses were performed at Quanterra’s North Canton, Ohio, facility. Explosive analyses were performed at its Knoxville, Tennessee, facility, and nitroguanidine/nitrocellulose analyses were performed at its Sacramento, California, facility. These laboratories have been validated by the USACE Missouri River Division Hazardous, Toxic, and Radioactive Waste Mandatory Center of Expertise (MCX) in Omaha, Nebraska. Quality assurance (QA) samples were collected by SAIC and submitted to GP Environmental, Inc., of Gaithersburg, Maryland, a USACE-MCX contracted laboratory. SAIC-contracted laboratories supporting this work have statements of qualifications including organizational structures, QA manuals, and standard operating procedures that can be made available upon request.

Samples were analyzed according to the RVAAP Facility-wide SAP and the NTA Phase I RI SAP Addendum. Prepared in accordance with USACE and EPA guidance, the SAP outlines the organization, objectives, intended data uses, and QA/quality control (QA/QC) activities to achieve the desired DQOs and to maintain the defensibility of the data. Project DQOs were established in accordance with EPA Region 5 guidance. Requirements for sample collection, handling, analyses criteria, target analytes, laboratory criteria, and data validation criteria for NTA are consistent with EPA requirements for National Priority List sites. Analytical DQOs for this project included analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data. Appendix E presents an assessment of those objectives as they apply to the analytical program.

Strict adherence to the requirements set forth in the SAP was required of the analytical laboratory so that conditions adverse to quality would not arise. The laboratory was required to perform all analyses in compliance with EPA SW-846 (EPA 1990), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, analytical protocols. Chemical analytical procedures specified by EPA SW-846 were followed for the analyses of metals, VOCs, SVOCs, pesticides, PCBs, explosives propellants, and cyanide. Laboratories were required to comply with all methods as written; recommendations were considered requirements.

The requisite number of QA/QC samples was obtained during the Phase I RI (refer to Appendix E). Quality control samples for this project included field blanks, trip blanks, field duplicates, laboratory method blanks, laboratory control samples, laboratory duplicates, and matrix spike/matrix spike duplicate (MS/MSD) samples. Field blanks, consisting of potable water used in the decontamination process, equipment rinsate blanks, and trip blanks were submitted for analysis along with field duplicate (co-located) samples. These QC samples provide a means to assess the quality of the data resulting from the field sampling program. Field blank samples were analyzed to determine procedural contamination at the site that may contribute to sample contamination. Equipment rinsate blanks (associated with surface water sampling only) were used to assess the adequacy of equipment decontamination processes. Trip blanks were used to assess the potential for contamination of samples during sample shipment and storage. Field duplicate samples were analyzed to determine sample heterogeneity and sampling methodology reproducibility. Laboratory method blanks and laboratory control samples were employed to determine the accuracy and precision of the analytical method as implemented by the laboratory. Matrix spike samples provided information about the effect of the sample matrix on the measurement methodology. Laboratory sample duplicates and MSDs assisted in determining the analytical reproducibility and precision of the analysis for the samples of interest. Evaluation of these QC measures and their contribution to documenting the project data quality is provided in Appendix E as the Quality Control Summary Report (QCSR).

SAIC is the custodian of the project file and will maintain the contents of the files for this investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, correspondence, and chain-of-custody (COC) forms. These files will remain in a secure area under the custody of the SAIC Project Manager until they are transferred to the USACE Louisville District and RVAAP. Analytical data reports from Quanterra Laboratories, Inc. have been forwarded to the USACE-MCX laboratory for QA review and comparison. Quanterra will retain all original raw data information (both hard copy and electronic) in a secure area under the custody of the Laboratory Project Manager.

3.7.2 Data Review, Validation, and Quality Assessment

Samples were properly packaged for shipment and dispatched to Quanterra Laboratories, Inc. for analysis. A separate, signed custody record was enclosed with each shipment with sample numbers, quantities, and locations listed. When transferring the possession of samples, the individuals relinquishing and receiving the samples signed, dated, and noted the time on the record. All shipments were in compliance with applicable Department of Transportation regulations for environmental samples.

Data were produced, reviewed, and reported by the laboratory in accordance with specifications outlined in the project SAP and the laboratory's QA manual. Laboratory reports included documentation verifying analytical holding time compliance.

Quanterra Laboratories, Inc. performed in-house analytical data reduction under the direction of the Laboratory Project Manager and QA Officer. These individuals were responsible for assessing data quality and informing SAIC and USACE of any data that were considered "unacceptable" or required caution on the part of the data user in terms of its reliability. Data were reduced, reviewed, and reported as described in the laboratory QA manual and standard operating procedures. Data reduction, review, and reporting by the laboratory were conducted as follows.

- Raw data produced by the analyst were turned over to the respective area supervisor.
- The area supervisor reviewed the data for attainment of QC criteria as outlined in the established methods and for overall reasonableness.
- Upon acceptance of the raw data by the area supervisor, a report was generated and sent to the Laboratory Project Manager.
- The Laboratory Project Manager completed a thorough review of all reports.
- Final reports were generated by the Laboratory Project Manager.
- Data were then delivered to SAIC, and copies of all data packages were forwarded to the USACE for evaluation and preparation of QA and data validation documents.

Quanterra Laboratories, Inc. prepared and retained full analytical and QC documentation for the project in both hard copy (paper) and electronic storage media (e.g., magnetic tape) as directed by the analytical methodologies employed. The analytical laboratory provided the following information to SAIC in each analytical data package submitted

- cover sheets listing the sample included in the report and narrative comments describing problems encountered in analysis;
- tabulated results of inorganic and organic compounds identified and quantified; and
- analytical results for QC sample spikes, sample duplicates, initial and continuing calibration verifications of standards and blanks, method blanks, and laboratory control sample information.

A systematic process for data verification and evaluation was performed by SAIC to ensure that the precision and accuracy of the analytical data were adequate for their intended use. Analytical data verification equivalent to EPA Tier II validation was performed on 100 percent of the sample delivery groups to minimize the potential of using false positive or false negative results in the decision-making process (i.e., to ensure accurate identification of detected versus non-detected compounds). This approach was consistent with the DQOs for the project and with the analytical methods and was appropriate for determining contaminants of concern and calculating risk. Samples were identified thorough implementation of "definitive" analytical methods. "Definitive" analytical methods are considered to be methods that are consistent with the protocols and procedures as presented by EPA methodologies (i.e., SW 846 Methods, EPA Drinking Water Method, etc.) and are performed by a USACE-validated laboratory applying comprehensive analytical QC measures. "Definitive data" were reported consistent with the deliverables identified in the project statement of work. These "Definitive data" were then validated through the review process outlined in the Facility-wide SAP and NTA Phase I RI SAP Addendum and presented in Appendix E.

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4.0 INVESTIGATION RESULTS

This chapter presents results of the Phase I RI data screening process to identify constituents indicative of impacts from AOC operations. The constituents that are deemed to be related to AOC operations are classified as SRCs. These SRCs are then evaluated to determine their occurrence and distribution in environmental media at the NTA. The data incorporated in the evaluation include only those from the Phase I RI investigation. The limited amount of historical data obtained during previous investigations (see Section 1.3.3) were not used quantitatively during the evaluation due to the lack of data quality documentation.

Section 4.1 of this chapter presents the statistical methods and facility-wide background screening criteria used to distinguish naturally occurring constituents from SRCs indicative of impacts from historical site operations. Sections 4.2 through 4.5 present occurrence and distribution of identified SRCs within each of the data aggregates (surface soil, subsurface soil, sediment, surface water) established for the purposes of this Phase I RI report. Section 4.6 addresses analytical results from the groundwater screening sample collected from the piezometer installed at station NTA-038. A summary of the results of the OE avoidance survey is presented in Section 4.7. Summary analytical results are presented in graphical or tabular formats in the sections addressing each environmental media. Complete analytical results are contained within Appendix F.

Some SRCs were identified at concentrations potentially posing a risk to human health or the environment based on additional risk screening processes discussed in Chapter 5.0. These SRCs are denoted as COPCs. The occurrence and distribution of those contaminants identified as COPCs are of particular interest and represent the focus of the evaluation in this chapter.

4.1 DATA EVALUATION METHODS

The processes used to evaluate NTA Phase I RI analytical data for each environmental media involve four general steps: (1) initial data reduction; (2) defining data aggregates; (3) data quality assessment; and (4) screening against statistical, background, and weight-of-evidence criteria. The data evaluation methods applied for this study are consistent with those established in the *Phase I RI for 11 High-Priority AOCs at RVAAP* (USACE 1997). Screening methods were applied as specified in the NACA Test Area Phase I RI SAP (USACE 1999a); no modifications were required during the time period between execution of field activities and issuance of this report.

4.1.1 Initial Data Reduction

More than 140 environmental soil, sediment, surface water, and field QC samples were collected with approximately 18,000 discrete analyses (i.e., analytes) being obtained, reviewed, and integrated into this RI. These totals do not include field measurements and field descriptions. Analytical results were reported by the laboratory in electronic format and loaded into a database. Verification of data was performed to ensure all requested data were received and complete. A data validation process (equivalent to EPA Tier II validation) was performed to document data quality. Data validation included evaluation of the following parameters.

- data completeness;
- holding times;
- calibration (initial and continuing);

- method blanks;
- sample results verification;
- surrogate recovery;
- laboratory control standard (LCS) analysis;
- internal standard performance;
- matrix spike (MS) recovery;
- duplicate analysis comparison;
- reported detection limits;
- compound, element, isotope quantification;
- reported detection levels; and
- secondary dilutions.

Validation qualifiers were assigned to each result based on the technical assessment of the validation criteria. Results were qualified as follows.

- U – Not detected;
- UJ – Not detected, detection limit estimated;
- J – Analyte present but concentration estimated;
- R – Result not usable; and
- = – Analyte present and concentration accurate.

In addition to assigning qualifiers, the validation process also selected the appropriate result to use when reanalyses or dilutions were performed. Where laboratory surrogate recovery data or laboratory quality control samples were outside of analytical method specifications, a determination was made regarding whether laboratory reanalysis should be used in place of an original reported result. If results were reported for both diluted and undiluted samples, results from the diluted sample were used only for those analytes that exceeded the calibration range of the undiluted sample.

A complete discussion of the results of the validation process is contained in the data quality QCSR presented in Appendix D. A summary of the results of the data quality assessment contained in the QCSR is presented in the sections below.

4.1.2 Definition of Aggregates

Results from the NTA samples were grouped into data aggregates to produce statistical summaries, to conduct the evaluation of contaminant occurrence and distribution, and to perform the risk screening. These data aggregates were selected to be consistent with the facility-wide background criteria and risk screening approach. For soil media, samples were grouped into a surface soil data aggregate, representing the interval from 0 to 0.3 meter (0 to 1.0 foot) bgs, and a subsurface soil interval containing all samples collected greater than 0.3 meter (1.0 foot) bgs. All sediment samples were grouped into one data aggregate. Surface water samples were also grouped into one data aggregate. The groundwater sample collected from the piezometer installed in boring NTA-038 is considered as a screening sample only. These groundwater data are employed qualitatively to assess potential occurrence of contamination; however, they were not included in the risk screening process.

Sample groupings or data aggregates related to specific functional areas of the NTA (i.e., the crash area, plane burial area, etc.) were not constructed for the purposes of data screening or risk evaluation. However, analytical results for each environmental medium were evaluated qualitatively to determine whether any clustering of SRCs occurred within a particular functional area. Where such clustering was evident, a description of the types of SRCs and area of concentration was included in the occurrence and distribution discussions for each medium.

4.1.3 Data Quality Assessment

QA and QC procedures were followed to assure that data collected would meet the DQOs established in the Facility-wide SAP and the NACA Test Area Phase I RI SAP Addendum (USACE 1996b, 1999a). The procedures and results of data quality assessment are described in the QCSR (Appendix D).

More than 99 percent of the data were considered of usable quality. Some analytical results were rejected for use based on the data validation criteria. The rejected results were primarily antimony in soil and hexachlorocyclopentadiene in water. Results for 3 of the 6 sediment samples and 10 of the 120 soil samples analyzed for antimony were rejected because low MS recoveries increased the possibility of false negative results. Low MS recoveries also resulted in the rejection of four soil results for 3,3'-dichlorobenzidine; three results for pentachlorophenol; and one result each for hexachlorocyclopentadiene, PCB-1016, and PCB-1260. Two mercury results for sediments were rejected because of problems with the calibration standard. Copper results for 4 of 10 surface water samples were rejected because of a problem with the instrument baseline. Hexachlorocyclopentadiene results for all five of the surface water samples and one of two groundwater samples were rejected because of low MS recoveries.

Laboratory reporting limits were compared to the project quantitation goals to assure that analytes could be detected at concentrations low enough to meet project objectives. Reporting limits were at or below the project quantitation goals for all analytes in water. Reporting limits were more variable in soils and sediments because of variability in sample size and moisture content. In general, the lowest reporting limits for soils and sediment were at or below the quantitation limit goals, and the highest reporting limits were 2 to 10 times higher. For one soil sample (NTA0108) most of the SVOCs had a reporting limit of 16,000 µg/kg compared to the goal of 330 µg/kg. Results for analytes with elevated detection limits (more than 5 times the average reporting limit) were not included in the calculation of statistics for the site characterization.

There were no data quality problems identified that would prevent the accomplishment of the goals of this study.

4.1.4 Data Screening

The data screening process employed to identify SRCs involved first calculating data summary statistics. Data were then evaluated using (1) a frequency of detection/weight-of-evidence screen, (2) screening against established facility-wide background values, and (3) screening of essential nutrients. All analytes having at least one detected value were included in the screening process. Analytes that were never detected were eliminated as SRCs. Site data were extracted from the database such that QC splits and field duplicates were excluded from the screening data sets. Samples that were rejected during data validation were excluded from the screening process. Additional screening of identified SRCs was conducted as part of the risk evaluation to identify human health and ecological COPCs (see Chapter 5.0).

4.1.4.1 Summary statistics and frequency of detection screen

Summary statistics calculated for each data aggregate included the minimum, maximum, and average (mean) detected values and the proportion of detected results to the total number of samples collected (Tables 4-1 through 4-4). Non-detected results meeting contract-required detection limits were set to one-half of the reported detection limit during calculation of the mean result for each compound. Non-detected results with elevated detection limits (more than 5 times the contract-required detection limit) were excluded from the summary statistics in order not to skew the calculation of mean values.

For sample aggregates containing more than 20 samples (surface soil, subsurface soil, and sediment), a frequency of detection criterion greater than or equal to 5 percent was used to identify inorganic constituents, SVOCs, and VOCs as SRCs. If the frequency of detection for one of these classes of analytes was less than 5 percent, a weight-of-evidence approach was used to determine if the chemical was an SRC. The weight-of-evidence approach involved examining the magnitude and locations (clustering) of the detected results. If no clustering within a particular area was noted and concentrations were not substantially elevated relative to the detection limits, the detected results were considered spurious, and the compound was eliminated as an SRC.

All detected explosives and propellants were considered as SRCs regardless of the frequency of detection and were subjected to the risk evaluation (Chapter 5.0). However, appropriate qualification is made in the assessment of occurrence and distribution for those explosives and propellants having a frequency of detection less than 5 percent.

For subsurface soil at NTA, 13 SVOCs and dimethylbenzene were detected in 1 of 21 samples, which equates to a 5 percent frequency of detection (Table 4-2). Therefore, weight-of-evidence logic was applied to screen these particular compounds. The constituent in question was retained as an SRC for subsurface soil if both of the following weight-of-evidence criteria applied: (1) the constituent was identified as an SRC in surface soil, and (2) the result was greater than the method reporting limit (i.e., not J-qualified). Based on this process, six of the SVOCs and dimethylbenzene were eliminated as subsurface soil SRCs because the single detected result was J-qualified (estimated). The remaining eight SVOCs were conservatively retained as subsurface soil SRCs because they were also identified in surface soil as SRCs, and the single detected result for subsurface soil was greater than reporting limits.

4.1.4.2 Facility-wide background screen

For each inorganic constituent passing the frequency of detection screen, concentrations were compared against final facility-wide background values established in the WBG Phase II RI Report (USACE 1999c). Background criteria for all analytes detected at least once are included in the screening summary tables for each data aggregate (Tables 4-1 through 4-4). For inorganic constituents, if the maximum detected concentration of an analyte exceeded its respective background criterion, it was considered to be an SRC. In the event a constituent was not detected in the background data set, the background value was set to zero, and any detected result for that constituent was considered above background. This conservative process ensured that detected constituents were not eliminated as SRCs simply because they were not detected in the background data set. All organic compounds that passed the frequency of detection screen were considered to be above background because these classes of compounds do not occur naturally.

Table 4-1. Summary Statistics and Determination of SRCs in Surface Soil

Analyte	Units	Results > Detection Limit	Average Result[a]	Minimum Detect	Maximum Detect	Site Background Criteria	Site Related?
Explosives and Propellants							
2,4,6-Trinitrotoluene	mg/kg	2/ 11	0.13	0.11	0.15	NB	Yes
2,4-Dinitrotoluene	mg/kg	1/ 11	0.12	0.05	0.05	NB	Yes
Nitrocellulose	mg/kg	3/ 11	5.62	3.50	45.40	NB	Yes
Inorganics							
Aluminum	mg/kg	99/ 99	11,450.00	5,090.00	33,900.00	17,700.00	Yes
Antimony	mg/kg	15/ 89	0.67	0.53	2.90	0.96	Yes
Arsenic	mg/kg	99/ 99	8.41	2.20	23.00	15.40	Yes
Barium	mg/kg	99/ 99	75.02	18.00	359.00	88.40	Yes
Beryllium	mg/kg	39/ 99	0.39	0.22	3.80	0.88	Yes
Cadmium	mg/kg	12/ 99	0.57	0.28	14.50	0.00	Yes
Calcium[b]	mg/kg	87/ 99	10,070.00	134.00	195,000.00	15,800.00	No
Chromium	mg/kg	99/ 99	13.04	6.30	54.20	17.40	Yes
Cobalt	mg/kg	99/ 99	7.05	1.50	38.20	10.40	Yes
Copper	mg/kg	99/ 99	29.59	2.60	1760.00	17.70	Yes
Cyanide	mg/kg	7/ 99	0.36	0.68	1.60	0.00	Yes
Iron[b]	mg/kg	99/ 99	18,630.00	4,570.00	38,700.00	23,100.00	No
Lead	mg/kg	99/ 99	17.88	6.90	149.00	26.10	Yes
Magnesium[b]	mg/kg	99/ 99	3,008.00	760.00	25,100.00	3,030.00	No
Manganese	mg/kg	99/ 99	694.40	49.00	6,240.00	1,450.00	Yes
Mercury	mg/kg	80/ 99	0.04	0.01	0.10	0.04	Yes
Nickel	mg/kg	99/ 99	13.49	2.10	41.40	21.10	Yes
Potassium[b]	mg/kg	99/ 99	871.70	248.00	2,270.00	927.00	No
Selenium	mg/kg	65/ 99	0.73	0.46	2.80	1.40	Yes
Silver	mg/kg	2/ 99	0.66	1.30	1.50	0.00	No
Sodium[b]	mg/kg	8/ 99	101.60	238.00	780.00	123.00	No
Thallium	mg/kg	81/ 99	0.29	0.16	0.57	0.00	Yes
Vanadium	mg/kg	99/ 99	17.72	8.70	36.60	31.10	Yes
Zinc	mg/kg	99/ 99	60.72	17.40	603.00	61.80	Yes
Semivolatile Organic Compounds							
Acenaphthene	mg/kg	2/ 99	0.26	0.29	2.10	NB	No
Acenaphthylene	mg/kg	5/ 99	0.32	0.33	7.90	NB	Yes
Anthracene	mg/kg	5/ 99	0.34	0.17	9.60	NB	Yes
Benz(a)anthracene	mg/kg	11/ 99	0.71	0.05	36.00	NB	Yes
Benzo(a)pyrene	mg/kg	13/ 99	0.79	0.05	41.00	NB	Yes
Benzo(b)fluoranthene	mg/kg	17/ 99	0.99	0.05	54.00	NB	Yes
Benzo(g,h,i)perylene	mg/kg	12/ 99	0.56	0.07	24.00	NB	Yes
Benzo(k)fluoranthene	mg/kg	11/ 99	0.48	0.05	19.00	NB	Yes
Bis(2-ethylhexyl)phthalate	mg/kg	18/ 99	0.37	0.04	6.60	NB	Yes
Carbazole	mg/kg	3/ 99	0.28	0.21	4.90	NB	No
Chrysene	mg/kg	16/ 99	0.86	0.04	46.00	NB	Yes
Di-n-butyl phthalate	mg/kg	2/ 99	0.32	0.04	0.08	NB	No
Dibenz(a,h)anthracene	mg/kg	7/ 99	0.28	0.08	5.70	NB	Yes
Dibenzofuran	mg/kg	2/ 99	0.25	0.28	1.90	NB	No
Fluoranthene	mg/kg	16/ 99	1.49	0.04	98.00	NB	Yes

Table 4-1. Summary Statistics and Determination of SRCs in Surface Soil (continued)

Analyte	Units	Results > Detection Limit	Average Result[a]	Minimum Detect	Maximum Detect	Site Background Criteria	Site Related?
Fluorene	mg/kg	3/ 99	0.32	0.21	7.90	NB	No
Indeno(1,2,3-cd)pyrene	mg/kg	11/ 99	0.56	0.07	24.00	NB	Yes
Naphthalene	mg/kg	2/ 99	0.27	0.18	2.80	NB	No
Phenanthrene	mg/kg	11/ 99	1.21	0.06	83.00	NB	Yes
Phenol	mg/kg	2/ 99	0.33	0.11	0.27	NB	No
Pyrene	mg/kg	17/ 99	1.48	0.04	93.00	NB	Yes
Volatile Organic Compounds							
Acetone	mg/kg	4/ 99	0.01	0.005	0.01	NB	No
Dimethylbenzene	mg/kg	9/ 99	0.003	0.001	0.002	NB	Yes
Methylene chloride	mg/kg	9/ 99	0.003	0.001	0.005	NB	Yes
Styrene	mg/kg	4/ 99	0.003	0.001	0.002	NB	No
Toluene	mg/kg	6/ 99	0.003	0.001	0.004	NB	Yes

[a] Values less than the detection limit were set to one-half of the reporting limit in calculation of the average.
[b] Eliminated as an SRC based on the essential element screen.
NB = No facility-wide background criterion established.

Table 4-2. Summary Statistics and Determination of SRCs in Subsurface Soil

Analyte	Units	Results > Detection Limit	Average Result[a]	Minimum Detect	Maximum Detect	Site Background Criteria	Site Related?
Inorganics							
Aluminum	mg/kg	21/ 21	10,700.00	5,340.00	18,500.00	19,500.00	No
Arsenic	mg/kg	21/ 21	11.23	3.80	18.30	19.80	No
Barium	mg/kg	21/ 21	62.99	15.60	196.00	124.00	Yes
Beryllium	mg/kg	11/ 21	0.31	0.24	0.83	0.88	No
Cadmium	mg/kg	3/ 21	1.73	0.44	30.00	0.00	Yes
Calcium[b]	mg/kg	16/ 21	950.50	123.00	6,240.00	35,500.00	No
Chromium	mg/kg	21/ 21	13.70	6.70	24.30	27.20	No
Cobalt	mg/kg	21/ 21	9.04	3.10	19.30	23.20	No
Copper	mg/kg	21/ 21	36.15	6.90	400.00	32.30	Yes
Iron[b]	mg/kg	21/ 21	21,990.00	9,550.00	32,600.00	35,200.00	No
Lead	mg/kg	21/ 21	20.24	6.60	151.00	19.10	Yes
Magnesium[b]	mg/kg	21/ 21	2,243.00	1,060.00	4,960.00	8,790.00	No
Manganese	mg/kg	21/ 21	523.70	51.40	1,790.00	3,030.00	No
Mercury	mg/kg	21/ 21	0.03	0.02	0.05	0.04	Yes
Nickel	mg/kg	21/ 21	16.64	9.00	35.10	60.70	No
Potassium[b]	mg/kg	21/ 21	946.00	358.00	2,380.00	3,350.00	No
Selenium	mg/kg	6/ 21	0.41	0.49	1.10	1.50	No
Thallium	mg/kg	17/ 21	0.28	0.17	0.40	0.91	No
Vanadium	mg/kg	21/ 21	19.10	9.30	27.70	37.60	No
Zinc	mg/kg	21/ 21	56.48	24.80	132.00	93.30	Yes
Semivolatile Organic Compounds							
Acenaphthylene[c]	mg/kg	1/ 21	0.19	0.23	0.23	NB	No
Anthracene[c]	mg/kg	1/ 21	0.19	0.09	0.09	NB	No
Benz(a)anthracene[c]	mg/kg	1/ 21	0.20	0.46	0.46	NB	No
Benzo(a)pyrene[c]	mg/kg	1/ 21	0.21	0.70	0.70	NB	No
Benzo(b)fluoranthene[c]	mg/kg	1/ 21	0.23	1.00	1.00	NB	No
Benzo(g,h,i)perylene[c]	mg/kg	1/ 21	0.21	0.65	0.65	NB	No
Benzo(k)fluoranthene[c]	mg/kg	1/ 21	0.19	0.23	0.23	NB	No
Bis(2-ethylhexyl)phthalate	mg/kg	8/ 21	0.17	0.05	0.43	NB	Yes
Chrysene[c]	mg/kg	1/ 21	0.21	0.62	0.62	NB	No
Dibenz(a,h)anthracene[c]	mg/kg	1/ 21	0.19	0.11	0.11	NB	No
Fluoranthene[c]	mg/kg	1/ 21	0.23	1.00	1.00	NB	No
Indeno(1,2,3-cd)pyrene[c]	mg/kg	1/ 21	0.21	0.52	0.52	NB	No
Phenanthrene[c]	mg/kg	1/ 21	0.20	0.33	0.33	NB	No
Pyrene	mg/kg	1/ 21	0.23	1.00	1.00	NB	No
Volatile Organic Compounds							
Dimethylbenzene[c]	mg/kg	1/ 21	0.003	0.002	0.002	NB	No
Methylene chloride	mg/kg	2/ 21	0.003	0.001	0.002	NB	Yes
Styrene	mg/kg	6/ 21	0.002	0.001	0.003	NB	Yes
Toluene	mg/kg	3/ 21	0.003	0.001	0.01	NB	Yes

[a] Values less than the detection limit were set to one-half of the reporting limit in calculation of the average.

[b] Eliminated as an SRC based on the essential element screen.

[c] Constituent was evaluated as an SRC on the basis of weight-of-evidence because the frequency of detection was equal to 5 percent. The constituent was conservatively retained as a subsurface soil SRC if it was (1) an SRC in surface soil and (2) if the result was greater than method reporting limits (i.e., not J-qualified).

NB = No facility-wide background criterion established.

Table 4-3. Summary Statistics and Determination of SRCs in Sediment

Analyte	Units	Results > Detection Limit	Average Result[a]	Minimum Detect	Maximum Detect	Site Background Criteria	Site Related?
Explosives and Propellants							
Nitrocellulose	mg/kg	2/ 6	3.82	4.80	11.00		Yes
Inorganics							
Aluminum	mg/kg	6/ 6	8,803.00	6,320.00	11,500.00	13,900.00	No
Arsenic	mg/kg	6/ 6	9.30	4.40	19.20	19.50	No
Barium	mg/kg	6/ 6	180.60	48.30	436.00	123.00	Yes
Beryllium	mg/kg	3/ 6	0.42	0.26	0.90	0.38	Yes
Cadmium	mg/kg	2/ 6	1.31	1.10	5.00	0.00	Yes
Calcium[b]	mg/kg	6/ 6	5,568.00	1,110.00	20,400.00	5,510.00	No
Chromium	mg/kg	6/ 6	14.30	8.80	24.60	18.10	Yes
Cobalt	mg/kg	6/ 6	11.87	5.40	29.90	9.10	Yes
Copper	mg/kg	6/ 6	37.62	7.90	155.00	27.60	Yes
Cyanide	mg/kg	1/ 6	0.48	0.74	0.74	0.00	Yes
Iron[b]	mg/kg	6/ 6	28,900.00	12,900.00	58,700.00	28,200.00	No
Lead	mg/kg	6/ 6	2,214.00	9.60	13,200.00	27.40	Yes
Magnesium[b]	mg/kg	6/ 6	2,152.00	1,650.00	2,960.00	2,760.00	No
Manganese	mg/kg	6/ 6	2,004.00	164.00	9,440.00	1,950.00	Yes
Mercury	mg/kg	1/ 4	0.02	0.04	0.04	0.06	No
Nickel	mg/kg	6/ 6	20.10	11.60	34.90	17.70	Yes
Potassium[b]	mg/kg	6/ 6	1,178.00	452.00	1,850.00	1,950.00	No
Selenium	mg/kg	3/ 6	1.05	1.00	2.90	1.70	Yes
Silver	mg/kg	1/ 6	0.91	0.50	0.50	0.00	Yes
Thallium	mg/kg	6/ 6	0.36	0.27	0.44	0.89	No
Vanadium	mg/kg	6/ 6	16.08	10.70	19.90	26.10	No
Zinc	mg/kg	6/ 6	171.30	44.00	631.00	532.00	Yes
Miscellaneous							
Total Organic Carbon	mg/kg	6/ 6	16,730.00	4,300.00	36,000.00	NB	NA
Volatile Organic Compounds							
2-Butanone	mg/kg	1/ 6	0.01	0.02	0.02	NB	Yes
Acetone	mg/kg	3/ 6	0.02	0.01	0.06	NB	Yes
Dimethylbenzene	mg/kg	1/ 6	0.004	0.003	0.003	NB	Yes
Methylene chloride	mg/kg	1/ 6	0.005	0.01	0.01	NB	Yes

[a] Values less than the detection limit were set to one-half of the reporting limit in calculation of the average.
[b] Eliminated as an SRC based on the essential element screen.
NA = Not applicable.
NB = No facility-wide background criterion established.

Table 4-4. Summary Statistics and Determination of SRCs in Surface Water

Analyte	Units	Results > Detection Limit	Average Result[a]	Minimum Detect	Maximum Detect	Site Background Criteria	Site Related?
Explosives and Propellants							
2,4-Dinitrotoluene	µg/L	1/ 5	0.06	0.05	0.05	NB	Yes
Inorganics							
Aluminum	µg/L	5/ 5	670.00	190.00	1,400.00	3,370.00	No
Antimony	µg/L	1/ 5	2.38	1.90	1.90	0.00	Yes
Barium	µg/L	5/ 5	57.00	17.00	110.00	47.50	Yes
Cadmium	µg/L	1/ 5	2.64	3.20	3.20	0.00	Yes
Calcium[b]	µg/L	5/ 5	61,580.00	23,700.00	170,000.00	41,400.00	No
Cobalt	µg/L	1/ 5	32.40	62.00	62.00	0.00	Yes
Iron[b]	µg/L	5/ 5	1,306.00	420.00	3,400.00	2,560.00	No
Lead	µg/L	2/ 5	2.24	2.40	4.30	0.00	Yes
Magnesium[b]	µg/L	5/ 5	11,960.00	4,800.00	31,400.00	10,800.00	No
Manganese	µg/L	5/ 5	2,778.00	80.00	12,800.00	391.00	Yes
Nickel	µg/L	1/ 5	26.80	54.00	54.00	0.00	Yes
Potassium[b]	µg/L	5/ 5	3,280.00	1,200.00	4,700.00	3,170.00	No
Sodium[b]	µg/L	5/ 5	6,340.00	1,200.00	17,200.00	21,300.00	No
Zinc	µg/L	4/ 5	256.60	19.00	1100.00	42.00	Yes
Semivolatile Organic Compounds							
Bis(2-ethylhexyl)phthalate	µg/L	1/ 5	4.64	3.20	3.20	NB	Yes
Volatile Organic Compounds							
Acetone	µg/L	2/ 5	4.96	4.20	5.60	NB	Yes

[a] Values less than the detection limit were set to one-half of the reporting limit in calculation of the average.
[b] Eliminated as an SRC based on the essential element screen.
NB = No facility-wide background criterion established.

Essential Nutrients Screen

Chemicals that are considered as essential nutrients (calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the food supply and are often added to foods as supplements. Thus, these constituents are not generally addressed as contaminants (EPA 1989, 1996) unless they are grossly elevated relative to background values. For the NTA Phase I RI, analyses were conducted for calcium, iron, magnesium, potassium, and sodium. These five constituents were eliminated as SRCs in all environmental media based on comparison to background values.

4.1.5 Data Presentation

Within each of the sections addressing the nature and extent of contamination, analytical results for SRCs are presented as tabular summaries. Selected constituents are presented in graphical format to depict aerial distribution. Because sampling depths were limited to 1.5 meters (5 feet) bgs, vertical profiles of contaminant distribution were not prepared. Data summary statistics and screening results to identify SRCs in each data aggregate are presented in Tables 4-1 through 4-4.

All identified SRCs are evaluated within the text of the contaminant occurrence and distribution sections below. However, certain SRCs are of specific interest and represent the focus of the assessment. The basis for identifying SRCs of specific interest involved several considerations. Those SRCs known to be related to historical operations (i.e., explosives and propellants) are highlighted. Site-related contaminants that were most frequently detected (i.e., in greater than 50 percent of samples) or at the highest concentrations above background also represent a focus for discussion. In addition, certain SRCs occurred at concentrations high enough to exceed risk-based screening criteria as presented in Chapter 5.0; therefore, these constituents also represent a focus for evaluation. For a particular data aggregate, graphical depictions in each chemical class of compounds are typically limited to four or five SRCs of specific interest for clarity of presentation.

4.2 SURFACE SOIL

4.2.1 Geotechnical Results

Geotechnical samples were collected from six surface soil stations at NTA (Table 4-5) and submitted for moisture content, Atterberg limits, and USCS classification analyses. Station NTA-090 is located along the crash strip; stations NTA-015, NTA-028, and NTA-047 are located in the crash area; stations NTA-069 and NTA-078 are located in the plane burial area on the eastern side of the AOC (Figure 3-1). Table 4-5 presents results of the geotechnical analyses of surface soil samples collected during the Phase I RI.

Geotechnical results show a narrow range of variation in moisture content and Atterberg limit results. The USCS classifications for these samples range from clay (CL) to silt (ML), indicating relatively consistent surface soil lithology across the site.

Table 4-5. Summary of Surface Soil Geotechnical data

Sample Station	NTA-015	NTA-028	NTA-047	NTA-069	NTA-078	NTA-090
Depth of sample (feet)	0 – 1	0 – 1	0 – 1	0 – 1	0 – 1	0 – 1
Moisture content (%)	22.9	18.0	22.0	25.0	22.0	21.2
Atterberg limits: Liquid limit	30.9	44.1	32.6	32.9	31.1	44.6
Plastic limit	20.9	21.7	26.7	22.7	17.9	27.6
Plasticity index	10	22.4	5.9	10.2	13.2	17.0
USCS classification	CL	CL	ML	CL	CL	ML

CL = Clay.
ML = Silt.

4.2.2 Explosives and Propellants

4.2.2.1 Explosives

Samples for explosives analysis were collected from 11 stations during the Phase I RI. Two explosives were detected on at least one occasion. Table 4-1 presents a summary of analytical results for these detected explosive compounds. Detected values for each individual station are shown on Figure 4-1. These two explosive compounds include 2,4,6-TNT detected at station NTA-037 (0.15J mg/kg) and station NTA-067 (0.11J mg/kg) and 2,4-dinitrotoluene (DNT) detected at station NTA-090 (0.048J mg/kg). Evaluation of the explosives data for surface soil shows that these compounds are sporadic with no observed distribution pattern. The presence of 2,4-DNT at station NTA-090, in conjunction with nitrocellulose as noted below, may reflect some impacts related to DA1.

4.2.2.2 Propellants

Nitrocellulose was detected in 3 of the 11 surface soil samples analyzed for explosives and propellants. As with the explosive compounds, the detected values for propellants are scattered across the AOC. Concentrations range from 3.5 mg/kg at stations NTA-004 and NTA-090 to a maximum of 45.4 mg/kg at station NTA-062 (Figure 4-1).

4.2.3 TAL Metals and Cyanide

Table 4-1 contains summary statistics and results of the background comparison for inorganic compounds (metals and cyanide) in surface soil. A total of 24 inorganic compounds were detected at least once in surface soil samples collected during the Phase I RI, 18 of which were identified as SRCs and carried forward to the risk screening step (Chapter 5.0). Six of the detected constituents were eliminated as potential surface soil SRCs because they were either considered as essential nutrients (calcium, iron, potassium, magnesium, and sodium) or the frequency of detection was less than 5 percent (silver) and weight-of-evidence did not suggest that they were SRCs. Cadmium, cyanide, and thallium were retained as SRCs based on the background screening; however, the site background criteria for these constituents are set to zero because they were not detected in the background sample population.

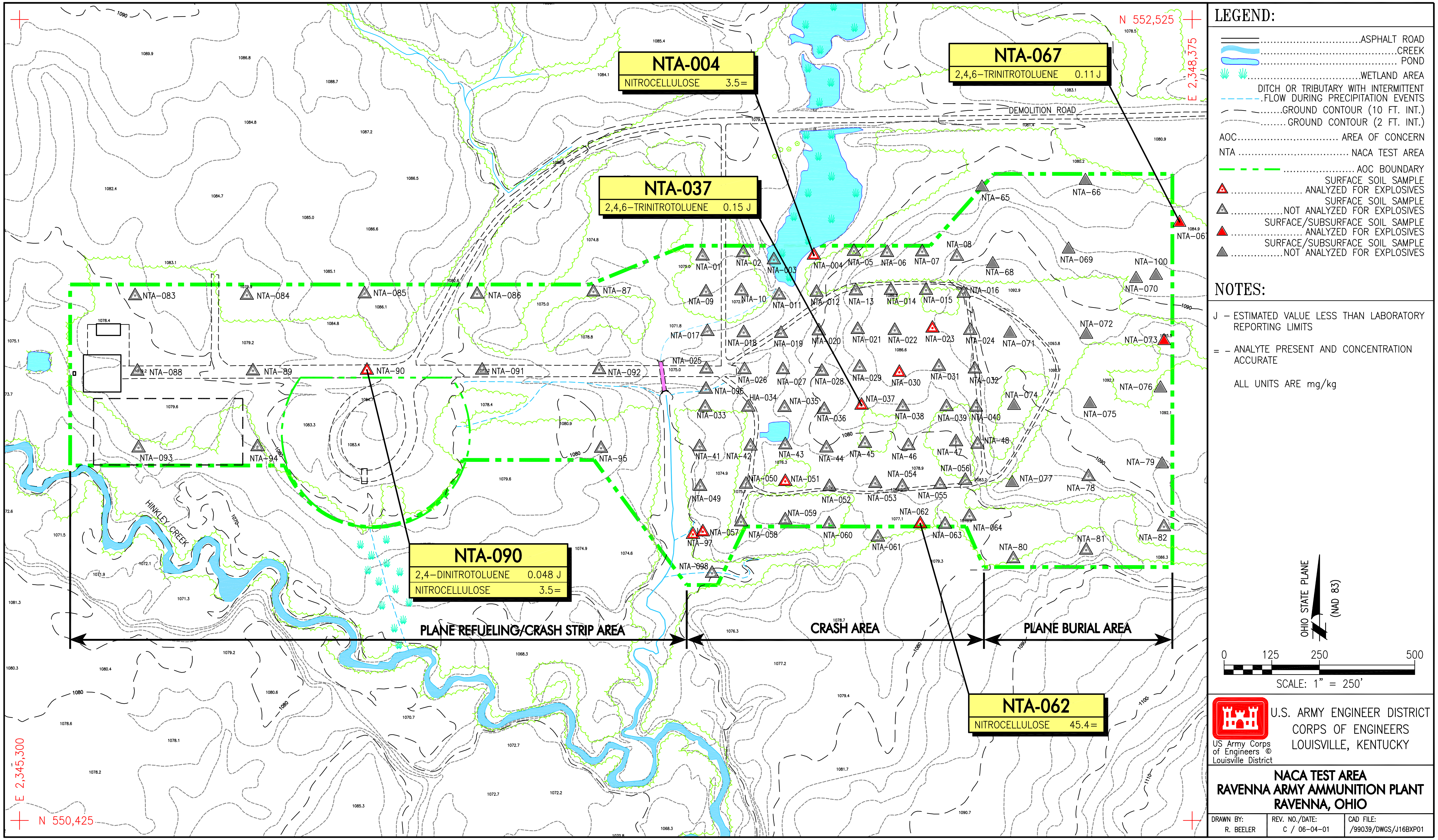


Figure 4-1. Detected Explosives and Propellants in Surface Soils

Table 4-6 provides a summary of results for inorganic SRCs in surface soil at EBG. For those metals retained as SRCs in surface soil, aluminum, arsenic, barium, chromium, cobalt, copper, lead, manganese, nickel, vanadium, and zinc were detected in all 99 samples analyzed. Mercury, selenium, and thallium were also detected in more than 50 percent of the samples analyzed. Barium, copper, mercury, and zinc were detected at concentrations above the site background criteria in 20 percent or more of the samples. Therefore, these four metals are considered as the most prevalent inorganic SRCs at the site. To provide a representative illustration of the occurrence and distribution for this class of contaminants, the concentrations of these four metals relative to their background values are illustrated on Figures 4-2 through 4-5.

In general, the occurrence of metals above background criteria was distributed across the entire AOC. Slightly higher concentrations and frequency of occurrence above background were observed along the crash strip, the central portion of the crash area, and the northeastern corner of the plane burial area. The maximum concentrations of most inorganics in surface soil were detected at station NTA-092 along the crash strip and at two stations (NTA-067 and NTA-070) in the northeast corner of the AOC. The discussion below contains a brief summary of the nature and extent for each of the four most prevalent inorganic SRCs listed in above.

- Barium exceeded its background criterion in 23 samples. Concentrations above background ranged from 90.7 mg/kg to a maximum of 359 mg/kg (4 times background), which occurred at station NTA-092 (Figure 4-2). More than 50 percent (12 of 23) of the detected concentrations, including the maximum detected value, above the background criteria are J-flagged (estimated) values. The highest concentrations of barium consistently detected above background occur along the crash strip, possibly indicating impacts due to abundant slag in this area. In addition, barium values above background were clustered at a group of stations near the former crash barrier (NTA-019, NTA-028, NTA-026, NTA-034, and NTA-096) and the southwestern quadrant (NTA-055, NTA-056, NTA-062, and NTA-064) of the crash area.

- Copper exceeded its background criterion in 17 samples. Concentrations above background were clustered in three areas: the central portion of the crash area; a cluster of stations (NTA-053, NTA-054, and NTA-063) in the southwestern quadrant of the crash area; and the northeastern portion of the plane burial area. The maximum detected concentration was 1,760J mg/kg at station NTA-070, which is more than 30 times higher than any other detected concentration (Figure 4-3). The elevated values observed in the plane burial area correlate to areas with metallic debris at the ground surface as well as to areas of suspected buried debris. Fourteen of the 17 values exceeding the background criterion are J-flagged (estimated) values.

- Mercury was detected above its background criterion in 45 samples. The average detected concentration of mercury exceeded the background criterion; however, only three results were more than twice the background value. Concentrations above background are distributed across the AOC, and no observable patterns in the distribution are noted. The maximum detected concentration (0.1 mg/kg) occurred at station NTA-062 along the southern boundary of the crash area (Figure 4-4).

- Zinc was detected above its background criterion in 27 samples. Only five results were more than twice the background value. Concentrations above background occurred primarily in the southern half of the crash area and the plane burial area (Figure 4-5). The highest concentration was detected at station NTA-070 in the northeastern plane burial area where metallic surface debris were observed. Ten of the reported values are J-flagged (estimated) values.

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-001**	**NTA-002**	**NTA-003**	**NTA-004**	**NTA-005**
Customer ID		**NTAss-001-0001-SO**	**NTAss-002-0002-SO**	**NTAss-003-0003-SO**	**NTAss-004-0004-SO**	**NTAss-005-0005-SO**
Date		**10/20/1999**	**10/21/1999**	**10/21/1999**	**10/21/1999**	**10/21/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	13,400 =	12,900 =	8,760 =	11,100 =	10,600 =
Antimony	mg/kg	0.59 J	0.8 J			0.92 J
Arsenic	mg/kg	6.2 =	5.7 =	3.5 =	5.5 =	11.1 =
Barium	mg/kg	57.1 =	38.3 =	59.1 =	35.1 =	68.9 =
Beryllium	mg/kg					
Cadmium	mg/kg					
Chromium	mg/kg	17.6 = *	14.7 =	11.1 =	12.3 =	13.4 =
Cobalt	mg/kg	6.5 J	6.4 =	6.1 J	3.8 J	16.7 = *
Copper	mg/kg	10.7 =	10.3 =	7.1 =	6.4 =	11.9 =
Cyanide	mg/kg					
Lead	mg/kg	18.3 =	11.3 =	14.2 =	8.2 =	18.4 =
Manganese	mg/kg	137 =	154 =	281 =	55.4 =	1,370 =
Mercury	mg/kg	0.04 J *	0.025 J	0.038 J *	0.023 J	0.024 J
Nickel	mg/kg	18.2 =	16 =	11.8 =	9.7 =	15.4 =
Potassium	mg/kg	1,230 = *	692 =	584 J	652 =	703 =
Selenium	mg/kg	0.88 =	1 =	0.64 J	0.55 J	0.55 J
Thallium	mg/kg	0.31 J *	0.31 J *	0.32 J *	0.27 J *	0.3 J *
Vanadium	mg/kg	22.2 =	19.5 =	15 =	16.9 =	20 =
Zinc	mg/kg	63.2 J *	48.3 =	43.4 =	37.8 =	52.1 =

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-006**	**NTA-007**	**NTA-008**	**NTA-009**	**NTA-010**
Customer ID		**NTAss-006-0006-SO**	**NTAss-007-0007-SO**	**NTAss-008-0008-SO**	**NTAss-009-0009-SO**	**NTAss-010-0010-SO**
Date		**10/22/1999**	**10/24/1999**	**10/24/1999**	**10/20/1999**	**10/21/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	11,600 =	7,680 =	7,220 =	16,500 =	7,830 =
Antimony	mg/kg					
Arsenic	mg/kg	12.5 =	8.2 =	7.5 =	4.9 =	3.9 =
Barium	mg/kg	35.4 =	36.2 =	26.3 =	53.5 =	42 =
Beryllium	mg/kg	0.24 J				
Cadmium	mg/kg					
Chromium	mg/kg	14.9 =	9.3 =	8.2 =	18.3 = *	10.2 =
Cobalt	mg/kg	5.9 J	5.4 J	4.1 J	6.4 =	4.2 J
Copper	mg/kg	12.3 J	6.9 J	8.1 J	13.2 =	7 =
Cyanide	mg/kg					
Lead	mg/kg	11.2 =	15.1 =	14.7 =	15 =	12.8 =
Manganese	mg/kg	206 =	256 =	97.5 =	171 =	139 =
Mercury	mg/kg				0.046 J *	0.057 J *
Nickel	mg/kg	14.9 =	8.9 =	7.7 =	15.3 =	10.6 =
Potassium	mg/kg	847 =	450 J	315 J	1150 = *	419 J
Selenium	mg/kg	0.82 =	0.56 J	0.83 =		
Thallium	mg/kg	0.32 J *	0.26 J *	0.25 J *	0.27 J *	0.24 J *
Vanadium	mg/kg	20.1 =	16.2 =	13.9 =	25.3 =	13.6 =
Zinc	mg/kg	46.6 =	38.6 =	36.6 =	59.6 =	39.5 =

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-011**	**NTA-012**	**NTA-013**	**NTA-014**	**NTA-015**
Customer ID		**NTAss-011-0011-SO**	**NTAss-012-0012-SO**	**NTAss-013-0013-SO**	**NTAss-014-0014-SO**	**NTAss-015-0015-SO**
Date		**10/21/1999**	**10/21/1999**	**10/21/1999**	**10/22/1999**	**10/24/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	20,900 = *	10,100 =	10,600 =	9,590 =	12,500 =
Antimony	mg/kg	0.66 J	0.53 J	0.8 J		
Arsenic	mg/kg	9.9 =	7.3 =	10.3 =	11.1 =	9.3 =
Barium	mg/kg	205 = *	56.5 =	43 =	48.2 =	73.2 =
Beryllium	mg/kg	1.4 = *				
Cadmium	mg/kg					
Chromium	mg/kg	16.4 =	12.1 =	13.1 =	11.4 =	14.2 =
Cobalt	mg/kg	7.3 =	9.4 =	5.8 =	6.5 =	6.5 =
Copper	mg/kg	13.7 =	7.5 =	13.6 =	9.3 J	10.2 J
Cyanide	mg/kg					
Lead	mg/kg	11.2 =	17.6 =	14 =	15.9 =	17.2 =
Manganese	mg/kg	2,280 = *	721 =	224 =	392 =	496 =
Mercury	mg/kg	0.023 J	0.013 J	0.038 J *		
Nickel	mg/kg	16.2 =	11 =	12.2 =	10.5 =	10.6 =
Potassium	mg/kg	1,800 = *	683 =	510 J	634 =	1,270 = *
Selenium	mg/kg	1.1 =	0.72 =	0.91 =	0.76 =	
Thallium	mg/kg		0.22 J *	0.29 J *	0.3 J *	0.31 J *
Vanadium	mg/kg	18.3 =	18.5 =	22.3 =	20.1 =	24 =
Zinc	mg/kg	48.7 =	45.2 =	41.1 =	41.9 =	50.7 =

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Crash Area** **NTA-016** **NTAss-016-0016-SO** **10/24/1999** **0 - 1** **Grab**	**Crash Area** **NTA-017** **NTAss-017-0017-SO** **10/20/1999** **0 - 1** **Grab**	**Crash Area** **NTA-018** **NTAss-018-0018-SO** **10/21/1999** **0 - 1** **Grab**	**Crash Area** **NTA-019** **NTAss-019-0019-SO** **10/21/1999** **0 - 1** **Grab**	**Crash Area** **NTA-020** **NTAss-020-0020-SO** **10/21/1999** **0 - 1** **Grab**
Analyte	Units					
Aluminum	mg/kg	19,200 = *	12,600 =	15,300 =	11,300 =	14,500 =
Antimony	mg/kg	1.2 R	0.85 J	1.1 J *	0.64 J	0.68 J
Arsenic	mg/kg	5.1 J	9.7 =	10.2 =	5.1 =	10.2 =
Barium	mg/kg	250 J *	38.4 =	56.7 =	102 = *	66.2 =
Beryllium	mg/kg	1.7 J *				
Cadmium	mg/kg					
Chromium	mg/kg	8.9 J	17.5 = *	20.7 = *	11 =	17.3 =
Cobalt	mg/kg	3 J	6 J	3.9 J	4.3 J	8.6 =
Copper	mg/kg	5.8 J	14.4 =	13.6 =	9.4 =	16.5 =
Cyanide	mg/kg			0.68 = *		
Lead	mg/kg	8.8 J	14.9 =	12.8 =	15 =	20.1 =
Manganese	mg/kg	2,480 = *	94.1 =	86.7 =	810 =	331 =
Mercury	mg/kg	0.033 J	0.018 J	0.043 J *	0.044 J *	0.019 J
Nickel	mg/kg	4.9 J	18.6 =	9.2 =	9.1 =	18.4 =
Potassium	mg/kg	1,000 J *	622 J	677 =	626 J	1,630 = *
Selenium	mg/kg	1.7 J *	0.65 =	1.2 =	0.97 =	0.63 =
Thallium	mg/kg	0.27 J *	0.28 J *	0.32 J *	0.23 J *	0.25 J *
Vanadium	mg/kg	11.2 J	21.3 =	30 =	15.6 =	23.1 =
Zinc	mg/kg	26.7 =	46.8 =	38.2 =	42.6 =	61.5 =

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-021**	**NTA-022**	**NTA-023**	**NTA-024**	**NTA-025**
Customer ID		**NTAss-021-0021-SO**	**NTAss-022-0022-SO**	**NTAss-023-0023-SO**	**NTAss-024-0024-SO**	**NTAss-025-0025-SO**
Date		**10/22/1999**	**10/22/1999**	**10/24/1999**	**10/24/1999**	**10/20/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	6,130 =	5,860 =	6,600 =	6,680 =	25,400 = *
Antimony	mg/kg			1.2 R	1.2 R	0.95 J
Arsenic	mg/kg	8.3 =	7.1 =	9.6 J	10.3 J	4 =
Barium	mg/kg	21.5 J	48.9 =	48.1 J	49.8 J	254 J *
Beryllium	mg/kg	0.25 J		0.22 J		1.4 = *
Cadmium	mg/kg					
Chromium	mg/kg	8.1 =	8.3 =	9.6 J	10.3 J	16.5 J
Cobalt	mg/kg	6.3 =	5.5 J	6.5 J	5.9 J	3.6 J
Copper	mg/kg	16.8 J	15.8 J	13.7 J	7 J	9 =
Cyanide	mg/kg					1.3 = *
Lead	mg/kg	10.3 =	16.6 =	21.3 J	21.1 J	17 =
Manganese	mg/kg	303 =	364 =	384 =	594 =	2,850 = *
Mercury	mg/kg			0.042 J *	0.041 J *	
Nickel	mg/kg	13.1 =	10 =	10 J	7.4 J	6.2 =
Potassium	mg/kg	702 =	414 J	436 J	332 J	1,950 J *
Selenium	mg/kg		0.46 J	0.94 J	1.4 J	1.5 = *
Thallium	mg/kg	0.16 J *	0.28 J *	0.37 J *	0.36 J *	0.19 J *
Vanadium	mg/kg	11.1 =	12.3 =	14.8 J	18.3 J	17.6 =
Zinc	mg/kg	45.1 =	38.9 =	41.7 =	31 =	41.3 J

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-026**	**NTA-027**	**NTA-028**	**NTA-029**	**NTA-030**
Customer ID		**NTAss-026-0026-SO**	**NTAss-027-0027-SO**	**NTAss-028-0028-SO**	**NTAss-029-0029-SO**	**NTAss-030-0030-SO**
Date		**10/20/1999**	**10/22/1999**	**10/22/1999**	**10/22/1999**	**10/22/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	14,300 =	13,300 =	11,800 =	8,270 =	9,650 =
Antimony	mg/kg	0.55 J				
Arsenic	mg/kg	13.6 =	12.2 =	13.2 =	9.1 =	8.5 =
Barium	mg/kg	95.2 = *	63.8 =	96.9 = *	40.9 =	55.1 =
Beryllium	mg/kg	0.75 =	0.41 J	0.39 J		0.28 J
Cadmium	mg/kg	0.59 J *				1.3 = *
Chromium	mg/kg	16.4 =	17.8 = *	16.9 =	10.9 =	12.4 =
Cobalt	mg/kg	9.4 =	8.9 =	14.3 J *	6.8 =	7.1 =
Copper	mg/kg	19.3 = *	17.1 J	20.3 J *	14.5 J	55.6 J *
Cyanide	mg/kg					
Lead	mg/kg	20.1 =	18.1 =	22.6 =	18.8 =	34 = *
Manganese	mg/kg	737 =	288 =	1,110 =	307 =	305 =
Mercury	mg/kg	0.058 J *				
Nickel	mg/kg	20.6 =	21.6 = *	26.6 = *	15.9 =	14.2 =
Potassium	mg/kg	1,140 = *	2,270 = *	1,360 = *	801 =	741 =
Selenium	mg/kg	0.84 =			0.46 J	0.7 =
Thallium	mg/kg	0.26 J *	0.34 J *	0.3 J *	0.3 J *	0.35 J *
Vanadium	mg/kg	20.2 =	23.3 =	20.9 =	14.1 =	16.1 =
Zinc	mg/kg	67 J *	58 =	62.4 = *	46.4 =	62.2 = *

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-031**	**NTA-032**	**NTA-032**	**NTA-033**	**NTA-034**
Customer ID		**NTAss-031-0031-SO**	**NTAss-032-0032-SO**	**NTAss-032-0139-SO**	**NTAss-033-0033-SO**	**NTAss-034-0034-SO**
Date		**10/24/1999**	**10/24/1999**	**10/24/1999**	**10/20/1999**	**10/22/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Field Duplicate**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	10,900 =	9,270 =	10,400 =	11,100 =	8,510 =
Antimony	mg/kg	1.2 R	1.2 R	1.2 R		
Arsenic	mg/kg	10 J	7.2 J	8.5 J	4.8 =	17.4 = *
Barium	mg/kg	58.4 J	73 J	70.2 J	50.1 J	93.9 = *
Beryllium	mg/kg	0.31 J	0.25 J	0.26 J		0.72 =
Cadmium	mg/kg	0.28 J *				
Chromium	mg/kg	14.5 J	11.2 J	11.9 J	13 J	12.4 =
Cobalt	mg/kg	7.8 J	4.6 J	4.9 J	5.4 J	38.2 = *
Copper	mg/kg	25.4 J *	10.2 J	11.9 J	6.2 =	5.9 J
Cyanide	mg/kg					
Lead	mg/kg	23.4 J	17.4 J	15 J	15.8 =	27.5 = *
Manganese	mg/kg	354 =	694 =	619 =	155 =	4500 = *
Mercury	mg/kg	0.033 J	0.03 J		0.061 J *	
Nickel	mg/kg	15.9 J	8.6 J	9.7 J	9.1 =	10.4 =
Potassium	mg/kg	930 J *	546 J	575 J	746 J	494 J
Selenium	mg/kg	0.68 J	1.3 J	1.2 J	0.89 =	2.6 = *
Thallium	mg/kg	0.36 J *	0.35 J *	0.37 J *	0.46 J *	0.3 J *
Vanadium	mg/kg	20.6 J	16.7 J	20.1 J	20.1 =	29 =
Zinc	mg/kg	54.9 =	38 =	38.9 =	45.8 J	47.9 =

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Crash Area** **NTA-035** **NTAss-035-0035-SO** **10/22/1999** **0 - 1** **Grab**	**Crash Area** **NTA-036** **NTAss-036-0036-SO** **10/22/1999** **0 - 1** **Grab**	**Crash Area** **NTA-037** **NTAss-037-0037-SO** **10/22/1999** **0 - 1** **Grab**	**Crash Area** **NTA-038** **NTAss-038-0038-SO** **10/24/1999** **0 - 1** **Grab**	**Crash Area** **NTA-039** **NTAss-039-0040-SO** **10/24/1999** **0 - 1** **Grab**
Analyte	Units					
Aluminum	mg/kg	9,560 =	5,400 =	6,820 =	7,570 =	10,400 =
Antimony	mg/kg				1.3 R	1.3 R
Arsenic	mg/kg	11.3 =	6.9 =	6.7 =	6.9 J	9.7 J
Barium	mg/kg	54.7 =	18 J	36.6 =	43.6 J	51.2 J
Beryllium	mg/kg	0.29 J		0.24 J		0.23 J
Cadmium	mg/kg					
Chromium	mg/kg	13.8 =	6.6 =	7.7 =	8.9 J	12.3 J
Cobalt	mg/kg	8.2 =	4.5 J	8.1 =	4.3 J	8.2 J
Copper	mg/kg	25 J *	8.6 J	6.2 J	12 J	9.4 J
Cyanide	mg/kg					
Lead	mg/kg	32.9 = *	6.9 =	20.7 =	14.5 J	17.3 J
Manganese	mg/kg	258 =	109 =	625 =	180 =	456 =
Mercury	mg/kg				0.047 J *	0.06 J *
Nickel	mg/kg	19.9 =	10.8 =	8.7 =	9.8 J	11.4 J
Potassium	mg/kg	1,180 = *	371 J	468 J	460 J	716 J
Selenium	mg/kg	0.61 =	0.46 J		0.63 J	1.4 J
Thallium	mg/kg	0.31 J *	0.2 J *	0.29 J *	0.33 J *	0.39 J *
Vanadium	mg/kg	17 =	8.7 =	15.2 =	14.5 J	21.4 J
Zinc	mg/kg	57.8 =	28.7 =	38.1 =	40.1 =	67.7 = *

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-040**	**NTA-041**	**NTA-042**	**NTA-043**	**NTA-043**
Customer ID		**NTAss-040-0041-SO**	**NTAss-041-0042-SO**	**NTAss-042-0043-SO**	**NTAss-043-0044-SO**	**NTAss-043-0140-SO**
Date		**10/24/1999**	**10/20/1999**	**10/25/1999**	**10/25/1999**	**10/25/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Field Duplicate**
Analyte	Units					
Aluminum	mg/kg	7,740 =	8,640 =	8,950 =	6,290 =	7,660 =
Antimony	mg/kg	1.2 R				
Arsenic	mg/kg	9.4 J	3.8 =	6.1 =	4.9 =	4.9 =
Barium	mg/kg	35.4 J	45.6 J	33 =	30.4 =	35.8 =
Beryllium	mg/kg					
Cadmium	mg/kg					
Chromium	mg/kg	10.2 J	10 J	10.3 J	6.3 J	7.4 J
Cobalt	mg/kg	5.5 J	5.9 J	4.4 J	3.1 J	3.1 J
Copper	mg/kg	7.6 J	5.1 =	8 J	7.9 J	13.2 J
Cyanide	mg/kg					
Lead	mg/kg	17.8 J	13.8 =	12.7 J	13 J	13 J
Manganese	mg/kg	198 =	317 =	125 =	103 =	94 =
Mercury	mg/kg	0.04 J *	0.036 J	0.017 J	0.026 J	0.031 J
Nickel	mg/kg	9.5 J	7.3 =	11.6 =	7 =	7.2 =
Potassium	mg/kg	575 J	698 J	606 =	338 J	455 J
Selenium	mg/kg	1.2 J	0.54 J			
Thallium	mg/kg	0.32 J *	0.26 J *	0.27 J *	0.23 J *	0.23 J *
Vanadium	mg/kg	15.9 J	15.5 =	14.6 =	10.4 =	11.9 =
Zinc	mg/kg	39.9 =	38.6 J	44.1 J	33.7 J	38.5 J

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-044**	**NTA-045**	**NTA-046**	**NTA-047**	**NTA-048**
Customer ID		**NTAss-044-0045-SO**	**NTAss-045-0046-SO**	**NTAss-046-0047-SO**	**NTAss-047-0048-SO**	**NTAss-048-0049-SO**
Date		**10/25/1999**	**10/26/1999**	**10/26/1999**	**10/26/1999**	**10/24/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	8,920 =	6,870 =	7,230 =	8,040 =	6,230 =
Antimony	mg/kg					1.2 R
Arsenic	mg/kg	9.8 =	5.5 =	6.1 =	4.9 =	8.7 J
Barium	mg/kg	45.1 =	28.5 =	48.7 =	36.7 =	36.6 J
Beryllium	mg/kg					0.24 J
Cadmium	mg/kg					
Chromium	mg/kg	12.2 J	7.9 =	8.3 =	8.8 =	7.8 J
Cobalt	mg/kg	7.6 =	3 J	4.6 J	2.7 J	7 J
Copper	mg/kg	16.8 J	6.3 J	7.9 J	6.2 J	7.9 J
Cyanide	mg/kg					
Lead	mg/kg	16.1 J	13.7 =	14.7 =	12.2 =	15 J
Manganese	mg/kg	280 =	78.3 =	196 =	49 =	374 =
Mercury	mg/kg	0.036 J	0.049 J *	0.032 J	0.036 J	
Nickel	mg/kg	17.1 =	7 =	9.2 =	7.2 =	9.7 J
Potassium	mg/kg	975 = *	478 J	520 J	726 =	425 J
Selenium	mg/kg		1.1 =	0.9 =		0.8 J
Thallium	mg/kg	0.24 J *				0.23 J *
Vanadium	mg/kg	15.4 =	13.5 =	13.2 =	15.6 =	15.1 J
Zinc	mg/kg	53.2 J	35.4 =	77.7 = *	34.5 =	42.3 =

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-049**	**NTA-050**	**NTA-051**	**NTA-052**	**NTA-053**
Customer ID		**NTAss-049-0050-SO**	**NTAss-050-0051-SO**	**NTAss-051-0052-SO**	**NTAss-052-0053-SO**	**NTAss-053-0054-SO**
Date		**10/20/1999**	**10/25/1999**	**10/25/1999**	**10/25/1999**	**10/25/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	11,300 =	10,100 =	10,100 =	14,000 =	12,300 =
Antimony	mg/kg					
Arsenic	mg/kg	3.7 =	3.3 =	4 =	9.7 =	12.7 =
Barium	mg/kg	41.3 J	68.1 =	30.1 =	59.8 =	53 =
Beryllium	mg/kg					
Cadmium	mg/kg					
Chromium	mg/kg	12.7 J	9.2 J	9.8 J	15.8 J	16.1 J
Cobalt	mg/kg	4.4 J	3.7 J	3.1 J	6.2 J	12.7 = *
Copper	mg/kg	6.7 =	3.9 J	5.2 J	10.5 J	17.9 J *
Cyanide	mg/kg					
Lead	mg/kg	9.9 =	12.3 J	11.3 J	16.4 J	13.7 J
Manganese	mg/kg	129 =	367 =	52.5 =	193 =	466 =
Mercury	mg/kg		0.032 J	0.026 J	0.037 J *	0.036 J
Nickel	mg/kg	10.9 =	7.7 =	9 =	14 =	22.2 = *
Potassium	mg/kg	872 J	623 J	507 J	1280 = *	986 = *
Selenium	mg/kg	0.57 J				
Thallium	mg/kg	0.36 J *	0.25 J *	0.3 J *	0.37 J *	0.29 J *
Vanadium	mg/kg	19.3 =	13.8 =	14.7 =	22.1 =	18.5 =
Zinc	mg/kg	51.5 J	43.5 J	40.8 J	64.3 J *	57.7 J

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-054**	**NTA-055**	**NTA-055**	**NTA-056**	**NTA-057**
Customer ID		**NTAss-054-0055-SO**	**NTAss-055-0056-SO**	**NTAss-055-0141-SO**	**NTAss-056-0057-SO**	**NTAss-057-0058-SO**
Date		**10/26/1999**	**10/26/1999**	**10/26/1999**	**10/26/1999**	**10/20/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Field Duplicate**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	11,700 =	8,980 =	8,090 =	15,000 =	10,300 =
Antimony	mg/kg					
Arsenic	mg/kg	12.4 =	8.5 =	10 =	8.8 =	6.2 =
Barium	mg/kg	75.9 =	109 = *	52.9 =	127 = *	42 =
Beryllium	mg/kg	0.41 J	0.27 J	0.25 J	0.58 J	
Cadmium	mg/kg				1.1 = *	
Chromium	mg/kg	17 =	9.8 =	10.5 =	17.7 = *	14 =
Cobalt	mg/kg	10.5 = *	6.4 =	8 =	8.3 =	5.8 J
Copper	mg/kg	20.6 J *	13.1 J	16.7 J	15.1 J	7.3 =
Cyanide	mg/kg					
Lead	mg/kg	19.6 =	12.2 =	12.9 =	27.4 = *	13.3 =
Manganese	mg/kg	385 =	560 =	344 =	151 =	130 =
Mercury	mg/kg	0.029 J	0.021 J	0.027 J	0.064 J *	0.039 J *
Nickel	mg/kg	25.2 = *	11.1 =	14.8 =	20.8 =	12.6 =
Potassium	mg/kg	984 = *	592 J	588 J	1,410 = *	869 =
Selenium	mg/kg	1.1 =	0.82 =	0.99 =	0.63 J	0.91 =
Thallium	mg/kg					0.35 J *
Vanadium	mg/kg	19.1 =	12.4 =	13.9 =	24.9 =	19 =
Zinc	mg/kg	75.8 = *	35.6 =	42.8 =	150 = *	51.5 J

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Crash Area** **NTA-058** **NTAss-058-0060-SO** **10/25/1999** **0 - 1** **Grab**	**Crash Area** **NTA-058** **NTAss-058-0137-SO** **10/20/1999** **0 - 1** **Field Duplicate**	**Crash Area** **NTA-059** **NTAss-059-0061-SO** **10/25/1999** **0 - 1** **Grab**	**Crash Area** **NTA-060** **NTAss-060-0062-SO** **10/25/1999** **0 - 1** **Grab**	**Crash Area** **NTA-061** **NTAss-061-0063-SO** **10/25/1999** **0 - 1** **Grab**
Analyte	Units					
Aluminum	mg/kg	10,600 =	10,600 =	10,700 =	7,020 =	12,900 =
Antimony	mg/kg	1.3 R	0.73 J			
Arsenic	mg/kg	5.2 J	5.8 =	5.2 =	6.4 =	10.8 =
Barium	mg/kg	68.9 J	39.5 =	35.2 =	42.3 =	113 = *
Beryllium	mg/kg	0.34 J				
Cadmium	mg/kg					
Chromium	mg/kg	12.1 J	13.8 =	11.1 J	9.1 J	16 J
Cobalt	mg/kg	5.5 J	5.2 J	3.9 J	8.4 =	10 =
Copper	mg/kg	8.5 J	7.4 =	7 J	5.6 J	17.7 J
Cyanide	mg/kg					
Lead	mg/kg	14.4 J	12.5 =	9.6 J	13.8 J	22.8 J
Manganese	mg/kg	368 =	110 =	79.7 =	493 =	946 =
Mercury	mg/kg	0.043 J *	0.036 J	0.032 J	0.046 J *	0.072 J *
Nickel	mg/kg	13.2 J	12.3 =	10.7 =	9.7 =	22.3 = *
Potassium	mg/kg	662 J	857 =	534 J	411 J	1570 = *
Selenium	mg/kg	0.76 J	0.75 =			
Thallium	mg/kg	0.43 J *	0.27 J *	0.24 J *	0.28 J *	0.3 J *
Vanadium	mg/kg	16.1 J	18.4 =	16.6 =	12.9 =	20.6 =
Zinc	mg/kg	47.4 =	52.4 J	44.4 J	52.6 J	168 J *

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Plane Burial Area**	**Plane Burial Area**
Station		**NTA-062**	**NTA-063**	**NTA-064**	**NTA-065**	**NTA-066**
Customer ID		**NTAss-062-0064-SO**	**NTAss-063-0065-SO**	**NTAss-064-0066-SO**	**NTAss-065-0067-SO**	**NTAss-066-0069-SO**
Date		**10/26/1999**	**10/26/1999**	**10/26/1999**	**11/02/1999**	**11/02/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	8,020 =	8,650 =	11,900 =	9,430 J	16,500 J
Antimony	mg/kg					
Arsenic	mg/kg	12.3 =	7.2 =	19 = *	7.4 =	11.6 =
Barium	mg/kg	89.1 = *	61 =	95.1 = *	35.6 J	70.2 J
Beryllium	mg/kg	0.51 J	0.3 J	0.47 J	0.28 J	0.49 J
Cadmium	mg/kg	0.56 J *	0.63 J			
Chromium	mg/kg	12 =	10.5 =	16 =	12.6 J	22.3 J *
Cobalt	mg/kg	10.3 =	6.8 =	8.9 =	6.3 J	7 =
Copper	mg/kg	24.8 J *	8.8 J	23.5 J *	6.1 J	13.4 J
Cyanide	mg/kg	1.1 = *				
Lead	mg/kg	29.6 = *	14.5 =	17.9 =	15.2 =	13.8 =
Manganese	mg/kg	674 =	188 =	507 =	229 J	142 J
Mercury	mg/kg	0.1 J *	0.043 J *	0.054 J *	0.042 J *	0.033 J
Nickel	mg/kg	21.3 = *	12.4 =	21.6 = *	12.4 =	21.6 = *
Potassium	mg/kg	951 J *	767 =	1510 = *	809 =	1,960 = *
Selenium	mg/kg	1.7 = *	1.1 =	0.86 =		
Thallium	mg/kg				0.33 J *	0.44 J *
Vanadium	mg/kg	16.2 =	15.6 =	21.2 =	16.1 =	27.5 =
Zinc	mg/kg	231 = *	73 = *	116 = *	43.1 =	65.3 = *

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**
Station		**NTA-067**	**NTA-068**	**NTA-069**	**NTA-069**	**NTA-070**
Customer ID		**NTAss-067-0071-SO**	**NTAss-068-0073-SO**	**NTAss-069-0075-SO**	**NTAss-069-0142-SO**	**NTAss-070-0078-SO**
Date		**11/03/1999**	**11/02/1999**	**11/02/1999**	**11/02/1999**	**11/02/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Field Duplicate**	**Grab**
Analyte	Units					
Aluminum	mg/kg	17,400 =	7,750 =	9,520 =	9,270 =	31,200 = *
Antimony	mg/kg					2.9 = *
Arsenic	mg/kg	23 = *	8.8 =	9.9 =	9.2 =	8.3 =
Barium	mg/kg	253 J *	31 J	67.6 J	63 J	109 J *
Beryllium	mg/kg	0.94 = *	0.22 J	0.41 J	0.39 J	0.36 J
Cadmium	mg/kg					14.5 = *
Chromium	mg/kg	23.5 J *	9.1 J	11.3 J	10.9 J	54.2 J *
Cobalt	mg/kg	10.6 = *	5.9 =	8.6 =	6.4 =	5.9 J
Copper	mg/kg	19.2 J *	8.6 J	7 J	7.1 J	1,760 J *
Cyanide	mg/kg					
Lead	mg/kg	22.2 =	11.5 =	18 =	18.5 =	149 = *
Manganese	mg/kg	2,190 = *	350 J	1,500 J *	1,040 J	804 J
Mercury	mg/kg	0.061 J *	0.046 J *	0.068 J *	0.066 J *	0.038 J *
Nickel	mg/kg	33.2 = *	11.6 =	9.9 =	9.6 =	41.4 = *
Potassium	mg/kg	1,700 = *	496 J	575 J	579 J	281 J
Selenium	mg/kg		0.58 =			
Thallium	mg/kg	0.52 J *	0.22 J *	0.33 J *	0.33 J *	0.33 J *
Vanadium	mg/kg	36.6 = *	13.7 =	19.8 =	18.5 =	14.9 =
Zinc	mg/kg	97.1 = *	44 =	51.3 =	54.8 =	603 = *

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Plane Burial Area** **NTA-071** **NTAss-071-0080-SO** **10/27/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-072** **NTAss-072-0082-SO** **10/27/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-073** **NTAss-073-0084-SO** **11/02/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-074** **NTAss-074-0086-SO** **10/27/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-075** **NTAss-075-0088-SO** **10/27/1999** **0 - 1** **Grab**
Analyte	Units					
Aluminum	mg/kg	12,000 =	11,700 =	5,090 =	6,850 =	7,080 =
Antimony	mg/kg					
Arsenic	mg/kg	12.3 =	8.6 =	7.2 =	7.6 =	4.5 =
Barium	mg/kg	80.2 =	56.1 =	36.8 J	46.3 =	46.7 =
Beryllium	mg/kg	0.42 J		0.23 J		
Cadmium	mg/kg		0.74 = *	1.6 = *		
Chromium	mg/kg	16.7 =	14 =	7 J	8.4 =	7.9 =
Cobalt	mg/kg	10 =	7.8 =	4.4 J	5.5 J	3.4 J
Copper	mg/kg	16 J	27.2 J *	19.6 J *	8.2 J	5.2 J
Cyanide	mg/kg					
Lead	mg/kg	25.1 =	17.7 =	29.7 = *	12.3 =	13.6 =
Manganese	mg/kg	658 =	392 =	265 J	296 =	358 =
Mercury	mg/kg	0.022 J	0.031 J	0.038 J *	0.049 J *	0.035 J
Nickel	mg/kg	17.2 =	15.3 =	8.5 =	8.9 =	5.5 =
Potassium	mg/kg	1,270 = *	726 =	248 J	427 J	550 J
Selenium	mg/kg	0.74 =	0.73 =		0.54 J	
Thallium	mg/kg			0.18 J *		
Vanadium	mg/kg	23.8 =	20.8 =	9.6 =	14.4 =	11.4 =
Zinc	mg/kg	75.5 = *	64.4 = *	43 =	37.3 =	41 =

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Plane Burial Area** **NTA-076** **NTAss-076-0090-SO** **11/03/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-077** **NTAss-077-0092-SO** **11/01/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-078** **NTAss-078-0094-SO** **11/03/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-079** **NTAss-079-0095-SO** **11/03/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-080** **NTAss-080-0097-SO** **11/01/1999** **0 - 1** **Grab**
Analyte	Units					
Aluminum	mg/kg	7,350 =	8,720 =	8,800 =	8,360 =	9,470 =
Antimony	mg/kg					
Arsenic	mg/kg	6.2 =	7.9 =	10.9 =	8.3 =	7.9 =
Barium	mg/kg	48.1 J	30.9 J	63.4 J	42.3 J	81.5 J
Beryllium	mg/kg		0.23 J			0.48 J
Cadmium	mg/kg					
Chromium	mg/kg	8.6 J	10.6 J	11.4 J	10.5 J	12.1 J
Cobalt	mg/kg	4.6 J	4.6 J	12 = *	5.1 J	6.2 J
Copper	mg/kg	5.7 J	7.8 J	9.8 J	7.7 J	10.1 J
Cyanide	mg/kg					
Lead	mg/kg	9.8 =	12.1 =	14.3 =	10.6 =	17.8 =
Manganese	mg/kg	201 =	112 J	946 =	218 =	183 J
Mercury	mg/kg	0.032 J	0.035 J	0.038 J *	0.032 J	0.047 J *
Nickel	mg/kg	6.7 =	11.4 =	12.4 =	9.6 =	13.9 =
Potassium	mg/kg	375 J	572 J	634 =	552 J	710 =
Selenium	mg/kg			0.68 =	0.85 =	0.87 =
Thallium	mg/kg	0.27 J *	0.23 J *	0.25 J *	0.28 J *	0.35 J *
Vanadium	mg/kg	14.9 =	14.7 =	17.7 =	16.3 =	18.5 =
Zinc	mg/kg	28.4 =	41.7 =	41.7 =	44.3 =	93.2 = *

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Plane Burial Area**	**Plane Burial Area**	**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**
Station		**NTA-081**	**NTA-082**	**NTA-083**	**NTA-084**	**NTA-085**
Customer ID		**NTAss-081-0098-SO**	**NTAss-082-0099-SO**	**NTAss-083-0100-SO**	**NTAss-084-0102-SO**	**NTAss-085-0104-SO**
Date		**11/03/1999**	**11/03/1999**	**10/19/1999**	**10/19/1999**	**10/19/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	7,210 =	10,200 =	12,400 J	14,400 J	10,300 J
Antimony	mg/kg					
Arsenic	mg/kg	11.5 =	8.8 =	5.2 J	8 J	10.1 J
Barium	mg/kg	73.3 J	77.4 J	130 J *	181 J *	37.8 J
Beryllium	mg/kg	0.36 J		1.2 = *		
Cadmium	mg/kg			5.2 = *	0.67 = *	
Chromium	mg/kg	10.4 J	12.5 J	8 =	14.7 =	12.6 =
Cobalt	mg/kg	7.8 =	6 J	4.7 J	27.5 = *	5.2 J
Copper	mg/kg	12.2 J	10.7 J	8.8 J	10.8 J	10.1 J
Cyanide	mg/kg				0.77 = *	
Lead	mg/kg	17.7 =	22.5 =	56.6 J *	22.6 J	19.9 J
Manganese	mg/kg	527 =	246 =	1,310 J	6,240 J *	185 J
Mercury	mg/kg	0.046 J *	0.073 J *	0.013 J	0.073 J *	0.05 J *
Nickel	mg/kg	14.7 =	13.2 =	9 =	24.2 = *	11.8 =
Potassium	mg/kg	873 =	958 = *	788 =	1,070 = *	638 =
Selenium	mg/kg	0.75 =	0.61 J	1.4 =	1.7 = *	
Thallium	mg/kg	0.27 J *	0.31 J *	0.17 J *	0.4 J *	0.34 J *
Vanadium	mg/kg	14 =	17.9 =	9.8 =	21.6 =	20 =
Zinc	mg/kg	67.8 = *	62.5 = *	41.8 J	158 J *	46.3 J

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Plane Refueling/ Crash Strip Area** **NTA-086** **NTAss-086-0106-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-087** **NTAss-087-0107-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-088** **NTAss-088-0108-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-089** **NTAss-089-0109-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-090** **NTAss-090-0110-SO** **10/19/1999** **0 - 1** **Grab**
Analyte	Units					
Aluminum	mg/kg	17,500 J	12,800 J	11,700 J	12,500 J	22,800 J *
Antimony	mg/kg					
Arsenic	mg/kg	13.8 J	3 J	4.3 J	4.7 J	6.1 J
Barium	mg/kg	59.8 J	57.9 J	111 J *	90.7 J *	253 J *
Beryllium	mg/kg					2.3 = *
Cadmium	mg/kg			0.59 U		
Chromium	mg/kg	21.9 = *	14.7 =	9.6 =	8.5 =	13.5 =
Cobalt	mg/kg	8.1 =	6.6 =	2 J	3.8 J	4.9 J
Copper	mg/kg	14.2 J	5.1 J	4.5 J	5.6 J	6.7 J
Cyanide	mg/kg			0.98 = *		
Lead	mg/kg	15 J	10.9 J	11.1 J	10.2 =	10.8 J
Manganese	mg/kg	205 J	187 J	1,570 J *	1,030 J	3,410 J *
Mercury	mg/kg	0.053 J *	0.028 J	0.066 J *	0.038 J *	0.04 J *
Nickel	mg/kg	20 =	13.3 =	4.6 J	5.7 =	7.4 =
Potassium	mg/kg	1,540 = *	1,290 = *	724 =	647 =	1,420 = *
Selenium	mg/kg	0.67 =	0.75 =			1.4 =
Thallium	mg/kg	0.33 J *	0.29 J *	0.16 J *		0.18 J *
Vanadium	mg/kg	29.2 =	22.6 =	10.9 =	13.9 =	13 =
Zinc	mg/kg	63.2 J *	57.2 J	24.9 J	31.4 J	28.7 J

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location		**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**
Station		**NTA-091**	**NTA-091**	**NTA-092**	**NTA-093**	**NTA-094**
Customer ID		**NTAss-091-0111-SO**	**NTAss-091-0144-SO**	**NTAss-092-0112-SO**	**NTAss-093-0113-SO**	**NTAss-094-0114-SO**
Date		**10/19/1999**	**10/19/1999**	**10/19/1999**	**10/19/1999**	**10/19/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Field Duplicate**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Aluminum	mg/kg	26,100 J *	26,800 J *	33,900 J *	12,800 J	12,900 J
Antimony	mg/kg					
Arsenic	mg/kg	3.4 J	3 J	2.2 J	11.1 J	12.3 J
Barium	mg/kg	301 J *	325 J *	359 J *	57.4 J	71 J
Beryllium	mg/kg	3.3 = *	3.3 = *	3.8 = *		
Cadmium	mg/kg					
Chromium	mg/kg	8.2 =	11.3 =	11.6 =	16.2 =	17.9 = *
Cobalt	mg/kg	3.1 J	2.3 J	1.5 J	7.2 =	10.8 = *
Copper	mg/kg	5.2 J	4 J	2.6 J	10.6 J	30.3 J *
Cyanide	mg/kg	1.2 = *	1.5 = *	1.6 = *		
Lead	mg/kg	12.5 J	10.4 J	11.4 J	15.1 J	18.2 J
Manganese	mg/kg	3,370 J *	3,930 J *	6,080 J *	297 J	424 J
Mercury	mg/kg	0.032 J	0.011 J	0.033 J	0.036 J	0.056 J *
Nickel	mg/kg	4.3 J	3 J	2.1 J	16.6 =	23.3 = *
Potassium	mg/kg	2,020 = *	2,210 = *	2,120 = *	1,300 = *	1,050 = *
Selenium	mg/kg	2.2 = *	2.4 = *	2.8 = *		0.84 =
Thallium	mg/kg				0.36 J *	0.31 J *
Vanadium	mg/kg	10.1 =	11.9 =	8.9 =	21.7 =	19.9 =
Zinc	mg/kg	26.8 J	21.9 J	17.4 J	63.7 J *	91.4 J *

Table 4-6. Summary of Principal Site-Related Metals in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Plane Refueling/ Crash Strip Area** **NTA-095** **NTAss-095-0115-SO** **10/19/1999** **0 - 1** **Grab**	**Ditches flowing from NACA Test Area** **NTA-096** **NTAss-096-0117-SO** **10/20/1999** **0 - 1** **Grab**	**Ditches flowing from NACA Test Area** **NTA-097** **NTAss-097-0118-SO** **10/20/1999** **0 - 1** **Grab**	**Ditches flowing from NACA Test Area** **NTA-098** **NTAss-098-0119-SO** **10/20/1999** **0 - 1** **Grab**	**Ditches flowing from NACA Test Area** **NTA-098** **NTAss-098-0145-SO** **10/20/1999** **0 - 1** **Field Duplicate**	**Contingency – Plane Burial Area** **NTA-100** **NTAss-100-0122-SO** **11/04/1999** **0 - 1** **Grab**
Analyte	Units						
Aluminum	mg/kg	6,380 J	22,500 = *	17,200 =	9,290 =	8,620 =	9,560 =
Antimony	mg/kg			0.7 J	0.88 J		
Arsenic	mg/kg	5 J	4.8 =	13 =	18.3 = *	6 =	8 =
Barium	mg/kg	30.4 J	99.8 J *	104 = *	62.9 =	44.2 =	75.6 J
Beryllium	mg/kg						
Cadmium	mg/kg			0.32 J *			2.4 = *
Chromium	mg/kg	7.1 =	25.2 J *	22.4 = *	12.7 =	11.6 =	11.9 J
Cobalt	mg/kg	3.3 J	9.3 =	11.6 = *	9 =	5.5 J	8.5 =
Copper	mg/kg	6.3 J	19.3 = *	20.4 = *	14.6 =	7.3 =	24.4 J *
Cyanide	mg/kg						
Lead	mg/kg	9.1 =	11.7 =	16.9 =	10.6 =	10 =	24.2 =
Manganese	mg/kg	88.2 J	101 =	352 =	372 =	261 =	1,140 =
Mercury	mg/kg	0.037 J *	0.037 U	0.041 J *	0.0093 J	0.025 J	0.073 J *
Nickel	mg/kg	8.6 =	26.3 = *	29.2 = *	21.2 = *	14.2 =	10.7 =
Potassium	mg/kg	489 J	1,740 J *	1,710 = *	1,060 = *	904 =	561 J
Selenium	mg/kg		0.53 J	0.94 =	0.9 =		
Thallium	mg/kg	0.25 J *	0.57 J *		0.29 J *	0.3 J *	0.32 J *
Vanadium	mg/kg	11 =	27.9 =	27.5 =	14.5 =	15.3 =	18.4 =
Zinc	mg/kg	30.7 J	82.2 J *	84.8 J *	55.3 =	46.1 J	38.3 =

= = Analyte present and concentration accurate.
* = Value above facility-wide background criterion.
J = Estimated value less than reporting limits.
R = Rejected value.
U = Not detected.
Blank cells represent non-detect values.

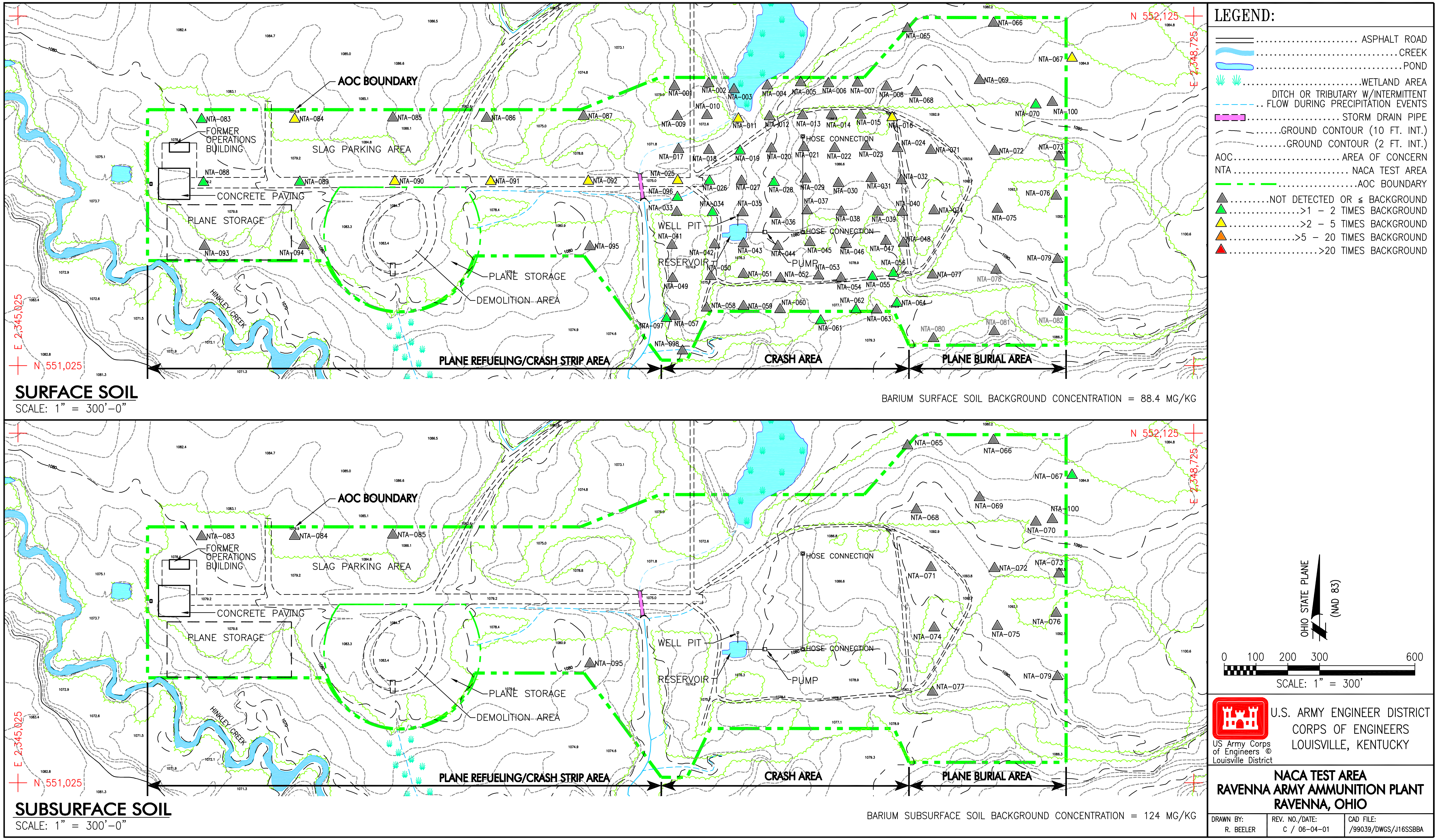


Figure 4-2. Distribution of Barium in Surface and Subsurface Soil

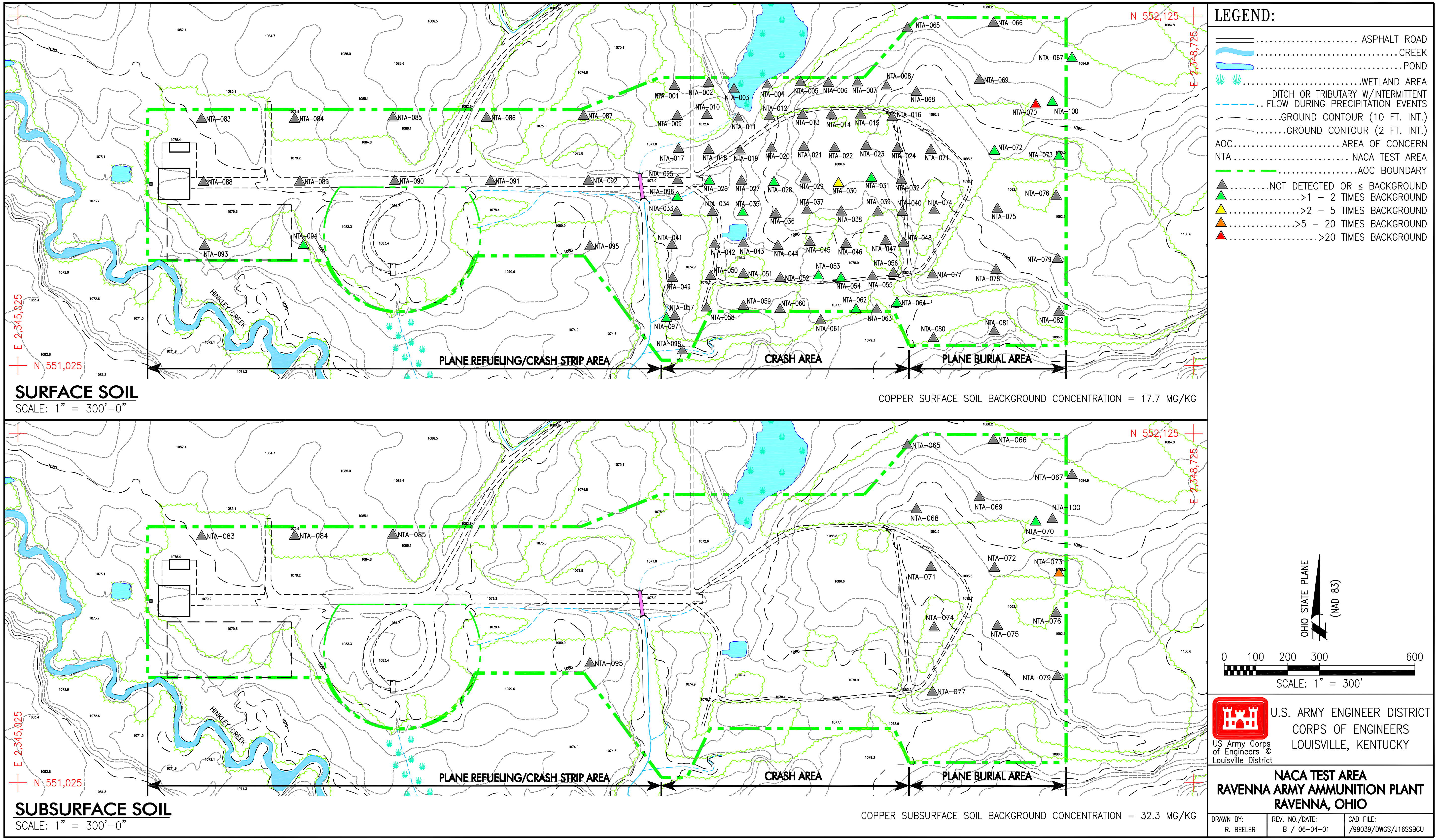


Figure 4-3. Distribution of Copper in Surface and Subsurface Soil

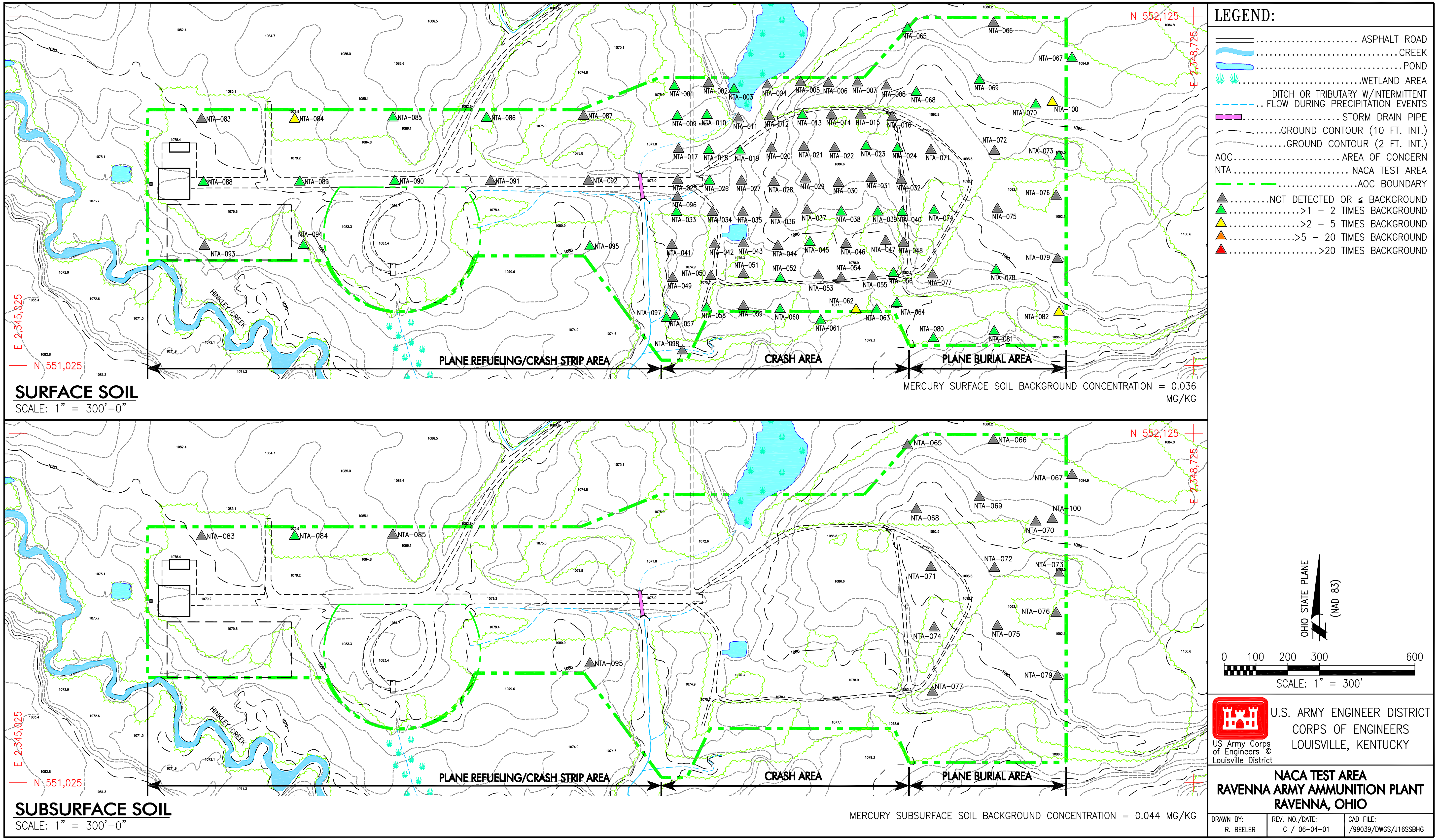


Figure 4-4. Distribution of Mercury in Surface and Subsurface Soil

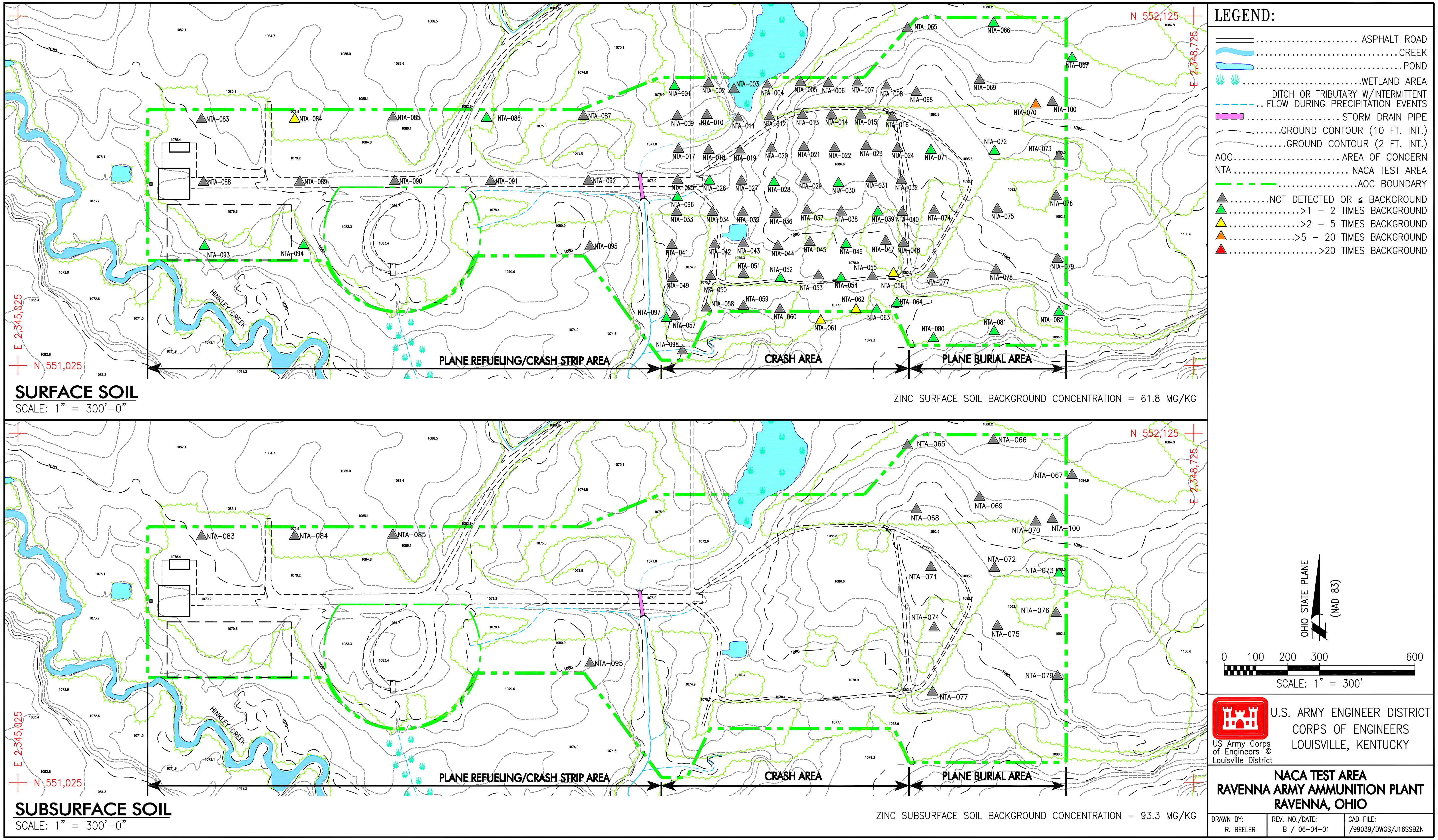


Figure 4-5. Distribution of Zinc in Surface and Subsurface Soil

In addition to these four prevalent inorganic SRCs, a number of additional metals of interest were detected at relatively high frequencies; however, the number of results greater than background values for these constituents was comparatively low. These inorganic constituents, with the number of detected values above background in parentheses, include aluminum (8), arsenic (4), chromium (12), cobalt (10), lead (8), manganese (11), nickel (15), and vanadium (1). The distribution of these SRCs above background was sporadic. For example, the maximum values for these eight constituents occurred at five different stations: NTA-034 in the crash area (cobalt at 38.20 mg/kg); NTA-092 along the crash strip (aluminum at 33,900 mg/kg); NTA-067 in the plane burial area (arsenic at 23.0 mg/kg and vanadium at 36.6 mg/kg); NTA-070 in the plane burial area (chromium at 54.2 mg/kg, lead at 149 mg/kg, and nickel at 41.4 mg/kg); and NTA-084 along the crash strip (manganese).

Cadmium (12 of 99 detections), cyanide (7 of 99 detections), and thallium (81 of 99 detections) were detected occasionally; however, no background criteria exist for comparative purposes. These three metals were detected across the AOC with no apparent pattern in their distribution. The maximum detected concentration of cadmium (14.5 mg/kg) occurred at station NTA-070; the maximum concentration of cyanide (1.6 mg/kg) was detected at station NTA-092; and the maximum detected value for thallium (8.27 mg/kg) occurred at station NTA-081. All results for thallium are J-flagged (estimated).

4.2.4 SVOCs

A total of 64 SVOCs were analyzed for in all 99 surface soil samples collected during the Phase I RI (Table 4-1). Of these, 21 SVOCs were detected at least once. Seven SVOCs were eliminated from further consideration as SRCs based on weight of evidence, including frequency of detect (detected in three or fewer samples), the fact that a high percentage of the results were J-flagged (estimated), and the fact that they were not identified as SRCs in other media. The seven SVOCs eliminated as SRCs include: acenaphthene, carbazole, di-n-butylphthalate, dibenzofuran, fluorene, naphthalene, and phenol. The frequency of detection for the remaining 14 SVOCs ranged from 5 of 99 samples to 18 of 99 samples. A large majority of the detected values were estimated results (J-flagged). All results for acenaphthylene and anthracene were J-flagged (estimated) values, but these constituents were conservatively retained as SRCs. Table 4-7 lists the detected concentrations of the 14 SVOCs retained as SRCs in surface soil at NTA.

Although numerous SVOCs were detected, only 34 of the 99 surface soil samples contained detectable concentrations of these compounds. Ten stations in particular had the majority of detected SVOC compounds: NTA-025, NTA-026, NTA-032, NTA-071, NTA-083, NTA-084, NTA-088, NTA-089, NTA-090, and NTA-091. Figure 4-6 shows the distribution of SVOCs in surface soil at NTA and illustrates that 6 of the 10 stations with the majority of the detected values are within the plane refueling/crash strip area.

The observed SVOCs may be divided into two classes: (1) bis(2-ethylhexyl)phthalate and (2) polycyclic aromatic hydrocarbons (PAHs) that are usually derived from petroleum-based materials such as fuel, oil, and hydraulic fluid. Bis(2-ethylhexyl)phthalate was the most widespread SVOC (18 detected values); however, 17 of the results were J-flagged (estimated). The maximum detected value for bis(2-ethylhexyl)phthalate occurred at station NTA-007 at the northern edge of the crash area.

Those constituents identified as PAHs include acenaphthylene; anthracene; benz(a)anthracene; benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene. The maximum detected value for each of these constituents occurred at station NTA-088 in the western-most portion of the plane refueling/crash strip area.

Table 4-7. Summary Data for Site-Related SVOCs in Surface Soil

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-007**	**NTA-016**	**NTA-021**	**NTA-022**	**NTA-025**	**NTA-026**
Customer ID		NTAss-007-0007-SO	**NTAss-016-0016-SO**	**NTAss-021-0021-SO**	**NTAss-022-0022-SO**	**NTAss-025-0025-SO**	**NTAss-026-0026-SO**
Date		**10/24/1999**	**10/24/1999**	**10/22/1999**	**10/22/1999**	**10/20/1999**	**10/20/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units						
Acenaphthylene	mg/kg						0.330J
Anthracene	mg/kg						0.330J
Benz(a)anthracene	mg/kg					0.064J	1.5=
Benzo(a)pyrene	mg/kg					0.084J	1.9=
Benzo(b)fluoranthene	mg/kg				0.050J	0.120J	3.2=
Benzo(g,h,i)perylene	mg/kg			0.150J		0.066J	1.0=
Benzo(k)fluoranthene	mg/kg					0.050J	1.2=
Bis(2-ethylhexyl)phthalate	mg/kg	6.6=	0.059J				
Chrysene	mg/kg				0.050J	0.096J	2.7=
Dibenz(a,h)anthracene	mg/kg			0.140J			0.350J
Fluoranthene	mg/kg					0.130J	1.7=
Indeno(1,2,3-cd)pyrene	mg/kg			0.120J		0.068J	1.2=
Phenanthrene	mg/kg					0.060J	0.340J
Pyrene	mg/kg				0.039J	0.140J	1.8=

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-028**	**NTA-029**	**NTA-030**	**NTA-032**	**NTA-039**	**NTA-045**
Customer ID		**NTAss-028-0028-SO**	**NTAss-029-0029-SO**	**NTAss-030-0030-SO**	**NTAss-032-0032-SO**	**NTAss-039-0040-SO**	**NTAss-045-0046-SO**
Date		**10/22/1999**	**10/22/1999**	**10/22/1999**	**10/24/1999**	**10/24/1999**	**10/26/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units						
Acenaphthylene	mg/kg						
Anthracene	mg/kg				0.170J		
Benz(a)anthracene	mg/kg				0.460=		
Benzo(a)pyrene	mg/kg		0.60J		0.430=		
Benzo(b)fluoranthene	mg/kg		0.079J		0.610=		
Benzo(g,h,i)perylene	mg/kg		0.073J		0.270J		
Benzo(k)fluoranthene	mg/kg				0.230J		
Bis(2-ethylhexyl)phthalate	mg/kg	0.093J		0.099J		0.048J	
Chrysene	mg/kg		0.059J		0.460=		
Dibenz(a,h)anthracene	mg/kg				0.075J		
Fluoranthene	mg/kg				0.810=		0.042J
Indeno(1,2,3-cd)pyrene	mg/kg				0.340J		
Phenanthrene	mg/kg				0.270J		
Pyrene	mg/kg				0.650=		0.040J

Table 4-7. Summary Data for Site-Related SVOCs in Surface Soil (continued)

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**
Station		**NTA-056**	**NTA-062**	**NTA-063**	**NTA-070**	**NTA-071**	**NTA-072**
Customer ID		**NTAss-056-0057-SO**	**NTAss-062-0064-SO**	**NTAss-063-0065-SO**	**NTAss-070-0078-SO**	**NTAss-071-0080-SO**	**NTAss-072-0082-SO**
Date		**10/26/1999**	**10/26/1999**	**10/26/1999**	**11/02/1999**	**10/27/1999**	**10/27/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units						
Acenaphthylene	mg/kg						
Anthracene	mg/kg						
Benz(a)anthracene	mg/kg	0.050J				0.190J	
Benzo(a)pyrene	mg/kg					0.180J	
Benzo(b)fluoranthene	mg/kg	0.058J	0.092J			0.210J	
Benzo(g,h,i)perylene	mg/kg					0.130J	
Benzo(k)fluoranthene	mg/kg					0.096J	
Bis(2-ethylhexyl)phthalate	mg/kg	0.062J		0.070J	0.490J	0.045J	0.063J
Chrysene	mg/kg	0.060J	0.089J			0.200J	
Dibenz(a,h)anthracene	mg/kg						
Fluoranthene	mg/kg	0.076J	0.170J			0.300J	
Indeno(1,2,3-cd)pyrene	mg/kg					0.150J	
Phenanthrene	mg/kg		0.130J			0.086J	
Pyrene	mg/kg	0.068J	0.150J			0.270J	

Location		**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**
Station		**NTA-073**	**NTA-074**	**NTA-077**	**NTA-081**	**NTA-083**	**NTA-084**
Customer ID		**NTAss-073-0084-SO**	**NTAss-074-0086-SO**	**NTAss-077-0092-SO**	**NTAss-081-0098-SO**	**NTAss-083-0100-SO**	**NTAss-084-0102-SO**
Date		**11/02/1999**	**10/27/1999**	**11/01/1999**	**11/03/1999**	**10/19/1999**	**10/19/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units						
Acenaphthylene	mg/kg					0.890J	
Anthracene	mg/kg						
Benz(a)anthracene	mg/kg					2.4=	0.86J
Benzo(a)pyrene	mg/kg					3.5J	0.100J
Benzo(b)fluoranthene	mg/kg				0.057J	4.7=	0.130J
Benzo(g,h,i)perylene	mg/kg					3.1J	0.082J
Benzo(k)fluoranthene	mg/kg					1.6J	0.055J
Bis(2-ethylhexyl)phthalate	mg/kg	0.400J	0.043J	0.058J			0.075J
Chrysene	mg/kg		0.045J			3.2J	0.120J
Dibenz(a,h)anthracene	mg/kg					0.650J	
Fluoranthene	mg/kg		0.053J		0.060J	4.7=	0.210J
Indeno(1,2,3-cd)pyrene	mg/kg					2.7J	0.082J
Phenanthrene	mg/kg					1.5=	0.100J
Pyrene	mg/kg		0.051J		0.056J	5.3=	0.180J

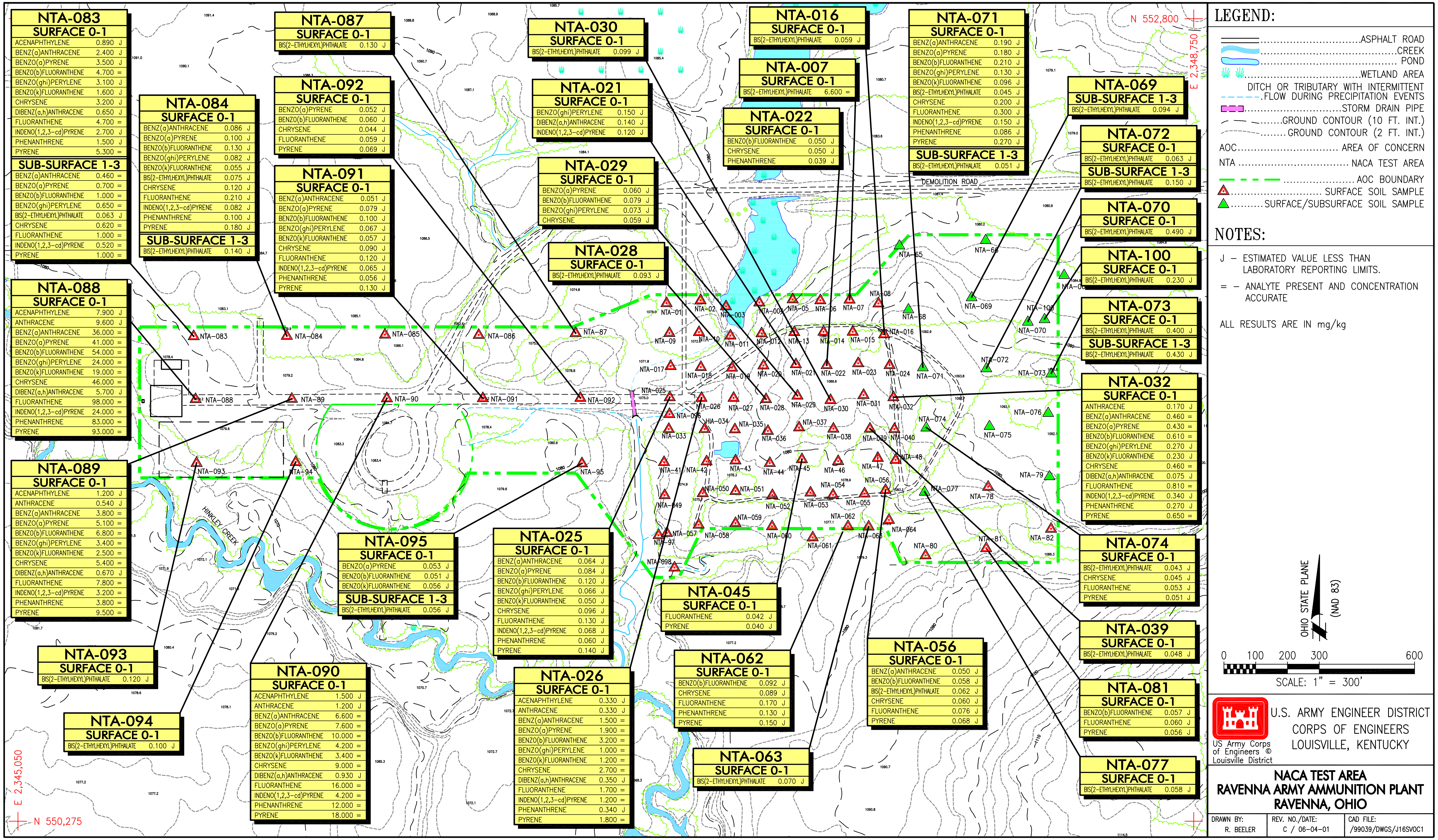
Table 4-7. Summary Data for Site-Related SVOCs in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Plane Refueling/ Crash Strip Area** **NTA-087** **NTAss-087-0107-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-088** **NTAss-088-0108-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-089** **NTAss-089-0109-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-090** **NTAss-090-0110-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-091** **NTAss-091-0111-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-092** **NTAss-092-0112-SO** **10/19/1999** **0 - 1** **Grab**
Analyte	Units						
Acenaphthylene	mg/kg		7.9J	1.2J	1.5J		
Anthracene	mg/kg		9.6J	0.54=	1.2J		
Benz(a)anthracene	mg/kg		36.0=	3.8=	6.6=	0.051J	
Benzo(a)pyrene	mg/kg		41.0=	5.1=	7.6=	0.079J	0.052J
Benzo(b)fluoranthene	mg/kg		54.0=	6.8=	10.0=	0.100J	0.060J
Benzo(g,h,i)perylene	mg/kg		24.0=	3.4=	4.2=	0.067J	
Benzo(k)fluoranthene	mg/kg		19.0=	2.5=	3.2=	0.057J	
Bis(2-ethylhexyl)phthalate	mg/kg	0.130J					
Chrysene	mg/kg		46.0=	5.4=	9.0=	0.090J	0.044J
Dibenz(a,h)anthracene	mg/kg		5.7J	0.670J	0.930J		
Fluoranthene	mg/kg		98.0=	7.8=	16.0=	0.120J	0.059J
Indeno(1,2,3-cd)pyrene	mg/kg		24.0=	3.2=	4.2=	0.065J	
Phenanthrene	mg/kg		83.0=	3.8=	12.0=	0.056J	
Pyrene	mg/kg		93.0=	9.5=	18.0=	0.130J	0.069J

Table 4-7. Summary Data for Site-Related SVOCs in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Plane Refueling/ Crash Strip Area** **NTA-093** **NTAss-093-0113-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-094** **NTAss-094-0114-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Refueling/ Crash Strip Area** **NTA-095** **NTAss-095-0115-SO** **10/19/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-100** **NTAss-100-0122-SO** **11/04/1999** **0 - 1** **Grab**
Analyte	Units				
Acenaphthylene	mg/kg				
Anthracene	mg/kg				
Benz(a)anthracene	mg/kg				
Benzo(a)pyrene	mg/kg			0.053J	
Benzo(b)fluoranthene	mg/kg			0.051J	
Benzo(g,h,i)perylene	mg/kg				
Benzo(k)fluoranthene	mg/kg			0.056J	
Bis(2-ethylhexyl)phthalate	mg/kg	0.120J	0.100J		0.230J
Chrysene	mg/kg				
Dibenz(a,h)anthracene	mg/kg				
Fluoranthene	mg/kg				
Indeno(1,2,3-cd)pyrene	mg/kg				
Phenanthrene	mg/kg				
Pyrene	mg/kg				

= = Analyte present and concentration accurate.
J = Estimated values less than laboratory reporting limits.



NTA-083

SURFACE 0-1		
ACENAPHTHYLENE	0.890	J
BENZ(a)ANTHRACENE	2.400	J
BENZO(a)PYRENE	3.500	J
BENZO(b)FLUORANTHENE	4.700	=
BENZO(ghi)PERYLENE	3.100	J
BENZO(k)FLUORANTHENE	1.600	J
CHRYSENE	3.200	J
DIBENZ(a,h)ANTHRACENE	0.650	J
FLUORANTHENE	4.700	=
INDENO(1,2,3–cd)PYRENE	2.700	J
PHENANTHRENE	1.500	J
PYRENE	5.300	=
SUB-SURFACE 1-3		
BENZ(a)ANTHRACENE	0.460	=
BENZO(a)PYRENE	0.700	=
BENZO(b)FLUORANTHENE	1.000	=
BENZO(ghi)PERYLENE	0.650	=
BIS(2–ETHYLHEXYL)PHTHALATE	0.063	J
CHRYSENE	0.620	=
FLUORANTHENE	1.000	=
INDENO(1,2,3–cd)PYRENE	0.520	=
PYRENE	1.000	=

NTA-084

SURFACE 0-1		
BENZ(a)ANTHRACENE	0.086	J
BENZO(a)PYRENE	0.100	J
BENZO(b)FLUORANTHENE	0.130	J
BENZO(ghi)PERYLENE	0.082	J
BENZO(k)FLUORANTHENE	0.055	J
BIS(2–ETHYLHEXYL)PHTHALATE	0.075	J
CHRYSENE	0.120	J
FLUORANTHENE	0.210	J
INDENO(1,2,3–cd)PYRENE	0.082	J
PHENANTHRENE	0.100	J
PYRENE	0.180	J
SUB-SURFACE 1-3		
BIS(2–ETHYLHEXYL)PHTHALATE	0.140	J

NTA-088

SURFACE 0-1		
ACENAPHTHYLENE	7.900	J
ANTHRACENE	9.600	J
BENZ(a)ANTHRACENE	36.000	=
BENZO(a)PYRENE	41.000	=
BENZO(b)FLUORANTHENE	54.000	=
BENZO(ghi)PERYLENE	24.000	=
BENZO(k)FLUORANTHENE	19.000	=
CHRYSENE	46.000	=
DIBENZ(a,h)ANTHRACENE	5.700	J
FLUORANTHENE	98.000	=
INDENO(1,2,3–cd)PYRENE	24.000	=
PHENANTHRENE	83.000	=
PYRENE	93.000	=

NTA-089

SURFACE 0-1		
ACENAPHTHYLENE	1.200	J
ANTHRACENE	0.540	J
BENZ(a)ANTHRACENE	3.800	=
BENZO(a)PYRENE	5.100	=
BENZO(b)FLUORANTHENE	6.800	=
BENZO(ghi)PERYLENE	3.400	=
BENZO(k)FLUORANTHENE	2.500	=
CHRYSENE	5.400	=
DIBENZ(a,h)ANTHRACENE	0.670	J
FLUORANTHENE	7.800	=
INDENO(1,2,3–cd)PYRENE	3.200	=
PHENANTHRENE	3.800	=
PYRENE	9.500	=

NTA-093

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.120	J

NTA-094

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.100	J

NTA-087

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.130	J

NTA-092

SURFACE 0-1		
BENZO(a)PYRENE	0.052	J
BENZO(b)FLUORANTHENE	0.060	J
CHRYSENE	0.044	J
FLUORANTHENE	0.059	J
PYRENE	0.069	J

NTA-091

SURFACE 0-1		
BENZ(a)ANTHRACENE	0.051	J
BENZO(a)PYRENE	0.079	J
BENZO(b)FLUORANTHENE	0.100	J
BENZO(ghi)PERYLENE	0.067	J
BENZO(k)FLUORANTHENE	0.057	J
CHRYSENE	0.090	J
FLUORANTHENE	0.120	J
INDENO(1,2,3–cd)PYRENE	0.065	J
PHENANTHRENE	0.056	J
PYRENE	0.130	J

NTA-095

SURFACE 0-1		
BENZO(a)PYRENE	0.053	J
BENZO(b)FLUORANTHENE	0.051	J
BENZO(k)FLUORANTHENE	0.056	J
SUB-SURFACE 1-3		
BIS(2–ETHYLHEXYL)PHTHALATE	0.056	J

NTA-090

SURFACE 0-1		
ACENAPHTHYLENE	1.500	J
ANTHRACENE	1.200	J
BENZ(a)ANTHRACENE	6.600	=
BENZO(a)PYRENE	7.600	=
BENZO(b)FLUORANTHENE	10.000	=
BENZO(ghi)PERYLENE	4.200	=
BENZO(k)FLUORANTHENE	3.400	=
CHRYSENE	9.000	=
DIBENZ(a,h)ANTHRACENE	0.930	J
FLUORANTHENE	16.000	=
INDENO(1,2,3–cd)PYRENE	4.200	=
PHENANTHRENE	12.000	=
PYRENE	18.000	=

NTA-030

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.099	J

NTA-021

SURFACE 0-1		
BENZO(ghi)PERYLENE	0.150	J
DIBENZ(a,h)ANTHRACENE	0.140	J
INDENO(1,2,3–cd)PYRENE	0.120	J

NTA-029

SURFACE 0-1		
BENZO(a)PYRENE	0.060	J
BENZO(b)FLUORANTHENE	0.079	J
BENZO(ghi)PERYLENE	0.073	J
CHRYSENE	0.059	J

NTA-028

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.093	J

NTA-025

SURFACE 0-1		
BENZ(a)ANTHRACENE	0.064	J
BENZO(a)PYRENE	0.084	J
BENZO(b)FLUORANTHENE	0.120	J
BENZO(ghi)PERYLENE	0.066	J
BENZO(k)FLUORANTHENE	0.050	J
CHRYSENE	0.096	J
FLUORANTHENE	0.130	J
INDENO(1,2,3–cd)PYRENE	0.068	J
PHENANTHRENE	0.060	J
PYRENE	0.140	J

NTA-026

SURFACE 0-1		
ACENAPHTHYLENE	0.330	J
ANTHRACENE	0.330	J
BENZ(a)ANTHRACENE	1.500	=
BENZO(a)PYRENE	1.900	=
BENZO(b)FLUORANTHENE	3.200	=
BENZO(ghi)PERYLENE	1.000	=
BENZO(k)FLUORANTHENE	1.200	=
CHRYSENE	2.700	=
DIBENZ(a,h)ANTHRACENE	0.350	J
FLUORANTHENE	1.700	=
INDENO(1,2,3–cd)PYRENE	1.200	=
PHENANTHRENE	0.340	J
PYRENE	1.800	=

NTA-016

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.059	J

NTA-007

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	6.600	=

NTA-022

SURFACE 0-1		
BENZO(b)FLUORANTHENE	0.050	J
CHRYSENE	0.050	J
PHENANTHRENE	0.039	J

NTA-045

SURFACE 0-1		
FLUORANTHENE	0.042	J
PYRENE	0.040	J

NTA-062

SURFACE 0-1		
BENZO(b)FLUORANTHENE	0.092	J
CHRYSENE	0.089	J
FLUORANTHENE	0.170	J
PHENANTHRENE	0.130	J
PYRENE	0.150	J

NTA-063

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.070	J

NTA-071

SURFACE 0-1		
BENZ(a)ANTHRACENE	0.190	J
BENZO(a)PYRENE	0.180	J
BENZO(b)FLUORANTHENE	0.210	J
BENZO(ghi)PERYLENE	0.130	J
BENZO(k)FLUORANTHENE	0.096	J
BIS(2–ETHYLHEXYL)PHTHALATE	0.045	J
CHRYSENE	0.200	J
FLUORANTHENE	0.300	J
INDENO(1,2,3–cd)PYRENE	0.150	J
PHENANTHRENE	0.086	J
PYRENE	0.270	J
SUB-SURFACE 1-3		
BIS(2–ETHYLHEXYL)PHTHALATE	0.051	J

NTA-056

SURFACE 0-1		
BENZ(a)ANTHRACENE	0.050	J
BENZO(b)FLUORANTHENE	0.058	J
BIS(2–ETHYLHEXYL)PHTHALATE	0.062	J
CHRYSENE	0.060	J
FLUORANTHENE	0.076	J
PYRENE	0.068	J

NTA-069

SUB-SURFACE 1-3		
BIS(2–ETHYLHEXYL)PHTHALATE	0.094	J

NTA-072

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.063	J
SUB-SURFACE 1-3		
BIS(2–ETHYLHEXYL)PHTHALATE	0.150	J

NTA-070

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.490	J

NTA-100

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.230	J

NTA-073

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.400	J
SUB-SURFACE 1-3		
BIS(2–ETHYLHEXYL)PHTHALATE	0.430	J

NTA-032

SURFACE 0-1		
ANTHRACENE	0.170	J
BENZ(a)ANTHRACENE	0.460	=
BENZO(a)PYRENE	0.430	=
BENZO(b)FLUORANTHENE	0.610	=
BENZO(ghi)PERYLENE	0.270	J
BENZO(k)FLUORANTHENE	0.230	J
CHRYSENE	0.460	=
DIBENZ(a,h)ANTHRACENE	0.075	J
FLUORANTHENE	0.810	=
INDENO(1,2,3–cd)PYRENE	0.340	J
PHENANTHRENE	0.270	J
PYRENE	0.650	=

NTA-074

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.043	J
CHRYSENE	0.045	J
FLUORANTHENE	0.053	J
PYRENE	0.051	J

NTA-039

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.048	J

NTA-081

SURFACE 0-1		
BENZO(b)FLUORANTHENE	0.057	J
FLUORANTHENE	0.060	J
PYRENE	0.056	J

NTA-077

SURFACE 0-1		
BIS(2–ETHYLHEXYL)PHTHALATE	0.058	J

LEGEND:

═	ASPHALT ROAD
🟦	CREEK
🟦	POND
ψ ψ	WETLAND AREA
- - - - -	DITCH OR TRIBUTARY WITH INTERMITTENT FLOW DURING PRECIPITATION EVENTS
▭	STORM DRAIN PIPE
— — —	GROUND CONTOUR (10 FT. INT.)
- - - -	GROUND CONTOUR (2 FT. INT.)
AOC	AREA OF CONCERN
NTA	NACA TEST AREA
— — —	AOC BOUNDARY
△	SURFACE SOIL SAMPLE
▲	SURFACE/SUBSURFACE SOIL SAMPLE

NOTES:

J – ESTIMATED VALUE LESS THAN LABORATORY REPORTING LIMITS.

= – ANALYTE PRESENT AND CONCENTRATION ACCURATE

ALL RESULTS ARE IN mg/kg

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

NACA TEST AREA
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
R. BEELER	C / 06–04–01	/99039/DWGS/J16SVOC1

Figure 4-6. Detected Surface and Subsurface Soil Site-Related SVOCs

4.2.5 VOCs and PCBs

4.2.5.1 VOCs

A total of 35 VOCs were analyzed for in all surface soil samples collected during the Phase I RI. Five VOCs were detected, including acetone, dimethylbenzene, methylene chloride, styrene, and toluene (Table 4-1). The frequency of detection for acetone and styrene is less than 5 percent, and the detected results are all qualified as estimated concentrations less than reporting limits; thus, they are eliminated from further consideration as SRCs. Dimethylbenzene and methylene chloride were each detected in 9 of 99 samples, and toluene was detected in 6 samples. All detected concentrations are J-flagged (estimated) values; however, these three VOCs are conservatively retained as SRCs. Table 4-8 lists the stations and detected concentrations for these compounds.

The distribution for the three VOCs retained as SRCs is shown on Figure 4-7. As evident from the map of the distribution, at least 1 of the 3 VOCs was detected at 22 different sampling stations. All of the detected values were clustered in the northern half of the crash area (12 stations) or in the plane storage area (6 stations).

4.2.5.2 PCBs

A total of 7 PCB compounds (Aroclors) were analyzed for in surface soil samples collected at 11 stations. No PCB compounds were detected.

4.3 SUBSURFACE SOIL

4.3.1 Geotechnical Results

One disturbed (grab) subsurface soil geotechnical sample was collected from station NTA-069 [0.3 to 0.9 meter (1 to 3 feet)] and submitted for moisture, Atterberg limits, and USCS classification. In addition, three undisturbed geotechnical samples (Shelby tube) were taken using a direct-push rig (Geoprobe) at stations NTA-038, NTA-058, and NTA-069 and submitted for an expanded list of geotechnical parameters as noted below. Table 4-9 presents results of the geotechnical analyses for subsurface soil samples.

Sieve analyses and USCS classification identified the samples as ranging from lean clay (CL) to silt with sand (ML). Analytical results indicate a high degree of similarity in the samples collected from stations NTA-038 and NTA-069. As with surface soil geotechnical results, these data indicate consistency in the soil lithology across the site. The sample collected at station NTA-058 was located off of the end of a service road in the southwestern corner of the crash area. Evident reworking of the soil and added fill material at station NTA-058 may be the reason for the observed differences in moisture content, Atterberg limits, and grain size distribution between the sample from this station and those from stations NTA-038 and NTA-069.

4.3.2 Explosives and Propellants

Subsurface soil samples were collected from stations NTA-067 and NTA-073 and submitted for explosives and propellants analyses. No explosives or propellants were detected.

Table 4-8. Summary Data for Site-Related VOCs in Surface Soil

Location		**Crash Area**	**Crash Area**	**Crash Area**	Crash Area
Station		**NTA-008**	**NTA-012**	**NTA-014**	**NTA-016**
Customer ID		**NTAss-008-0008-SO**	**NTAss-012-0012-SO**	**NTAss-014-0014-SO**	**NTAss-016-0016-SO**
Date		**10/24/1999**	**10/21/1999**	**10/22/1999**	**10/24/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units				
Dimethylbenzene	mg/kg	0.0016J			0.0014J
Methylene chloride	mg/kg			0.0028J	
Toluene	mg/kg		0.0028J		

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-021**	**NTA-022**	**NTA-023**	**NTA-024**
Customer ID		**NTAss-021-0021-SO**	**NTAss-022-0022-SO**	**NTAss-023-0023-SO**	**NTAss-024-0024-SO**
Date		**10/22/1999**	**10/22/1999**	**10/24/1999**	**10/24/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units				
Dimethylbenzene	mg/kg			0.002J	0.0023J
Methylene chloride	mg/kg	0.0028J	0.0028J		
Toluene	mg/kg				

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-027**	**NTA-028**	**NTA-029**	**NTA-030**
Sample ID		**NTA0027**	**NTA0028**	**NTA0029**	**NTA0030**
Customer ID		**NTAss-027-0027-SO**	**NTAss-028-0028-SO**	**NTAss-029-0029-SO**	**NTAss-030-0030-SO**
Date		**10/22/1999**	**10/22/1999**	**10/22/1999**	**10/22/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units				
Dimethylbenzene	mg/kg	0.0021J			0.0019J
Methylene chloride	mg/kg		0.0046J	0.0039J	
Toluene	mg/kg	0.0017J			

Location		**Crash Area**	**Crash Area**	**Crash Area**	**Crash Area**
Station		**NTA-031**	**NTA-036**	**NTA-037**	**NTA-048**
Customer ID		**NTAss-031-0031-SO**	**NTAss-036-0036-SO**	**NTAss-037-0037-SO**	**NTAss-048-0049-SO**
Date		**10/24/1999**	**10/22/1999**	**10/22/1999**	**10/24/1999**
Depth (feet)		**0 - 1**	**0 - 1**	**0 - 1**	**0 - 1**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units				
Dimethylbenzene	mg/kg	0.0019J	0.0018J		0.0012J
Methylene chloride	mg/kg			0.0041J	
Toluene	mg/kg				

Table 4-8. Summary Data for Site-Related VOCs in Surface Soil (continued)

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Plane Burial Area** **NTA-065** **NTAss-065-0067-SO** **11/02/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-067** **NTAss-067-0071-SO** **11/03/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-076** **NTAss-076-0090-SO** **11/03/1999** **0 - 1** **Grab**
Analyte	Units			
Dimethylbenzene	mg/kg			
Methylene chloride	mg/kg		0.00086J	
Toluene	mg/kg	0.0012J		0.0042J

Location **Station** **Customer ID** **Date** **Depth (feet)** **Field Type**		**Plane Burial Area** **NTA-078** **NTAss-078-0094-SO** **11/03/1999** **0 - 1** **Grab**	**Plane Burial Area** **NTA-081** **NTAss-081-0098-SO** **11/03/1999** **0 - 1** **Grab**
Analyte	Units		
Dimethylbenzene	mg/kg		
Methylene chloride	mg/kg	0.0007J	0.0015J
Toluene	mg/kg	0.00078J	0.0017J

J = Estimated value less than laboratory reporting limits.

4.3.3 TAL Metals and Cyanide

As noted in Chapter 3.0, subsurface soil samples were collected from 15 of the 19 plane burial area stations and 4 stations within the plane refueling/crash strip area. All of these samples were analyzed for inorganic constituents. No subsurface stations were collected from within the crash area (Figure 3-1). Table 4-2 contains summary statistics and results of the background screen for inorganic constituents in subsurface soil.

A total of 20 metals were detected at least once in subsurface soil samples collected during the Phase I RI. Fourteen of these were eliminated as potential SRCs because they were either considered as essential nutrients (calcium, iron, potassium, and magnesium), or there were no detections above their respective background criteria (aluminum, arsenic, beryllium, chromium, cobalt, manganese, nickel, selenium, thallium, and vanadium). The remaining six inorganics (barium, cadmium, copper, lead, mercury, and zinc) were classified as SRCs based on their frequency of detection and carried forward to the risk screening step (Chapter 5.0) Table 4-10 provides summary data for the six inorganics identified as SRCs. In order to provide a consistent comparison with surface soil, the distribution and magnitude of barium, copper, mercury, and zinc in subsurface soil are highlighted on Figures 4-2 through 4-5 along with that observed in surface soil. These four compounds were identified as the prevalent surface soil inorganic SRCs.

Although the frequency of detection was 100 percent for each of the four prevalent inorganic SRCs, the number of results greater than their respective background criteria is very low. The occurrence of these four SRCs above background is limited to stations NTA-067, NTA-070, and NTA-073 in the plane burial area and station NTA-084 in the plane refueling/crash strip area.

The sample stations exhibiting the principal inorganics above background criteria include

- Barium at station NTA-067 (196J mg/kg) in the 0.3- to 0.9-meter (1- to 3-foot) depth interval.

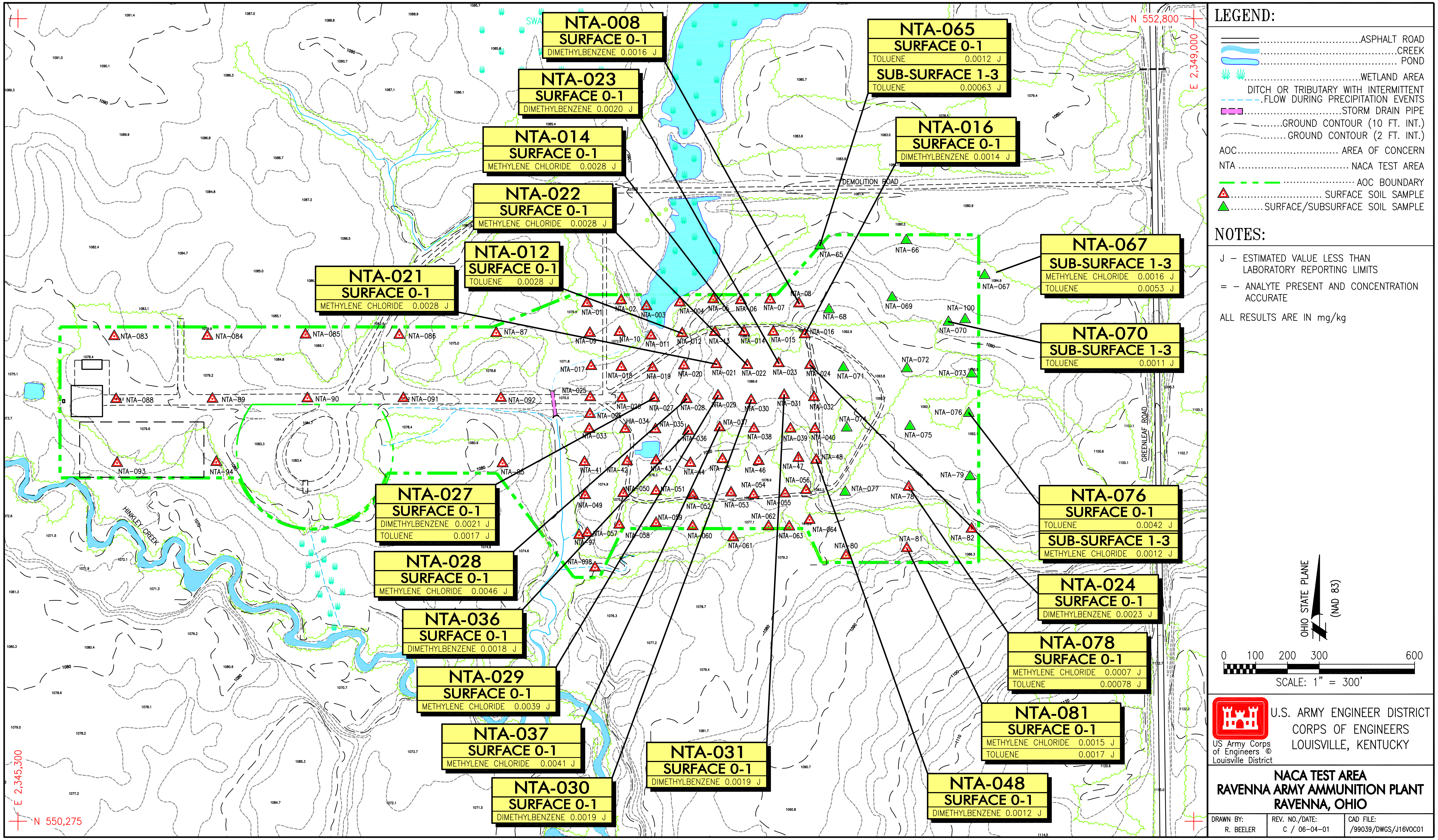


Figure 4-7. Detected Surface and Subsurface Soil Site-Related VOCs

Table 4-9. Geotechnical Results for NTA Subsurface Soil

Sample Station Depth of Sample	**NTA-069* 1 – 3 feet**	**NTA-038 1 – 3 feet**	**NTA-058 1 – 3 feet**	**NTA-069 1 – 3 feet**
Moisture content (%)	18.0	11.82	24.82	15.10
Atterberg limits: LL	31.7	24.2	46.1	26.8
PL	16.4	14.8	40.1	17.2
PI	15.3	9.4	6.0	9.6
Classification	CL	CL	ML	CL
Bulk density, pcf	NA	111.21	NA	114.48
Porosity	NA	0.33	NA	0.31
Permeability (cm/sec)	NA	1.53E-05	NA	4.78E-05
Specific gravity	NA	2.66	NA	2.65
pH in water	NA	4.12	4.30	4.65
pH in 0.01 calcium chloride	NA	4.53	4.35	4.61
Total organic carbon (%)	NA	3.92	4.50	2.51
Redox potential	NA	546	524	559
Grain Size Analysis (% passing)				
3 inch – 3/4 inch	NA	100	100	100
3/8 inch	NA	100	100	98.54
#4	NA	95.57	100	91.53
#10	NA	85.59	97.57	86.01
#20	NA	74.01	95.41	81.18
#40	NA	62.49	93.87	74.16
#60	NA	50.16	92.43	64.53
#140	NA	37.24	90.39	52.22
#200	NA	35.63	89.74	50.22

* = Disturbed sample.
CL = Lean clay.
LL = Liquid limit.
ML = Sandy silt.
NA = Not analyzed.
PI = Plasticity index.
PL = Plastic limit.

Table 4-10. Summary of Principal Site-Related Inorganics in Subsurface Soil

Location		**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**
Station		**NTA-065**	**NTA-066**	**NTA-067**	**NTA-068**	**NTA-069**
Customer ID		**NTAso-065-0068-SO**	**NTAso-066-0070-SO**	**NTAso-067-0072-SO**	**NTAso-068-0074-SO**	**NTAso-069-0076-SO**
Date		**11/02/1999**	**11/02/1999**	**11/03/1999**	**11/02/1999**	**11/02/1999**
Depth (feet)		**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**
Filtered		**Total**	**Total**	**Total**	**Total**	**Total**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Barium	mg/kg	114 J	45.6 J	196 J *	47 J	57.3 J
Cadmium	mg/kg					
Copper	mg/kg	17.6 J	12.2 J	21.4 J	7.3 J	13.6 J
Lead	mg/kg	12.9 =	8.4 =	14.2 =	10.9 =	11.4 =
Mercury	mg/kg	0.032 J	0.027 J	0.028 J	0.035 J	0.041 J
Zinc	mg/kg	71.1 =	45.7 =	55.9 =	44.9 =	45.5 =

Location		**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**
Station		**NTA-069**	**NTA-070**	**NTA-070**	**NTA-070**	**NTA-071**
Customer ID		**NTAss-069-0143-SO**	**NTAso-070-0079-SO**	**NTAss-070-0120-SO**	**NTAss-070-0147-SO**	**NTAso-071-0081-SO**
Date		**11/02/1999**	**11/02/1999**	**11/02/1999**	**11/02/1999**	**10/27/1999**
Depth (feet)		**1 - 3**	**1 - 3**	**3 - 5**	**3 - 5**	**1 - 3**
Filtered		**Total**	**Total**	**Total**	**Total**	**Total**
Field Type		**Field Duplicate**	**Grab**	**Grab**	**Field Duplicate**	**Grab**
Analyte	Units					
Barium	mg/kg	62.2 J	59.1 J	60.8 J	72.4 J	35.1 =
Cadmium	mg/kg					
Copper	mg/kg	12.9 J	55.8 J *	34.9 J *	47.3 J *	15.3 J
Lead	mg/kg	12.5 =	16.1 =	14.3 =	15.3 =	11.5 =
Mercury	mg/kg	0.047 J *	0.036 J	0.022 J	0.028 J	0.018 J
Zinc	mg/kg	49.6 =	67.3 =	59.5 =	76.1 =	41.1 =

Table 4-10. Summary of Principal Site-Related Inorganics in Subsurface Soil (continued)

Location		**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**
Station		**NTA-072**	**NTA-073**	**NTA-073**	**NTA-073**	**NTA-073**
Customer ID		**NTAso-072-0083-SO**	**NTAso-073-0085-SO**	**NTAss-073-0138-SO**	**NTAso-073-0121-SO**	**NTAss-073 -0146-SO**
Date		**10/27/1999**	**11/02/1999**	**11/02/1999**	**11/02/1999**	**11/02/1999**
Depth (feet)		**1 - 3**	**1 - 3**	**1 - 3**	**3 - 5**	**3 - 5**
Filtered		**Total**	**Total**	**Total**	**Total**	**Total**
Field Type		**Grab**	**Grab**	**Field Duplicate**	**Grab**	**Field Duplicate**
Analyte	Units					
Barium	mg/kg	35.1 =	74 J	66.3 J	48.7 J	41.6 J
Cadmium	mg/kg		30 = *	29.5 = *	0.62 = *	0.64 = *
Copper	mg/kg	19.3 J	400 J *	733 J *	28.6 J	23.7 J
Lead	mg/kg	11.5 =	151 = *	151 = *	29.6 = *	33.6 = *
Mercury	mg/kg	0.036 J	0.042 J	0.022 J	0.025 J	0.041 J
Zinc	mg/kg	58.7 =	132 = *	119 = *	52.4 =	47.4 =

Location		**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**	**Plane Burial Area**
Station		**NTA-074**	**NTA-075**	**NTA-076**	**NTA-077**	**NTA-079**
Customer ID		**NTAso-074-0087-SO**	**NTAso-075-0089-SO**	**NTAso-076-0091-SO**	**NTAso-077-0093-SO**	**NTAso-079-0096-SO**
Date		**10/27/1999**	**10/27/1999**	**11/03/1999**	**11/01/1999**	**11/03/1999**
Depth (feet)		**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**
Filtered		**Total**	**Total**	**Total**	**Total**	**Total**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Barium	mg/kg	32.5 =	39.2 =	38.4 J	58.7 J	48.3 J
Cadmium	mg/kg					
Copper	mg/kg	16.2 J	9.7 J	10.8 J	16.7 J	17.3 J
Lead	mg/kg	12.9 =	17.1 =	12.8 =	10.2 =	11.6 J
Mercury	mg/kg	0.034 J	0.021 J	0.02 J	0.019 J	0.036 J
Zinc	mg/kg	45.5 =	60 =	38.4 =	60.3 =	47.3 =

Table 4-10. Summary of Principal Site-Related Inorganics in Subsurface Soil (continued)

Location		**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**	**Plane Refueling/ Crash Strip Area**	**Contingency – Plane Burial Area**
Station		**NTA-083**	**NTA-084**	**NTA-085**	**NTA-095**	**NTA-100**
Customer ID		**NTAso-083-0101-SO**	**NTAso-084-0103-SO**	**NTAso-085-0105-SO**	**NTAso-095-0116-SO**	**NTAso-100-0123-SO**
Date		**10/19/1999**	**10/19/1999**	**10/19/1999**	**10/19/1999**	**11/04/1999**
Depth (feet)		**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**	**1 - 3**
Filtered		**Total**	**Total**	**Total**	**Total**	**Total**
Field Type		**Grab**	**Grab**	**Grab**	**Grab**	**Grab**
Analyte	Units					
Barium	mg/kg	52.5 J	93.7 J	92.4 J	15.6 J	78.8 J
Cadmium	mg/kg	0.44 J *				
Copper	mg/kg	16.1 J	7.6 J	19.6 J	6.9 J	12.2 J
Lead	mg/kg	16.7 J	14.7 J	12.5 J	6.6 J	18.2 =
Mercury	mg/kg	0.02 J	0.05 J *	0.03 J	0.025 J	0.038 J
Zinc	mg/kg	49.6 J	65.5 J	62.4 J	24.8 J	58.1 =

* = Value above facility-wide background criterion.
= = Analyte present and concentration accurate.
J = Estimated value less than reporting limits.
R = Rejected value.
Blank cells represent non-detect values.

- Copper at station NTA-073 (400J mg/kg) in the 0.3- to 0.9-meter (1- to 3-foot) depth interval and at station NTA-070 in the 0.3- to 0.9-meter (1- to 3-foot) depth interval (55.8J mg/kg) and in the 0.9- to 1.5-meter (3- to 5-foot) depth interval (34.9 J mg/kg).

- Mercury at station NTA-084 (0.05J mg/kg) in the 0.3- to 0.9-meter (1- to 3-foot) depth interval.

- Zinc at station NTA-076 (132 mg/kg) in the 0.3- to 0.9-meter (1- to 3-foot) depth interval.

In addition to the four principal inorganic SRCs, two other metals were detected at least once at concentrations above the background criteria. These two metals include

- Cadmium (background criterion of zero) at station NTA-083 in the 0.3- to 0.9-meter (1- to 3-foot) depth interval (0.44J mg/kg) and station NTA-073 in the 0.3- to 0.9-meter (1- to 3-foot) depth interval (30 mg/kg) and the 0.9- to 1.5-meter (3- to 5-foot) depth interval (0.62 mg/kg).

- Lead at station NTA-076 in the 0.3- to 0.9-meter (1- to 3-foot) depth interval (151 mg/kg) and the 0.9- to 1.5-meter (3- to 5-foot) depth interval (29.6 mg/kg).

In general, the average detected concentrations and the maximum detected values for inorganic SRCs in subsurface soil were less than the corresponding average concentrations in surface soil. The average detected value for copper in subsurface soil (36.15 mg/kg) increased relative to that of surface soil (29.59 mg/kg), which may simply reflect natural variation (i.e., background values for copper increase with depth).

4.3.4 SVOCs

A total of 64 SVOC compounds were analyzed for in all 21 subsurface soil samples collected during the Phase I RI at NTA. A total of 14 SVOCs were detected; however, 13 of these were detected only in the sample from station NTA-083 [0.3- to 0.9-meter (1- to 3-foot) depth interval]. As noted in Section 4.1.4, some of the SVOCs detected only once were eliminated from further consideration as SRCs on the basis of weight-of-evidence screening. The constituents retained as SRCs include benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene (Figure 4-6). All of these constituents were also detected in the surface soil interval.

The only SVOC detected at stations other than NTA-083 was bis(2-ethylhexyl)phthalate (8 of 21 detections). All of the results were J-flagged (estimated) and ranged in concentration from 0.051 mg/kg to 0.430 mg/kg. Figure 4-6 shows the distribution of this compound in subsurface soils at NTA.

4.3.5 VOCs and PCBs

4.3.5.1 VOCs

A total of 35 VOC compounds were analyzed for in 21 subsurface soil samples collected during the Phase I RI. Four compounds were detected in at least one subsurface soil sample: dimethylbenzene, methylene chloride, styrene, and toluene. Dimethylbenzene was detected in only 1 of 21 samples (5 percent) and was eliminated as an SRC based on the weight-of-evidence screen noted in Section 4.1.4. Methylene chloride was detected twice, with a maximum concentration of 0.0016J mg/kg at station NTA-067. Styrene was detected in six samples from five different stations, with a maximum concentration of 0.0014J mg/kg in the 0.3- to 0.9-meter (1- to 3-foot) depth interval of NTA-073. Toluene was detected in three samples, with a maximum concentration of 0.0053J mg/kg at NTA-067. Figure 4-7 shows the distribution of VOC compounds in subsurface soil at NTA.

4.3.5.2 PCBs

A total of seven PCBs (Aroclors) were analyzed for in subsurface soil samples collected at two stations. No PCB compounds were detected.

4.4 SEDIMENT

As described in Section 3.3, six sediment samples from six separate stations were collected for geotechnical and chemical analysis during the NTA Phase I RI. Tables 3-1 and 3-2 list the designated functional areas and sediment sampling stations from which they were collected. Figure 3-1 illustrates the locations for these six sediment samples. One dry sediment sample was collected within the concrete pit enclosing a former water supply well (NTA-101). A subaqueous sediment sample was collected at the small reservoir that formerly served as a water supply for fire control equipment (NTA-102). Two samples were collected at stations within drainage conveyances located north (upstream) of the AOC (subaqueous sediment at NTA-104 and NTA-105). Within the principal tributary draining the NTA and portions of DA1, two sediment samples were collected; one at the headwaters within the AOC (subaqueous sediment at NTA-103) and one at the confluence with Hinkley Creek (subaqueous sediment at station NTA-106). The sediment data collected at station NTA-106 was also evaluated with respect to additional sediment (and surface water) samples collected along Hinkley Creek as part of the concurrent Phase I RI for DA1 (USACE 2000). These additional samples include an ambient (background) station (DA1-043) located upstream of both DA1 and NTA, station DA1-045 located south of DA1 and upstream of NTA, and station DA1-046 at the facility exit point (HC-2).

4.4.1 Geotechnical Results

Geotechnical samples were collected from all six sediment stations and submitted for moisture content, grain size distribution, and TOC analyses. All of the sediment samples were disturbed (grab) samples. Table 4-11 presents summary results of the geotechnical analyses for sediment samples. Appendix I contains complete geotechnical laboratory results.

The maximum TOC value corresponds to the sediment sample collected from the well pit. The lowest TOC values correlate to the tributary to Hinkley Creek. The variability noted in the moisture content and grain size analyses reflects the wide range of conditions represented by the sediment stations. The sample from station NTA-104, which is within a ditch line adjacent to Demolition Road, is coarser grained than the others due to erosion and deposition of road base material.

4.4.2 Explosives and Propellants

Low levels of nitrocellulose were detected in sediment samples collected at stations NTA-101 (well pit, 11 mg/kg) and NTA-104 (ambient station, 4.8 mg/kg).

4.4.3 TAL Metals and Cyanide

Table 4-3 contains summary statistics and results of the background comparison for inorganics in sediment. A total of 21 metals and cyanide were detected at least once in the sediment sample population. Twelve of the detected metals were eliminated as potential SRCs because they were either major geochemical constituents normally considered as essential elements (calcium, iron, magnesium, and

Table 4-11. Geotechnical Data for NTA Phase I RI Sediment Samples

Station	NTA-101	NTA-102	NTA-103	NTA-104	NTA-105	NTA-106
Total Organic Carbon (mg/kg)						
	36,000	16,000	4,300	14,000	24,000	6,100
Moisture Content (percent)						
	26.2	19.6	37.3	22.3	38.4	42.3
Grain Size Analysis (% passing)						
3 inch – 3/4 inch	100	100	100	100	100	100
3/8 inch	100	100	94.64	97.87	98.03	98.88
#4	97.82	97.93	91.88	74.27	94.94	98.65
#10	93.71	93.78	89.26	56.66	92.88	98.22
#20	88.37	88.56	87.04	42.9	87.76	97.15
#40	79.15	78.91	83.25	31.17	80.07	95.41
#60	68.90	69.02	77.63	22.01	69.33	90.58
#140	52.61	57.52	71.21	15.47	57.41	73.17
#200	48.83	48.83	69.06	14.57	55.32	67.93

potassium), or the maximum detected value was less than their respective background criteria (aluminum, arsenic, mercury, thallium, and vanadium. No inorganic was eliminated on the basis of frequency of detection due to the low number of samples collected. Those metals retained as SRCs include barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, lead, manganese, nickel, selenium, silver, and zinc. A summary of the analytical results for these SRCs is presented in Table 4-12.

Table 4-12. Summary Data for Site-Related Inorganics in Sediment at the NTA

Station	NTA-101[a]	NTA-102	NTA-103	NTA-104	NTA-105	NTA-106
Barium	436=*	48.3=	76.1J	398J*	59.1=	65.8J
Beryllium			0.52J*	0.9J*		0.26J
Cadmium	5=*			1.1J*		
Chromium	24.6=*	11.1=	15J	14.1J	12.2=	8.8J
Cobalt	8.4=	7.5J	14.2J*	29.9J*	5.8J	5.4J
Copper	155J*	14.1J	19.3J	15.4J	14J	7.9J
Cyanide				0.74=		
Lead	13,200=*	16.7=	13.2J	22.1J	19.4=	9.6J
Manganese	1,310=	164=	629=	9440=*	235=	247=
Nickel	23.9=*	14.2=	23.5J*	34.9J*	12.5=	11.6J
Selenium	1=		1J	2.9J*		
Silver	0.5J*					
Zinc	631=*	52.4=	68.6=	158=	73.9=	44=

[a] Sample NT-101 was collected from the pit housing the former production well.
* = Value above facility-wide background criterion.
= = Analyte present and concentration accurate.
J = Estimated value less than laboratory reporting limits.
Blank cells indicate the result was less than detection limits.
All results in mg/kg.

The maximum detected values for all of the inorganic SRCs occurred at stations NTA-101 in the well pit and NTA-104 north of NTA along Demolition Road. The elevated levels of metals in the well pit sediment are likely due to rust and spalling from the carbon steel well casing within the pit and paint flaking, as well as rust from the painted steel cover of the pit, which was heavily corroded. Elevated metals at NTA-104 indicate potential influence of slag or other road base material and heavy vehicle traffic over the years, resulting in accumulation of contaminants in the ditch line sediment. The only other inorganics detected above background criteria occurred at station NTA-103. It is noteworthy that the concentrations of all detected inorganics decreased along the tributary to Hinkley Creek between stations NTA-103 and NTA-106. The consistency of the observed decrease among all of the inorganics suggests some observable impacts to the tributary from site runoff, although rarely to the point that background is exceeded.

Four inorganic SRCs identified in DA1 Phase I RI sediment samples collected along Hinkley Creek are also SRCs in the NTA sediment samples (chromium, cobalt, lead, and nickel). Results for all four SRCs at station NTA-106 are less than background; however, they are consistently slightly higher than the samples collected from two upstream stations (DA1-045 and DA1-043; Figure 3-1). The results for these four constituents at NTA-106 are consistently slightly less than those at station DA1-046 (HC-2, facility exit point). Although the data suggest some observable impacts at the NTA tributary confluence, the results are all less than background values and within the range of natural variability at RVAAP.

4.4.4 SVOCs

No SVOCs were detected in the sediment samples collected during the NTA Phase I RI.

4.4.5 VOCs and PCBs

Trace levels of four VOCs were detected in the sediment samples collected during the NTA Phase I RI. Acetone was detected at stations NTA-102 (0.061J mg/kg), NTA-103 (0.027J mg/kg), and NTA-105 (0.013J mg/kg). The remaining three VOCs were each detected once as follows: 2-butanone at station NTA-102 (0.016J mg/kg), dimethylbenzene at station NTA-101 (0.003J mg/kg), and methylene chloride at station NTA-105 (0.0079J mg/kg).

Samples for PCB analyses were collected at all six sediment stations. No PCBs were detected.

4.5 SURFACE WATER

Co-located surface water samples were collected from five of the six sediment sampling stations. No water was present within the well pit (NTA-101) at the time of the field investigation.

4.5.1 Explosives and Propellants

An estimated concentration of 2,4-DNT (0.051J µg/L) was reported for the sample collected at station NTA-104 upstream of the AOC along Demolition Road. No other explosive or propellant compound was detected.

4.5.2 TAL Metals and Cyanide

Table 4-4 contains summary statistics and results of the background comparison for inorganics in surface water. Fourteen metals were detected at least once in the surface water sample population. Six metals were eliminated as SRCs on the basis of the essential element screen (calcium, iron, magnesium, potassium, and sodium), or the maximum result was less than background (aluminum). The remaining eight metals retained as SRCs include antimony, barium, cadmium, cobalt, lead, manganese, nickel, and zinc. No constituent was eliminated as an SRC on the basis of frequency of detection due to the low number of samples collected. A summary of the analytical results for the inorganic SRCs is presented in Table 4-13.

Table 4-13. Summary Data for Site-Related Inorganics in Surface Water at the NTA

Station ID		**NTA-102**		**NTA-103**		**NTA-104**		**NTA-105**		**NTA-106**	
Sample Type		**Total**	**Filtered**	**Total**	**Filtered**	**Total**	**Filtered**	**Total**	**Filtered**	**Total**	**Filtered**
Analyte	Units										
Antimony	µg/L		1.7*					2.4 J*		1.9 J*	1.8 J*
Barium	µg/L	17 J	11 J	23 J	17 J	47 J		110 J*	110 J*	88 J*	62 J*
Cadmium	µg/L							3.2 J*			
Cobalt	µg/L							60 =*	62 =*		
Lead	µg/L					2.4 J*		4.3 =*	2 J*		
Manganese	µg/L	80 =	23 =	180 =	56 =	650 =*	400 =	12800 =*	12700 =*	180 =	28 =
Nickel	µg/L							52 =*	54 =*		
Zinc	µg/L				19 J	23 =	44 =	1100 =*	1000 =*	110 =*	

* = Value above facility-wide background criterion.
= = Analyte present and concentration accurate.
J = Estimated value less than laboratory reporting limits.
Blank cells indicate the result was less than the detection limit.
All results in mg/kg.

The maximum detected values for all eight inorganic surface water SRCs occurred at station NTA-105 located north (upstream) of the AOC along Demolition Road. Lead, manganese, and zinc results exceeded their respective background criteria in the other sample station located north of the AOC (NTA-104). Within NTA at stations NTA-102 (reservoir) and NTA-103 (tributary headwaters), only one result exceeded background criteria (filtered result for antimony at NTA-102). Antimony, barium, and zinc exceeded their respective background criteria at station NTA-106 (tributary confluence with Hinkley Creek). The observed consistent decreases in sediment SRCs between stations NTA-103 and NTA-106 were not apparent for surface water SRCs; values either remained constant or increased downstream.

Only one inorganic (zinc) identified as an SRC in DA1 Phase I RI surface water samples collected along Hinkley Creek was also an SRC in the NTA surface water samples. The unfiltered zinc result at station NTA-106 (110 µg/L) is slightly less than the result obtained at upstream station DA1-045 (Figure 3-1) but was higher than the values observed at the Hinkley Creek ambient station (DA1-043) and the facility exit point (HC-2).

4.5.3 SVOCs

A trace concentration of bis(2-ethylhexyl)phthalate (3.2J µg/L) was reported for a sample collected from station NTA-103 (headwaters of the tributary to Hinkley Creek). This SVOC was not detected in the corresponding sediment sample at this station. No other SVOCs were detected.

4.5.4 VOCs and PCBs

Estimated concentrations of acetone were reported in the samples collected from station NTA-104 (4.2J µg/L) and NTA-105 (5.6J µg/L). Both of these stations are upstream of the AOC. Acetone was not detected in the corresponding sediment sample collected at station NTA-104. An estimated acetone concentration of 0.013J mg/kg was observed in the associated sediment sample collected at station NTA-105.

No PCB compounds were detected in surface water samples collected during the NTA Phase I RI.

4.6 GROUNDWATER SCREENING SAMPLE RESULTS

One groundwater sample was collected from the temporary piezometer installed in boring NTA-038. Both filtered and unfiltered samples were collected for analysis of inorganics. Because the piezometer was not constructed following protocols designated for monitoring wells and was not developed, the groundwater results are considered as screening data and are used for qualitative evaluation only.

Summary results for detected constituents in the groundwater sample are contained in Table 4-14. An estimated concentration of one explosive [4-nitrotoluene (NT)] was reported in the groundwater sample; this compound was not detected in any other media at NTA or DA1. Five of the 10 detected inorganics (calcium, iron, magnesium, potassium, and sodium) may be eliminated as potential SRCs because they are essential elements and considering that concentrations were all less than both unfiltered and filtered background values. Of the detected inorganics in the unfiltered sample, none exceeded their corresponding unconsolidated zone, unfiltered groundwater background values. Only arsenic and barium in the filtered sample exceeded their background criteria for unconsolidated zone groundwater.

Table 4-14. Summary of Detected Constituents in Groundwater at Station NTA-038

Analyte	Unfiltered	Filtered
4-NT	0.14J	NA
Aluminum	5,600J	200U
Arsenic	16=	17=*
Barium	110J	98J*
Calcium	74,900=	69,200=
Iron	8,700=	300U
Magnesium	17,200=	16,000=
Manganese	290=	250=
Potassium	1,300J	860J
Sodium	7,000J	5,800=
Zinc	34J	20U
Phenol	28=	NA

* = Value above facility-wide background criterion.
= = Analyte present and concentration accurate.
J = Estimated value less than laboratory reporting limits.
NA = Not analyzed.
NT = Nitrotoluene.
U = Not detected.
All results in µg/L.

Phenol was reported in the groundwater sample; however, this SVOC was not identified as an SRC in any other media at NTA or DA1.

As part of the human health screening risk evaluation discussed in Chapter 5.0, the maximum concentrations of constituents identified as SRCs are compared to generic soil screening levels for the protection of groundwater contained in the *Soil Screening Guidance: Technical Background Document* (EPA 1996). The generic soil screening criteria are extremely conservative in that they assume contamination extends to the top of the saturated zone, which does not appear to apply at NTA based on observed soil characterization results. The generic soil screening values are based on a DAF of 10, which, for the purposes of Phase I RI screening at RVAAP, were divided by a factor of 10 (effective DAF = 1). Site-specific conditions at NTA affecting the DAF include (1) concentrations decreased substantially in subsurface soil below 0.3 meter (1.0 foot) bgs; (2) the depth to the water table is about 5.0 meters (16.6 feet); (3) subsurface lithology is a silty clay to clay; and (4) inorganics and SVOCs have comparatively high retardation factors, especially in a clay-rich matrix. A rough estimation of a site-specific DAF was performed using the empirical dilution model presented in EPA 1996:

$$DAF = 1 + (Kid/IL),$$

where

DAF = dilution factor,
K = hydraulic conductivity (m/yr),
i = hydraulic gradient,
I = infiltration rate (m),
L = length of source parallel to flow (m),
d = mixing zone depth.

$$d = (0.0112L^2)^{0.5} + d_a\,\{1\text{-}\exp[(\text{-}LI)/Kid_a)]\},$$

where

d_a = aquifer depth (m).

A value for K was derived from the maximum result from Phase I RI Shelby tube analyses of subsurface soil at stations NTA-038 and NTA-069 (1.51×10^1 m/yr). The absence of monitoring wells at the site preclude an accurate assessment of hydraulic gradient. However, the water level obtained from the piezometer at station NTA-038 compared to that in the piezometer installed at station DA1-027, south of the AOC, provides the maximum approximation of the overall flat gradients in the area (gradient value of 0.0006). Site-specific infiltration rates are not available for NTA; therefore, the average value for glacial fill in the north-central United States overlying shale/sandstone (0.14 m/yr) was employed (EPA 1996). Conservatively, the length of the source parallel to flow was assumed to be the entire length of the crash area from north to south [228 meters (740 feet)]. The unconsolidated aquifer thickness is estimated at 45 meters (150 feet) as noted in Chapter 2.0.

When these assumptions are applied, the estimated DAF at the AOC is 1.02. This empirical model does not account for chemical or biological attenuation in the vadose zone or aquifer; thus, it is likely an underestimation of actual DAF. Additionally, hydraulic conductivity and gradient data for the site have a high degree of uncertainty. Application of numerical modeling (i.e., Seasonal Compartment Soil [SESOIL]) to estimate leaching potential utilizing soil and monitoring well data would provide a better approximation of anticipated contaminant concentrations at a groundwater receptor point.

4.7 ORDNANCE AND EXPLOSIVES AVOIDANCE SURVEY SUMMARY

Visual and magnetometer surveys of access routes and proposed sample points were conducted by qualified UXO technicians within the plane refueling/crash strip area due to its proximity to DA1. During sampling activities within this area, soil borings were screened at 0.6-meter (2-foot) intervals to ensure that no metallic anomalies were encountered. No visible OE was noted within this functional area of NTA. No boring had to be abandoned due to the presence of subsurface anomalies. A detailed report of OE avoidance activities is contained in Appendix G.

4.8 SUMMARY OF CONTAMINANT OCCURRENCE AND DISTRIBUTION

Based on the evaluation of the occurrence and distribution of contamination in soil, sediment, and surface water, the following conclusions are made.

Surface Soil

- Sporadic detections of 2,4,6-TNT, 2,4-DNT, and nitrocellulose were identified in surface soil. No apparent pattern of distribution was noted for this class of SRCs.

- The principal inorganic SRCs in surface soil include barium, copper, mercury, and zinc, which exceeded background in 20 percent or more of the sample population. Inorganics above background occur throughout the AOC, but the highest concentrations of metals occurred along the crash strip and in the northeast portion of the plane burial area in association with observed surface debris and suspected subsurface debris.

- Bis(2-ethylhexyl)phthalate and PAH compounds were detected in some combination in approximately one third of all samples analyzed. Bis(2-ethylhexyl)phthalate was the most widespread SVOC, with detected values at 18 sample stations. The majority of the detected PAH values occurred within the plane refueling/crash strip area. The maximum detected value for each of the PAHs occurred at station NTA-088 in the western-most portion of the plane refueling/crash strip area.

- The VOCs dimethylbenzene, methylene chloride, and toluene were each detected in six of nine samples. VOCs were concentrated in the center of the crash area and on the perimeter of the plane burial area.

- PCBs were not detected in any surface soil samples.

Subsurface Soil

- Explosives and propellants were not detected in subsurface soil.

- Aluminum, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc were detected in all subsurface soil samples, but they only rarely exceeded their background criteria. Almost all exceedances of background occurred in the northeastern corner of the plane burial area in association with observed surface debris and suspected subsurface debris.

- Bis(2-ethylhexyl)phthalate and 13 PAHs were detected in subsurface soil samples. All of the PAHs were detected only in the sample from station NTA-083 in the plane refueling area. Bis(2ethylhexyl)phthalate was detected at eight different stations scattered across the AOC. Eight of the PAHs at station NTA-083 were retained as SRCs based on weight-of-evidence evaluation, despite only being detected once in 21 samples.

- In general, the average and maximum detected concentrations for inorganic SRCs in subsurface soil were less than the corresponding values in surface soil.

- Low, estimated concentrations of three VOCs were detected in more than 5 percent of the subsurface soil samples (methylene chloride, styrene, and toluene). The maximum detected values for these three VOCs occurred at stations NTA-067 and NTA-073 in the plane burial area.

- No PCB compounds were detected in subsurface soils.

Sediment

- Low levels of nitrocellulose and the maximum detected values for all of the inorganic sediment SRCs occurred at stations NTA-101 in the well pit and NTA-104 north of NTA along Demolition Road. These results do not reflect contamination related to former NTA operations. Concentrations of all detected inorganics decreased along the tributary to Hinkley Creek between stations NTA-103 and NTA-106. The consistency of the observed decrease among the inorganics suggests some observable contamination of the tributary from site runoff; however, background values are not exceeded at the confluence with Hinkley Creek.

Surface Water

- The majority of constituents above background levels in surface water occurred at the two stations located north and upstream of the NTA (NTA-104 and NTA-105). Given the elevated concentrations of constituents upstream of the AOC, no significant contamination of the tributary to Hinkley Creek can be ascertained. The water reservoir also does not appear to have been significantly contaminated by former NTA operations.

Groundwater

- Only arsenic and barium concentrations in the filtered sample collected from NTA-038 exceeded background criteria. Based on the available limited screening data, leaching of contaminants from soil to shallow groundwater in the vicinity of station NTA-038 has not occurred. These data from NTA-038 do not necessarily represent conditions in other portions of the site or imply that they have been impacted by former operations at NTA.

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5.0 RISK EVALUATION

5.1 INTRODUCTION

A risk evaluation process is applied to the Phase I sampling results to determine the potential magnitude of risk associated with contamination detected in NTA. Chemicals of potential concern are identified by performing the two-part process outlined below (Figure 5-1).

1. Identify SRCs (see Chapter 4.0).

    - Identify chemicals for exclusion from further risk evaluation based on a frequency of detection screening. Each chemical for each environmental medium is evaluated to determine its frequency of detection. Chemicals never detected are not considered to be SRCs. For media with greater than 20 samples and a frequency of detection of less than 5 percent, a weight-of-evidence approach is used to determine if the chemical is an SRC. The magnitudes and locations (clustering) of the detected concentrations are evaluated. A chemical with detected results that show no clustering and a frequency of detection less than 5 percent is considered spurious and is eliminated as an SRC. Explosives and propellants with a frequency of detection less than 5 percent are exceptions and are not eliminated as SRCs since they are most likely related to previous processes/activities performed at NTA.

    - Identify inorganic chemicals that pass the background screening process. Inorganic chemicals whose maximum detected concentration is below the background screening criteria are not considered to be SRCs.

    - Identify essential human nutrients that can be eliminated from further consideration in the human health risk screening process. Chemicals that are considered as essential nutrients (calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) are not evaluated as SRCs unless grossly elevated relative to background. These chemicals are an integral part of the country's food supply and are often added to foods as supplements; thus, these constituents are not generally addressed as contaminants (EPA 1989, 1995) in the human health risk evaluation. However, essential nutrients detected above background levels are evaluated in the ecological risk evaluation.

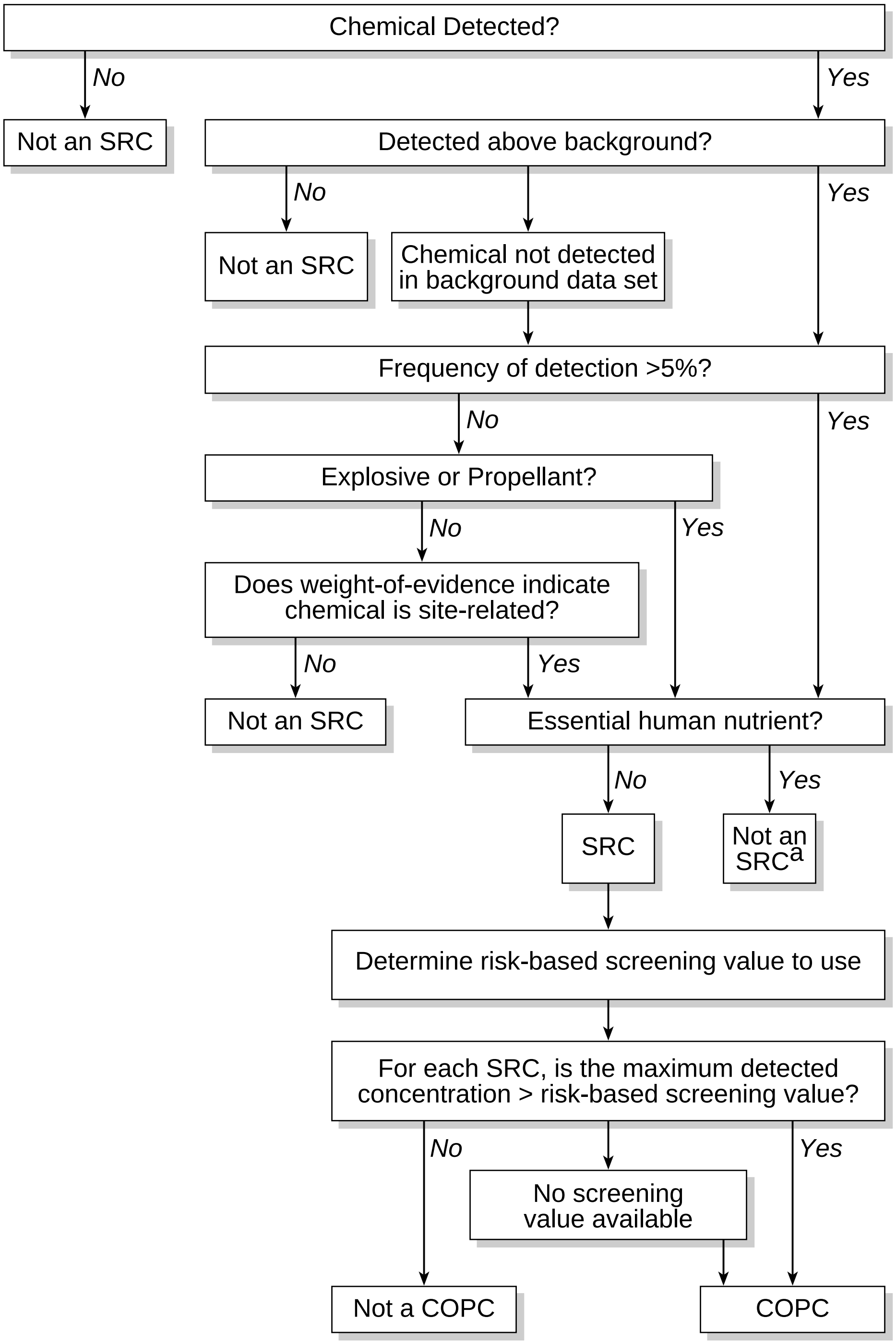
    - Those chemicals excluded as SRCs are not carried through the risk-based screening.

2. Screen against risk-based screening levels.

    - Identify potential migration and exposure pathways associated with the site and identify potential exposure scenarios that should be used to select screening levels (see Section 5.3).

    - Identify risk-based and applicable and relevant or appropriate requirement based screening levels for each contaminant detected at least once above background levels for each medium at NTA (see Section 5.4).

    - Compare concentrations to screening levels to determine if site conditions warrant additional characterization or action (see Sections 5.4.2 and 5.5).



[a] These essential human nutrients are considered as SRCs for subsequent ecological risk-based screening, but are not considered as SRCs for subsequent human health risk-based screening.

60-050301-091c

Figure 5-1. Flow Chart of Risk-Based Screening Process

Only those data passing the data quality assessment (see Section 5.2) are used for the risk evaluation. This assessment is necessary to address the impact of any data quality issues on the use of the data for decision-making purposes. Of particular importance are the analytical detection limits used and how these detection limits relate to the risk-based screening values.

5.2 DATA QUALITY ASSESSMENT

Section 4.1 and Appendix D present a detailed assessment of the quality of the Phase I sampling analytical results. For purposes of this risk evaluation, it is necessary to address the impact of any data quality issues on the use of the data for decision-making purposes. In particular, an evaluation of the detection limits relative to risk-screening values is performed.

An evaluation is made to determine if chemicals eliminated based on frequency of detection (e.g., those never detected) have detection limits that are elevated above human health risk-based screening levels. As indicated in Table 5-1, several chemicals that were not detected during the Phase I RI have detection limits that are above their respective human health risk-based screening criteria. In this situation, it is impossible to determine whether the chemical is present at levels above or below the risk-based screening values. Thus, the results cannot be used to determine if action is necessary to address that chemical. However, as seen in Table 5-1, the project quantitation limits oftentimes exceed the human health screening criteria. In these cases, it should be noted that most of these risk-based screening levels represent levels that are not easily achieved analytically.

5.3 EXPOSURE PATHWAY ANALYSIS

The demography and land use for RVAAP is presented in Section 1.2 of this Phase I RI report. Potential receptors are discussed in Section 2.6. The exposure pathways analysis presented here summarizes the points from these earlier sections that are relevant to the risk evaluation.

5.3.1 Site History and Current Land Use

The largest population centers closest to NTA are the town of Ravenna (population 11,771), located approximately 3.2 kilometers (2 miles) to the west of RVAAP, and Newton Falls (population 3,002), located approximately 1.6 kilometers (1 mile) to the southeast of RVAAP. The land use immediately surrounding RVAAP and NTA is primarily rural. Land use within the facility is restricted access. The current land use status for RVAAP is “inactive-modified (un-maintained) caretaker,” which indicates that the facility is no longer needed to mobilize for war efforts. The only remaining federally mandated mission of the facility is ammunition and bulk explosives storage and environmental restoration.

NTA and the adjacent DA1 lie within OHARNG Training Area “G” in the southwestern portion of the RVAAP. Currently, the AOC is primarily covered with coarse grass and scrub, and the site is periodically mowed using tractor-mounted equipment. The AOC is categorized as restricted entry. The DA1 boundary is marked with Seibert stakes. No physical barriers (i.e., fencing or gates) block access.

Metallic and nonmetallic debris, primarily consisting of aircraft components, occur on the ground surface in the northwestern portion of the plane burial area. Areas of mounded soils also exist in this portion of the AOC, indicating potential buried debris. No notable areas of stressed vegetation or bare ground suggestive of possible soil contamination were noted during the Phase I RI.

Table 5-1. Detection Limits in Excess of Risk-Based Screening Values

Chemical[a]	Frequency of Detection	Minimum Detection Limit	Maximum Detection Limit	Project Quantitation Limit[b]	Residential RBSC[c]	Industrial RBSC[d]
Surface Soil (mg/kg)						
Explosives						
2,6-Dinitrotoluene	0/11	0.25	0.25	1	0.0715	88.1
RDX	0/11	0.5	0.5	2	0.442	2.24
PCBs						
PCB-1221	0/11	0.037	0.063	0.067	0.0222	0.1
PCB-1232	0/11	0.037	0.063	0.033	0.0222	0.1
PCB-1242	0/11	0.037	0.063	0.033	0.0222	0.1
PCB-1248	0/11	0.037	0.063	0.033	0.0222	0.1
PCB-1254	0/11	0.037	0.063	0.033	0.0222	0.1
PCB-1260	0/11	0.037	0.063	0.033	0.0222	0.1
Semivolatile Organic Compounds						
1,3-Dichlorobenzene	0/97	0.36	16	0.33	1.32	5.18
1,4-Dichlorobenzene	0/97	0.36	16	0.33	0.344	0.813
2,4,6-Trichlorophenol	0/97	0.36	16	0.33	4.42	22.4
2,4-Dinitrophenol	0/97	0.88	38	0.8	12.2	176
2-Chlorophenol	0/97	0.36	16	0.33	6.34	24.1
2-Nitrobenzenamine	0/97	0.88	38	0.8	0.349	5.03
3,3'-Dichlorobenzidine	0/93	0.36	16	0.33	0.108	0.548
Bis(2-chloroisopropyl) ether	0/97	0.36	16	0.33	0.288	0.808
Hexachlorobenzene	0/97	0.36	16	0.33	0.0304	0.154
Hexachlorobutadiene	0/97	0.36	16	0.33	0.624	3.16
Hexachloroethane	0/97	0.36	16	0.33	3.47	17.6
N-Nitroso-di-n-propylamine	0/97	0.36	16	0.33	0.00695	0.0352
N-Nitrosodiphenylamine	0/97	0.36	16	0.33	9.93	50.3
Pentachlorophenol	0/95	0.88	38	0.8	0.298	1.11
bis(2-Chloroethyl) ether	0/97	0.36	16	0.33	0.0211	0.062
Volatile Organic Compounds						
1,1-Dichloroethene	0/97	0.0055	0.0096	0.005	0.00536	0.0119
1,2-Dibromoethane	0/97	0.0055	0.0096	NA	0.000689	0.00483
Vinyl chloride	0/97	0.011	0.019	0.01	0.0022	0.0049
Subsurface Soil (mg/kg)						
Explosives						
2,4-Dinitrotoluene	0/2	0.25	0.25	1	0.0715	176
2,6-Dinitrotoluene	0/2	0.25	0.25	1	0.0715	88.1
RDX	0/2	0.5	0.5	2	0.442	2.24
PCBs						
PCB-1221	0/2	0.038	0.041	0.067	0.0222	0.1
PCB-1232	0/2	0.038	0.041	0.033	0.0222	0.1
PCB-1242	0/2	0.038	0.041	0.033	0.0222	0.1
PCB-1248	0/2	0.038	0.041	0.033	0.0222	0.1
PCB-1254	0/2	0.038	0.041	0.033	0.0222	0.1
PCB-1260	0/1	0.038	0.038	0.033	0.0222	0.1
Semivolatile Organic Compounds						
1,4-Dichlorobenzene	0/20	0.35	0.41	0.33	0.344	0.813
2-Nitrobenzenamine	0/20	0.86	1	0.8	0.349	5.03
3,3'-Dichlorobenzidine	0/20	0.35	0.41	0.33	0.108	0.548

Table 5-1. Detection Limits in Excess of Risk-Based Screening Values (continued)

Chemical[a]	Frequency of Detection	Minimum Detection Limit	Maximum Detection Limit	Project Quantitation Limit[b]	Residential RBSC[c]	Industrial RBSC[d]
Bis(2-chloroisopropyl) ether	0/20	0.35	0.41	0.33	0.288	0.808
Hexachlorobenzene	0/20	0.35	0.41	0.33	0.0304	0.154
N-Nitroso-di-n-propylamine	0/20	0.35	0.41	0.33	0.00695	0.0352
Pentachlorophenol	0/20	0.86	1	0.8	0.298	1.11
bis(2-Chloroethyl) ether	0/20	0.35	0.41	0.33	0.0211	0.062
Volatile Organic Compounds						
1,1-Dichloroethene	0/20	0.0053	0.0063	0.005	0.00536	0.0119
1,2-Dibromoethane	0/20	0.0053	0.0063	NA	0.000689	0.00483
Vinyl chloride	0/20	0.011	0.013	0.01	0.0022	0.0049
Sediment (mg/kg)						
Explosives						
2,4-Dinitrotoluene	0/6	0.25	0.25	1	0.0715	176
2,6-Dinitrotoluene	0/6	0.25	0.25	1	0.0715	88.1
RDX	0/6	0.5	0.5	2	0.442	2.24
PCBs						
PCB-1221	0/6	0.045	0.074	0.067	0.0222	0.1
PCB-1232	0/6	0.045	0.074	0.033	0.0222	0.1
PCB-1242	0/6	0.045	0.074	0.033	0.0222	0.1
PCB-1248	0/6	0.045	0.074	0.033	0.0222	0.1
PCB-1254	0/6	0.045	0.074	0.033	0.0222	0.1
PCB-1260	0/6	0.045	0.074	0.033	0.0222	0.1
Semivolatile Organic Compounds						
1,3-Dichlorobenzene	0/6	0.45	3.2	0.33	1.32	5.18
1,4-Dichlorobenzene	0/6	0.45	3.2	0.33	0.344	0.813
2-Nitrobenzenamine	0/6	1.1	7.7	0.8	0.349	5.03
3,3'-Dichlorobenzidine	0/6	0.45	3.2	0.33	0.108	0.548
Benz(a)anthracene	0/6	0.45	3.2	0.33	0.0621	0.289
Benzo(a)pyrene	0/6	0.45	3.2	0.33	0.00621	0.0289
Benzo(b)fluoranthene	0/6	0.45	3.2	0.33	0.0621	0.289
Benzo(k)fluoranthene	0/6	0.45	3.2	0.33	0.621	2.89
Bis(2-chloroisopropyl) ether	0/6	0.45	3.2	0.33	0.288	0.808
Carbazole	0/6	0.45	3.2	0.33	2.43	12.3
Dibenz(a,h)anthracene	0/6	0.45	3.2	0.33	0.00621	0.0289
Hexachlorobenzene	0/6	0.45	3.2	0.33	0.0304	0.154
Hexachlorobutadiene	0/6	0.45	3.2	0.33	0.624	3.16
Indeno(1,2,3-cd)pyrene	0/6	0.45	3.2	0.33	0.0621	0.289
N-Nitroso-di-n-propylamine	0/6	0.45	3.2	0.33	0.00695	0.0352
Pentachlorophenol	0/6	1.1	7.7	0.8	0.298	1.11
bis(2-Chloroethyl) ether	0/6	0.45	3.2	0.33	0.0211	0.062
Volatile Organic Compounds						
1,1-Dichloroethene	0/6	0.0069	0.011	0.005	0.00536	0.0119
1,2-Dibromoethane	0/6	0.0069	0.011	NA	0.000689	0.00483
Vinyl chloride	0/6	0.014	0.022	0.01	0.0022	0.0049

Table 5-1. Detection Limits in Excess of Risk-Based Screening Values (continued)

Chemical[a]	Frequency of Detection	Minimum Detection Limit	Maximum Detection Limit	Project Quantitation Limit[b]	Residential RBSC[c]	Industrial RBSC[d]
Surface Water (µg/L)						
Explosives						
2,6-Dinitrotoluene	0/5	0.13	0.13	0.1	0.00989	
Nitroglycerin	0/5	2.5	2.5	10	0.48	
RDX	0/5	0.5	0.5	20	0.0611	
Metals						
Arsenic	0/5	5	5	5	0.00448	
Thallium	0/5	2	2	2	0.292	
Vanadium	0/5	50	50	50	25.5	
PCBs						
PCB-1016	0/5	1	1	1	0.096	
PCB-1221	0/5	1	1	2	0.00336	
PCB-1232	0/5	1	1	1	0.00336	
PCB-1242	0/5	1	1	1	0.00336	
PCB-1248	0/5	1	1	1	0.00336	
PCB-1254	0/5	1	1	1	0.00336	
PCB-1260	0/5	1	1	1	0.00336	
Semivolatile Organic Compounds						
1,3-Dichlorobenzene	0/5	10	10	10	0.548	
1,4-Dichlorobenzene	0/5	10	10	10	0.0502	
2,4,6-Trichlorophenol	0/5	10	10	10	0.611	
2,4-Dinitrophenol	0/5	25	25	25	7.3	
2-Chlorophenol	0/5	10	10	10	3.04	
2-Nitrobenzenamine	0/5	25	25	25	0.209	
3,3'-Dichlorobenzidine	0/5	10	10	10	0.0149	
Benz(a)anthracene	0/5	10	10	10	0.00921	
Benzo(a)pyrene	0/5	10	10	10	0.000921	
Benzo(b)fluoranthene	0/5	10	10	10	0.00921	
Benzo(k)fluoranthene	0/5	10	10	10	0.0921	
Bis(2-chloroisopropyl) ether	0/5	10	10	10	0.0274	
Carbazole	0/5	10	10	10	0.336	
Chrysene	0/5	10	10	10	0.921	
Dibenz(a,h)anthracene	0/5	10	10	10	0.000921	
Dibenzofuran	0/5	10	10	10	2.43	
Hexachlorobenzene	0/5	10	10	10	0.0042	
Hexachlorobutadiene	0/5	10	10	10	0.0862	
Hexachloroethane	0/5	10	10	10	0.48	
Indeno(1,2,3-cd)pyrene	0/5	10	10	10	0.00921	
Isophorone	0/5	10	10	10	7.08	
N-Nitroso-di-n-propylamine	0/5	10	10	10	0.00096	
N-Nitrosodiphenylamine	0/5	10	10	10	1.37	
Naphthalene	0/5	10	10	10	0.62	
Pentachlorophenol	0/5	25	25	25	0.056	
bis(2-Chloroethyl) ether	0/5	10	10	10	0.000978	
Volatile Organic Compounds						
1,1,2,2-Tetrachloroethane	0/5	5	5	5	0.00553	
1,1,2-Trichloroethane	0/5	5	5	5	0.02	
1,1-Dichloroethene	0/5	5	5	5	0.00456	
1,2-Dibromoethane	0/5	5	5	NA	0.0000757	

Table 5-1. Detection Limits in Excess of Risk-Based Screening Values (continued)

Chemical[a]	Frequency of Detection	Minimum Detection Limit	Maximum Detection Limit	Project Quantitation Limit[b]	Residential RBSC[c]	Industrial RBSC[d]
1,2-Dichloroethane	0/5	5	5	5	0.0123	
1,2-Dichloropropane	0/5	5	5	5	0.0165	
Benzene	0/5	5	5	5	0.041	
Bromodichloromethane	0/5	5	5	5	0.0181	
Bromoform	0/5	5	5	NA	0.851	
Bromomethane	0/5	10	10	10	0.866	
Carbon tetrachloride	0/5	5	5	5	0.0171	
Chloroethane	0/5	10	10	10	0.464	
Chloroform	0/5	5	5	5	0.0165	
Chloromethane	0/5	10	10	10	0.151	
Dibromochloromethane	0/5	5	5	5	0.0133	
Methylene chloride	0/5	5	5	5	0.428	
Tetrachloroethene	0/5	5	5	5	0.108	
Trichloroethene	0/5	5	5	5	0.164	
Vinyl chloride	0/5	10	10	10	0.00198	

[a] Only chemicals with all non-detected concentrations are shown in this table. The chemicals shown have detection limits that exceed the human health risk-based screening values.

[b] Project quantitation limits, from Table 4 in the *Sampling and Analysis Plan Addendum No. 1 for the RVAAP NACA Test Area Phase I RI* (USACE 1999a). Since some units of measure are shown in µg/kg in the work plan, these values are converted to mg/kg for this table.

[c] Residential screening value for surface soil, subsurface soil, and sediment is one-tenth of the EPA Region 9 residential soil PRG. The residential screening value for surface water is one-tenth of the EPA Region 9 tap water PRG.

[d] Industrial screening value for surface soil, subsurface soil, and sediment is one-tenth of the EPA Region 9 industrial soil PRG. Determination of human health COPCs is based on the screen against the residential RBSC; industrial RBSCs are provided for information only for soil and sediment (there are no industrial RBSCs for surface water).

NA = Not available.

PCB = Polychlorinated biphenyl.

RBSC = Risk-based screening criteria.

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

Since 1969, the Ohio National Guard has been the licensed user of Training Area "G." NTA is currently used for training purposes including dismounted troop training, bivouacking of the troops in training, and vehicle parking. The training area has also been used as a helicopter day and night landing zone. Firing of small (7.62 millimeter and smaller) blank ammunition is permitted within the Training Area as approved by the Training Site Commander. Groundwater currently is not used for potable or non-potable purposes by the OHARNG.

5.3.2 Future Land Use

Future use of NTA has not been determined at this time, although the OHARNG will most likely continue to use the AOC for training. Under a baseline human health risk assessment, potential use of groundwater for potable and non-potable purposes by the OHARNG would be evaluated as applicable. For the purpose of this risk evaluation, it is conservatively assumed that NTA land could revert to rural farmland in the future.

5.3.3 Selected Exposure Pathways

Phase I risk screening methods generally require the use of the most conservative potential land use assumptions for a site (EPA 1991, 1996; ASTM 1995). This ensures that a site with a potential future hazard will not be identified as needing "no further action" too early in the CERCLA process. Based on this approach, the land use assumed for this DA1 risk evaluation is rural residential farmland. For this land use assumption, the following exposure pathways and assumptions have been identified by EPA Region 9 for developing screening levels.

5.3.3.1 Soil and sediment

- Soil/Sediment Ingestion – Because contact rates may be different for children and adults, carcinogenic effects during the first 30 years of life are evaluated using age-adjusted factors. For carcinogenic effects, the receptor's exposure comes from a weighted average of a 15-kilogram (33-pound) child ingesting 200 milligram (0.007 ounce) soil/sediment per day over a 6-year time period and a 70-kg adult ingesting 100 mg soil/sediment per day over a 24-year time period. For non-carcinogenic effects, the child and adult are evaluated independently using the ingestion parameters listed above, with the adult exposed over a 30-year time period.

- Soil/Sediment Inhalation – For consistency with the ingestion pathway, inhalation carcinogenic effects come from a weighted-average of a 15-kg child who inhales volatile organics and particulates at a rate of 10 m^3/day over a 6-year time period and a 70-kilogram (154-pound) adult who inhales volatile organics and particulates at a rate of 20 m^3/day over a 24-year time period. For noncarcinogenic effects, the child and adult are evaluated independently using the inhalation parameters listed above, with the adult exposed over a 30-year time period.

- Soil/Sediment Dermal Contact – For consistency with the ingestion and inhalation pathways, dermal carcinogenic effects come from a weighted average of a 15- kilogram (33-pound) child with 2,900 cm^2 skin surface area exposed per day over a 6-year time period and a 70-kilogram (154-pound) adult with 5,700 cm^2 skin surface area exposed per day over a 24-year time period. For non-carcinogenic effects, the child and adult are evaluated independently using the dermal parameters listed above, with the adult exposed over a 30-year time period.

- Leaching of contaminants to groundwater, with subsequent ingestion of groundwater. Screening concentrations are back-calculated from acceptable groundwater concentrations [i.e., nonzero maximum contaminant level goals (MCLGs), maximum contaminant levels (MCLs), or risk-based preliminary remedial goals (PRGs)].

Surface Water

- Ingestion of surface water – although it is not realistic that anyone would drink the surface water, the receptor is conservatively assumed to ingest 2 liters (0.5 gallon) of surface water per day over a 30-year time period.

- Inhalation while showering – although it is not realistic to use surface water for domestic use (i.e., while showering), the receptor is assumed to inhale VOCs from the surface water at a rate of 20 m^3/day over a 30-year time period.

For this Phase I RI, the groundwater medium is not evaluated, as monitoring wells were not sampled. One screening groundwater sample was collected but is not evaluated in this risk evaluation. The surface water evaluation conservatively assumes that the surface water in Hinkley Creek is a potential drinking water source.

Because of the high degree of modeling uncertainty associated with the gardening/irrigation exposure pathway, this pathway is not evaluated in the Phase I risk evaluation screen. It may be identified as a complete pathway in a Phase II baseline risk assessment, if required.

5.4 SCREENING LEVELS

Sources of screening levels are presented for surface soil, subsurface soil, sediment, and surface water data in Sections 5.4.1 to 5.4.4, respectively, with actual values for these screening levels shown in the associated tables within Sections 5.5.1 to 5.5.4. These levels reflect Tier 1-type screening values (ASTM 1995), e.g., values that are easily obtainable and, due to their conservative nature, can be used with a high degree of confidence to indicate sites for which no further action is necessary. The regulatory screening values reflect a residential land use and, thus, are appropriate for a Phase I evaluation. Soil screening levels based on industrial land use are also provided for reference, as is used by the OHARNG for training purposes. Future land use may be addressed more thoroughly as part of a baseline risk assessment, if deemed necessary. Ecological risk screening is performed for surface water and sediment only, as discussed in Sections 5.5.3 and 5.5.4.

5.4.1 Screening Levels

The following sections present the source of the screening levels and the comparison methods used in the risk evaluation for each medium type.

5.4.1.1 Screening levels for surface and subsurface soil

Surface soil and subsurface soil screening levels used in the human health risk evaluation represent screening values developed by EPA Region 9 (EPA 1999). No ecological risk evaluation is made for soil as discussed below. The EPA Region 9 soil screening values reflect the following:

- residential and industrial land use;

- soil screening levels for the protection of groundwater, derived using default values in standardized equations presented in EPA's *Soil Screening Guidance* (EPA 1996); and

- risk target goals of 10^{-6} for carcinogens and a hazard quotient (HQ) of 1 for noncarcinogens.

The residential and industrial Region 9 values have been adjusted to reflect the Ohio EPA target screening goals of 10^{-7} risk and an HQ of 0.1. Thus, the values used for screening are one-tenth of the Region 9 PRGs. The Region 9 values reflect the following exposure pathways:

- ingestion,
- inhalation of particulates,
- inhalation of VOCs, and
- dermal absorption.

The industrial values are provided for information only; these values should be carefully applied in a Phase I risk evaluation since use of these values implies that some action—*land use restrictions*—must be implemented.

The soil levels developed for protection of groundwater are derived (by EPA Region 9) from standardized equations presented in EPA's *Soil Screening Guidance* (EPA 1996). These values back-calculate an acceptable concentration in soil based on acceptable groundwater concentrations. They incorporate several sensitive assumptions and, thus, should be used with caution. Some of the more important assumptions used in developing these values include

- soil contamination extends to the top of the aquifer; thus, there is no accounting for dilution/attenuation in the unsaturated zone; and

- use of a default DAF in the saturated zone of 1.0 suggests unconfined, unconsolidated conditions in the aquifer.

These assumptions could be extremely conservative for NTA. Values based on leaching to groundwater are significantly lower than other screening values and thus should be applied with caution.

Soil screening levels for lead reflect current EPA guidance (EPA 1994a, 1994b). The values were developed by EPA using the Integrated Exposure Uptake Biokinetic Model.

For ecological risk evaluation of soil, no reliable screening data sources exist, as was discussed for the WBG Phase II RI on March 18, 1998, at RVAAP among the U.S. Army, Ohio EPA, and SAIC ecological risk assessors. Assuming an ecological risk assessment is required as part of a subsequent RI phase, soil will be evaluated using an HQ and weight-of-evidence approach

5.4.1.2 Screening levels for sediment

Sediment screening levels reflect levels protective of ecological receptors and human receptors. The most conservative (i.e., smallest) ecological screening levels is chosen from the following sources as the sediment ecological screening value for NTA. These values and the hierarchy are in harmony with the work plans approved at that time.

- Ecological Data Quality Levels (EDQLs) from EPA Region V (EPA 1998);

- Ontario Ministry of the Environment (Persaud, Jaagumagi, and Hayton 1993);

- National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables Threshold Effects Levels (TELs) (Buchman 1998); and

- NOAA Effect Range Lows (Jones, Suter, and Hull 1997, from sources such as Long and Morgan 1991).

Table 5-2 shows the preferred sediment screening values, using data from the sources mentioned above. These screening values are then used to screen NTA sediment data in order to determine ecological COPCs for sediment.

Sediment concentrations are also screened against the adjusted EPA Region 9 (i.e., one-tenth of the Region 9 PRGs) soil screening values for human health, as presented in Section 5.4.1.1. The exception is that the soil levels developed for protection of groundwater are not used to screen sediment concentrations at the NTA.

5.4.1.3 Screening levels for surface water

Surface water criteria used for human health screening are adjusted EPA Region 9 PRGs for tap water. The calculated risk-based values presented in the Region 9 PRG table reflect the default exposure pathways and parameters identified by EPA (EPA 1999). For most chemicals, the risk-based screening value reflects the water ingestion scenario; the inhalation pathway is included for VOCs only. The screening values used in the human health risk evaluation are based on a carcinogenic risk level of 10^{-7} or on a noncarcinogenic HQ of 0.1. Thus, the human health screening values are one-tenth of the Region 9 PRGs.

For ecological screening of surface water, the most conservative (i.e., smallest) ecological screening level is chosen from the following sources as the surface water ecological screening value for the NTA. These values and hierarchy were in the work plan approved at that time.

- Ecotox thresholds from the EDQLs from EPA Region 5 (EPA 1998);

- Chapter 3745-1-25 of the Ohio Administrative Code for the Mahoning River, which is the Lake Erie Basin (Ohio EPA 1999); and

- A compilation of toxicological benchmarks from Oak Ridge National Laboratory (Suter and Tsao 1996).

Table 5-3 shows the preferred surface water screening values using the sources provided above. These screening values are used to screen NTA surface water data in order to determine ecological COPCs.

5.4.2 Screening Comparison Method

The screening level comparison is a systematic screening of sample results against the appropriate screening levels. Chemicals that are not screened out during this process will be considered as potential COPCs for the NTA. Initial screening is performed for all media to determined SRCs (see Chapter 4.0 and Section 5.1). Results of the SRC identification are used in the following manner:

- Chemicals that are never detected are not considered to be COPCs.

- Metals detected at or below background are not considered to be COPCs.

Table 5-2. Ecological Biotic Screening Values for Chemical Constituents in Sediment at NACA Test Area

Chemicals	CAS Registry Number	Sediment									
		Ecological Data Quality Levels (EDQL)[a]		Ontario MOE[b] Low		NOAA SQuiRTs[c] Threshold Effects Level (TEL)		NOAA[d] Effects Range-Low (ER-L)		Preferred Sediment[e] Value (PSV)	
		Number	Source	Number	Source	Number	Source	Number	Source	Number	Source
Metals											
(Target Analyte List)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)		(mg/kg)	
Aluminum	7429-90-5				--		--		--	--	--
Antimony	7440-36-0				--		--	2	NOAA ER-L	2	NOAA ER-L
Arsenic (Diss)	7440-38-2	5.9	EDQL EPA Region 5 (1998)	6	Ontario MOE low	5.9	SQuiRTs TEL (1998)	8.2	NOAA ER-L	5.9	EDQL EPA Region 5 (1998)
Barium	7440-39-3				--		--		--	--	--
Beryllium	7440-41-7				--		--		--	--	--
Cadmium (Diss)	7440-43-9	0.596	EDQL EPA Region 5 (1998)	0.6	Ontario MOE low	0.596	SQuiRTs TEL (1998)	1.2	NOAA ER-L	0.596	EDQL EPA Region 5 (1998)
Calcium	7440-70-2				--		--		--	--	--
Chromium (Diss)	7440-47-3	26	EDQL EPA Region 5 (1998)	26	Ontario MOE low	37.3	SQuiRTs TEL (1998)	81	NOAA ER-L	26	EDQL EPA Region 5 (1998)
Cobalt	7440-48-4	50	EDQL EPA Region 5 (1998)		--		--		--	50	EDQL EPA Region 5 (1998)
Copper (Diss)	7440-50-8	16	EDQL EPA Region 5 (1998)	16	Ontario MOE low	35.7	SQuiRTs TEL (1998)	34	NOAA ER-L	16	EDQL EPA Region 5 (1998)
Cyanide	57-12-5	0.0001	EDQL EPA Region 5 (1998)		--		--		--	0.0001	EDQL EPA Region 5 (1998)
Iron	7439-89-6			20	Ontario MOE low		--		--	20	Ontario MOE low
Lead (Diss)	7439-92-1	31	EDQL EPA Region 5 (1998)	31	Ontario MOE low	35	SQuiRTs TEL (1998)	46.7	NOAA ER-L	31	EDQL EPA Region 5 (1998)
Magnesium	7439-95-4				--		--		--	--	--
Manganese	7439-96-5			460	Ontario MOE low		--		--	460	Ontario MOE low
Mercury	7439-97-6	0.174	EDQL EPA Region 5 (1998)	0.2	Ontario MOE low	0.174	SQuiRTs TEL (1998)	0.15	NOAA ER-L	0.15	NOAA ER-L
Nickel (Diss)	7440-02-0	16	EDQL EPA Region 5 (1998)	16	Ontario MOE low	18	SQuiRTs TEL (1998)	20.9	NOAA ER-L	16	EDQL EPA Region 5 (1998)
Potassium	7440-07-7				--		--		--	--	--
Selenium (Diss)	7782-49-2				--		--		--	--	--
Silver (Diss)	7440-22-4	0.5	EDQL EPA Region 5 (1998)		--		--	1	NOAA ER-L	0.5	EDQL EPA Region 5 (1998)
Sodium	7440-23-5				--		--		--	--	--
Thallium	7440-28-0				--		--		--	--	--
Vanadium	7440-62-2				--		--		--	--	--
Zinc (Diss)	7440-66-6	120	EDQL EPA Region 5 (1998)	120	Ontario MOE low	123.1	SQuiRTs TEL (1998)	150	NOAA ER-L	120	EDQL EPA Region 5 (1998)
Organic Compounds		(µg/kg)		(µg/kg)		(µg/kg)		(µg/kg)			
Acenaphthene	83-32-9	6.71	EDQL EPA Region 5 (1998)		--		--	16	NOAA ER-L	6.71	EDQL EPA Region 5 (1998)
Acenaphthylene	208-96-8	5.87	EDQL EPA Region 5 (1998)		--		--	44	NOAA ER-L	5.87	EDQL EPA Region 5 (1998)
Acetone	67-64-1	453.37	EDQL EPA Region 5 (1998)		--		--		--	453.37	EDQL EPA Region 5 (1998)
Aldrin	309-00-2	2	EDQL EPA Region 5 (1998)	2	Ontario MOE low		--			2	EDQL EPA Region 5 (1998)
Anthracene	120-12-7	46.9	EDQL EPA Region 5 (1998)	220	Ontario MOE low		--	85.3	NOAA ER-L	46.9	EDQL EPA Region 5 (1998)
Aroclor-1016	12674-11-2			7	Ontario MOE low		--		--	7	Ontario MOE low
Aroclor-1221	11104-28-2				--		--		--	--	--
Aroclor-1232	11141-16-5				--		--		--	--	--
Aroclor-1242	53469-21-9				--		--		--	--	--
Aroclor-1248	12672-29-6			30	Ontario MOE low		--		--	30	Ontario MOE low
Aroclor-1254	11097-69-1			60	Ontario MOE low		--		--	60	Ontario MOE low
Aroclor-1260	11096-82-5			5	Ontario MOE low		--		--	5	Ontario MOE low
Benzene	71-43-2	141.57	EDQL EPA Region 5 (1998)		--		--		--	141.57	EDQL EPA Region 5 (1998)
Benzo(a)anthracene	56-55-3	31.7	EDQL EPA Region 5 (1998)	320	Ontario MOE low	31.7	SQuiRTs TEL (1998)	261	NOAA ER-L	31.7	EDQL EPA Region 5 (1998)
Benzo(a)pyrene	50-32-8	31.9	EDQL EPA Region 5 (1998)	370	Ontario MOE low	31.9	SQuiRTs TEL (1998)	430	NOAA ER-L	31.9	EDQL EPA Region 5 (1998)
Benzo(b)fluoranthene	205-99-2	10400	EDQL EPA Region 5 (1998)		--		--		--	10400	EDQL EPA Region 5 (1998)
Benzo(g,h,i)perylene	191-24-2	170	EDQL EPA Region 5 (1998)	170	Ontario MOE low		--		--	170	EDQL EPA Region 5 (1998)
Benzo(k)fluoranthene	207-08-9	240	EDQL EPA Region 5 (1998)	240	Ontario MOE low		--		--	240	EDQL EPA Region 5 (1998)
BHC	608-73-1			3	Ontario MOE low		--		--	3	Ontario MOE low
BHC, alpha	319-84-6	6	EDQL EPA Region 5 (1998)	6	Ontario MOE low		--		--	6	EDQL EPA Region 5 (1998)

Table 5-2. Ecological Biotic Screening Values for Chemical Constituents in Sediment at NACA Test Area (continued)

		Sediment									
	CAS Registry	Ecological Data Quality Levels (EDQL)[a]		Ontario MOE[b] Low		NOAA SQuiRTs[c] Threshold Effects Level (TEL)		NOAA[d] Effects Range-Low (ER-L)		Preferred Sediment[e] Value (PSV)	
Chemicals	**Number**	**Number**	**Source**	**Number**	**Source**	**Number**	**Source**	**Number**	**Source**	**Number**	**Source**
BHC, beta	319-85-7	5	EDQL EPA Region 5 (1998)	5	Ontario MOE low		--		--	5	EDQL EPA Region 5 (1998)
Biphenyl	92-52-4				--		--		--	--	--
bis(2-chloroethoxy) methane	111-91-1	349.71	EDQL EPA Region 5 (1998)		--		--		--	349.71	EDQL EPA Region 5 (1998)
bis(2-Chloroethyl) ether	111-44-4	211.96	EDQL EPA Region 5 (1998)		--		--		--	211.96	EDQL EPA Region 5 (1998)
bis(2-Ethylhexyl)phthalate	117-81-7	182	EDQL EPA Region 5 (1998)		--		--		--	182	EDQL EPA Region 5 (1998)
Bromodichloromethane	74-97-5	1.13	EDQL EPA Region 5 (1998)		--		--		--	1.13	EDQL EPA Region 5 (1998)
Bromomethane	74-83-9	0.148	EDQL EPA Region 5 (1998)		--		--		--	0.148	EDQL EPA Region 5 (1998)
4-bromophenyl-phenylether	101-55-3	1550	EDQL EPA Region 5 (1998)		--		--		--	1550	EDQL EPA Region 5 (1998)
2-Butanone	78-93-3	136.96	EDQL EPA Region 5 (1998)		--		--		--	136.96	EDQL EPA Region 5 (1998)
Butylbenzylphthalate	85-68-7	4190	EDQL EPA Region 5 (1998)		--		--		--	4190	EDQL EPA Region 5 (1998)
Carbazole	86-74-8				--		--		--	--	--
Carbon disulfide	75-15-0	133.97	EDQL EPA Region 5 (1998)		--		--		--	133.97	EDQL EPA Region 5 (1998)
Carbon tetrachloride	56-23-5	35.73	EDQL EPA Region 5 (1998)		--		--		--	35.73	EDQL EPA Region 5 (1998)
4-Chloroaniline	106-47-8	146.08	EDQL EPA Region 5 (1998)		--		--		--	146.08	EDQL EPA Region 5 (1998)
Chlorobenzene	108-90-7	61.94	EDQL EPA Region 5 (1998)		--		--		--	61.94	EDQL EPA Region 5 (1998)
Chlordane	12789-03-6			7	Ontario MOE low	4.5	SQuiRTs TEL (1998)	0.5	NOAA ER-L	0.5	NOAA ER-L
Chloroethane	75-00-3	58600	EDQL EPA Region 5 (1998)		--		--		--	58600	EDQL EPA Region 5 (1998)
Chloroform	67-66-3	27	EDQL EPA Region 5 (1998)		--		--		--	27	EDQL EPA Region 5 (1998)
Chloromethane	74-87-3	0.0785	EDQL EPA Region 5 (1998)		--		--		--	0.0785	EDQL EPA Region 5 (1998)
2-Chloronaphthalene	91-58-7	417.23	EDQL EPA Region 5 (1998)		--		--		--	417.23	EDQL EPA Region 5 (1998)
2-Chlorophenol	95-57-8	11.7	EDQL EPA Region 5 (1998)		--		--		--	11.7	EDQL EPA Region 5 (1998)
4-Chlorophenyl-phenyl ether	7005-72-3	656.12	EDQL EPA Region 5 (1998)		--		--		--	656.12	EDQL EPA Region 5 (1998)
4-chloro-3-methylphenol	59-50-7	388.18	EDQL EPA Region 5 (1998)		--		--		--	388.18	EDQL EPA Region 5 (1998)
Chrysene	218-01-9	57.1	EDQL EPA Region 5 (1998)	340	Ontario MOE low	57.1	SQuiRTs TEL (1998)	384	NOAA ER-L	57.1	EDQL EPA Region 5 (1998)
4,4'-DDD	72-54-8	5.53	EDQL EPA Region 5 (1998)	8	Ontario MOE low	3.54	SQuiRTs TEL (1998)	2	NOAA ER-L	2	NOAA ER-L
4,4'-DDE	72-55-9	1.42	EDQL EPA Region 5 (1998)	5	Ontario MOE low	1.42	SQuiRTs TEL (1998)	2.2	NOAA ER-L	1.42	EDQL EPA Region 5 (1998)
4,4'-DDT	50-29-3	1.19	EDQL EPA Region 5 (1998)	7	Ontario MOE low	6.98	SQuiRTs TEL (1998)	1.58	NOAA ER-L	1.19	EDQL EPA Region 5 (1998)
Diazinon	333-41-5				--		--		--	--	--
Dibenzo(a,h)anthracene	53-70-3	6.22	EDQL EPA Region 5 (1998)	60	Ontario MOE low		--	63.4	NOAA ER-L	6.22	EDQL EPA Region 5 (1998)
Dibenzofuran	132-64-9	1520	EDQL EPA Region 5 (1998)		--		--		--	1520	EDQL EPA Region 5 (1998)
Dibromochloromethane	124-48-1	267.61	EDQL EPA Region 5 (1998)		--		--		--	267.61	EDQL EPA Region 5 (1998)
1,2-Dichlorobenzene	95-50-1	231.32	EDQL EPA Region 5 (1998)		--		--		--	231.32	EDQL EPA Region 5 (1998)
1,3-Dichlorobenzene	541-73-1	3010	EDQL EPA Region 5 (1998)		--		--		--	3010	EDQL EPA Region 5 (1998)
1,4-Dichlorobenzene	106-46-7	1450	EDQL EPA Region 5 (1998)		--		--		--	1450	EDQL EPA Region 5 (1998)
3,3'-Dichlorobenzidine	91-94-1	28.22	EDQL EPA Region 5 (1998)		--		--		--	28.22	EDQL EPA Region 5 (1998)
1,1-Dichloroethane	75-34-3	0.575	EDQL EPA Region 5 (1998)		--		--		--	0.575	EDQL EPA Region 5 (1998)
1,2-Dichloroethane	107-06-2	54.18	EDQL EPA Region 5 (1998)		--		--		--	54.18	EDQL EPA Region 5 (1998)
1,1-Dichloroethene	75-35-4	23.27	EDQL EPA Region 5 (1998)		--		--		--	23.27	EDQL EPA Region 5 (1998)
1,2-Dichloroethene (total)	540-59-0				--		--		--	--	--
2,4-Dichlorophenol	120-83-2	133.63	EDQL EPA Region 5 (1998)		--		--		--	133.63	EDQL EPA Region 5 (1998)
1,2-Dichloropropane	78-87-5	351.61	EDQL EPA Region 5 (1998)		--		--		--	351.61	EDQL EPA Region 5 (1998)
cis-1,3-Dichloropropene	10061-02-6	2.96	EDQL EPA Region 5 (1998)		--		--		--	2.96	EDQL EPA Region 5 (1998)
trans-1,3-Dichloropropene	10061-02-6	2.96	EDQL EPA Region 5 (1998)		--		--		--	2.96	EDQL EPA Region 5 (1998)
Dieldrin	60-57-1	2	EDQL EPA Region 5 (1998)	2	Ontario MOE low	2.85	SQuiRTs TEL (1998)	0.02	NOAA ER-L	0.02	NOAA ER-L
Diethylphthalate	84-66-2	8.04	EDQL EPA Region 5 (1998)		--		--		--	8.04	EDQL EPA Region 5 (1998)
Dimethylphthalate	131-11-3	24.95	EDQL EPA Region 5 (1998)		--		--		--	24.95	EDQL EPA Region 5 (1998)

Table 5-2. Ecological Biotic Screening Values for Chemical Constituents in Sediment at NACA Test Area (continued)

Chemicals	CAS Registry Number	Sediment									
		Ecological Data Quality Levels (EDQL)[a]		Ontario MOE[b] Low		NOAA SQuiRTs[c] Threshold Effects Level (TEL)		NOAA[d] Effects Range-Low (ER-L)		Preferred Sediment[e] Value (PSV)	
		Number	Source	Number	Source	Number	Source	Number	Source	Number	Source
2,4-Dimethylphenol	105-67-9	304.53	EDQL EPA Region 5 (1998)		--		--		--	304.53	EDQL EPA Region 5 (1998)
Di-n-butylphthalate	84-74-2	110.5	EDQL EPA Region 5 (1998)		--		--		--	110.5	EDQL EPA Region 5 (1998)
Di-n-octylphthalate	117-84-0	40600	EDQL EPA Region 5 (1998)		--		--		--	40600	EDQL EPA Region 5 (1998)
1,3-Dinitrobenzene	99-65-0	0.924	EDQL EPA Region 5 (1998)		--		--		--	0.924	EDQL EPA Region 5 (1998)
2,4-Dinitrophenol	51-28-5	1.33	EDQL EPA Region 5 (1998)		--		--		--	1.33	EDQL EPA Region 5 (1998)
2,4-Dinitrotoluene	121-14-2	75.13	EDQL EPA Region 5 (1998)		--		--		--	75.13	EDQL EPA Region 5 (1998)
2,6-Dinitrotoluene	606-20-2	20.62	EDQL EPA Region 5 (1998)		--		--		--	20.62	EDQL EPA Region 5 (1998)
4,6-Dinitro-2-methylphenol	534-52-1	10.38	EDQL EPA Region 5 (1998)		--		--		--	10.38	EDQL EPA Region 5 (1998)
Endosulfan, alpha	959-98-8	0.175	EDQL EPA Region 5 (1998)		--		--		--	0.175	EDQL EPA Region 5 (1998)
Endosulfan, beta	33213-65-9	0.104	EDQL EPA Region 5 (1998)		--		--		--	0.104	EDQL EPA Region 5 (1998)
Endosulfan, mixed isomers	--				--		--		--	--	--
Endosulfan sulfate	1031-07-8	34.6	EDQL EPA Region 5 (1998)		--		--		--	34.6	EDQL EPA Region 5 (1998)
Endrin	72-20-8	2.67	EDQL EPA Region 5 (1998)	3	Ontario MOE low	2.67	SQuiRTs TEL (1998)	0.02	NOAA ER-L	0.02	NOAA ER-L
Ethylbenzene	100-41-4	0.1	EDQL EPA Region 5 (1998)		--		--		--	0.1	EDQL EPA Region 5 (1998)
Fluoranthene	206-44-0	111.3	EDQL EPA Region 5 (1998)	750	Ontario MOE low	111	SQuiRTs TEL (1998)	600	NOAA ER-L	111	SQuiRTs TEL (1998)
Fluorene	86-73-7	21.2	EDQL EPA Region 5 (1998)	190	Ontario MOE low		--	19	NOAA ER-L	19	NOAA ER-L
gamma-BHC (lindane)	58-89-9	0.94	EDQL EPA Region 5 (1998)	3	Ontario MOE low	0.94	SQuiRTs TEL (1998)		--	0.94	EDQL EPA Region 5 (1998)
Heptachlor Epoxide	1024-57-3	0.6	EDQL EPA Region 5 (1998)	5	Ontario MOE low	0.6	SQuiRTs TEL (1998)		--	0.6	EDQL EPA Region 5 (1998)
Hexachlorobenzene	118-74-1	20	EDQL EPA Region 5 (1998)	20	Ontario MOE low		--		--	20	EDQL EPA Region 5 (1998)
Hexachlorobutadiene	87-68-3	1380	EDQL EPA Region 5 (1998)		--		--		--	1380	EDQL EPA Region 5 (1998)
Hexachlorocyclopentadiene	77-47-4	900.74	EDQL EPA Region 5 (1998)		--		--		--	900.74	EDQL EPA Region 5 (1998)
Hexachloroethane	67-72-1	2230	EDQL EPA Region 5 (1998)		--		--		--	2230	EDQL EPA Region 5 (1998)
2-Hexanone	591-78-6	1010	EDQL EPA Region 5 (1998)		--		--		--	1010	EDQL EPA Region 5 (1998)
HMX Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	2691-41-0				--		--		--	--	--
Indeno(1,2,3-cd)pyrene	193-39-5	200	EDQL EPA Region 5 (1998)	200	Ontario MOE low		--		--	200	EDQL EPA Region 5 (1998)
Isophorone	78-59-1	422.3	EDQL EPA Region 5 (1998)		--		--		--	422.3	EDQL EPA Region 5 (1998)
Malathion	121-75-5				--		--		--	--	--
Methoxychlor	72-43-5	3.59	EDQL EPA Region 5 (1998)		--		--		--	3.59	EDQL EPA Region 5 (1998)
Methylene chloride	75-09-2	1260	EDQL EPA Region 5 (1998)		--		--		--	1260	EDQL EPA Region 5 (1998)
2-Methylnaphthalene	91-57-6	20.2	EDQL EPA Region 5 (1998)		--		--	70	NOAA ER-L	20.2	EDQL EPA Region 5 (1998)
2-Methylphenol	95-48-7	0.826	EDQL EPA Region 5 (1998)		--		--		--	0.826	EDQL EPA Region 5 (1998)
4-Methylphenol	106-44-5	0.808	EDQL EPA Region 5 (1998)		--		--		--	0.808	EDQL EPA Region 5 (1998)
4-Methyl-2-pentanone	108-10-1	544.37	EDQL EPA Region 5 (1998)		--		--		--	544.37	EDQL EPA Region 5 (1998)
Mirex	2385-85-5			7	Ontario MOE low		--		--	7	Ontario MOE low
Naphthalene	91-20-3	34.6	EDQL EPA Region 5 (1998)		--		--	160	NOAA ER-L	34.6	EDQL EPA Region 5 (1998)
2-Nitroaniline	88-74-4	0.222	EDQL EPA Region 5 (1998)		--		--		--	0.222	EDQL EPA Region 5 (1998)
3-Nitroaniline	99-09-2	0.222	EDQL EPA Region 5 (1998)		--		--		--	0.222	EDQL EPA Region 5 (1998)
4-Nitroaniline	100-01-6	0.222	EDQL EPA Region 5 (1998)		--		--		--	0.222	EDQL EPA Region 5 (1998)
Nitrobenzene	99-95-3	487.6	EDQL EPA Region 5 (1998)		--		--		--	487.6	EDQL EPA Region 5 (1998)
Nitrobenzene	99-95-3				--		--		--	--	--
Nitrocellulose	9004-70-0				--		--		--	--	--
Nitroglycerin	55-63-0				--		--		--	--	--
Nitroquanidine	--				--		--		--	--	--
2-Nitrophenol	88-75-5	7.77	EDQL EPA Region 5 (1998)		--		--		--	7.77	EDQL EPA Region 5 (1998)
4-Nitrophenol	100-02-7	7.78	EDQL EPA Region 5 (1998)		--		--		--	7.78	EDQL EPA Region 5 (1998)
m-Nitrotoluene	99-08-1				--		--		--	--	--

Table 5-2. Ecological Biotic Screening Values for Chemical Constituents in Sediment at NACA Test Area (continued)

Chemicals	CAS Registry Number	Sediment									
		Ecological Data Quality Levels (EDQL)[a]		Ontario MOE[b] Low		NOAA SQuiRTs[c] Threshold Effects Level (TEL)		NOAA[d] Effects Range-Low (ER-L)		Preferred Sediment[e] Value (PSV)	
		Number	Source	Number	Source	Number	Source	Number	Source	Number	Source
N-nitroso-di-n-dipropylamine	621-64-7	0.217	EDQL EPA Region 5 (1998)		--		--		--	0.217	EDQL EPA Region 5 (1998)
N-nitrosodiphenylamine	86-30-6	155.24	EDQL EPA Region 5 (1998)		--		--		--	155.24	EDQL EPA Region 5 (1998)
o-Nitrotoluene	88-72-2				--		--		--	--	--
2,2'- oxybis(1-Chloropropane)	108-60-1	68.78	EDQL EPA Region 5 (1998)		--		--		--	68.78	EDQL EPA Region 5 (1998)
Pentachlorophenol	87-86-5	30100	EDQL EPA Region 5 (1998)		--		--		--	30,100	EDQL EPA Region 5 (1998)
Pentachlorobenzene	608-93-5	1260	EDQL EPA Region 5 (1998)		--		--		--	1,260	EDQL EPA Region 5 (1998)
Phenanthrene	85-01-8	41.9	EDQL EPA Region 5 (1998)	560	Ontario MOE low	41.9	SQuiRTs TEL (1998)	240	NOAA ER-L	41.9	EDQL EPA Region 5 (1998)
Phenol	108-95-2	27.26	EDQL EPA Region 5 (1998)		--		--		--	27.26	EDQL EPA Region 5 (1998)
Polynuclear aromatic hydrocarbons				4,000	Ontario MOE low		--	4,022	NOAA ER-L	4,000	Ontario MOE low
Polychlorinated biphenyls	1336-36-3	34.1	EDQL EPA Region 5 (1998)	70	Ontario MOE low	34.1	SQuiRTs TEL (1998)	22.7	NOAA ER-L	22.7	NOAA ER-L
p-Nitrotoluene	99-99-0				--		--		--	--	--
Pyrene	129-00-0	53	EDQL EPA Region 5 (1998)	490	Ontario MOE low	53	SQuiRTs TEL (1998)	665	NOAA ER-L	53	EDQL EPA Region 5 (1998)
RDX (cyclonite) Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4				--		--		--	--	--
Styrene	100-42-5	444.96	EDQL EPA Region 5 (1998)		--		--		--	444.96	EDQL EPA Region 5 (1998)
Tetrachloroethene	127-18-4	195.83	EDQL EPA Region 5 (1998)		--		--		--	195.83	EDQL EPA Region 5 (1998)
Tetrachloroethylene	127-18-4	195.83	EDQL EPA Region 5 (1998)		--		--		--	195.83	EDQL EPA Region 5 (1998)
1,1,2,2-Tetrachloroethane	79-34-5	29.08	EDQL EPA Region 5 (1998)		--		--		--	29.08	EDQL EPA Region 5 (1998)
Tetrachloromethane	56-23-5	35.73	EDQL EPA Region 5 (1998)		--		--		--	35.73	EDQL EPA Region 5 (1998)
Tetryl	479-45-8				--		--		--	--	--
Toluene	108-88-3	52500	EDQL EPA Region 5 (1998)		--		--		--	52500	EDQL EPA Region 5 (1998)
Toxaphene	8001-35-2	0.109	EDQL EPA Region 5 (1998)		--		--		--	0.109	EDQL EPA Region 5 (1998)
Tribromomethane	75-25-2	996.27	EDQL EPA Region 5 (1998)		--		--		--	996.27	EDQL EPA Region 5 (1998)
Trichloroethene	79-01-6	179.56	EDQL EPA Region 5 (1998)		--		--		--	179.56	EDQL EPA Region 5 (1998)
1,2,4-Trichlorobenzene	120-82-1	11700	EDQL EPA Region 5 (1998)		--		--		--	11,700	EDQL EPA Region 5 (1998)
1,1,1-Trichloroethane	71-55-6	246.85	EDQL EPA Region 5 (1998)		--		--		--	246.85	EDQL EPA Region 5 (1998)
1,1,2-Trichloroethane	79-00-5	673.51	EDQL EPA Region 5 (1998)		--		--		--	673.51	EDQL EPA Region 5 (1998)
Trichloroethylene	79-01-6	179.56	EDQL EPA Region 5 (1998)		--		--		--	179.56	EDQL EPA Region 5 (1998)
2,4,5-Trichlorophenol	95-95-4	85.56	EDQL EPA Region 5 (1998)		--		--		--	85.56	EDQL EPA Region 5 (1998)
2,4,6-Trichlorophenol	88-06-2	84.84	EDQL EPA Region 5 (1998)		--		--		--	84.84	EDQL EPA Region 5 (1998)
1,3,5-Trinitrobenzene	99-35-4	0.121	EDQL EPA Region 5 (1998)		--		--		--	0.121	EDQL EPA Region 5 (1998)
2,4,6-Trinitrotoluene	118-96-7				--		--		--	--	--
Vinyl chloride	75-01-4	2	EDQL EPA Region 5 (1998)		--		--		--	2	EDQL EPA Region 5 (1998)
Xylenes (total)	1330-20-7	1880	EDQL EPA Region 5 (1998)		--		--		--	1,880	EDQL EPA Region 5 (1998)

[a] EPA (1998). RCRA QAPP Instructions, USEPA Region 5, Chicago, IL, April 1998 revision. http://www.epa.gov/reg5rcra/wptdiv/cars/cars.htm

[b] Jones, Suter, and Hull (1997). Toxicological Benchmarks for Screening Constituents of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision, ES/ER/TM-95/R4, Lockheed Martin Energy Systems, Inc., November

[c] Buchman (1998). NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 97-2, Hazardous Material Response and Assessment Division, National Oceanic and Atmospheric Administration, Seattle, WA.

[d] Jones, Suter, and Hull (1997). Toxicological Benchmarks for Screening Constituents of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision, ES/ER/TM-95/R4, Lockheed Martin Energy Systems, Inc., November

[e] The Preferred Sediment Value is the lowest value among the EDQLs, the MOE, NOAA SQuiRTs, and NOAA ER-L sediment values

-- = No value.

Diss. = Dissolved.

Table 5-3. Ecological Biotic Screening Values for Chemical Constituents in Surface Water at NACA Test Area

		Surface Water							
		Ecological Data Quality Levels (EDQL)[a]		Ohio EPA OMZA (Outside Mixing Zone Average)[b]		Suter and Tsao (1996)[c]		Preferred Surface Water Value[d]	
Chemicals	CAS Registry Number	Number (µg/L)	Source	Number (µg/L)	Source	Number (µg/L)	Source	Number (µg/L)	Source
Metals									
(Target Analyte List)									
Aluminum	7429-90-5		EDQL EPA Region 5 (1998)		--	87	NAWQC (Suter & Tsao 1996)	87	NAWQC (Suter & Tsao 1996)
Antimony	7440-36-0	31	EDQL EPA Region 5 (1998)	190	Ohio Administrative Code	30	Draft FCV values (EPA 1988b in Suter & Tsao 1996)	30	Draft FCV values (EPA 1988b in Suter & Tsao 1996)
Arsenic III (Diss)	7440-38-2	53	EDQL EPA Region 5 (1998)	150	Ohio Administrative Code	190	NAWQC (Suter & Tsao 1996)	53	EDQL EPA Region 5 (1998)
Arsenic (TR)	7440-38-2	53	EDQL EPA Region 5 (1998)	150	Ohio Administrative Code		--	53	EDQL EPA Region 5 (1998)
Arsenic V (Diss)	7440-38-2	53	EDQL EPA Region 5 (1998)		--	3.1	Tier II (Suter & Tsao 1996)	3.1	Tier II (Suter & Tsao 1996)
Barium	7440-39-3	5,000	EDQL EPA Region 5 (1998)	220	Ohio Administrative Code	4.0	Tier II (Suter & Tsao 1996)	4	Tier II (Suter & Tsao 1996)
Beryllium (TR)	7440-41-7	7.6	EDQL EPA Region 5 (1998)	11^e	Ohio Administrative Code	0.66	Tier II (Suter & Tsao 1996)	0.66	Tier II (Suter & Tsao 1996)
Boron	7440-42-8			950	Ohio Administrative Code	1.6	Tier II (Suter & Tsao 1996)	1.6	Tier II (Suter & Tsao 1996)
Cadmium (Diss)	7440-43-9	0.7	EDQL EPA Region 5 (1998)	2.2^e	Ohio Administrative Code	1.1	NAWQC (Suter & Tsao 1996)	0.7	EDQL EPA Region 5 (1998)
Cadmium (TR)	7440-43-9	0.7	EDQL EPA Region 5 (1998)	2.5^e	Ohio Administrative Code		--	0.7	EDQL EPA Region 5 (1998)
Calcium	7440-70-2				--		--	--	--
Chlorine (TR)	7782-50-5			11	Ohio Administrative Code		--	11	Ohio Administrative Code
Chromium III (Diss)	7440-47-3	42	EDQL EPA Region 5 (1998)	74^e	Ohio Administrative Code	210	Tier II (Suter & Tsao 1996)	42	EDQL EPA Region 5 (1998)
Chromium (TR)	7440-47-3	42	EDQL EPA Region 5 (1998)	86^e	Ohio Administrative Code		--	42	EDQL EPA Region 5 (1998)
Chromium VI (Diss)	7440-47-3	42	EDQL EPA Region 5 (1998)		--	11	Tier II (Suter & Tsao 1996)	11	Tier II (Suter & Tsao 1996)
Cobalt	7440-48-4	5	EDQL EPA Region 5 (1998)	24	Ohio Administrative Code	23	Tier II (Suter & Tsao 1996)	5	EDQL EPA Region 5 (1998)
Copper (Diss)	7440-50-8	5	EDQL EPA Region 5 (1998)	9.0^e	Ohio Administrative Code	12	NAWQC (Suter & Tsao 1996)	5	EDQL EPA Region 5 (1998)
Copper (TR)	7440-50-8	5	EDQL EPA Region 5 (1998)	9.3^e	Ohio Administrative Code		--	5	EDQL EPA Region 5 (1998)
Cyanide	57-12-5	5.2	EDQL EPA Region 5 (1998)	5.2	Ohio Administrative Code	5.2	NAWQC (Suter & Tsao 1996)	5.2	NAWQC (Suter & Tsao 1996)
Iron	7439-89-6				--	1000	NAWQC (Suter & Tsao 1996)	1,000	NAWQC (Suter & Tsao 1996)
Lead (Diss)	7439-92-1	1.3	EDQL EPA Region 5 (1998)	5.1^e	Ohio Administrative Code	3.2	NAWQC (Suter & Tsao 1996)	1.3	EDQL EPA Region 5 (1998)
Lead (TR)	7439-92-1	1.3	EDQL EPA Region 5 (1998)	6.4^e	Ohio Administrative Code		--	1.3	EDQL EPA Region 5 (1998)
Magnesium	7439-95-4				--		--	--	--
Manganese (TR)	7439-96-5			180	Ohio Administrative Code	120	Tier II (Suter & Tsao 1996)	120	NAWQC (Suter & Tsao 1996)
Mercury (CVAA) (Diss)	7439-97-6	0.0013	EDQL EPA Region 5 (1998)	0.77	Ohio Administrative Code	1.3	Tier II (Suter & Tsao 1996)	0.0013	EDQL EPA Region 5 (1998)
Mercury (TR)	7439-97-6	0.0013	EDQL EPA Region 5 (1998)	0.91	Ohio Administrative Code		--	0.0013	EDQL EPA Region 5 (1998)
Mercury, Methyl	7439-97-6	0.0013	EDQL EPA Region 5 (1998)		--	0.0028	Tier II (Suter & Tsao 1996)	0.0013	EDQL EPA Region 5 (1998)
Molybdenum	7439-98-7			110	Ohio Administrative Code	370	Tier II (Suter & Tsao 1996)	110	Ohio Administrative Code
Nickel (Diss)	7440-02-0	29	EDQL EPA Region 5 (1998)	52^e	Ohio Administrative Code	160	NAWQC (Suter & Tsao 1996)	29	EDQL EPA Region 5 (1998)
Nickel (TR)	7440-02-1	29	EDQL EPA Region 5 (1998)	52^e	Ohio Administrative Code		--	29	EDQL EPA Region 5 (1998)
Potassium	7440-09-7				--		--	--	--
Selenium (Diss)	7782-49-2	5	EDQL EPA Region 5 (1998)	4.6	Ohio Administrative Code	5.0	NAWQC (Suter & Tsao 1996)	4.6	Ohio Administrative Code
Selenium (TR)	7782-49-2	5	EDQL EPA Region 5 (1998)	5.0	Ohio Administrative Code		--	5	EDQL EPA Region 5 (1998)
Silver (Diss)	7440-22-4	1	EDQL EPA Region 5 (1998)		--	0.36	Tier II (Suter & Tsao 1996)	0.36	Tier II (Suter & Tsao 1996)
Silver (TR)	7440-22-4	1	EDQL EPA Region 5 (1998)	0.06	Ohio Administrative Code		--	0.06	Ohio Administrative Code
Sodium	7440-23-5				--		--	--	--
Strontium	7440-24-6			770	Ohio Administrative Code	1500	Tier II (Suter & Tsao 1996)	770	Ohio Administrative Code
Thallium	7440-28-0	0.6	EDQL EPA Region 5 (1998)	17	Ohio Administrative Code	12	Tier II (Suter & Tsao 1996)	0.6	EDQL EPA Region 5 (1998)
Tin	7440-31-5	73	EDQL EPA Region 5 (1998)	180	Ohio Administrative Code	73	Tier II (Suter & Tsao 1996)	73	EDQL EPA Region 5 (1998)
Uranium	7440-61-1				--	2.6	Tier II (Suter & Tsao 1996)	2.6	Tier II (Suter & Tsao 1996)
Vanadium	7440-62-2	19	EDQL EPA Region 5 (1998)	26	Ohio Administrative Code	20	Tier II (Suter & Tsao 1996)	19	EDQL EPA Region 5 (1998)

Table 5-3. Ecological Biotic Screening Values for Chemical Constituents in Surface Water at NACA Test Area (continued)

		Surface Water							
		Ecological Data Quality Levels (EDQL)[a]		Ohio EPA OMZA (Outside Mixing Zone Average)[b]		Suter and Tsao (1996)[c]		Preferred Surface Water Value[d]	
Chemicals	CAS Registry Number	Number (µg/L)	Source	Number (µg/L)	Source	Number (µg/L)	Source	Number (µg/L)	Source
Zinc (Diss)	7440-66-6	59	EDQL EPA Region 5 (1998)	120[e]	Ohio Administrative Code	110	NAWQC (Suter & Tsao 1996)	59	EDQL EPA Region 5 (1998)
Zinc (TR)	7440-66-6	59	EDQL EPA Region 5 (1998)	120[e]	Ohio Administrative Code		--	59	EDQL EPA Region 5 (1998)
Zirconium	7440-67-7				--	17	Tier II (Suter & Tsao 1996)	17	Tier II (Suter & Tsao 1996)
Volatile Organic Compounds (VOCs)									
Acenaphthene	83-32-9	10	EDQL EPA Region 5 (1998)	9.4	Ohio Administrative Code	23	NAWQC(EPA 1993b in Suter & Tsao 1996)[f]	9.4	Ohio Administrative Code
Acenaphthylene	208-96-8	4,840	EDQL EPA Region 5 (1998)		--		--	4,840	EDQL EPA Region 5 (1998)
Acetonitrile	75-05-8	30,000	EDQL EPA Region 5 (1998)	12,000	Ohio Administrative Code		--	12,000	Ohio Administrative Code
Acetone	67-64-1	78,000	EDQL EPA Region 5 (1998)		--	1,500	Tier II (Suter & Tsao 1996)	1,500	Tier II (Suter & Tsao 1996)
Acrylonitrile	107-13-1	0.9	EDQL EPA Region 5 (1998)	78	Ohio Administrative Code		--	0.9	EDQL EPA Region 5 (1998)
Anthracene	120-12-7	0.3	EDQL EPA Region 5 (1998)	0.02	Ohio Administrative Code	0.73	Tier II (Suter & Tsao 1996)	0.02	Ohio Administrative Code
Arochlor-1016	12674-11-2				--		--	--	--
Arochlor-1221	11104-28-2				--	0.28	Tier II (Suter & Tsao 1996)	0.28	Tier II (Suter & Tsao 1996)
Arochlor-1232	11141-16-5				--	0.58	Tier II (Suter & Tsao 1996)	0.58	Tier II (Suter & Tsao 1996)
Arochlor-1242	53469-21-9				--	0.053	Tier II (Suter & Tsao 1996)	0.053	Tier II (Suter & Tsao 1996)
Arochlor-1248	12672-29-6				--	0.081	Tier II (Suter & Tsao 1996)	0.081	Tier II (Suter & Tsao 1996)
Arochlor-1254	11097-69-1				--	0.033	Tier II (Suter & Tsao 1996)	0.033	Tier II (Suter & Tsao 1996)
Arochlor-1260	11096-82-5				--	94	Tier II (Suter & Tsao 1996)	94	Tier II (Suter & Tsao 1996)
Benzene	71-43-2	114	EDQL EPA Region 5 (1998)	160	Ohio Administrative Code	130	Tier II (Suter & Tsao 1996)	114	EDQL EPA Region 5 (1998)
Benzidene	92-87-5				--	3.9	Tier II (Suter & Tsao 1996)	3.9	Tier II (Suter & Tsao 1996)
Benz(a)anthracene	56-55-3	0.9	EDQL EPA Region 5 (1998)		--	0.027	Tier II (Suter & Tsao 1996)	0.027	Tier II (Suter & Tsao 1996)
Benzo(a)pyrene	50-32-8	0.1	EDQL EPA Region 5 (1998)		--	0.014	Tier II (Suter & Tsao 1996)	0.014	Tier II (Suter & Tsao 1996)
Benzo(b)fluoranthene	205-99-2	9.1	EDQL EPA Region 5 (1998)		--		--	9.1	EDQL EPA Region 5 (1998)
Benzo(g,h,i)perylene	191-24-2	7.6	EDQL EPA Region 5 (1998)		--		--	7.6	EDQL EPA Region 5 (1998)
Benzo(k)fluoranthene	207-08-9	0.0056	EDQL EPA Region 5 (1998)		--		--	0.0056	EDQL EPA Region 5 (1998)
Benzoic Acid	65-85-0				--	42	Tier II (Suter & Tsao 1996)	42	Tier II (Suter & Tsao 1996)
Benzyl Alcohol	100-51-6	281	EDQL EPA Region 5 (1998)		--	8.6	Tier II (Suter & Tsao 1996)	8.6	Tier II (Suter & Tsao 1996)
bis(2-chloroethoxy) methane	111-91-1	6,400	EDQL EPA Region 5 (1998)		--		--	6,400	EDQL EPA Region 5 (1998)
bis(2-Chloroethyl) ether	111-44-4	1,140	EDQL EPA Region 5 (1998)		--		--	1,140	EDQL EPA Region 5 (1998)
bis(2-Ethylhexyl)phthalate	117-81-7	2.1	EDQL EPA Region 5 (1998)	8.4	Ohio Administrative Code	3.0	Tier II (Suter & Tsao 1996)	2.1	EDQL EPA Region 5 (1998)
Biphenyl	92-52-4				--	14.0	OSWER 1996 (in Suter & Tsao 1996)	14	OSWER 1996 (in Suter & Tsao 1996)
Bromodichloromethane	75-27-4			340	Ohio Administrative Code		--	340	Ohio Administrative Code
Bromoform	75-25-2	466	EDQL EPA Region 5 (1998)	230	Ohio Administrative Code		--	230	Ohio Administrative Code
Bromomethane	74-83-9			16	Ohio Administrative Code		--	16	Ohio Administrative Code
4-bromophenyl-phenylether	101-55-3	1.5	EDQL EPA Region 5 (1998)		--	1.5	OSWER 1996 (in Suter & Tsao 1996)	1.5	EDQL EPA Region 5 (1998)
2-Butanone	78-93-3	7,100	EDQL EPA Region 5 (1998)	22,000	Ohio Administrative Code	14,000	Tier II (Suter & Tsao 1996)	7,100	EDQL EPA Region 5 (1998)
Butylbenzylphthalate	85-68-7	49	EDQL EPA Region 5 (1998)	23	Ohio Administrative Code	19	OSWER 1996 (in Suter & Tsao 1996)	19	OSWER 1996 (in Suter & Tsao 1996)
Carbazole	86-74-8				--		--	--	--
Carbon disulfide	75-15-0	84	EDQL EPA Region 5 (1998)		--	0.92	Tier II (Suter & Tsao 1996)	0.92	Tier II (Suter & Tsao 1996)
Carbon tetrachloride	56-23-5	5.9	EDQL EPA Region 5 (1998)	240	Ohio Administrative Code	9.8	Tier II (Suter & Tsao 1996)	5.9	EDQL EPA Region 5 (1998)
4-Chloroaniline	106-47-8	232	EDQL EPA Region 5 (1998)		--		--	232	EDQL EPA Region 5 (1998)

Table 5-3. Ecological Biotic Screening Values for Chemical Constituents in Surface Water at NACA Test Area (continued)

Chemicals	CAS Registry Number	Surface Water: Ecological Data Quality Levels (EDQL)[a] Number (μg/L)	Surface Water: Ecological Data Quality Levels (EDQL)[a] Source	Surface Water: Ohio EPA OMZA (Outside Mixing Zone Average)[b] Number (μg/L)	Surface Water: Ohio EPA OMZA (Outside Mixing Zone Average)[b] Source	Surface Water: Suter and Tsao (1996)[c] Number (μg/L)	Surface Water: Suter and Tsao (1996)[c] Source	Surface Water: Preferred Surface Water Value[d] Number (μg/L)	Surface Water: Preferred Surface Water Value[d] Source
Chlorobenzene	108-90-7	10	EDQL EPA Region 5 (1998)	47	Ohio Administrative Code	64	Tier II (Suter & Tsao 1996)	10	EDQL EPA Region 5 (1998)
Chlordane	12789-03-6				--	0.17	NAWQC(EPA 1993b in Suter & Tsao 1996)	0.17	NAWQC(EPA 1993b in Suter & Tsao 1996)
Chloroethane	75-00-3	230,000	EDQL EPA Region 5 (1998)		--		--	230,000	EDQL EPA Region 5 (1998)
Chloroform	67-66-3	79	EDQL EPA Region 5 (1998)	140	Ohio Administrative Code	28	Tier II (Suter & Tsao 1996)	28	Tier II (Suter & Tsao 1996)
Chloromethane	74-87-3				--		--	--	--
2-Chloronaphthalene	91-58-7	0.396	EDQL EPA Region 5 (1998)		--		--	0.396	EDQL EPA Region 5 (1998)
2-Chlorophenol	95-57-8	8.8	EDQL EPA Region 5 (1998)	32	Ohio Administrative Code		--	8.8	EDQL EPA Region 5 (1998)
4-Chlorophenyl-phenyl ether	7005-72-3				--		--	--	--
4-chloro-3-methylphenol	59-50-7	34.79	EDQL EPA Region 5 (1998)		--		--	34.79	EDQL EPA Region 5 (1998)
Chrysene	218-01-9	0.033	EDQL EPA Region 5 (1998)		--		--	0.033	EDQL EPA Region 5 (1998)
Decane	124-18-5				--	49	Tier II (Suter & Tsao 1996)	49	Tier II (Suter & Tsao 1996)
Diazinon	333-41-5				--	0.043	Great Lakes Water Quality Initiative (in Suter & Tsao 1996)	0.043	Great Lakes Water Quality Initiative (in Suter & Tsao 1996)
Dibenz(a,h)anthracene	53-70-3	0.0016	EDQL EPA Region 5 (1998)		--		--	0.0016	EDQL EPA Region 5 (1998)
Dibromochloromethane	124-48-1	6,400	EDQL EPA Region 5 (1998)	320	Ohio Administrative Code		--	320	Ohio Administrative Code
1,2-Dichlorobenzene	95-50-1	11	EDQL EPA Region 5 (1998)	23	Ohio Administrative Code	14	OSWER 1996 (in Suter & Tsao 1996)	11	EDQL EPA Region 5 (1998)
1,3-Dichlorobenzene	541-73-1	87	EDQL EPA Region 5 (1998)	22	Ohio Administrative Code	71	OSWER 1996 (in Suter & Tsao 1996)	22	Ohio Administrative Code
1,4-Dichlorobenzene	106-46-7	43	EDQL EPA Region 5 (1998)	9.4	Ohio Administrative Code	15	OSWER 1996 (in Suter & Tsao 1996)	9.4	Ohio Administrative Code
3,3'-Dichlorobenzidine	91-94-1	99.75	EDQL EPA Region 5 (1998)		--		--	99.75	EDQL EPA Region 5 (1998)
Dibenzofuran	132-64-9	20	EDQL EPA Region 5 (1998)		--	3.7	Tier II (Suter & Tsao 1996)	3.7	Tier II (Suter & Tsao 1996)
1,1-Dichloroethane	75-34-3	47	EDQL EPA Region 5 (1998)	410	Ohio Administrative Code	47	Tier II (Suter & Tsao 1996)	47	EDQL EPA Region 5 (1998)
1,2-Dichloroethane	107-06-2	190	EDQL EPA Region 5 (1998)	2,000	Ohio Administrative Code	910	Tier II (Suter & Tsao 1996)	190	EDQL EPA Region 5 (1998)
1,1-Dichloroethene	75-35-4	78	EDQL EPA Region 5 (1998)		--	25	Tier II (Suter & Tsao 1996)	25	Tier II (Suter & Tsao 1996)
1,2-Dichloroethene (total)	540-59-0				--	590	Tier II (Suter & Tsao 1996)	590	Tier II (Suter & Tsao 1996)
1,1-Dichloroethylene	75-35-4	78	EDQL EPA Region 5 (1998)	210	Ohio Administrative Code		--	78	EDQL EPA Region 5 (1998)
2,4-Dichlorophenol	120-83-2	18	EDQL EPA Region 5 (1998)	11	Ohio Administrative Code		--	11	Ohio Administrative Code
1,2-Dichloropropane	78-87-5	380	EDQL EPA Region 5 (1998)	520	Ohio Administrative Code		--	380	EDQL EPA Region 5 (1998)
1,3-Dichloropropene	10061-02-6	7.9	EDQL EPA Region 5 (1998)	1.7	Ohio Administrative Code	0.055	Tier II (Suter & Tsao 1996)	0.055	Tier II (Suter & Tsao 1996)
4,4'-DDD	72-54-8	0.0011	EDQL EPA Region 5 (1998)		--	0.011	Tier II (Suter & Tsao 1996)	0.0011	EDQL EPA Region 5 (1998)
4,4'-DDT	50-29-3	0.001	EDQL EPA Region 5 (1998)		--	0.013	Tier II (Suter & Tsao 1996)	0.001	EDQL EPA Region 5 (1998)
Dieldrin	60-57-1	0.000026	EDQL EPA Region 5 (1998)	0.056	Ohio Administrative Code	0.062	NAWQC(EPA 1993b in Suter & Tsao 1996)	2.6E-05	EDQL EPA Region 5 (1998)
Diethylphthalate	84-66-2	3	EDQL EPA Region 5 (1998)	220	Ohio Administrative Code	210	Tier II (Suter & Tsao 1996)	3	EDQL EPA Region 5 (1998)
Dimethylphthalate	131-11-3	73	EDQL EPA Region 5 (1998)		--		--	73	EDQL EPA Region 5 (1998)
2,4-Dimethylphenol	105-67-9	100.17	EDQL EPA Region 5 (1998)	15	Ohio Administrative Code		--	15	Ohio Administrative Code
Di-n-butylphthalate	84-74-2	3	EDQL EPA Region 5 (1998)		Ohio Administrative Code		--	3	EDQL EPA Region 5 (1998)
Di-n-octylphthalate	117-84-0	30	EDQL EPA Region 5 (1998)		--		--	30	EDQL EPA Region 5 (1998)
1,3-Dinitrobenzene	99-65-0	2.36	EDQL EPA Region 5 (1998)		--		--	2.36	EDQL EPA Region 5 (1998)
2,4-Dinitrophenol	51-28-5	4.07	EDQL EPA Region 5 (1998)		--		--	4.07	EDQL EPA Region 5 (1998)
2,4-Dinitrotoluene	121-14-2	230	EDQL EPA Region 5 (1998)	44	Ohio Administrative Code		--	44	Ohio Administrative Code
2,6-Dinitrotoluene	606-20-2	42	EDQL EPA Region 5 (1998)	81	Ohio Administrative Code		--	42	EDQL EPA Region 5 (1998)
4,6-Dinitro-2-methylphenol	534-52-1	2.3	EDQL EPA Region 5 (1998)		--		--	2.3	EDQL EPA Region 5 (1998)

Table 5-3. Ecological Biotic Screening Values for Chemical Constituents in Surface Water at NACA Test Area (continued)

		Surface Water							
		Ecological Data Quality Levels (EDQL)[a]		Ohio EPA OMZA (Outside Mixing Zone Average)[b]		Suter and Tsao (1996)[c]		Preferred Surface Water Value[d]	
Chemicals	CAS Registry Number	Number (µg/L)	Source	Number (µg/L)	Source	Number (µg/L)	Source	Number (µg/L)	Source
Endosulfan, mixed isomers					--	0.051	Tier II (Suter & Tsao 1996)	0.051	Tier II (Suter & Tsao 1996)
Endosulfan, alpha	959-98-8	0.003	EDQL EPA Region 5 (1998)		--		--	0.003	EDQL EPA Region 5 (1998)
Ethylene Glycol	107-21-1			140,000	Ohio Administrative Code		--	140,000	Ohio Administrative Code
Endosulfan, beta	33213-65-9	0.003	EDQL EPA Region 5 (1998)		--		--	0.003	EDQL EPA Region 5 (1998)
Endrin	72-20-8	0.002	EDQL EPA Region 5 (1998)	0.036	Ohio Administrative Code	0.061	NAWQC(EPA 1993b in Suter &	0.002	EDQL EPA Region 5 (1998)
Ethylbenzene	100-41-4	17.2	EDQL EPA Region 5 (1998)	61	Ohio Administrative Code	7.3	Tier II (Suter & Tsao 1996)	7.3	Tier II (Suter & Tsao 1996)
Fluoranthene	206-44-0	8.1	EDQL EPA Region 5 (1998)	0.48	Ohio Administrative Code	6.16	NAWQC(EPA 1993b in Suter & Tsao 1996)	0.48	Ohio Administrative Code
Fluorene	86-73-7	3.9	EDQL EPA Region 5 (1998)	19	Ohio Administrative Code	3.9	OSWER 1996 (in Suter & Tsao 1996)	3.9	EDQL EPA Region 5 (1998)
gamma-BHC (lindane)	58-89-9	0.01	EDQL EPA Region 5 (1998)	0.057	Ohio Administrative Code	0.08	NAWQC(EPA 1993b in Suter & Tsao 1996)	0.01	EDQL EPA Region 5 (1998)
Heptachlor	76-44-8	0.00039	EDQL EPA Region 5 (1998)		--	12	Tier II (Suter & Tsao 1996)	0.00039	EDQL EPA Region 5 (1998)
Hexachlorobenzene	118-74-1	0.00024	EDQL EPA Region 5 (1998)		--		--	0.00024	EDQL EPA Region 5 (1998)
Hexachlorobutadiene	87-68-3	0.223	EDQL EPA Region 5 (1998)		--		--	0.223	EDQL EPA Region 5 (1998)
Hexachlorocyclopentadiene	77-47-4	77.04	EDQL EPA Region 5 (1998)		--		--	77.04	EDQL EPA Region 5 (1998)
Hexachloroethane	67-72-1	30.5	EDQL EPA Region 5 (1998)		--	12	OSWER 1996 (in Suter & Tsao 1996)	12	OSWER 1996 (in Suter & Tsao 1996)
Hexane	110-54-3				--	0.58	Tier II (Suter & Tsao 1996)	0.58	Tier II (Suter & Tsao 1996)
2-Hexanone	591-78-6	1,710	EDQL EPA Region 5 (1998)		--	99	Tier II (Suter & Tsao 1996)	99	Tier II (Suter & Tsao 1996)
HMX Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine	2691-41-0				--		--	--	--
Indeno(1,2,3-cd)pyrene	193-39-5	4.31	EDQL EPA Region 5 (1998)		--		--	4.31	EDQL EPA Region 5 (1998)
Isophorone	78-59-1	900	EDQL EPA Region 5 (1998)	920	Ohio Administrative Code		--	900	EDQL EPA Region 5 (1998)
Isopropylbenzene	98-82-8			4.8	Ohio Administrative Code		--	4.8	Ohio Administrative Code
Malathion	121-75-5				--		--	--	--
Methoxychlor	72-43-5	0.005	EDQL EPA Region 5 (1998)		--	0.019	Tier II (Suter & Tsao 1996)	0.005	EDQL EPA Region 5 (1998)
Methylene chloride	75-09-2	430	EDQL EPA Region 5 (1998)	1,900	Ohio Administrative Code	2,200	Tier II (Suter & Tsao 1996)	430	EDQL EPA Region 5 (1998)
1-Methylnaphthalene	90-12-0				--	2.1	Tier II (Suter & Tsao 1996)	2.1	Tier II (Suter & Tsao 1996)
2-Methylnaphthalene	91-57-6	329.55	EDQL EPA Region 5 (1998)		--		--	329.55	EDQL EPA Region 5 (1998)
2-Methylphenol	95-48-7				Ohio Administrative Code	13	Tier II (Suter & Tsao 1996)	13	Tier II (Suter & Tsao 1996)
4-Methylphenol	106-44-5			53	Ohio Administrative Code		--	53	Ohio Administrative Code
4-Methyl-2-pentanone	108-10-1	3,680	EDQL EPA Region 5 (1998)		--		--	3,680	EDQL EPA Region 5 (1998)
Naphthalene	91-20-3	44	EDQL EPA Region 5 (1998)	21	Ohio Administrative Code	12	Tier II (Suter & Tsao 1996)	12	Tier II (Suter & Tsao 1996)
2-Nitroaniline	88-74-4				--		--	--	--
3-Nitroaniline	99-09-2				--		--	--	--
4-Nitroaniline	100-01-6				--		--	--	--
Nitrobenzene	99-95-3			330	Ohio Administrative Code		--	330	Ohio Administrative Code
Nitrocellulose	9004-70-0				--		--	--	--
Nitroglycerin	55-63-0				--		--	--	--
Nitroquanidine					--		--	--	--
2-Nitrophenol	88-75-5	13.5	EDQL EPA Region 5 (1998)	73	Ohio Administrative Code		--	13.5	EDQL EPA Region 5 (1998)
4-Nitrophenol	100-02-7	35	EDQL EPA Region 5 (1998)		--	300	Tier II (Suter & Tsao 1996)	35	EDQL EPA Region 5 (1998)
m-Nitrotoluene	99-08-1				--		--	--	--

Table 5-3. Ecological Biotic Screening Values for Chemical Constituents in Surface Water at NACA Test Area (continued)

		Surface Water							
		Ecological Data Quality Levels (EDQL)[a]		Ohio EPA OMZA (Outside Mixing Zone Average)[b]		Suter and Tsao (1996)[c]		Preferred Surface Water Value[d]	
Chemicals	CAS Registry Number	Number (μg/L)	Source	Number (μg/L)	Source	Number (μg/L)	Source	Number (μg/L)	Source
N-nitroso-di-n-dipropylamine	621-64-7				--		--	--	--
N-nitrosodiphenylamine	86-30-6	13	EDQL EPA Region 5 (1998)		--	210	Tier II (Suter & Tsao 1996)	13	EDQL EPA Region 5 (1998)
o-Nitrotoluene	88-72-2				--		--	--	--
2-Octanone	111-13-7				--	8.3	Tier II (Suter & Tsao 1996)	8.3	Tier II (Suter & Tsao 1996)
2,2'- oxybis(1-Chloropropane)	108-60-1	20	EDQL EPA Region 5 (1998)		--		--	20	EDQL EPA Region 5 (1998)
Parathion	56-38-2	0.008	EDQL EPA Region 5 (1998)	0.013	Ohio Administrative Code		--	0.008	EDQL EPA Region 5 (1998)
Pentachlorobenzene	608-93-5	0.47	EDQL EPA Region 5 (1998)		--		--	0.47	EDQL EPA Region 5 (1998)
Pentachlorophenol	87-86-5	5.23	EDQL EPA Region 5 (1998)	11[f]	Ohio Administrative Code		--	5.23	EDQL EPA Region 5 (1998)
Phenanthrene	85-01-8	2.1	EDQL EPA Region 5 (1998)		--	6.3	NAWQC (EPA 1993b in Suter & Tsao 1996)	2.1	EDQL EPA Region 5 (1998)
1-Pentanol	71-41-0				--	110	Tier II (Suter & Tsao 1996)	110	Tier II (Suter & Tsao 1996)
Phenol	108-95-2	100	EDQL EPA Region 5 (1998)		--	110	Great Lakes Water Quality Initiative (in Suter & Tsao 1996)	100	EDQL EPA Region 5 (1998)
p-Nitrotoluene	99-99-0				--		--	--	--
Polychlorinated biphenyls	1336-36-3	0.000029	EDQL EPA Region 5 (1998)		--		--	2.9E-05	EDQL EPA Region 5 (1998)
Polynuclear aromatic hydrocarbons					--		--	--	--
2-Propanol	67-63-0				--	7.5	Tier II (Suter & Tsao 1996)	7.5	Tier II (Suter & Tsao 1996)
Propylene glycol	57-55-6			78,000	Ohio Administrative Code		--	78,000	Ohio Administrative Code
Pyrene	129-00-0	0.3	EDQL EPA Region 5 (1998)	4.6	Ohio Administrative Code		--	0.3	EDQL EPA Region 5 (1998)
RDX (cyclonite) Hexahydro-1,3,5-trinitro-1,3,5-triazine	121-82-4				--		--	--	--
Styrene	100-42-5	56	EDQL EPA Region 5 (1998)	32	Ohio Administrative Code		--	32	Ohio Administrative Code
Tetryl	479-45-8				--		--	--	--
Tetrachloroethene	127-18-4	8.9	EDQL EPA Region 5 (1998)		--	98	Tier II (Suter & Tsao 1996)	8.9	EDQL EPA Region 5 (1998)
1,1,1,2-Tetrachoroethane	630-20-6	90.25	EDQL EPA Region 5 (1998)	85	Ohio Administrative Code		--	85	Ohio Administrative Code
1,1,2,2-Tetrachloroethane	79-34-5	13	EDQL EPA Region 5 (1998)	260	Ohio Administrative Code	610	Tier II (Suter & Tsao 1996)	13	EDQL EPA Region 5 (1998)
Tetrachloroethylene	127-18-4	8.9	EDQL EPA Region 5 (1998)	53	Ohio Administrative Code		--	8.9	EDQL EPA Region 5 (1998)
Tetrachloromethane	56-23-5	5.9	EDQL EPA Region 5 (1998)		--	240	OSWER 1996 (in Suter & Tsao 1996)	5.9	EDQL EPA Region 5 (1998)
Toluene	108-88-3	253	EDQL EPA Region 5 (1998)	62	Ohio Administrative Code	9.8	Tier II (Suter & Tsao 1996)	9.8	Tier II (Suter & Tsao 1996)
Toxaphene	8001-35-2	0.0002	EDQL EPA Region 5 (1998)		--		--	0.0002	EDQL EPA Region 5 (1998)
Tribromomethane	75-25-2	466	EDQL EPA Region 5 (1998)		--	320	OSWER 1996 (in Suter & Tsao 1996)	320	OSWER 1996 (in Suter & Tsao 1996)
Trichloroethene	79-01-6	75	EDQL EPA Region 5 (1998)		--	47	Tier II (Suter & Tsao 1996)	47	Tier II (Suter & Tsao 1996)
1,2,4-Trichlorobenzene	120-82-1	69.2	EDQL EPA Region 5 (1998)		--	110	OSWER 1996 (in Suter & Tsao 1996)	69.2	EDQL EPA Region 5 (1998)
1,1,1-Trichloroethane	71-55-6	88	EDQL EPA Region 5 (1998)	76	Ohio Administrative Code	11	Tier II (Suter & Tsao 1996)	11	Tier II (Suter & Tsao 1996)
1,1,2-Trichloroethane	79-00-5	650	EDQL EPA Region 5 (1998)		--	1,200	Tier II (Suter & Tsao 1996)	650	EDQL EPA Region 5 (1998)
Trichloroethylene	79-01-6	75	EDQL EPA Region 5 (1998)	220	Ohio Administrative Code		--	75	EDQL EPA Region 5 (1998)
2,4,5-Trichlorophenol	95-95-4				--		--	--	--
2,4,6-Trichlorophenol	88-06-2	2	EDQL EPA Region 5 (1998)	4.9	Ohio Administrative Code		--	2	EDQL EPA Region 5 (1998)
1,2,4-Trimethylbenzene	95-63-6			15	Ohio Administrative Code		--	15	Ohio Administrative Code
1,3,5-Trimethylbenzene	108-67-8			26	Ohio Administrative Code		--	26	Ohio Administrative Code
1,3,5-Trinitrobenzene	99-35-4				--		--	--	--
2,4,6-Trinitrotoluene	118-96-7				--		--	--	--

Table 5-3. Ecological Biotic Screening Values for Chemical Constituents in Surface Water at NACA Test Area (continued)

		Surface Water							
	CAS	Ecological Data Quality Levels (EDQL)[a]		Ohio EPA OMZA (Outside Mixing Zone Average)[b]		Suter and Tsao (1996)[c]		Preferred Surface Water Value[d]	
Chemicals	Registry Number	Number (µg/L)	Source	Number (µg/L)	Source	Number (µg/L)	Source	Number (µg/L)	Source
Urea	57-13-6			17,000	Ohio Administrative Code		--	17,000	Ohio Administrative Code
Vinyl acetate	108-05-4	248.03	EDQL EPA Region 5 (1998)		--	16	Tier II (Suter & Tsao 1996)	16	Tier II (Suter & Tsao 1996)
Vinyl chloride	75-01-4	9.2	EDQL EPA Region 5 (1998)		--		--	9.2	EDQL EPA Region 5 (1998)
o-Xylene	95-47-6			35	Ohio Administrative Code		--	35	Ohio Administrative Code
m-Xylene	108-38-3			67	Ohio Administrative Code	1.8	Tier II (Suter & Tsao 1996)	1.8	Tier II (Suter & Tsao 1996)
p-Xylene	106-42-3			18	Ohio Administrative Code		--	18	Ohio Administrative Code
Xylenes (total)	1330-20-7	117	EDQL EPA Region 5 (1998)		--	13	Tier II (Suter & Tsao 1996)	13	Tier II (Suter & Tsao 1996)

[a] EPA (1998). RCRA QAPP Instructions, USEPA Region 5, Chicago, IL, April 1998 revision. http://www.epa.gov/reg5rcra/wptdiv/cars/cars.htm

[b] Ohio EPA, Division of Surface Water (1999). Ohio Administrative Code, Chapter 3745-1-25, May 11 (Lake Erie Basin in which the Mahoning River runs).

[c] Suter and Tsao (1996). Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision, ES/ER/TM-96/R2, Lockheed Martin Energy Systems, Oak Ridge National Laboratory, Oak Ridge, TN.

[d] The Preferred Surface Water Value is the lowest among the Ecotox, the Ohio Administrative Code, and Suter and Tsao surface water values.

[e] Hardness adjusted to 100 mg/L $CaCO_3$.

[f] pH dependent, unless otherwise specified value is adjusted to 7.5 pH for all Ohio Administrative Code criteria.

-- = No value.

CVAA = Cold Vapor Atomic Absorption.

Diss. = Dissolved.

ID = Insufficient data available to calculate criterion.

TR = Total Recoverable.

- Essential human nutrients are not considered to be human health COPCs (if detected above background, essential human nutrients could potentially be ecological COPCs).

At this point of the process, the media-specific, risk-based screens are applied. The following sections describe the risk-based screening process for soil, sediment, and surface water.

5.4.2.1 Human health screening process for soil

The final step used to finalize COPCs for soil is to compare maximum detected concentrations for SRCs against the human health soil screening levels presented in Section 5.4.1.1. Surface soil [collected from 0 to 0.3 meter (0 to 1 foot) bgs] and subsurface soil [collected from 0.3 to 0.9 meter (1 to 3 feet) bgs] are screened separately. When the maximum detected concentration exceeds the residential soil screening level (which is more conservative than the industrial screening value), the chemical is retained as a human health COPC. Chemicals exceeding the migration to groundwater screening criteria are noted (on the screening tables) but not identified as definitive COPCs because of the high degree of uncertainty and conservatism inherent in this screen (see Section 5.4.1.1).

5.4.2.2 Human health and ecological screening process for sediment

Sediment SRCs are screened against the same human health screening values used to evaluate soil (see Section 5.4.1.2), with the exception of the soil-leaching screen, which is not performed for sediment. When the maximum detected concentration exceeds the residential soil screening level (which is more conservative than the industrial screening value), the chemical is retained as a human health COPC.

Sediment SRCs also are screened against the ecological screening criteria established for sediment in Section 5.4.1.2 (see Table 5-2). When the maximum detected concentration exceeds the sediment ecological screening level, the chemical is retained as an ecological COPC for sediment.

5.4.2.3 Human health and ecological screening process for surface water

Surface water SRCs are screened against the surface water human health screening values established in Section 5.4.1.3. When the maximum detected concentration exceeds the screening level, the chemical is retained as a human health COPC for surface water.

Surface water SRCs are also screened against the ecological screening criteria established for surface water in Section 5.4.1.3 (see Table 5-3). When the maximum detected concentration exceeds the surface water ecological screening level, the chemical is retained as an ecological COPC for surface water.

5.5 RISK EVALUATION RESULTS

Results of the risk-screening process are presented for each medium in Sections 5.5.1 to 5.5.4. A summary of COPCs across all media is then presented in Section 5.5.5.

5.5.1 Surface Soil Screening Results

Table 5-4 presents the results of the SRC screening and human health risk-based screening for all chemicals detected in NTA surface soil. Chemicals that were never detected in surface soil are not shown on this table. As seen, nitrocellulose, 7 metals, and 11 SVOCs are identified as surface soil COPCs.

Table 5-4. Screening to Determine Human Health COPCs at the NTA for Surface Soil

Analyte	Results > Detection Limit	Average Result[a]	Min. Detect	Max. Detect	Site Backgd. Criteria	Site Related?[b]	One-tenth Region 9 Residential Soil PRG[c]	Max Detect > Residential Soil Criteria?[c]	One-tenth Region 9 Industrial Soil PRG[d]	Max Detect > Industrial Soil Criteria?[d]	One-tenth Region 9 Migration to GW (DAF 1)[d]	Max Detect > Migration to Groundwater Criteria?[d]	COPC?[c,d]
Explosives (mg/kg)													
2,4,6-Trinitrotoluene	2/ 11	1.3E-01	1.1E-01	1.5E-01		Yes	1.6E+00	No	8.2E+00	No		None	No
2,4-Dinitrotoluene	1/ 11	1.2E-01	4.8E-02	4.8E-02		Yes	7.2E-02	No	1.8E+02	No	4.0E-06	Yes	No
Nitrocellulose	3/ 11	5.6E+00	3.5E+00	4.5E+01		Yes		None		None		None	Yes
Inorganics (mg/kg)													
Aluminum	99/ 99	1.1E+04	5.1E+03	3.4E+04	1.8E+04	Yes	7.6E+03	Yes	1.0E+04	Yes		None	Yes
Antimony	15/ 89	6.7E-01	5.3E-01	2.9E+00	9.6E-01	Yes	3.1E+00	No	8.2E+01	No	3.0E-02	Yes	No
Arsenic	99/ 99	8.4E+00	2.2E+00	2.3E+01	1.5E+01	Yes	3.9E-02	Yes	2.7E-01	Yes	1.0E-01	Yes	Yes
Barium	99/ 99	7.5E+01	1.8E+01	3.6E+02	8.8E+01	Yes	5.4E+02	No	1.0E+04	No	8.2E+00	Yes	No
Beryllium	39/ 99	3.9E-01	2.2E-01	3.8E+00	8.8E-01	Yes	1.5E+01	No	2.2E+02	No	3.0E-01	Yes	No
Cadmium	12/ 99	5.7E-01	2.8E-01	1.5E+01		Yes	3.7E+00	Yes	8.1E+01	No	4.0E-02	Yes	Yes
Calcium *	87/ 99	1.0E+04	1.3E+02	2.0E+05	1.6E+04	No		None		None		None	No
Chromium	99/ 99	1.3E+01	6.3E+00	5.4E+01	1.7E+01	Yes	3.0E+00	Yes	6.4E+00	Yes	2.0E-01	Yes	Yes
Cobalt	99/ 99	7.0E+00	1.5E+00	3.8E+01	1.0E+01	Yes	4.7E+02	No	1.0E+04	No		None	No
Copper	99/ 99	3.0E+01	2.6E+00	1.8E+03	1.8E+01	Yes	2.9E+02	Yes	7.6E+03	No		None	Yes
Cyanide	7/ 99	3.6E-01	6.8E-01	1.6E+00		Yes	1.2E+02	No	1.8E+03	No	2.0E-01	Yes	No
Iron *	99/ 99	1.9E+04	4.6E+03	3.9E+04	2.3E+04	No	2.3E+03	Yes	1.0E+04	Yes		None	No
Lead	99/ 99	1.8E+01	6.9E+00	1.5E+02	2.6E+01	Yes	4.0E+01	Yes	1.0E+02	Yes		None	Yes
Magnesium *	99/ 99	3.0E+03	7.6E+02	2.5E+04	3.0E+03	No		None		None		None	No
Manganese	99/ 99	6.9E+02	4.9E+01	6.2E+03	1.5E+03	Yes	1.8E+02	Yes	3.2E+03	Yes		None	Yes
Mercury	80/ 99	3.6E-02	9.3E-03	1.0E-01	3.6E-02	Yes	2.3E+00	No	6.1E+01	No		None	No
Nickel	99/ 99	1.3E+01	2.1E+00	4.1E+01	2.1E+01	Yes	1.6E+02	No	4.1E+03	No	7.0E-01	Yes	No
Potassium *	99/ 99	8.7E+02	2.5E+02	2.3E+03	9.3E+02	No		None		None		None	No
Selenium	65/ 99	7.3E-01	4.6E-01	2.8E+00	1.4E+00	Yes	3.9E+01	No	1.0E+03	No	3.0E-02	Yes	No
Silver	2/ 99	6.6E-01	1.3E+00	1.5E+00		No	3.9E+01	No	1.0E+03	No	2.0E-01	Yes	No
Sodium *	8/ 99	1.0E+02	2.4E+02	7.8E+02	1.2E+02	No		None		None		None	No
Thallium	81/ 99	2.9E-01	1.6E-01	5.7E-01		Yes	6.3E-01	No	1.6E+01	No	4.0E-02	Yes	No
Vanadium	99/ 99	1.8E+01	8.7E+00	3.7E+01	3.1E+01	Yes	5.5E+01	No	1.4E+03	No	3.0E+01	Yes	No
Zinc	99/ 99	6.1E+01	1.7E+01	6.0E+02	6.2E+01	Yes	2.3E+03	No	1.0E+04	No	6.2E+01	Yes	No
Semivolatile Organic Compounds (mg/kg)													
Acenaphthene	2/ 99	2.6E-01	2.9E-01	2.1E+00		No	3.7E+02	No	3.8E+03	No	2.9E+00	No	No
Acenaphthylene	5/ 99	3.2E-01	3.3E-01	7.9E+00		Yes		None		None		None	Yes
Anthracene	5/ 99	3.4E-01	1.7E-01	9.6E+00		Yes	2.2E+03	No	1.0E+04	No	5.9E+01	No	No
Benz(a)anthracene	11/ 99	7.1E-01	5.0E-02	3.6E+01		Yes	6.2E-02	Yes	2.9E-01	Yes	8.0E-03	Yes	Yes
Benzo(a)pyrene	13/ 99	7.9E-01	5.2E-02	4.1E+01		Yes	6.2E-03	Yes	2.9E-02	Yes	4.0E-02	Yes	Yes
Benzo(b)fluoranthene	17/ 99	9.9E-01	5.0E-02	5.4E+01		Yes	6.2E-02	Yes	2.9E-01	Yes	2.0E-02	Yes	Yes
Benzo(g,h,i)perylene	12/ 99	5.6E-01	6.6E-02	2.4E+01		Yes		None		None		None	Yes
Benzo(k)fluoranthene	11/ 99	4.8E-01	5.0E-02	1.9E+01		Yes	6.2E-01	Yes	2.9E+00	Yes	2.0E-01	Yes	Yes
Bis(2-ethylhexyl)phthalate	18/ 99	3.7E-01	4.3E-02	6.6E+00		Yes	3.5E+00	Yes	1.8E+01	No		None	Yes
Carbazole	3/ 99	2.8E-01	2.1E-01	4.9E+00		No	2.4E+00	Yes	1.2E+01	No	3.0E-03	Yes	No
Chrysene	16/ 99	8.6E-01	4.4E-02	4.6E+01		Yes	6.2E+00	Yes	2.9E+01	Yes	8.0E-01	Yes	Yes

Table 5-4. Screening to Determine Human Health COPCs at the NTA for Surface Soil (continued)

Analyte	Results > Detection Limit	Average Result[a]	Min. Detect	Max. Detect	Site Backgd. Criteria	Site Related?[b]	One-tenth Region 9 Residential Soil PRG[c]	Max Detect > Residential Soil Criteria?[c]	One-tenth Region 9 Industrial Soil PRG[d]	Max Detect > Industrial Soil Criteria?[d]	One-tenth Region 9 Migration to GW (DAF 1)[d]	Max Detect > Migration to Groundwater Criteria?[d]	COPC?[c,d]
Di-n-butyl phthalate	2/ 99	3.2E-01	4.0E-02	7.5E-02		No	6.1E+02	No	8.8E+03	No	2.7E+01	No	No
Dibenz(a,h)anthracene	7/ 99	2.8E-01	7.5E-02	5.7E+00		Yes	6.2E-03	Yes	2.9E-02	Yes	8.0E-03	Yes	Yes
Dibenzofuran	2/ 99	2.5E-01	2.8E-01	1.9E+00		No	2.9E+01	No	5.1E+02	No		None	No
Fluoranthene	16/ 99	1.5E+00	4.2E-02	9.8E+01		Yes	2.3E+02	No	3.0E+03	No	2.1E+01	Yes	No
Fluorene	3/ 99	3.2E-01	2.1E-01	7.9E+00		No	2.6E+02	No	3.3E+03	No	2.8E+00	Yes	No
Indeno(1,2,3-cd)pyrene	11/ 99	5.6E-01	6.5E-02	2.4E+01		Yes	6.2E-02	Yes	2.9E-01	Yes	7.0E-02	Yes	Yes
Naphthalene	2/ 99	2.7E-01	1.8E-01	2.8E+00		No	5.6E+00	No	1.9E+01	No	4.0E-01	Yes	No
Phenanthrene	11/ 99	1.2E+00	5.6E-02	8.3E+01		Yes		None		None		None	Yes
Phenol	2/ 99	3.3E-01	1.1E-01	2.7E-01		No	3.7E+03	No	1.0E+04	No	5.0E-01	No	No
Pyrene	17/ 99	1.5E+00	3.9E-02	9.3E+01		Yes	2.3E+02	No	5.4E+03	No	2.1E+01	Yes	No
Volatile Organic Compounds (mg/kg)													
Acetone	4/ 99	6.3E-03	4.9E-03	9.1E-03		No	1.6E+02	No	6.2E+02	No	8.0E-02	No	No
Dimethylbenzene	9/ 99	3.0E-03	1.2E-03	2.3E-03		Yes	2.1E+01	No	2.1E+01	No	1.0E+00	No	No
Methylene chloride	9/ 99	3.1E-03	7.0E-04	4.6E-03		Yes	8.9E-01	No	2.1E+00	No	1.0E-04	Yes	No
Styrene	4/ 99	3.0E-03	8.8E-04	1.5E-03		No	1.7E+02	No	1.7E+02	No	2.0E-02	No	No
Toluene	6/ 99	3.0E-03	7.8E-04	4.2E-03		Yes	5.2E+01	No	5.2E+01	No	6.0E-02	No	No

[a] Values less than the detection limit were set to one-half of the reporting limit in calculation of the average.

[b] Site-related status is based on the frequency of detection and background screens; see Section 5.1.

[c] COPC status is based on screening against the residential soil screening criteria. If a chemical is site-related and is detected above its residential screening value, then it is a COPC. If a chemical is site-related and no residential screening value is available, then the chemical is retained as a COPC.

[d] Comparisons are made against industrial soil screening criteria and against the migration to groundwater screening criteria for information purposes only. These screens are not used to determine COPC status.

*Essential element (not considered a human health site-related contaminant).

COPC = Chemical of potential concern.

- Nitrocellulose, detected 3 times among 11 surface soil samples, is a COPC in absence of screening criterion. Its maximum detected concentration occurred at station NTA-062 (45.4 mg/kg).

- The seven metals, with their maximum detected concentrations noted in parentheses, identified as surface soil human health COPCs, are as follows:

  - Aluminum (33,900 mg/kg at station NTA-092), arsenic (23 mg/kg at station NTA-067), chromium (54.2 mg/kg at station NTA-070), lead (149 mg/kg at station NTA-070), and manganese (6,240 mg/kg at station NTA-084) were all detected at levels above both their respective residential and industrial screening values. Arsenic, chromium, and manganese were detected at levels more than one order of magnitude above their respective residential screening value, while aluminum and lead were detected within one order of magnitude of their residential screening values.

  - Cadmium (14.5 mg/kg at station NTA-070) and copper (1,760 mg/kg at station NTA-070) were both detected above their residential screening levels but below their industrial screening levels. Both of these metals were detected within one order of magnitude of their residential screening values.

- The 11 SVOCs, with their maximum detected concentrations noted below in parentheses, identified as surface soil human health COPCs are clustered at sample station NTA-088 located at the west end of the runway. This class of COPCs includes the following:

  - Benz(a)anthracene (36 mg/kg), benzo(a)pyrene (41 mg/kg), benzo(b)fluoranthene (54 mg/kg), benzo(k)fluoranthene (19 mg/kg), chrysene (46 mg/kg), dibenz(a,h)anthracene (5.7 mg/kg), and indeno(1,2,3-cd)pyrene (24 mg/kg) were all detected at levels above both their respective residential and industrial screening values at station NTA-088. Chrysene was detected within one order of magnitude of its residential screening value, while the other six SVOCs were detected at more than one order of magnitude above their respective residential screening values. Benzo(a)pyrene was detected within more than three orders of magnitude above its residential screening value.

  - Bis(2-ethylhexyl)phthalate (6.6 mg/kg at NTA-007) was detected above its residential screening value (3.5 mg/kg) but below its industrial screening value (18 mg/kg).

  - Maximum values for acenaphthylene (7.9 mg/kg), benzo(g,h,i)perylene (24 mg/kg), and phenanthrene (83 mg/kg) were all detected at station NTA-088. These SVOCs are all retained as surface soil COPCs in absence of available screening criteria for comparison.

It is not surprising to find PAHs, a subclass of SVOCs, in an area where burning activities have taken place; however, the levels detected in the surface soil at NTA are within the range of those that are often considered anthropogenic (e.g., man-made) in association with asphaltic road materials and/or ambient combustion sources, such as motor vehicle traffic (ATSDR 1995).

Summary results of the surface soil data screening against the migration to groundwater screening criteria (DAF=1) are as follows:

- The explosive 2,4-DNT exceeds its criterion.

- Three metals (arsenic, cadmium, and chromium) identified as COPCs exceed their respective criteria. Three additional metals identified as COPCs (aluminum, lead, and manganese) do not have criteria available for comparison.

- Seven SVOCs identified as COPCs exceed their respective leaching criteria: benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.

5.5.2 Subsurface Soil Screening Results

Table 5-5 presents the results of the SRC screening and human health risk-based screening for all chemicals detected in the NTA subsurface soil. Chemicals that were never detected in subsurface soil are not shown on this table. As seen, three metals and five SVOCs are identified as subsurface soil COPCs.

- The three metals, with their maximum detected concentrations noted in parentheses, identified as subsurface soil human health COPCs are as follows:

  – Lead (151 mg/kg at station NTA-073) was detected above both its residential and industrial screening values (40 mg/kg and 100 mg/kg, respectively).

  – Cadmium (30 mg/kg at station NTA-073) and copper (400 mg/kg at station NTA-073) were both detected above their residential screening levels, but below their industrial screening levels. Both are detected within an order of magnitude of their residential screening values (3.7 mg/kg and 290 mg/kg, respectively).

- The five SVOCs, with their maximum detected concentrations noted in parentheses below, identified as subsurface soil human health COPCs are clustered at a single location (sample station NTA-083, located at the west end of the runway). All of the SVOCs identified as subsurface soil COPCs were detected only once among the 21 subsurface soil samples.

  – Benz(a)anthracene (0.46 mg/kg), benzo(a)pyrene (0.7 mg/kg), benzo(b)fluoranthene (1.0 mg/kg), and indeno(1,2,3-cd)pyrene (0.52 mg/kg) were all detected at levels above both their respective residential and industrial screening values. Benz(a)anthracene and indeno(1,2,3-cd)pyrene were detected within one order of magnitude of their respective residential screening values, while benzo(a)pyrene and benzo(b)fluoranthene were detected at more than one order of magnitude above both their respective residential screening values.

  – No screening value is available for benzo(g,h,i)perylene (0.65 mg/kg). Thus, this SVOC is retained as a subsurface soil COPC.

As noted for surface soil, SVOCs are commonly found in areas where burning activities have taken place. However, the levels detected in subsurface soil at NTA are often considered anthropogenic (e.g., man-made) in association with asphalt roadways or ambient combustion sources.

Summary results of the subsurface soil data screening against the migration to groundwater screening criteria (DAF=1) are as follows:

- Of the three metals identified as subsurface soil COPCs, cadmium exceeded its criterion. Copper was below its screening criterion. Lead does not have a criterion available for comparison.

Table 5-5. Screening to Determine Human Health COPCs at NACA Test Area for Subsurface Soil

Analyte	Results > Detection Limit	Average Result[a]	Min. Detect	Max. Detect	Site Backgd. Criteria	Site Related?[b]	One-tenth Region 9 Residential Soil PRG[c]	Max Detect > Residential Soil Criteria?[c]	One-tenth Region 9 Industrial Soil PRG[d]	Max Detect > Industrial Soil Criteria?[d]	One-tenth Region 9 Migration to GW (DAF 1)[d]	Max Detect > Migration to Groundwater Criteria?[d]	COPC?[c,d]
Inorganics (mg/kg)													
Aluminum	21/ 21	1.1E+04	5.3E+03	1.9E+04	2.0E+04	No	7.6E+03	Yes	1.0E+04	Yes		None	No
Arsenic	21/ 21	1.1E+01	3.8E+00	1.8E+01	2.0E+01	No	3.9E-02	Yes	2.7E-01	Yes	1.0E-01	Yes	No
Barium	21/ 21	6.3E+01	1.6E+01	2.0E+02	1.2E+02	Yes	5.4E+02	No	1.0E+04	No	8.2E+00	Yes	No
Beryllium	11/ 21	3.1E-01	2.4E-01	8.3E-01	8.8E-01	No	1.5E+01	No	2.2E+02	No	3.0E-01	Yes	No
Cadmium	3/ 21	1.7E+00	4.4E-01	3.0E+01		Yes	3.7E+00	Yes	8.1E+01	No	4.0E-02	Yes	Yes
Calcium *	16/ 21	9.5E+02	1.2E+02	6.2E+03	3.6E+04	No		None		None		None	No
Chromium	21/ 21	1.4E+01	6.7E+00	2.4E+01	2.7E+01	No	3.0E+00	Yes	6.4E+00	Yes	2.0E-01	Yes	No
Cobalt	21/ 21	9.0E+00	3.1E+00	1.9E+01	2.3E+01	No	4.7E+02	No	1.0E+04	No		None	No
Copper	21/ 21	3.6E+01	6.9E+00	4.0E+02	3.2E+01	Yes	2.9E+02	Yes	7.6E+03	No		None	Yes
Iron *	21/ 21	2.2E+04	9.6E+03	3.3E+04	3.5E+04	No	2.3E+03	Yes	1.0E+04	Yes		None	No
Lead	21/ 21	2.0E+01	6.6E+00	1.5E+02	1.9E+01	Yes	4.0E+01	Yes	1.0E+02	Yes		None	Yes
Magnesium *	21/ 21	2.2E+03	1.1E+03	5.0E+03	8.8E+03	No		None		None		None	No
Manganese	21/ 21	5.2E+02	5.1E+01	1.8E+03	3.0E+03	No	1.8E+02	Yes	3.2E+03	No		None	No
Mercury	21/ 21	3.0E-02	1.8E-02	5.0E-02	4.4E-02	Yes	2.3E+00	No	6.1E+01	No		None	No
Nickel	21/ 21	1.7E+01	9.0E+00	3.5E+01	6.1E+01	No	1.6E+02	No	4.1E+03	No	7.0E-01	Yes	No
Potassium *	21/ 21	9.5E+02	3.6E+02	2.4E+03	3.4E+03	No		None		None		None	No
Selenium	6/ 21	4.1E-01	4.9E-01	1.1E+00	1.5E+00	No	3.9E+01	No	1.0E+03	No	3.0E-02	Yes	No
Thallium	17/ 21	2.8E-01	1.7E-01	4.0E-01	9.1E-01	No	6.3E-01	No	1.6E+01	No	4.0E-02	Yes	No
Vanadium	21/ 21	1.9E+01	9.3E+00	2.8E+01	3.8E+01	No	5.5E+01	No	1.4E+03	No	3.0E+01	No	No
Zinc	21/ 21	5.6E+01	2.5E+01	1.3E+02	9.3E+01	Yes	2.3E+03	No	1.0E+04	No	6.2E+01	Yes	No
Semivolatile Organic Compounds (mg/kg)													
Acenaphthylene	1/ 21	1.9E-01	2.3E-01	2.3E-01		No		None		None		None	No
Anthracene	1/ 21	1.9E-01	9.0E-02	9.0E-02		No	2.2E+03	No	1.0E+04	No	5.9E+01	No	No
Benz(a)anthracene	1/ 21	2.0E-01	4.6E-01	4.6E-01		Yes	6.2E-02	Yes	2.9E-01	Yes	8.0E-03	Yes	Yes
Benzo(a)pyrene	1/ 21	2.1E-01	7.0E-01	7.0E-01		Yes	6.2E-03	Yes	2.9E-02	Yes	4.0E-02	Yes	Yes
Benzo(b)fluoranthene	1/ 21	2.3E-01	1.0E+00	1.0E+00		Yes	6.2E-02	Yes	2.9E-01	Yes	2.0E-02	Yes	Yes
Benzo(g,h,i)perylene	1/ 21	2.1E-01	6.5E-01	6.5E-01		Yes		None		None		None	Yes
Benzo(k)fluoranthene	1/ 21	1.9E-01	2.3E-01	2.3E-01		No	6.2E-01	No	2.9E+00	No	2.0E-01	Yes	No
Bis(2-ethylhexyl)phthalate	8/ 21	1.7E-01	5.1E-02	4.3E-01		Yes	3.5E+00	No	1.8E+01	No		None	No
Chrysene	1/ 21	2.1E-01	6.2E-01	6.2E-01		Yes	6.2E+00	No	2.9E+01	No	8.0E-01	No	No
Dibenz(a,h)anthracene	1/ 21	1.9E-01	1.1E-01	1.1E-01		No	6.2E-03	Yes	2.9E-02	Yes	8.0E-03	Yes	No
Fluoranthene	1/ 21	2.3E-01	1.0E+00	1.0E+00		Yes	2.3E+02	No	3.0E+03	No	2.1E+01	No	No
Indeno(1,2,3-cd)pyrene	1/ 21	2.1E-01	5.2E-01	5.2E-01		Yes	6.2E-02	Yes	2.9E-01	Yes	7.0E-02	Yes	Yes

Table 5-5. Screening to Determine Human Health COPCs at NACA Test Area for Subsurface Soil (continued)

Analyte	Results > Detection Limit	Average Result[a]	Min. Detect	Max. Detect	Site Backgd. Criteria	Site Related?[b]	One-tenth Region 9 Residential Soil PRG[c]	Max Detect > Residential Soil Criteria?[c]	One-tenth Region 9 Industrial Soil PRG[d]	Max Detect > Industrial Soil Criteria?[d]	One-tenth Region 9 Migration to GW (DAF 1)[d]	Max Detect > Migration to Groundwater Criteria?[d]	COPC?[c,d]
Phenanthrene	1/ 21	2.0E-01	3.3E-01	3.3E-01		No		None		None		None	No
Pyrene	1/ 21	2.3E-01	1.0E+00	1.0E+00		Yes	2.3E+02	No	5.4E+03	No	2.1E+01	No	No
Volatile Organic Compounds (mg/kg)													
Dimethylbenzene	1/ 21	2.8E-03	2.0E-03	2.0E-03		No	2.1E+01	No	2.1E+01	No	1.0E+00	No	No
Methylene chloride	2/ 21	2.7E-03	1.2E-03	1.6E-03		Yes	8.9E-01	No	2.1E+00	No	1.0E-04	Yes	No
Styrene	6/ 21	2.4E-03	8.2E-04	2.7E-03		Yes	1.7E+02	No	1.7E+02	No	2.0E-02	No	No
Toluene	3/ 21	2.8E-03	6.3E-04	5.3E-03		Yes	5.2E+01	No	5.2E+01	No	6.0E-02	No	No

[a] Values less than the detection limit were set to one-half the reporting limit in calculation of the average.

[b] Site-related status is based on the frequency of detection and background screens; see Section 5.1.

[c] COPC status is based on screening against the residential soil screening criteria. If a chemical is site-related and is detected above its residential screening value, then it is a COPC. If a chemical is site-related and no residential screening value is available, then the chemical is retained as a COPC.

[d] Comparisons are made against industrial soil screening criteria and against the migration to groundwater screening criteria for information purposes only. These screens are not used to determine COPC status.

*Essential element (not considered a human health site-related contaminant).

COPC = Chemical of potential concern.

Four of the five SVOCs identified as subsurface soil COPCs exceed their respective leaching criteria: benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene.

5.5.3 Sediment Screening Results

Since both human health and ecological screens are performed for sediment, these two types of COPCs are discussed separately.

5.5.3.1 Human health screening results for sediment

Table 5-6 presents the results of the SRC screening and human health risk-based screening for all chemicals detected in NTA sediment. Chemicals that were never detected in sediment are not shown on this table. Nitrocellulose and four metals are identified as COPCs in sediment.

- Nitrocellulose, detected twice among six sediment samples, is the one explosive COPC. Its largest concentration is 11 mg/kg (from station NTA-101 in the former water supply well, concrete-lined pit); this explosive does not currently have sediment screening criteria and is therefore retained as a human health COPC for the sediment medium.

- The four metals, with their maximum detected concentrations noted in parentheses, identified as sediment human health COPCs are shown below. The maximum detected concentrations for three of the four COPCs occurred at station NTA-101.

    - Chromium (24.6 mg/kg at station NTA-101), lead (13,200 mg/kg at station NTA-101), and manganese (9,440 mg/kg at upgradient station NTA-104) were all detected above both their respective residential and industrial screening values. Chromium was detected within one order of magnitude of its residential screening value, while lead and manganese were detected more than one order of magnitude above their respective residential screening values.

    - Cadmium (5 mg/kg at station NTA-101) was detected just above its residential screening value (3.7 mg/kg) but below its industrial screening value (81 mg/kg).

5.5.3.2 Ecological screening results for sediment

Table 5-7 presents the results of the ecological risk-based screening for all chemicals determined to be SRCs in NTA sediment. Nitrocellulose and 13 metals are identified as sediment ecological COPCs.

- Nitrocellulose (11 mg/kg) is retained as a sediment ecological COPC in absence of an available screening value for comparison.

- The 13 metals, with maximum detected concentrations in parentheses, identified as sediment ecological COPCs include

    - Cadmium (5 mg/kg), copper (155 mg/kg), cyanide (0.74 mg/kg), iron (58,700 mg/kg), lead (13,200 mg/kg), manganese (9,440 mg/kg), nickel (34.9 mg/kg), and zinc (631 mg/kg) were all detected at levels above their ecological sediment screening values. Cadmium, copper, nickel, and zinc were all detected within one order of magnitude above their respective screening values, while cyanide, iron, lead, and manganese are all detected at levels more than an order of magnitude above their respective ecological screening values.

Table 5-6. Screening to Determine Human Health COPCs at the NTA for Sediment

Analyte	Results > Detection Limit	Average Result[a]	Min. Detect	Max. Detect	Site Backgd. Criteria	Site Related?[b]	One-tenth Region 9 Residential Soil PRG[c]	Max Detect > Residential Soil Criteria?[c]	One-tenth Region 9 Industrial Soil PRG[d]	Max Detect > Industrial Soil Criteria?[d]	COPC?[c,d]
Explosives and Propellants (mg/kg)											
Nitrocellulose	2/ 6	3.8E+00	4.8E+00	1.1E+01		Yes		None		None	Yes
Inorganics (mg/kg)											
Aluminum	6/ 6	8.8E+03	6.3E+03	1.2E+04	1.4E+04	No	7.6E+03	Yes	1.0E+04	Yes	No
Arsenic	6/ 6	9.3E+00	4.4E+00	1.9E+01	2.0E+01	No	3.9E-02	Yes	2.7E-01	Yes	No
Barium	6/ 6	1.8E+02	4.8E+01	4.4E+02	1.2E+02	Yes	5.4E+02	No	1.0E+04	No	No
Beryllium	3/ 6	4.2E-01	2.6E-01	9.0E-01	3.8E-01	Yes	1.5E+01	No	2.2E+02	No	No
Cadmium	2/ 6	1.3E+00	1.1E+00	5.0E+00		Yes	3.7E+00	Yes	8.1E+01	No	Yes
Calcium *	6/ 6	5.6E+03	1.1E+03	2.0E+04	5.5E+03	No		None		None	No
Chromium	6/ 6	1.4E+01	8.8E+00	2.5E+01	1.8E+01	Yes	3.0E+00	Yes	6.4E+00	Yes	Yes
Cobalt	6/ 6	1.2E+01	5.4E+00	3.0E+01	9.1E+00	Yes	4.7E+02	No	1.0E+04	No	No
Copper	6/ 6	3.8E+01	7.9E+00	1.6E+02	2.8E+01	Yes	2.9E+02	No	7.6E+03	No	No
Cyanide	1/ 6	4.8E-01	7.4E-01	7.4E-01		Yes	1.2E+02	No	1.8E+03	No	No
Iron *	6/ 6	2.9E+04	1.3E+04	5.9E+04	2.8E+04	No	2.3E+03	Yes	1.0E+04	Yes	No
Lead	6/ 6	2.2E+03	9.6E+00	1.3E+04	2.7E+01	Yes	4.0E+01	Yes	1.0E+02	Yes	Yes
Magnesium *	6/ 6	2.2E+03	1.7E+03	3.0E+03	2.8E+03	No		None		None	No
Manganese	6/ 6	2.0E+03	1.6E+02	9.4E+03	2.0E+03	Yes	1.8E+02	Yes	3.2E+03	Yes	Yes
Mercury	1/ 4	2.3E-02	3.6E-02	3.6E-02	5.9E-02	No	2.3E+00	No	6.1E+01	No	No
Nickel	6/ 6	2.0E+01	1.2E+01	3.5E+01	1.8E+01	Yes	1.6E+02	No	4.1E+03	No	No
Potassium *	6/ 6	1.2E+03	4.5E+02	1.9E+03	2.0E+03	No		None		None	No
Selenium	3/ 6	1.0E+00	1.0E+00	2.9E+00	1.7E+00	Yes	3.9E+01	No	1.0E+03	No	No
Silver	1/ 6	9.1E-01	5.0E-01	5.0E-01		Yes	3.9E+01	No	1.0E+03	No	No
Thallium	6/ 6	3.6E-01	2.7E-01	4.4E-01	8.9E-01	No	6.3E-01	No	1.6E+01	No	No
Vanadium	6/ 6	1.6E+01	1.1E+01	2.0E+01	2.6E+01	No	5.5E+01	No	1.4E+03	No	No
Zinc	6/ 6	1.7E+02	4.4E+01	6.3E+02	5.3E+02	Yes	2.3E+03	No	1.0E+04	No	No
Volatile Organic Compounds (mg/kg)											
2-Butanone	1/ 6	9.4E-03	1.6E-02	1.6E-02		Yes	7.3E+02	No	2.8E+03	No	No
Acetone	3/ 6	2.1E-02	1.3E-02	6.1E-02		Yes	1.6E+02	No	6.2E+02	No	No
Dimethylbenzene	1/ 6	4.0E-03	3.0E-03	3.0E-03		Yes	2.1E+01	No	2.1E+01	No	No
Methylene chloride	1/ 6	4.6E-03	7.9E-03	7.9E-03		Yes	8.9E-01	No	2.1E+00	No	No

[a] Values less than the detection limit were set to one-half the reporting limit in calculation of the average.
[b] Site-related status is based on the frequency of detection and background screens; see Section 5.1.
[c] COPC status is based on screening against the residential soil screening criteria. If a chemical is site-related and is detected above its residential screening value, then it is a COPC. If a chemical is site-related and no residential screening value is available, then the chemical is retained as a COPC.
[d] Comparisons are made against industrial soil screening criteria for information purposes only. This screen is not used to determine COPC status.
*Essential element (not considered a human health site-related contaminant).
COPC = Chemical of potential concern.

Table 5-7. Ecological Screening Table for Sediment at NACA Test Area

Analytes Remaining after Background and Site-Related Screen	Sediment Site Maximum (mg/kg)	Screening Value (mg/kg)	Reference	Is Maximum Above or Below the Screening Value?	Ecological COPC?
Inorganics					
Barium	4.36E+02	None	None	No screening value	Yes
Beryllium	9.00E-01	None	None	No screening value	Yes
Cadmium	5.00E+00	5.96E-01	EDQL EPA Region 5 (1998)	Above	Yes
Calcium	2.04E+04	None	None	No screening value	Yes
Chromium	2.46E+01	2.60E+01	EDQL EPA Region 5 (1998)	Below	No
Cobalt	2.99E+01	5.00E+01	EDQL EPA Region 5 (1998)	Below	No
Copper	1.55E+02	1.60E+01	EDQL EPA Region 5 (1998)	Above	Yes
Cyanide	7.40E-01	1.00E-04	EDQL EPA Region 5 (1998)	Above	Yes
Iron	5.87E+04	2.00E+01	Ontario MOE low	Above	Yes
Lead	1.32E+04	3.10E+01	EDQL EPA Region 5 (1998)	Above	Yes
Magnesium	2.96E+03	None	None	No screening value	Yes
Manganese	9.44E+03	4.60E+02	Ontario MOE low	Above	Yes
Nickel	3.49E+01	1.60E+01	EDQL EPA Region 5 (1998)	Above	Yes
Selenium	2.90E+00	None	None	No screening value	Yes
Silver	5.00E-01	5.00E-01	EDQL EPA Region 5 (1998)	Below	No
Zinc	6.31E+02	1.20E+02	EDQL EPA Region 5 (1998)	Above	Yes
Volatile Organic Compounds					
2-Butanone	1.60E-02	1.37E-01	EDQL EPA Region 5 (1998)	Below	No
Acetone	6.10E-02	4.53E-01	EDQL EPA Region 5 (1998)	Below	No
Dimethylbenzene	3.00E-03	1.88E+00	EDQL EPA Region 5 (1998)	Below	No
Methylene chloride	7.90E-03	1.26E+00	EDQL EPA Region 5 (1998)	Below	No
Explosives and Propellants					
Nitrocellulose	1.10E+01	None	None	No screening value	Yes

Yes = Maximum concentration > screening value.
No = Maximum concentration < screening value.
COPC = Chemical of potential concern.

  - Barium (436 mg/kg), beryllium (0.9 mg/kg), calcium (20,400 mg/kg), magnesium (2,960 mg/kg), and selenium (2.9 mg/kg) are retained as sediment ecological COPCs because there are no ecological screening values are available for comparison.

5.5.4 Surface Water Screening Results

Since both human health and ecological screens are performed for surface water, these two types of COPCs are discussed separately.

5.5.4.1 Human health screening results for surface water

Table 5-8 presents the results of the SRC screening and human health risk-based screening for all chemicals in NTA surface water. Chemicals that were never detected in surface water are not shown on this table. As seen, 2,4-DNT, five metals, and bis(2-ethylhexyl)phthalate are identified as human health surface water COPCs.

- 2,4-DNT was detected once, at 0.051 µg/L (station NTA-104, ambient station north of NTA), which is within an order of magnitude of its tap water screening value of 0.0099 µg/L.

- The five metals, with their maximum detected concentrations noted in parenthesis, identified as surface water human health COPCs are as follows:

  - Antimony (1.9 µg/L at station NTA-106), cadmium (3.2 µg/L at upgradient station NTA-105), manganese (12,800 µg/L at upgradient station NTA-105), and zinc (1,100 µg/L at upgradient station NTA-105) are all detected above their respective tap water screening values. Antimony, cadmium, and zinc are all detected just above their respective tap water screening values (1.46, 1.82, and 1,095 µg/L, respectively), while manganese is detected at more than two orders of magnitude above its tap water screening value of 87.6 µg/L.

  - Lead (4.3 µg/L at upgradient station NTA-105) is retained as a human health surface water COPC since there is no tap water screening value available for this metal.

- Bis(2-ethylhexyl)phthalate was detected once among the five surface water samples (3.2 µg/L at station NTA-103), which is within an order of magnitude of its tap water screening value of 0.48 µg/L.

5.5.4.2 Ecological screening results for surface water

Table 5-9 presents the results of the ecological risk-based screening for all chemicals determined to be SRCs in NTA surface water. As seen, 11 metals and bis(2-ethylhexyl)phthalate are identified as surface water ecological COPCs.

- The 11 metals, with their maximum detected concentrations noted in parenthesis, identified as surface water ecological COPCs are as follows:

  - Barium (110 µg/L), cobalt (62 µg/L), manganese (12,800 µg/L), and zinc (1,100 µg/L), which were all detected at levels more than one order of magnitude above their respective ecological surface water screening values.

Table 5-8. Screening to Determine Human Health COPCs at NACA Test Area for Surface Water

Analyte	Results > Detection Limit	Average Result	Minimum Detect	Maximum Detect	Site Background Criteria	Site Related?[a]	One-tenth Region 9 Tap Water PRG[b]	Max. Detect > Tap Water Criteria?[b]	COPC?[b]
Explosives and Propellants (µg/L)									
2,4-Dinitrotoluene	1/ 5	6.2E-02	5.1E-02	5.1E-02		Yes	9.9E-03	Yes	Yes
Inorganics (µg/L)									
Aluminum	5/ 5	6.7E+02	1.9E+02	1.4E+03	3.4E+03	No	3.6E+03	No	No
Antimony	1/ 5	2.4E+00	1.9E+00	1.9E+00		Yes	1.5E+00	Yes	Yes
Barium	5/ 5	5.7E+01	1.7E+01	1.1E+02	4.8E+01	Yes	2.6E+02	No	No
Cadmium	1/ 5	2.6E+00	3.2E+00	3.2E+00		Yes	1.8E+00	Yes	Yes
Calcium *	5/ 5	6.2E+04	2.4E+04	1.7E+05	4.1E+04	No		None	No
Cobalt	1/ 5	3.2E+01	6.2E+01	6.2E+01		Yes	2.2E+02	No	No
Iron *	5/ 5	1.3E+03	4.2E+02	3.4E+03	2.6E+03	No	1.1E+03	Yes	No
Lead	2/ 5	2.2E+00	2.4E+00	4.3E+00		Yes		None	Yes
Magnesium *	5/ 5	1.2E+04	4.8E+03	3.1E+04	1.1E+04	No		None	No
Manganese	5/ 5	2.8E+03	8.0E+01	1.3E+04	3.9E+02	Yes	8.8E+01	Yes	Yes
Nickel	1/ 5	2.7E+01	5.4E+01	5.4E+01		Yes	7.3E+01	No	No
Potassium *	5/ 5	3.3E+03	1.2E+03	4.7E+03	3.2E+03	No		None	No
Sodium *	5/ 5	6.3E+03	1.2E+03	1.7E+04	2.1E+04	No		None	No
Zinc	4/ 5	2.6E+02	1.9E+01	1.1E+03	4.2E+01	Yes	1.1E+03	Yes	Yes
Semivolatile Organic Compounds (mg/kg)									
Bis(2-ethylhexyl)phthalate	1/ 5	4.6E+00	3.2E+00	3.2E+00		Yes	4.8E-01	Yes	Yes
Volatile Organic Compounds (mg/kg)									
Acetone	2/ 5	5.0E+00	4.2E+00	5.6E+00		Yes	6.1E+01	No	No

[a] Site-related status is based on the frequency of detection and background screens; see Section 5.1.

[b] COPC status is based on screening against the tap water screening criteria. If a chemical is site-related and is detected above its tap water screening value, then it is a COPC. If a chemical is site-related and no tap water screening value is available, then the chemical is retained as a COPC.

*Essential element (not considered a human health site-related contaminant).

COPC = Chemical of potential concern.

Table 5-9. Ecological Screening Table for Surface Water at the NACA Test Area

Analytes Remaining after Background and Site-Related Screen	Surface Water Site Maximum (mg/L)	Screening Value (mg/L)	Reference	Is Maximum Above or Below the Screening Value?	Ecological COPC?
Inorganics					
Antimony	1.90E+00	3.00E+01	Draft FCV values (EPA 1988b in Suter & Tsao 1996)	Below	No
Barium	1.10E+02	4.00E+00	Tier II (Suter & Tsao 1996)	Above	Yes
Cadmium	3.20E+00	7.00E-01	EDQL EPA Region 5 (1998)	Above	Yes
Calcium	1.70E+05	None	None	No screening value	Yes
Cobalt	6.20E+01	5.00E+00	EDQL EPA Region 5 (1998)	Above	Yes
Iron	3.40E+03	1.00E+03	NAWQC (Suter & Tsao 1996)	Above	Yes
Lead	4.30E+00	1.30E+00	EDQL EPA Region 5 (1998)	Above	Yes
Magnesium	3.14E+04	None	None	No screening value	Yes
Manganese	1.28E+04	1.20E+02	NAWQC (Suter & Tsao 1996)	Above	Yes
Nickel	5.40E+01	2.90E+01	EDQL EPA Region 5 (1998)	Above	Yes
Potassium	4.70E+03	None	None	No screening value	Yes
Zinc	1.10E+03	5.90E+01	EDQL EPA Region 5 (1998)	Above	Yes
Semivolatile Organic Compounds					
Bis(2-ethylhexyl)phthalate	3.20E+00	2.10E+00	EDQL EPA Region 5 (1998)	Above	Yes
Volatile Organic Compounds					
Acetone	5.60E+00	1.50E+03	Tier II (Suter & Tsao 1996)	Below	No
Explosives and Propellants					
2,4-Dinitrotoluene	5.10E-02	4.40E+01	Ohio Administrative Code	Below	No

Yes = Maximum concentration > screening value.
No = Maximum concentration < screening value.
COPC = Chemical of potential concern.

  - Cadmium (3.2 µg/L), iron (3,400 µg/L), lead (4.3 µg/L), and nickel (54 µg/L), which were all detected above their respective ecological surface water screening values but within one order of magnitude of these screening values.

  - Calcium (170,000 µg/L), magnesium (31,400 µg/L), and potassium (4,700 µg/L), which were retained as ecological COPCs for surface water since there are no screening values available for these metals.

- Bis(2-ethylhexyl)phthalate was detected once at a concentration of 3.2 µg/L, which exceeds its surface water screening value of 2.1 µg/L.

5.5.5 Summary of COPCs

Table 5-10 presents a summary of human health and ecological COPCs across surface soil, subsurface soil, sediment, and surface water. As seen, there are 1 explosive, 1 propellant, 19 metals, and 11 SVOCs that are identified in at least one medium as a COPC at NTA.

Based on the abundance of COPCs (both for human health and ecological), site conditions do not support a “no further action” decision; additional characterization or action appears to be necessary.

Table 5-10. Summary of COPCs for NACA Test Area

Analyte	Surface Soil COPC[a]	Subsurface Soil COPC[a]	Sediment COPC[a]	Surface Water COPC[a]
Explosives				
2,4-Dinitrotoluene				H
Nitrocellulose	**H**		**H, E**	
Inorganics				
Aluminum	H			
Antimony				H
Arsenic	H			
Barium			**E**	E
Beryllium			**E**	
Cadmium	H	H	H, E	H, E
Calcium			**E**	**E**
Chromium	H		H	
Cobalt				E
Copper	H	H	E	
Cyanide			E	
Iron			E	E
Lead	H	H	H, E	**H**, E
Magnesium			**E**	**E**
Manganese	H		H, E	H, E
Nickel			E	E
Potassium				**E**
Selenium			**E**	
Zinc			E	H, E
Semivolatile Organic Compounds				
Acenaphthylene	**H**			
Benz(a)anthracene	H	H		
Benzo(a)pyrene	H	H		
Benzo(b)fluoranthene	H	H		
Benzo(g,h,i)perylene	**H**	**H**		
Benzo(k)fluoranthene	H			
Bis(2-ethylhexyl)phthalate	H			H, E
Chrysene	H			
Dibenz(a,h)anthracene	H			
Indeno(1,2,3-cd)pyrene	H	H		
Phenanthrene	**H**			

[a] Human health COPCs are designated by "H," and ecological COPCs are designated by "E"; designations in bold indicate that the chemical is retained as a COPC because it was detected in the medium, but no risk-based screening value was available for comparison. Designations appearing in regular font (i.e., not in bold) indicate that the chemical was detected at levels above its risk-based screening value.

COPC = Chemical of potential concern.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The NTA Phase I RI presents an evaluation of the distribution and occurrence of contamination at the site along with a risk evaluation to determine whether additional investigations or actions are warranted. This chapter presents a refined SCM (originally outlined in the Phase I RI SAP Addendum), conclusions based on the data compiled during this Phase I RI, and recommendations.

6.1 SITE CONCEPTUAL MODEL

The SCM is a summary of the knowledge gathered at NTA. Elements of the SCM include

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

The SCM integrates site chemical data with the physical characteristics of the AOC to illustrate where and how contaminants originate and the most likely mechanisms by which they can be transported. The SCM also identified any information that is still needed to adequately characterize the AOC. The SCM does not incorporate hydrogeologic data because characterization of groundwater was not a DQO of the Phase I RI. An illustrated version of the SCM is provided in Figure 6-1 to assist in visualizing the concepts discussed below.

6.1.1 Source Areas and Release Mechanisms

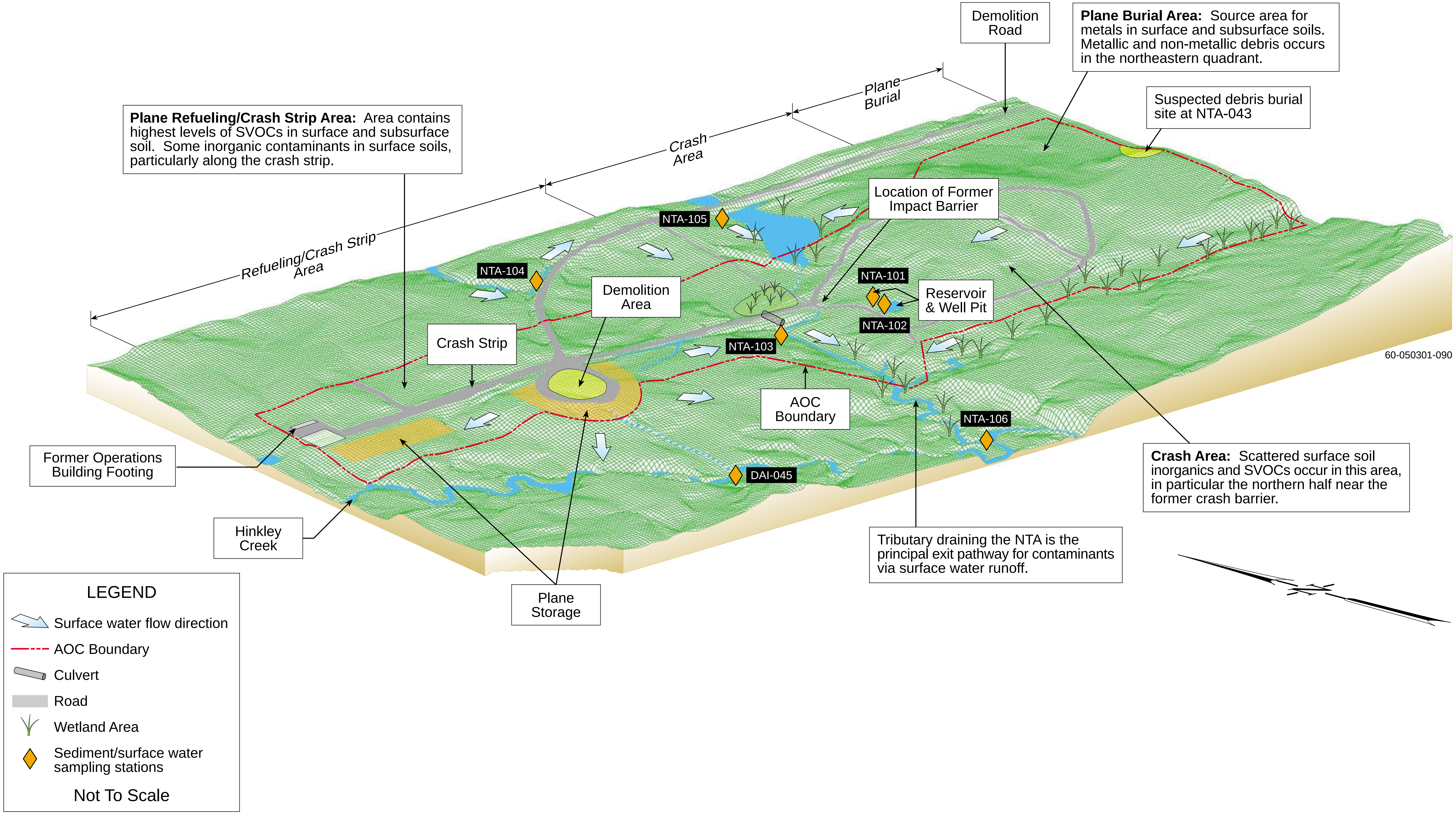
The results of Phase I RI soil sampling indicate that the plane refueling/crash strip area and the northeastern quadrant of the plane burial area are the portions of NTA with the greatest numbers and concentrations of contaminants. Inorganics are present in the soil of these areas at concentrations greater than background or risk-screening criteria. Subsurface soil inorganic contamination is present in a small portion of the plane burial area. Visible surface debris and suspected subsurface debris represent sources for metals contamination and potential exposure risk to land users such as the National Guard. The distribution of inorganic SRCs above background in the northeastern quadrant of the plane burial area indicates that contaminants are primarily centered around “hot spots” associated with areas having concentrated debris. Inorganic contamination was also observed at various locations within the crash area but to a lesser degree than in the two functional areas noted above.

SVOCs are present at a few locations at the west end of the plane refueling/crash strip area at levels exceeding risk-based criteria. The majority of contamination in the plane refueling/crash strip area is restricted to the surface soil interval, which is less than 0.3 meter (1.0 foot) deep. The identified PAHs may reflect more recent, frequent use of the AOC for training purposes (i.e., vehicle and equipment drips and leaks), as well as historical NTA operations.

The primary mechanisms for releases of contaminants from the source areas listed above include the following:

- spills, leaks, and releases of fluids (fuels, oil, hydraulic fluid, etc.) directly onto the ground surface;

- leaching of constituents from residual debris in the plane burial area into soil; and



Plane Refueling/Crash Strip Area: Area contains highest levels of SVOCs in surface and subsurface soil. Some inorganic contaminants in surface soils, particularly along the crash strip.

Plane Burial Area: Source area for metals in surface and subsurface soils. Metallic and non-metallic debris occurs in the northeastern quadrant.

Suspected debris burial site at NTA-043

Location of Former Impact Barrier

Crash Area: Scattered surface soil inorganics and SVOCs occur in this area, in particular the northern half near the former crash barrier.

Tributary draining the NTA is the principal exit pathway for contaminants via surface water runoff.

Figure 6-1. Site Conceptual Model for the NACA Test Area

- erosion of contaminated soil and redeposition along the drainageways exiting the site (i.e., tributary to Hinkley Creek).

Inorganic (metals) contaminants and SVOCs in surface soil exceeded conservative criteria for soil leaching to groundwater. In addition, 2,4-DNT exceeded its leaching criterion; however, this explosive was not identified as a surface soil COPC. In subsurface soil, cadmium was the only inorganic constituent that exceeded its leaching criterion. Several PAHs were also noted as exceeding soil leaching criteria; however, these constituents were limited to a single sample station (NTA-088). As noted above, the data evaluation overall showed substantially fewer inorganic and organic COPCs and lower overall concentrations in subsurface soil than in surface soil. These factors, combined with the small number of soil locations with concentrations above leaching criteria, suggest that, overall, soil leaching to groundwater is a minor release mechanism.

6.1.2 Contaminant Migration Pathways and Exit Points

Migration of contaminants from secondary soil sources to surface water conveyances occurs primarily by (1) mobilization of particle-bound contaminants in surface water runoff and (2) by transport of dissolved phase constituents in surface water. Upon reaching surface water conveyances or a low-lying area, flow velocities decrease, and particle-bound contaminants largely settle out as sediment accumulation. Sediment-bound contaminants may be remobilized through resuspension during storm events or partition to surface water and be transported in dissolved phase.

The primary identified contaminant exit pathway at NTA is the tributary to Hinkley Creek, which is fed by a number of small drainage ditches and conveyances that drain portions of the crash strip, the crash area, and the southern portion of the plane burial area. In addition, surface water runoff from areas north of NTA is directed through a wetland and ultimately to the tributary. Sampling data do not provide conclusive evidence that Hinkley Creek has received significant contamination related to former NTA operations.

Accumulation areas for contaminants in surface water exist along the shallow ditch lines in the western and southwestern portions of the crash area and in the small water reservoir. Within the plane refueling/crash strip area and plane burial area, no clearly defined surface water conveyances exist, and runoff occurs primarily as diffuse overland flow. The wetland area along the southern boundary of the crash and plane burial areas represents a collection point for some of the overland flow in the southern half of these areas. The wetland north of the AOC receives runoff from areas north of Demolition Road; however, some local slope directions along the northern portion of the crash area result in some runoff and potential entrained contaminants entering this wetland. The Phase I data do not demonstrate that Hinkley Creek sediment and surface water have received significant contamination related to NTA operations.

6.1.3 Uncertainties

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

- Contaminant migration from source areas to groundwater via leaching or surface water infiltration is an unknown element of the conceptual model at present. A number of contaminants identified as COPCs also exceeded conservative soil leaching screening criteria. Observed vertical distribution of soil contamination did not indicate significant leaching from surface soil to subsurface soil.

- In the northeast quadrant of the plane burial area, areas having observed debris at the surface extend laterally at least a short distance beyond the area characterized by the Phase I RI sampling. In particular, debris were noted along a former service road leading east from the plane burial area. Therefore, the lateral distribution of debris zones and associated inorganic SRCs may not be fully characterized.

- At least one suspected debris burial site was observed in the northeastern quadrant of the plane burial area (station NTA-073 vicinity). Subsurface soil in the vicinity of the suspected burial site was characterized to depths of 1.5 meters (5 feet). Therefore, some uncertainty exists as to the full vertical extent of contamination in association with the suspected burial site.

6.2 CONCLUSIONS

In summary, the results of the Phase I RI at NTA confirmed the presence of site-related contamination in soil. Inorganics and SVOCs are the principal classes of SRCs. Screening of chemical data against risk-based criteria shows the presence of human health and ecological COPCs in each environmental medium (Chapter 5.0). However, as noted in the specific conclusions below, the occurrence of subsurface COPCs was extremely limited. Figures 6-2 and 6-3 present an illustrated summary of the distribution of inorganic and SVOC COPCs in surface and subsurface soil, as well as the degree of contamination relative to human health risk evaluation criteria. In terms of sediment and surface water contamination, Hinkley Creek does not appear to have received significant contamination related to AOC operations. Contaminant migration off of the AOC appears to be negligible based on the Phase I RI data.

Surface Soil

- Trace levels of explosives were detected at only three stations within NTA; none of the concentrations exceeded human health residential risk screening criteria. Nitrocellulose was retained as a COPC in absence of available screening criteria but was detected at low levels only at three stations. On this basis, historical NTA operations did not result in impacts to surface soil related to explosives or propellants.

- Of the seven metals identified as COPCs, aluminum, arsenic, chromium, lead, and manganese exceeded both residential and industrial risk-based screening criteria. Copper and cadmium exceed only residential criteria. The greatest exceedances of human health risk-based screening criteria occur in the northeastern quadrant of the plane burial area in association with areas having surface debris.

- Ten PAH compounds and bis(2-ethylhexyl)phthalate were identified as COPCs. The highest concentrations of PAHs occur within the plane refueling/crash strip area and near the former crash barrier in the western-most crash area. Bis(2-ethylhexyl)phthalate values above residential risk-based standards occurred only at station NTA-007. The identified PAHs may reflect more recent, frequent use of the AOC for training purposes (i.e., vehicle and equipment drips and leaks) rather than historical NTA operations.

- VOCs and PCBs are not COPCs in surface soil.

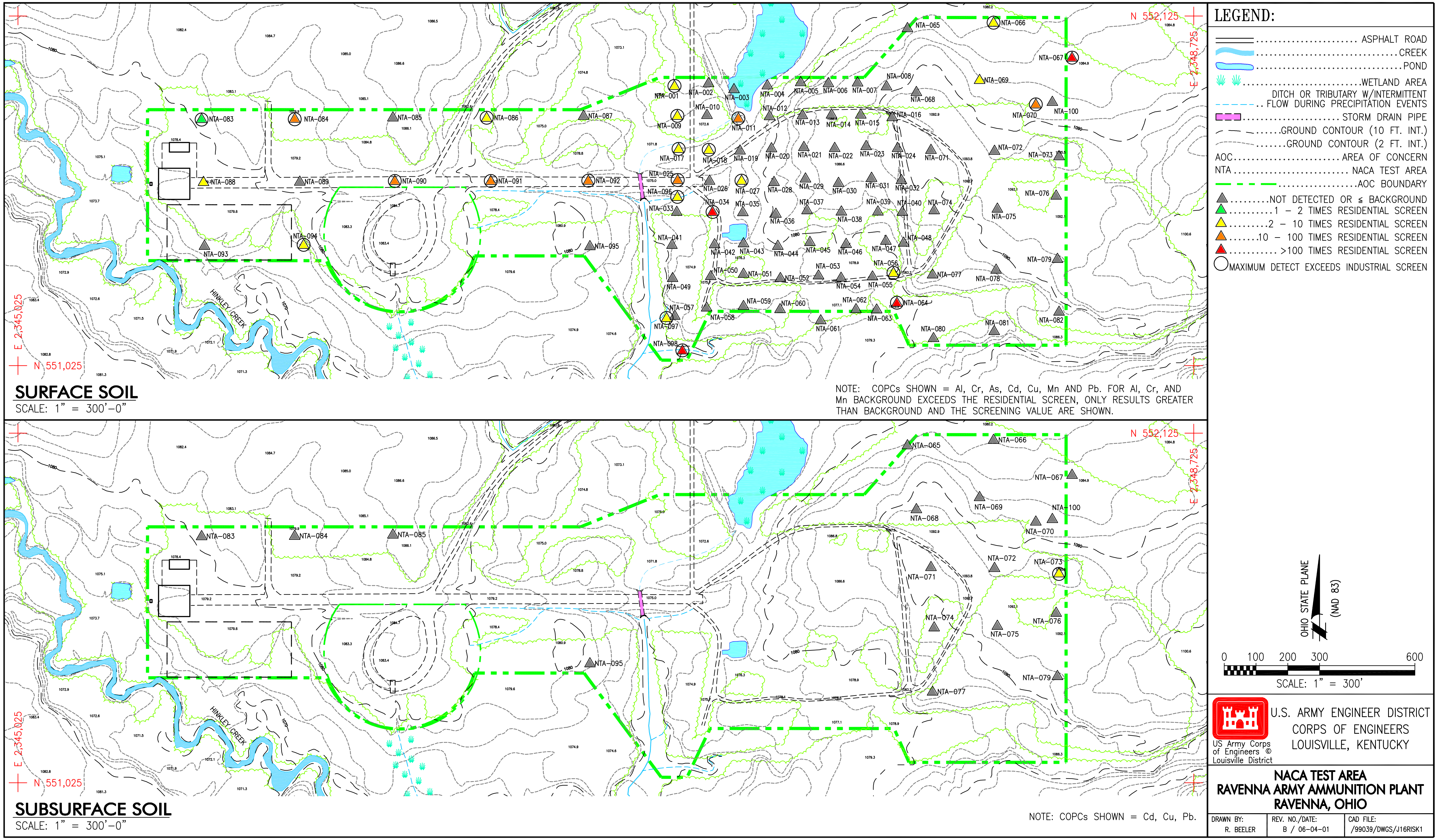


Figure 6-2. Summary of Human Health Risk Evaluation Results for Soils - Inorganic COPCs

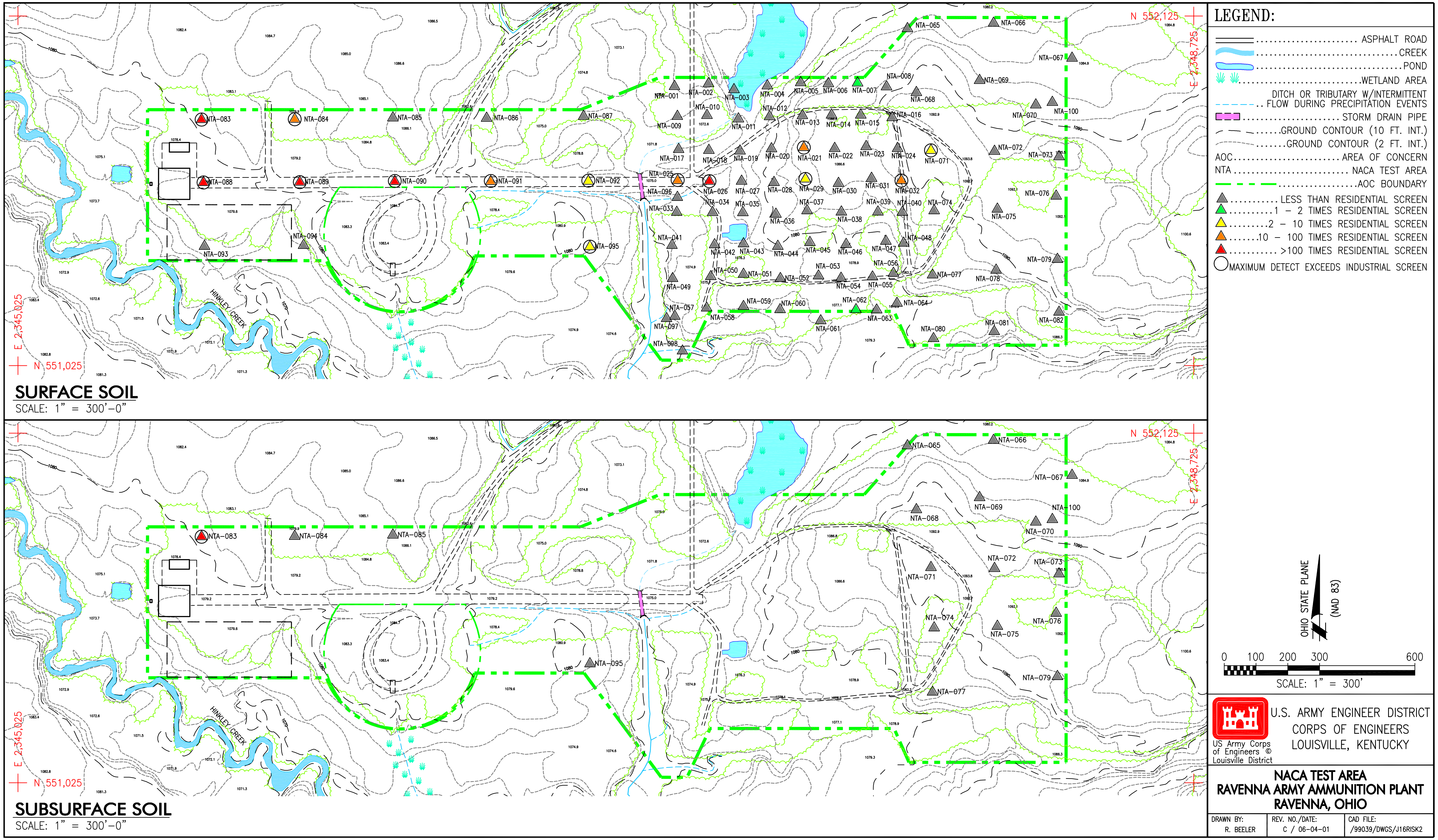


Figure 6-3. Summary of Human Health Risk Evaluation Results for Soils - SVOC COPCs

- Screening of data for identified COPCs against migration to groundwater criteria (DAF = 1) shows that arsenic, cadmium, chromium, and seven PAH compounds exceed their respective criteria. Three additional metals identified as COPCs (aluminum, lead, and manganese) do not have criteria available for comparison. The explosive 2,4-DNT exceeded its migration to groundwater criterion but was not identified as a COPC in surface soil.

Subsurface Soil

- Explosives/propellants, VOCs, and PCBs were not identified as COPCs in subsurface soil.

- In general, concentrations of inorganic SRCs in subsurface soil are substantially lower than those in surface soil.

- Lead, cadmium, and copper were identified as human health COPCs in subsurface soil only at station NTA-073 (suspected burial site). Five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene] were identified as COPCs only at station NTA-083 (plane refueling/crash strip area).

- Screening of data against soil leaching criteria (DAF = 1) shows that cadmium and four of the five identified SVOCs exceed their respective migration to groundwater criteria.

Sediment and Surface Water

- Nitrocellulose (no screening criterion), chromium, lead, manganese, and cadmium are identified as sediment human health COPCs. The maximum detected concentrations of these COPCs occurred at stations NTA-101 (well pit) and NTA-104 (upstream of NTA). The maximum concentrations of metals were detected within the well pit and are likely due to paint chips and metal from the heavily corroded, painted steel lid of the well pit.

- Nitrocellulose (no screening criterion) and 13 inorganics are identified as sediment ecological COPCs. As noted above, all of the maximum detected values for these constituents occurred either in station NTA-101 or NTA-104 and do not appear to be related to NTA.

- The explosive 2,4-DNT, five metals, and bis(2-ethylhexyl)phthalate are identified as human health surface water COPCs. The maximum detected values for all of the COPCs, except aluminum and bis(2-ethylhexyl)phthalate, occurred at upgradient stations NTA-104 and NTA-105, both of which are north of NTA and reflect other potential sources (i.e., Demolition Road). The maximum value for aluminum was observed at station NTA-106 at Hinkley Creek, which may or may not be related to NTA. Bis(2-ethylhexyl)phthalate was detected once (station NTA-103).

- Eleven metals and bis(2-ethylhexyl)phthalate are identified as surface water ecological COPCs. As noted above, the maximum detected values for a large majority of these COPCs occurred at stations NTA-104 and NTA-105 upstream of NTA. Bis(2-ethylhexyl)phthalate was detected once (station NTA-103).

- The data collected during the Phase I RI indicate that sediment and surface water in Hinkley Creek have not received significant levels of contamination related to former operations at NTA.

Groundwater

- Based on the available limited screening data, leaching of contaminants from soil to shallow groundwater in the vicinity of station NTA-038 has not occurred. These data from NTA-038 do not necessarily represent conditions in other portions of the AOC.

6.3 RECOMMENDATIONS

Based on the human health and ecological screening risk evaluations, human health COPCs were identified for surface soil at NTA. The principal COPCs are inorganics. Subsurface soil COPCs were very limited in extent to a suspected burial site in the northeastern portion of the plane burial area. Considering the high degree of current site use for OHARNG training and the projected land use for the AOC, a potential exists for exposure of human receptors to debris and associated inorganic surface soil contaminants within the NTA. Therefore, current site conditions do not support a “no further action” decision. Additional characterization and a baseline risk assessment are recommended under the auspices of a combined NTA/DA1 Phase II RI. Specific recommendations include

- Human health and ecological COPCs were identified for sediment and surface water collected during the Phase I RI; however, no definitive evidence exists correlating COPCs identified in the Hinkley Creek main stem to NTA. Subsequent investigation at NTA is recommended in the context of a combined NTA/DA1 exposure unit for surface water and sediment within streams and ditches in the AOC and downstream to the confluence with Hinkley Creek. Confirmation of the presence of constituents at HC-2 and within the Hinkley Creek main stem above background criteria will be addressed under a separate investigation.

- Because of the comprehensive characterization of surface soil during the Phase I RI and limited extent and number of COPCs identified in subsurface soil, the lateral and vertical extent of soil contamination has been largely determined. Additional characterization of soil is recommended in the context of a combined NTA/DA1 soils exposure unit. For NTA, a focused investigation of only the northeastern quadrant of the plane burial area is recommended to characterize any additional debris disposal areas as follows:

  - thorough visual survey of the area east of the plane burial area, particularly along the former service road, to identify potential debris disposal areas;

  - additional surface and subsurface soil investigation as required to characterize any newly identified debris disposal areas; and

  - specific horizontal and vertical characterization of the suspected burial site at station NTA-073.

- As noted in the DQOs presented in the NTA Phase I RI SAP Addendum, collection of site-specific hydrogeologic data is indicated because soil constituents exceeded migration to groundwater criteria. Collection of these data is recommended in the context of a combined NTA/DA1 groundwater exposure unit. Based on the observed vertical distribution of soil contaminants and the high likelihood of attenuation within the vadose zone, the scope of these efforts should be limited in extent and target only shallow groundwater in the unconsolidated zone immediately downgradient of and within the principal source areas. Deeper groundwater may be evaluated if shallow groundwater is found to be contaminated.

- Upon collection of groundwater characterization data, chemical fate and transport modeling and finalization of the SCM are recommended as necessary to identify contaminant migration potential within this medium and to facilitate the decision-making process for any necessary remedial actions.

- A screening ecological risk assessment will address soil, sediment, and surface water media, provided that sufficient quantity and quality of habitat is present. Sediment and surface water data will be grouped inside the AOC to the confluence with Hinkley Creek. The screening ERA using hazard quotients for specific receptors will be preceded by a pre-screen using ecological screening values. Thus, a tiered approach will be followed.

- A baseline human health risk assessment will address soil, surface water/sediment, and, if warranted based on additional characterization, groundwater exposure units for the combined exposure units described above.

- Plugging and abandonment of the former production well, removal of well pit sediment, and infilling of the well pit are recommended primarily to eliminate potential physical hazards but also to eliminate a potential contaminant migration pathway. Geophysical logging of the well may be considered prior to abandonment to obtain subsurface geologic data.

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Draft Final Phase I Remedial Investigation Report for the NACA Test Area at the Ravenna Army Ammunition Plant, Ravenna, Ohio
Comment Resolution

Comment No.	Page or Section	Comment	Response
Ohio EPA (Todd R. Fisher)			
1	General	The NACA Phase I Draft Final RI report is a revised report and includes all revisions to the text which were recommended during the comment resolution meeting held at RVAAP on February 14, 2001. Ohio EPA has reviewed the final document and it appears that all Agency recommendations have been adequately addressed and the appropriate changes have been made to this report.	Comment noted. Figure 2-3 was modified to show the approximate location of the suspected buried glacial valley in response to comments received on the Demolition Area 1 report. Figure 5-1 was modified slightly for consistency with responses to comments received on Erie Burning Grounds and Demolition Area 1 Draft Final RI reports.

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