DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

RCRA Corrective Action
Environmental Indicator (EI) RCRIS code (CA725)

Current Human Exposures Under Control

Facility Name: Watervliet Arsenal*
Facility Address: Broadway, Watervliet, NY
Facility EPA ID #: NY7213820940

** For the purpose of implementing concurrent RCRA Facility Investigations (RFIs) and subsequent Corrective Measures Studies (CMS) and Corrective Measures (CMs – both interim (ICM) and final), the Watervliet Arsenal was divided into two study areas: the Main Manufacturing Area (MMA) and the Siberia Area (SA). This document addresses both the MMA and the SA.*

1. Has **all** available relevant/significant information on known and reasonably suspected releases to soil, groundwater, surface water/sediments, and air, subject to RCRA Corrective Action (e.g., from Solid Waste Management Units (SWMU), Regulated Units (RU), and Areas of Concern (AOC)), been **considered** in this EI determination?

   __X__ If yes - check here and continue with #2 below.

   _____ If no - re-evaluate existing data, or

   _____ if data are not available skip to #6 and enter "IN" (more information needed) status code.

BACKGROUND

Definition of Environmental Indicators (for the RCRA Corrective Action)

Environmental Indicators (EI) are measures being used by the RCRA Corrective Action program to go beyond programmatic activity measures (e.g., reports received and approved, etc.) to track changes in the quality of the environment. The two EI developed to-date indicate the quality of the environment in relation to current human exposures to contamination and the migration of contaminated groundwater. An EI for non-human (ecological) receptors is intended to be developed in the future.

Definition of "Current Human Exposures Under Control" EI

A positive "Current Human Exposures Under Control" EI determination ("YE" status code) indicates that there are no "unacceptable" human exposures to "contamination" (i.e.,

contaminants in concentrations in excess of appropriate risk-based levels) that can be reasonably expected under current land- and groundwater-use conditions (for all "contamination" subject to RCRA corrective action at or from the identified facility (i.e., site-wide)).

Relationship of EI to Final Remedies

While Final remedies remain the long-term objective of the RCRA Corrective Action program the EI are near-term objectives which are currently being used as Program measures for the Government Performance and Results Act of 1993, GPRA). The "Current Human Exposures Under Control" EI are for reasonably expected human exposures under current land- and groundwater-use conditions ONLY, and do not consider potential future land- or groundwater-use conditions or ecological receptors. The RCRA Corrective Action program's overall mission to protect human health and the environment requires that Final remedies address these issues (i.e., potential future human exposure scenarios, future land and groundwater uses, and ecological receptors).

Duration / Applicability of EI Determinations

EI Determinations status codes should remain in RCRIS national database ONLY as long as they remain true (i.e., RCRIS status codes must be changed when the regulatory authorities become aware of contrary information).

2. Are groundwater, soil, surface water, sediments, or air **media** known or reasonably suspected to be **"contaminated"**[1] above appropriately protective risk-based "levels" (applicable promulgated standards, as well as other appropriate standards, guidelines, guidance, or criteria) from releases subject to RCRA Corrective Action (from SWMUs, RUs or AOCs)?

	Yes	No	?	Rationale / Key Contaminants
Groundwater	X			(see below)
Air (indoors)[2]	X			(see below)
Surface Soil (e.g., <2 ft)	X			(see below)
Surface Water		X		No known associated surface water contamination
Sediment	X			(see below)
Subsurf. Soil (e.g., >2 ft)	X			(see below)
Air (outdoors)		X		No known unpermitted discharge of contaminants

____ If no (for all media) - skip to #6, and enter "YE," status code after providing or citing appropriate "levels," and referencing sufficient supporting documentation demonstrating that these "levels" are not exceeded.

X If yes (for any media) - continue after identifying key contaminants in each "contaminated" medium, citing appropriate "levels" (or provide an explanation for the determination that the medium could pose an unacceptable risk), and referencing supporting documentation.

____ If unknown (for any media) - skip to #6 and enter "IN" status code.

Rationale and Reference(s):

Facility Description

The WVA is a 140-acre government-owned installation under the command of the U.S. Army Tank Automotive and Armaments Command (USTAAC). WVA is located in the City of Watervliet, New York. The City of Watervliet is located 3.5 miles northeast of the City of Albany, adjacent to the Hudson River. A site location map is attached as Figure 1. WVA is an active U.S. Army facility. Tenant activities include Oak-Mitsui, Benet Laboratories, a U.S. Army Health Clinic, elements of the New York Army National Guard (NYARNG), recruiting offices for both the U.S. Army and U.S. Marine Corps, and Defense Security Service.

WVA is the Nation's oldest cannon factory. The entire facility is a Registered Historic Landmark. The manufacturing of tubes and tube assemblies for cannons, cannon components, mortars, recoilless rifles, and other systems has occurred on-site. WVA consists of two areas: (1) Main Manufacturing Area (MMA) and (2) Siberia Area (SA). The MMA is primarily used for manufacturing and administrative operations. It encompasses approximately 125 acres and extends from New York Route 32 (Broadway) westward to Tenth Street and the New York Route 155 overpass. The SA is chiefly used for storage and comprises approximately 15 acres in the extreme western reaches of WVA (north of the Route 155 overpass). A site map delineating the Main Manufacturing Area and Siberia Area is attached as Figure 2.

Siberia Area

The 15-acre SA was purchased by WVA in the early 1940s. The SA was subsequently filled in with debris consisting of slag, cinders, wood, brick and other available debris of unknown origin. Once filled in, two areas were used for burning combustible material (i.e., scrap lumber and other sanitary waste) until 1967. The SA is now used for the interim storage of raw materials, hazardous materials, finished goods, and supplies brought in from the MMA. The handling of these materials may have contributed to groundwater and soil contamination, particularly the handling of metal chips coated with cutting oils; scrap metals which are salvaged; and scrap lumber which is stockpiled until removed from the site. All of the above have historically been stored directly on the ground surface. In addition, the WVA has reported that mixtures of oils and solvents removed from underground storage tanks (USTs) were sprayed on the ground for dust control in the SA. The WVA no longer employs this practice. Elevated levels of chromium and lead have also been detected in the soil and groundwater in the northeastern section of the SA. This chromium and lead contamination may have originated from the Perfection Plating Facility located hydraulically and topographically upgradient of the site.

Main Manufacturing Area

The MMA encompasses approximately 125 acres in the City of Watervliet. Broadway Street (Route 32) and a six-lane interstate highway (I-787) are located adjacent to the eastern property line and separate the WVA from the Hudson River. Residential and light commercial properties are located along the northern and southern site boundaries. To the west of the MMA are residential properties and unused manufacturing facilities. Perfection Plating, which formerly manufactured metal plates for brake pads and is currently under remediation by the NYSDEC.

Activities conducted at the MMA have historically included the manufacture of tubes and tube assemblies for cannons, cannon components, mortars, and recoilless rifles. During the peak years of manufacturing activities, which took place from the middle to late 20th century, the primary hazardous wastes generated at the MMA were acid and cyanide wastes from plating operations. These wastes are no longer generated by the WVA. Hazardous wastes currently generated from site operations include non-halogenated spent solvents, small quantities of soluble oils, pesticides, cleaning solutions, and laboratory waste such as sulfuric and phosphoric acid. Petroleum, oil, and lubricants (POLs) have been and are currently used in machining operations. There are eleven underground storage tanks (USTs) which store waste oil. Chlorinated solvents were used prior to 1982 in vapor degreasing operations. WVA generates several hundred tons of scrap metals per year, most of which is in chip form and contaminated with oil. During the 1950's and 1960's the chips were stored on the ground in the area south of Building 132. Small quantities of silver from photo-manufacturing operations were disposed into the sanitary sewer system in the past

with the authorization of the local sewer district; however these wastes are no longer generated at the WVA. Several of the manufacturing buildings in the MMA are no longer used. These building include: Building 110, Building 125, and Building 120. Manufacturing equipment and supplies have been removed from these buildings.

General Physical Setting

Topography

WVA is located in a valley between the Taconic Mountains on the east and the Helderberg Hills on the west. The topography at WVA ranges from gently sloping to steeply sloping land. Site topography rises westward from the site boundary along the Hudson River (18 feet above mean sea level) to Gillespie Road (76 feet above mean sea level). From there, the land slopes downward to an elevation of approximately 40 feet above mean sea level at the site's northwesterly corner. The SA is generally at a lower elevation than the Main Manufacturing Area. Siberia ranges in elevation from 45 feet above mean sea level to 41 feet above mean sea level.

Surface Water Bodies

There are currently no surface water bodies within WVA borders. The Hudson River is located east of WVA across a six lane highway. The Kroma Kill and an unnamed tributary are located to the west and northwest of Siberia, respectively. The Erie Canal, which was constructed in 1821, passed through the MMA. In 1922, it was abandoned in place. The canal provided WVA with transportation, power for its production machines, and water for fire protection. The walls of the Erie Canal remain on-site. The portion of the Erie Canal at the WVA was filled with dirt, brick, and other fill materials in the early 1940s. Siberia was swampland prior to being filled with sand, shale fragments, slag, cinders, brick, wire, wood, and concrete during the 1940s.

Geology

WVA and the surrounding area are situated on Snake Hill Shale (dark gray shale). Outcrops of Normanskill Shale are situated close to WVA. Normanskill Shale is comprised of minor mudstone and sandstone and is dark gray to black in color. The Snake Hill Formation lies stratigraphically above the Normanskill Shale.

The major overburden unit identified in the Main Manufacturing Area has been described as fill, consisting of brown or dark gray silty sand with angular gravel. The fill material is the only unit consistently found throughout the site. The fill in the former Erie canal is composed of very dark grayish brown sand and gravel and includes wire conduit, gravel, charcoal, glass, and wood. Fill materials are present throughout the MMA with the thickest amount of fill being in the eastern portion of the MMA. In places, native materials, including a fine grained alluvium, a coarser alluvium, and glacial till underlie the fill. The thickness of the overburden at the MMA is variable, although the thickness of the overburden deposits generally increases from west to east. During site investigations of the Main Manufacturing Area, highly weathered shale was encountered from approximately 1 to 18 feet below grade. In general, competent bedrock was encountered from 12 to 18 feet below grade based upon auger refusal during drilling activities.

Siberia was wetland prior to being filled during the 1940s. Today, Siberia is generally underlain by fill (sand, shale fragments, slag, cinders, brick, wire, wood, and concrete). During site investigations in Siberia, alluvium, layers of peat, and lacustrine clay deposits were encountered below this layer of fill. Highly weathered shale was encountered from approximately 3.5 to 31 feet below grade. In general, competent bedrock was encountered 12 feet below grade based upon auger refusal during drilling.

Hydrology

Groundwater flow in the Main Manufacturing Area is primarily controlled by topography, which is coincident with the bedrock surface. The most prominent feature on the potentiometric surface is a hydraulic divide running roughly north to south through the west side of the Main Manufacturing Area. The position of this divide follows a bedrock ridge in the area and the site topographic high. Groundwater to the east of this divide flows eastward toward the Hudson River. Groundwater to the west of the divide flows westward towards the SA.

Due to the shallow depth to bedrock and the limited amount of overburden in several areas of WVA the

groundwater table is present within different geologic units (overburden, weathered bedrock, or bedrock) at the MMA depending on the location. In general, groundwater is encountered in the bedrock at the western end of MMA, in the weathered bedrock in the central portion of the MMA, in the overburden deposits in the majority of the eastern portion of the MMA. Groundwater flow in the Main Manufacturing Area is primarily controlled by both the bedrock topography and the degree of fracturing within the bedrock.

Groundwater in Siberia generally flows west to the Kromma Kill and an unnamed tributary to the northwest. Groundwater level data indicate that Siberia is a local recharge area. The water table is generally encountered in the shallow overburden within four feet of the ground surface in the SA.

Summary of Environmental Investigations

A RCRA Facility Assessment Report, prepared by the New York State Department of Conservation (NYSDEC) in December 1986, updated in December 1987, and again in March 1992, identified several solid waste management units (SWMUs) at WVA. Several small-scale investigations were conducted at the WVA in the late 1980s through the early 1990s. In September 1993, the U.S. Environmental Protection Agency (EPA), NYSDEC, and WVA entered into an Administrative Order on Consent (Docket No. II RCRA-3008-h-93-0210) that requires assessments, investigations, corrective measure studies, and/or corrective measures for the SWMUs identified and any future SWMUs discovered. In accordance with the consent order, RCRA Facility Investigations (RFIs) were conducted at the WVA from 1995 through 1999. These RFIs involved the analysis of historical sampling data from previous investigative studies as well as the collection of soil, groundwater, and soil gas samples. All of the SWMUs at WVA were investigated under NYSDEC- and U.S. EPA-approved work plans. At the time of writing, the CMS for the SA has been completed and is under review. The CMS for the Main Manufacturing Area is not completed. Several interim corrective measures (ICMs) have been implemented at the SA and MMA during the CMS process. A Long-Term Monitoring Program (LTM) for groundwater has been conducted at the WVA since 1999.

Nature and Extent of Contamination

Siberia Area

Soil

Soil contamination has been detected throughout the SA. In general, organic contamination in the soil is primarily limited to the presence of petroleum hydrocarbons and associated polycyclic aromatic hydrocarbons (PAHs). Chromium, lead, and arsenic are the primary inorganic contaminants of concern in the soil. Organic and inorganic analytes detected in the SA are summarized in Table 1. The maximum and minimum concentrations detected for each analyte are also presented in Table 1. Areas with the greatest petroleum hydrocarbon and associated PAH contamination are:

- the Main Substation area;
- the Chip Handling Facility;
- the former Burn Pit in the NE Quadrant; and
- an area in the SE Quadrant near the former lumber yard (currently the National Guard vehicle storage area).

The highest PAH concentrations detected in the soil at the SA were detected in soil samples collected from the Main Substation area. PAHs detected in the Main Substation Area and their associated maximum concentrations are listed below:

PAH (Main Substation Area)	Maximum Concentration (ug/kg)
Pyrene	180000
Fluoranthene	150000
Phenanthrene	89000
2-Methylnaphthalene	82000
Benzo(b)fluoranthene	79000
Chrysene	63000
Benzo(a)pyrene	58000
Benzo(a)anthracene	51000
Benzo(k)fluoranthene	51000

Indeno(1,2,3-cd)pyrene	41000
Naphthalene	36000
Fluorene	26000
Benzo(g,h,i)perylene	17000
Acenaphthene	16000
Dibenzo(a,h)anthracene	15000
Anthracene	13000

Inorganic contamination in the soil is the most prevalent in the NE and SW areas of the SA. Chromium is the most extensive and widespread inorganic contaminant, with the maximum concentrations detected in the NE and SW (Main Substation area) Quadrants. The locations of the maximum detected inorganic concentrations in the SA soil are listed below:

Metal	Maximum Concentration (mg/kg)	Location
Arsenic	42.1	NE Quadrant
Barium	439	NE Quadrant
Cadmium	23.8	NW Quadrant
Chromium	2490	NE Quadrant
Lead	2530	SW Quadrant
Mercury	4	SW Quadrant
Selenium	30.1	NE Quadrant
Silver	10.5	NW Quadrant

Lead contamination in the soil is the most extensive along the eastern fence line and in the Main Substation area. Arsenic contamination is widespread, though the maximum concentrations in the surface and shallow soil were almost exclusively located along the eastern, northern, and western fence lines. Chromium, lead, and arsenic concentrations in the soil generally decrease with increasing depth. Soil and sediment samples (in a drainage ditch) were collected off of the WVA property adjacent to the NE and NW Quadrants during the RFI and CMS field activities to assess the impacts of the SA contamination on the surrounding area. Consistent with the nature of the contamination in the SA, elevated concentrations of PAHs and inorganic analytes were detected in the off-site surface soil and sediment samples; however, these concentrations were significantly lower than the maximum concentrations detected within the SA.

Groundwater

Petroleum hydrocarbons were detected in groundwater samples collected throughout the SA, but predominantly in the area of the Main Substation, Chip Handling Area, the former Burn Pit, and the former lumber yard. A sheen and petroleum odors were noted during monitoring well development and groundwater sampling activities within these areas. However, analytical results for these samples showed relatively few contaminants present at concentrations greater than groundwater standards, indicating that the petroleum hydrocarbons and associated PAHs in the soil do not partition into the groundwater to a large degree. SVOCs detected in groundwater at the SA are summarized in Table 2. PAHs detected in groundwater at concentrations exceeding the NYSDEC Class GA groundwater standards were benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, indeno(1,2,3-cd)pyrene, naphthalene, and phenol. The greatest concentrations of benzo(a)anthracene, chrysene, ideno(1,2,3-cd)pyrene, and naphthalene were detected in groundwater samples from monitoring well MW-32, which was located in the former burn pit area of the NE Quadrant. The highest concentrations of benzo(b)fluoranthene, benzo(b)fluoranthene, and bis(2-ethyhexyl)phthalate were detected in monitoring wells GTI-1 and GTI-3, located on the southern border of the NE Quadrant.

Groundwater VOC contamination at concentrations greater than the NYSDEC Class GA Standards is limited to the NE Quadrant of the SA. VOCs detected in groundwater at the SA are summarized in Table 3. Exceedances of NYSDEC Class GA Standards for chlorinated VOCs, including tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE), and vinyl chloride (VC)were noted in overburden, hybrid (screened in overburden and

bedrock), and bedrock wells. The VOC contamination in overburden and weathered bedrock groundwater in the NE Quadrant migrates along the shallow groundwater flow path from the source at the former Burn Pit towards the northwest. The highest VOC concentrations detected in overburden monitoring wells were detected in monitoring wells MW-39, MW-51, and MW-60, all of which are located in the NE Quadrant. Groundwater samples collected at various discrete vertical intervals during the installation of bedrock well SA-MW-41, which is located immediately adjacent to the former Burn Pit, confirmed the presence of VOC-contaminated groundwater in the bedrock. As shown in the table below, VOCs were primarily detected in the shallow bedrock at monitoring well SA-MW-41.

Summary of VOCs detected in Bedrock Monitoring Well MW-41

VOC	Depth Below Ground Surface			
	14-34 feet	34-54 feet	54-74 feet	74-94 feet
1,1-Dichloroethene	5	ND	ND	ND
1,2,4-Trimethylbenzene	3.5	ND	ND	ND
1,2-Dichloroethene	ND	ND	ND	9
1,3,5-Trimethylbenzene	1.7	ND	ND	ND
Acetone	ND	ND	ND	10
Benzene	11	ND	ND	ND
Chloroform	88	ND	ND	ND
cis-1,2-Dichloroethene	950	1300	50	ND
Methylene Chloride	ND	ND	ND	13
Tetrachloroethene	1100	170	1.7	ND
trans-1,2-Dichloroethene	4.9	ND	ND	ND
Trichloroethene	140	900	1.1	ND
Vinyl Chloride	2400	340	ND	19

Groundwater samples containing chromium concentrations exceeding NYSDEC Class GA Standards were collected from wells in the NE Quadrant screened within all stratigraphic units (overburden, weathered bedrock, and bedrock) and from the NW quadrant. Detected chromium concentrations in these groundwater samples ranged from 1.0 μg/l to 66 μg/l. The maximum chromium concentration was detected in the groundwater sample collected from monitoring well SA-MW-29 (total chromium), which is located in the NW Quadrant. The samples collected from the monitoring wells directly down gradient from Perfection Plating (MW-EA-7, MW-EA-8, and MW-ESE-9) contained hexavalent chromium concentrations in both the filtered and unfiltered samples. Detected hexavalent chromium concentrations in these wells ranged from 0.07 μg/l to 5.22 μg/l. The elevated chromium concentrations are likely related to the Perfection Plating facility, where a groundwater extraction system installed by the NYSDEC is currently operating. Lead and arsenic were also detected above NYSDEC Class GA standards in several groundwater samples, but only in the unfiltered samples. Lead and arsenic, therefore, are not contaminants of concern for the groundwater at the site.

Main Manufacturing Area

Soil

Subsurface soil samples were collected across the MMA during the RFI. The analytical results for these samples indicated that subsurface soil in the MMA is primarily contaminated with non-chlorinated, semi-volatile organic compounds (SVOCs), specifically polycyclic aromatic hydrocarbons (PAHs). Compounds detected in soil samples collected from the MMA are summarized in Table 4. The majority of PAH contamination is located in the fill, rather than the native soils. While PAHs are present throughout the MMA, the majority of the PAH contamination is located to the east of Buildings 20 and 25, along the former Erie Canal, and in the vicinity of Building 110. The highest concentration of PAH's were found in one soil sample (at depth) in the former Erie Canal. The subsurface soil sampling also revealed the presence of petroleum staining and odors. PAHs detected in each of these areas are summarized below:

- **Erie Canal Area**: Detected PAHs (and maximum concentrations) included benzo(a)anthracene

(20,000 μg/kg), benzo(a)pyrene (14,000 μg/kg), benzo(b)fluoranthene (11,000 μg/kg), benzo(k)fluoranthene (12,000 μg/kg), chrysene (27,000 μg/kg), fluoranthene (58,000 μg/kg), ideno(1,2,3-cd)pyrene (7,900 μg/kg), phenanthrene (140,000 μg/kg), and pyrene (58,000 μg/kg).

- **Building 110 Area**: Detected PAHs (and maximum concentrations) included benzo(a)anthracene (2,200 μg/kg), benzo(a)pyrene (1,700 μg/kg), chrysene (2,000 μg/kg), and dibenz(a,h)anthracene (340 μg/kg).

Arsenic, barium, chromium, lead, mercury, and selenium are the primary inorganic chemicals detected in subsurface soil. As with the organic compounds, the majority of inorganic chemical contamination is located in the fill, rather than the native soils. Arsenic contamination is located primarily throughout the western portion of the MMA. The maximum arsenic concentration detected at the MMA was 111 mg/kg at boring MW-30, which is located near Building 125. Chromium contamination is widespread throughout the MMA; however, the maximum chromium concentration (237 mg/kg) was detected near the wastewater treatment plant in the southeastern portion of the MMA. Barium (2,900 mg/kg), lead (17,800 mg/kg), mercury (0.84 mg/kg), and selenium (2.0 mg/kg) contamination are primarily located at depth within the former Erie Canal.

Groundwater

Groundwater samples were collected over the course of seven rounds of groundwater sampling during the RFI, as well as during the Long-Term Monitoring (LTM) Program and Data Gap Study at the MMA. While the nature of the soil contamination in the MMA is primarily related to the presence of PAHs, the nature of groundwater contamination in the MMA is primarily related to the presence of chlorinated volatile organic compounds (VOCs). PAH groundwater impacts are limited to the area between Buildings 110 and Buildings 35, where Light Non-Aqueous Phase Liquids (LNAPL) has been detected in the groundwater. The maximum SVOC groundwater concentrations shown in Table 5 are almost entirely from a sample collected at Building 35 PW-2, which is located in the LNAPL area. SVOC impacts in groundwater in the remainder of the MMA are minimal. VOCs detected in groundwater at the MMA are summarized in Table 6. The majority of the VOC contamination is located in the bedrock aquifer to the east of Building 40, east and southeast of Building 25, and in the vicinity of the Petroleum, Oil, Lubrication (POL) yard located in the central portion of the MMA. The analytical results for these samples indicated that groundwater in these areas is primarily contaminated with chlorinated VOCs predominantly composed of PCE, TCE, DCE, and VC. The maximum detected concentrations of each of these compounds in the areas of concern are described below:

- **Building 40**: Detected VOCs (and maximum detected concentrations) include PCE (110,000 μg/l), TCE (15,000 μg/l), cis-1,2-DCE (12,000 μg/l), and VC (8,300 μg/l).
- **Building 25**: Detected VOCs (and maximum detected concentrations) include TCE (410 μg/l), cis-1,2-DCE (70 μg/l), and VC (43 μg/l).
- **Hazardous Materials Storage Area**: Detected VOCs (and maximum detected concentrations) include PCE (9,100 μg/l), TCE (5,500 μg/l), cis-1,2-DCE (2,300 μg/l), and VC (1,700 μg/l).

Indoor Air

A soil gas and indoor air assessment was performed in a small dirt floor basement area of Building 40 located above the VOC contamination in the bedrock groundwater. The results of the assessment indicated that low concentrations of PCE, TCE, DCE, and, VC were present in the soil gas and indoor air. Additional indoor air assessments were conducted during September 2003. Samples were taken in the basement and first floor of Building 40 (under static conditions and also with the basement being ventilated). The preliminary results indicate that although low levels of VOC's are present in the occupied portions of the building, they are very close to background levels and there is insufficent evidence to prove that they are related to groundwater contamination beneath the building.

References:

- *Final RCRA Facility Investigation Report, Siberia Area, Watervliet Arsenal, Watervliet, New York*, December 1997.

- *Corrective Measures Study Field Data Report, Siberia Area, Watervliet Arsenal, Watervliet, New York*, October 1998.
- *Final Long-Term Monitoring Plan, Watervliet Arsenal, Watervliet, New York,* May 1999.
- *Final RCRA Facility Investigation Report, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York*, August 1999.
- *Summary Report, Ambient Air and Soil Gas Sampling, Building 40 Basement Area, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York*, April 2003

Footnotes:

[1] "Contamination" and "contaminated" describes media containing contaminants (in any form, NAPL and/or dissolved, vapors, or solids, that are subject to RCRA) in concentrations in excess of appropriately protective risk-based "levels" (for the media, that identify risks within the acceptable risk range).

[2] Recent evidence (from the Colorado Dept. of Public Health and Environment, and others) suggest that unacceptable indoor air concentrations are more common in structures above groundwater with volatile contaminants than previously believed. This is a rapidly developing field and reviewers are encouraged to look to the latest guidance for the appropriate methods and scale of demonstration necessary to be reasonably certain that indoor air (in structures located above (and adjacent to) groundwater with volatile contaminants) does not present unacceptable risks.

3. Are there **complete pathways** between "contamination" and human receptors such that exposures can be reasonably expected under the current (land- and groundwater-use) conditions?

Summary Exposure Pathway Evaluation Table

Potential **Human Receptors** (Under Current Conditions)

"Contaminated" Media	Residents	Workers	Day-Care	Construction	Trespassers	Recreation	Food[3]
Groundwater	No	No	No	Yes	No	No	No
Air (indoors)	No	Yes	No	No	No	No	No
Soil (surface, e.g., <2 ft)	No	No	No	Yes	No	No	No
~~Surface Water~~							
Sediment	No	No	No	No	No	No	No
Soil (subsurface e.g., >2 ft)	No	No	No	Yes	No	No	No
~~Air (outdoors)~~							

[3] Indirect Pathway/Receptor (e.g., vegetables, fruits, crops, meat and dairy products, fish, shellfish, etc.)

Instructions for Summary Exposure Pathway Evaluation Table:

1. Strike-out specific Media including Human Receptors' spaces for Media which are not "contaminated") as identified in #2 above.

2. enter "yes" or "no" for potential "completeness" under each "Contaminated" Media -- Human Receptor combination (Pathway).

Note: In order to focus the evaluation to the most probable combinations some potential "Contaminated" Media - Human Receptor combinations (Pathways) do not have check spaces ("___"). While these combinations may not be probable in most situations they may be possible in some settings and should be added as necessary.

_____If no (pathways are not complete for any contaminated media-receptor combination) - skip to #6, and enter "YE" status code, after explaining and/or referencing condition(s) in-place, whether natural or man-made, preventing a complete exposure pathway from each contaminated medium (e.g., use optional Pathway Evaluation Work Sheet to analyze major pathways).

__**X**__If yes (pathways are complete for any "Contaminated" Media - Human Receptor combination) - continue after providing supporting explanation.

_____If unknown (for any "Contaminated" Media - Human Receptor combination) - skip to #6 and enter "IN" status code

Rationale and Reference(s):

Siberia Area

Groundwater

Groundwater at the SA contains concentrations of VOCs, presumed to be associated with a former Burn Pit, at concentrations greater than NYSDEC Class GA standards. Groundwater in some areas of the SA also contains visual evidence of petroleum contamination, although concentrations of regulated compounds are, for the most part, less than Class GA Standards. The material in the Burn Pit was excavated in 2000 as a source removal ICM. To prevent discharge of VOCs from the SA, an in-situ permeable iron reactive wall system, consisting of two walls, was constructed downgradient of the former Burn Pit to intercept and treat the VOCs remaining in the groundwater after the source removal. Subsequent monitoring has demonstrated that the reactive wall system is successfully preventing the discharge of VOCs from the SA. As such, there is no pathway for exposure to VOCs in groundwater leaving the SA. The LTM program has shown that contaminant concentrations in the SA are stable or decreasing – indicating no ongoing sources of contamination. In addition, since the WVA and all surrounding properties are serviced by public potable water supplies provided by the City of Watervliet and the Town of Colonie, there is no pathway for ingestion or contact with contaminated groundwater for all receptors except for the potential for occasional contact exposure by construction workers working in or around subsurface excavations.

Indoor Air

There is no known or suspected indoor air contamination at the SA. All buildings at the SA are slab-on-grade construction and none are located above areas of concern for soil and/or groundwater.

Surface Soil

The majority of the surface soil contaminated with petroleum hydrocarbons and/or metals has been removed or treated as part of the ICM conducted at the SA in 2002 and 2003. Areas of surface soil that could not be treated or removed are currently covered with clean fill or crushed stone and will be capped with an asphalt cap. As such, there is no exposure pathway for any of the remaining contaminants in the surface soil other than the potential for occasional contact exposure by construction workers working in or around subsurface excavations in the capped areas.

Surface Water

There are no permanent surface water bodies present in the SA. There are no known discharges of contaminants from the subsurface contamination in the SA to any of the surface water bodies surrounding the WVA.

Sediment

Contaminated sediment in the drainage ditch located adjacent to the SA was removed as part of the ICM conducted at the SA in 2002 and 2003. As such, there is no exposure pathway to any receptors associated with the sediment at the SA.

Subsurface Soil

The majority of the subsurface soil above the water table contaminated with petroleum hydrocarbons and/or metals has been removed or treated as part of the ICM conducted at the SA in 2002 and 2003. Areas of subsurface soil that could not be treated or removed will be capped with an asphalt cap. Contaminated soil still exists beneath the water table, however there is no exposure pathway for any of the remaining contaminants in the subsurface soil other than the potential for occasional contact exposure by construction workers working in or around subsurface excavations in the capped areas and/or below the water table.

Outdoor Air

There are no known discharges to outdoor air from the contaminants at the SA.

Main Manufacturing Area

Groundwater

Groundwater at the MMA contains concentrations of chlorinated VOCs, presumed to be associated with a former manufacturing operations, at concentrations greater than NYSDEC Class GA standards. Groundwater in some areas of the MMA also contains visual evidence of petroleum contamination, although concentrations of regulated compounds are, for the most part, less than Class GA Standards. Chlorinated VOC groundwater contamination is present in the Building 40 area (bedrock groundwater), Building 25 area (bedrock and overburden groundwater), and in the area of the former hazardous materials storage area. Petroleum contamination is present in the bedrock groundwater in the Building 110/35 area and in the Building 135 area. VOCs in the groundwater in the Building 25 area are currently being treated using enhanced bioremediation under an ICM Pilot project. VOCs in the groundwater in the Building 40 area are currently treated as part of an ICM utilizing in-situ chemical oxidation. Petroleum contamination in the groundwater in the Building 110/35/135 areas is being collected through the pumping of process pits located in these buildings. The LTM program has shown that contaminant concentrations in the MMA are stable or decreasing – indicating no ongoing sources of contamination. Since the WVA and all surrounding properties are serviced by public potable water supplies provided by the City of Watervliet and the Town of Colonie, there is no pathway for ingestion or contact with contaminated groundwater for all receptors except for the potential for occasional contact exposure by construction workers working in or around subsurface excavations in the Building 25 area and the Building 110/35/135 area, and in the process pits in Buildings 110/35/135. There is no viable receptor pathway for the VOC contamination in the Building 40 and hazardous materials storage area since the contamination is located at depth within the bedrock groundwater.

Indoor Air

Low concentrations of chlorinated VOCs are present in the small basement area of Building 40 and on the first floor. As such, there is a potential pathway for exposure.

Surface Soil

Surface soil at the MMA is currently inaccessible to WVA workers and visitors due to buildings, asphalt or concrete pavement, or sufficient vegetative cover (i.e., grass lawn). Thus, the only potential receptor that may contact soil would be construction/utility workers conducting activities requiring excavation into the soil in the future.

Surface Water

There are no permanent surface water bodies present in the MMA. There is no known surface water contamination associated with the potential discharge of contaminants in the groundwater in the MMA to the surrounding surface water bodies.

Sediment

There are no surface water bodies within the WVA boundaries. There is no known or suspected sediment contamination in the surrounding water bodies associated with the groundwater or soil contamination at the MMA.

Subsurface Soil

Subsurface soil at the MMA is currently inaccessible to WVA workers and visitors due to buildings, asphalt or concrete pavement, or sufficient vegetative cover (i.e., grass lawn). Thus, the only potential receptor that may contact soil would be construction/utility workers conducting activities requiring excavation into the soil in the future.

Outdoor Air

There are no known discharges to outdoor air from the contaminants at the MMA.

References:

- *Final RCRA Facility Investigation Report, Siberia Area, Watervliet Arsenal, Watervliet, New York*, December 1997.
- *Corrective Measures Study Field Data Report, Siberia Area, Watervliet Arsenal, Watervliet, New York*, October 1998.
- *Final RCRA Facility Investigation Report, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York*, August 1999.
- *Summary Report, Ambient Air and Soil Gas Sampling, Building 40 Basement Area, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York*, April 2003
- *Final Exposure Assessment, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York*, May 2003.
- *Final Exposure Assessment, Siberia Area, Watervliet Arsenal, Watervliet, New York,* December 1998
- *Work Plan for Building 25 and Building 40 Pilot Studies, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York,* December 2001.
- *Long-Term Monitoring Data Summary Report, Watervliet Arsenal, Watervliet, New York,* February 2002.
- *Final Interim Corrective Measures Work Plan for Siberia Area Soil, Siberia Area, Watervliet Arsenal, Watervliet, New York,* November 2002.
- *Draft Corrective Measures Study, Siberia Area, Watervliet Arsenal, Watervliet, New York,* June 2003

4. Can the **exposures** from any of the complete pathways identified in #3 be reasonably expected to be **"significant"**[4] (i.e., potentially "unacceptable" because exposures can be reasonably expected to be: 1) greater in magnitude (intensity, frequency and/or duration) than assumed in the derivation of the acceptable "levels" (used to identify the "contamination"); or 2) the combination of exposure magnitude (perhaps even though low) and contaminant concentrations (which may be substantially above the acceptable "levels") could result in greater than acceptable risks)?

   X If no (exposures can not be reasonably expected to be significant (i.e., potentially "unacceptable") for any complete exposure pathway) - skip to #6 and enter "YE" status code after explaining and/or referencing documentation justifying why the exposures (from each of the complete pathways) to "contamination" (identified in #3) are not expected to be "significant."

   _____ If yes (exposures could be reasonably expected to be "significant" (i.e., potentially "unacceptable") for any complete exposure pathway) - continue after providing a description (of each potentially "unacceptable" exposure pathway) and explaining and/or referencing documentation justifying why the exposures (from each of the remaining complete pathways) to "contamination" (identified in #3) are not expected to be "significant."

   _____ If unknown (for any complete pathway) - skip to #6 and enter "IN" status code

   Rationale and Reference(s):

   Although Human Health and Ecological Exposure Assessments performed for the MMA and SA have identified the potential for exposures to construction/utility workers conducting activities requiring excavation into the subsurface soil in the future, and for utility workers to indoor air in the Building 40 basement, none of these exposures is deemed to be 'significant'. In addition, there is an indoor air

exposure to occupants on the first floor. None of these exposures are deemed to be "significant" for the following reasons:

- Subsurface construction/utility work is not a frequent activity at the WVA. As such, the potential for exposure, and potential exposure periods, are limited. In addition, construction/utility workers working in subsurface excavations at the Arsenal are required to follow a Health and Safety Plan during work activities. This plan includes the use of the appropriate personal protective equipment (PPE) and monitoring equipment.

- Low concentrations of chlorinated VOCs are present in the small basement area of Building 40 and on the first floor. As such, there is a potential exposure pathway. However, workers do not enter the building basement except during exceptional circumstances when maintenance is required so total annual exposures are not expected to be significant. The VOC concentrations on the first floor air are slightly above typical background values. Furthermore, it is uncertain whether these levels are related to the groundwater contamination beneath the building.

To address this concern, WVA will be requested to investigate the relationship of the VOCs in the indoor air and the groundwater plume. They will also be notified that, although occupational standards are appropriate for certain exposures in the workplace setting, for workplace settings in which the exposures are related to environmental sources rather than manufacturing processes, NYSDEC and NYSDOH believe that the risk guidelines established by the United States Environmental Protection Agency are also relevant. As such they should strive to minimize exposures in such settings to levels comparable to background values and to notify employees of those exposures that cannot be eliminated.

References:

- *Final Exposure Assessment, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York*, May 2003.
- *Final Exposure Assessment, Siberia Area, Watervliet Arsenal, Watervliet, New York,* December 1998

[4] If there is any question on whether the identified exposures are "significant" (i.e., potentially "unacceptable") consult a human health Risk Assessment specialist with appropriate education, training and experience.

5 Can the "significant" **exposures** (identified in #4) be shown to be within **acceptable** limits?

_____ If yes (all "significant" exposures have been shown to be within acceptable limits) - continue and enter "YE" after summarizing and referencing documentation justifying why all "significant" exposures to "contamination" are within acceptable limits (e.g., a site-specific Human Health Risk Assessment).

_____ If no (there are current exposures that can be reasonably expected to be "unacceptable")- continue and enter "NO" status code after providing a description of each potentially "unacceptable" exposure.

_____ If unknown (for any potentially "unacceptable" exposure) - continue and enter "IN" status code

Rationale and Reference(s):

N/A

6. Check the appropriate RCRIS status codes for the Current Human Exposures Under Control EI event code (CA725), and obtain Supervisor (or appropriate Manager) signature and date on the EI determination below (and attach appropriate supporting documentation as well as a map of the facility):

__X__ YE - Yes, "Current Human Exposures Under Control" has been verified. Based on a review of the information contained in this EI Determination, "Current Human Exposures" are expected to be "Under Control" at the *Watervliet Arsenal, EPA ID # NY7213820940, located at Broadway, Watervliet, New York* under current and reasonably expected conditions. This determination will be re-evaluated when the Agency/State becomes aware of significant changes at the facility.

____ NO - "Current Human Exposures" are NOT "Under Control."

____ IN - More information is needed to make a determination.

Approved by: Victor Valaitis Date: 9/30/03

Victor Valaitis
Environmental Engineer II
New York State Department of Environmental Conservation (NYSDEC)

And Daniel J Evans Date:9/30/03

Daniel J. Evans
Chief, Hazardous Waste Engineering Eastern Section
NYSDEC

Supervisor: E C Dassatti Date: 9/30/03

Edwin Dassatti
Director, Bureau of Hazardous Waste and Radiation Management
NYSDEC

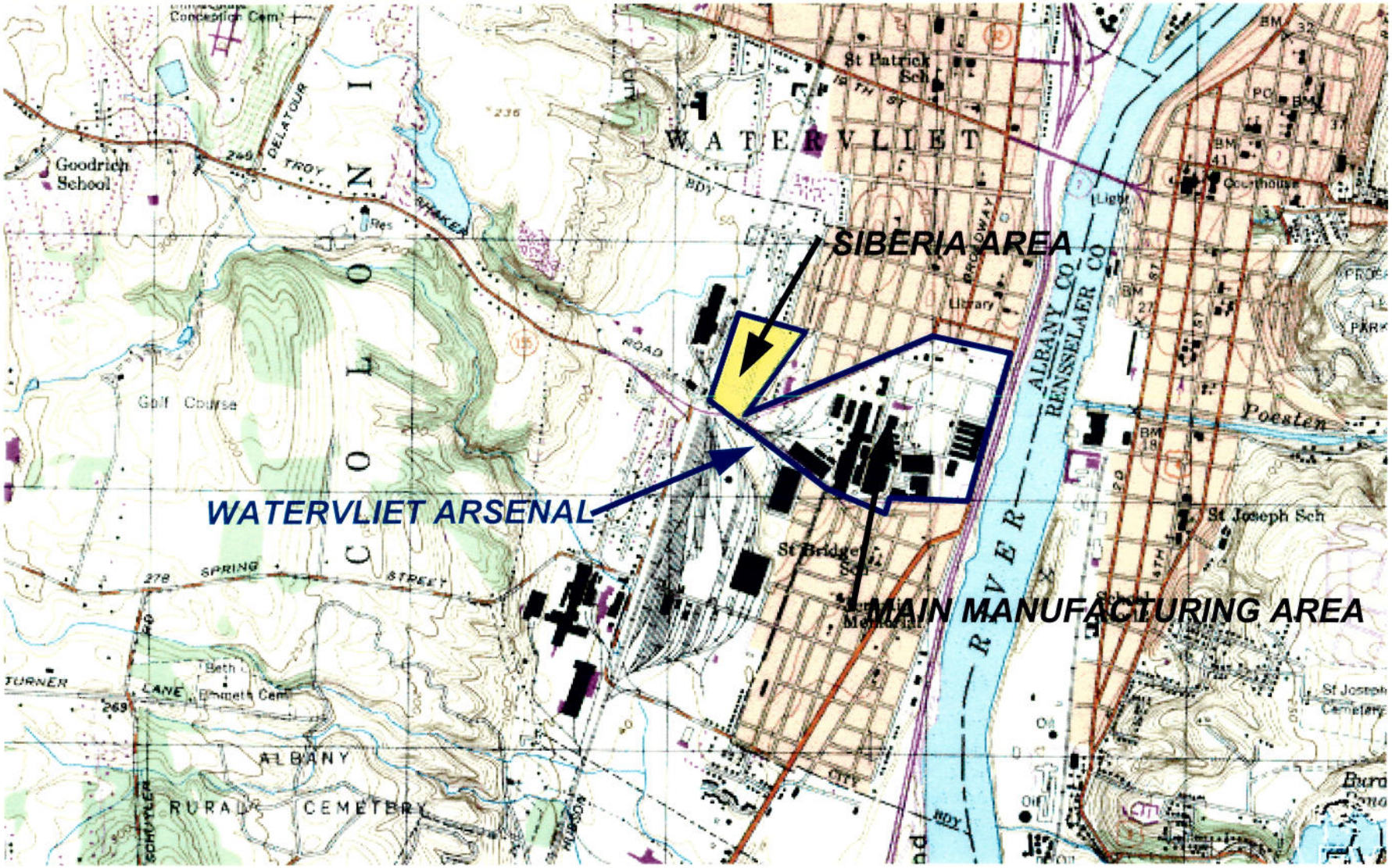
Locations where References may be found:

NYSDEC
Division of Solid and Hazardous Materials
625 Broadway
Albany, NY 12233-7258

Contact telephone and e-mail numbers

Victor Valaitis (518) 402-8594 E-Mail: vavalait@gw.dec.state.ny.us

FINAL NOTE: THE HUMAN EXPOSURES EI IS A QUALITATIVE SCREENING OF EXPOSURES AND THE DETERMINATIONS WITHIN THIS DOCUMENT SHOULD NOT BE USED AS THE SOLE BASIS FOR RESTRICTING THE SCOPE OF MORE DETAILED (E.G., SITE-SPECIFIC) ASSESSMENTS OF RISK.



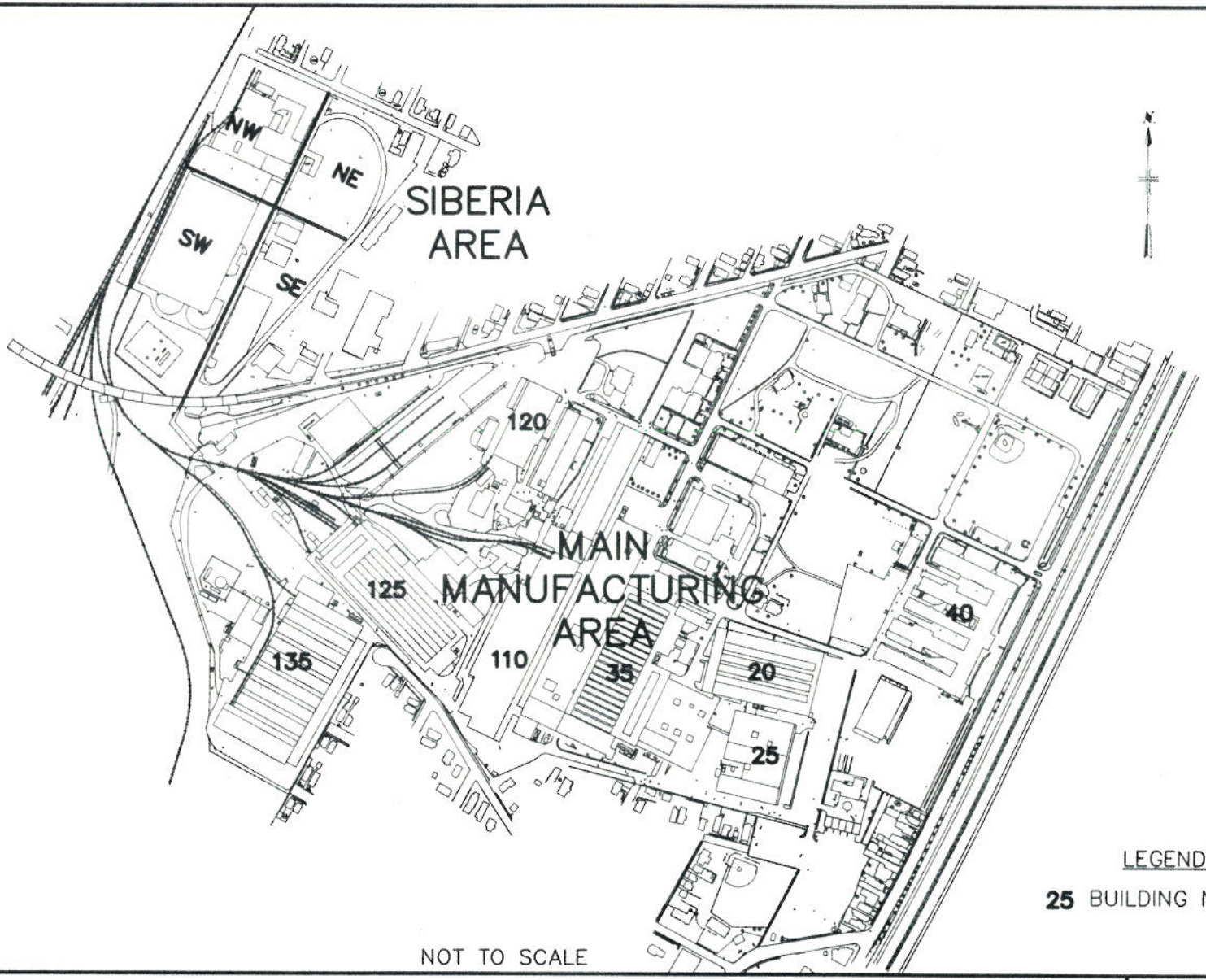
SOURCE: U.S.G.S 7.5 MIN. TROY SOUTH QUADRANGLE

US Army Corps of Engineers
Baltimore District

SITE LOCATION

WATERVLIET ARSENAL,
WATERVLIET, NEW YORK

FIGURE 1



NOT TO SCALE

US Army Corps of Engineers

SITE PLAN

WATERVLIET ARSENAL
WATERVLIET, NEW YORK

MALCOLM PIRNIE, INC.

FIGURE 2

XREF: I:\ACAD\PROJ\0285\BERGER2\BASEWIDE

Table 1
Summary of Detected Compounds in Soil Samples
Siberia Area
Watervliet Arsenal, Watervliet, New York

Compound	Units	Range of Detected Concentrations	
		Minimum	Maximum
Semi-Volatile Compounds			
1,2-Dichlorobenzene	ug/kg	25	630
2,6-Dinitrotoluene	ug/kg	220	220
2-Methylnaphthalene	ug/kg	12	82000
3,3'-Dichlorobenzidine	ug/kg	78	170
4-Chloro-3-methylphenol	ug/kg	10	10
Acenaphthene	ug/kg	7	16000
Acenaphthylene	ug/kg	5	4400
Anthracene	ug/kg	6	13000
Benzidine	ug/kg	270	270
Benzo(a)anthracene	ug/kg	5	51000
Benzo(a)pyrene	ug/kg	7	58000
Benzo(b)fluoranthene	ug/kg	3	79000
Benzo(g,h,i)perylene	ug/kg	7	17000
Benzo(k)fluoranthene	ug/kg	2	51000
bis(2-Ethylhexyl)phthalate	ug/kg	12	4600
Butylbenzylphthalate	ug/kg	4	42
Chrysene	ug/kg	8	63000
Dibenzo(a,h)anthracene	ug/kg	2	15000
Diethylphthalate	ug/kg	6	260
Di-n-butylphthalate	ug/kg	7	180
Di-n-octylphthalate	ug/kg	31	160
Fluoranthene	ug/kg	6	150000
Fluorene	ug/kg	11	26000
Indeno(1,2,3-cd)pyrene	ug/kg	6	41000
Naphthalene	ug/kg	9	36000
Pentachlorophenol	ug/kg	31	290
Phenanthrene	ug/kg	6	89000
Pyrene	ug/kg	8	180000
Volatile Compounds			
1,1,2,2-Tetrachloroethane	ug/kg	1	1
1,1-Dichloroethene	ug/kg	1	1
1,2-Dichloroethene (total)	ug/kg	300	300
2-Butanone	ug/kg	1	2100
4-Methyl-2-Pentanone	ug/kg	2	2
Benzene	ug/kg	0.5	24
Carbon Disulfide	ug/kg	0.6	19
Chlorobenzene	ug/kg	1	1
Chloroethane	ug/kg	4	4
Chloroform	ug/kg	0.6	19
cis-1,2-Dichloroethene	ug/kg	0.9	76
cis-1,3-Dichloropropene	ug/kg	2100	2100
Ethylbenzene	ug/kg	0.5	160
Methylene Chloride	ug/kg	0.7	190
Tetrachloroethene	ug/kg	0.3	17000
Toluene	ug/kg	0.4	310
trans-1,2-Dichloroethene	ug/kg	2	2
Trichloroethene	ug/kg	0.8	880
Vinyl Chloride	ug/kg	6	6
Xylene (total)	ug/kg	0.2	1700
Inorganic Compounds			
Arsenic	mg/kg	2.8	42.1
Barium	mg/kg	23.8	439
Cadmium	mg/kg	0.21	23.8
Chromium	mg/kg	9.7	2490
Lead	mg/kg	4.2	2530
Mercury	mg/kg	0.089	4
Selenium	mg/kg	0.78	30.1
Silver	mg/kg	0.24	10.5

Table 2
Summary of Detected VOCs in Groundwater Samples
Siberia Area
Watervliet Arsenal, Watervliet, New York

Compound	Units	NYSDEC Class GA Standard	Range of Detected Concentrations	
			Minimum	Maximum
1,1,1-Trichloroethane	ug/l		0.2	22
1,1,2,2-Tetrachloroethane	ug/l	5	0.2	12
1,1,2-Trichloroethane	ug/l		1	4
1,1-Dichloroethene	ug/l	5	0.7	14
1,2-Dichloroethane	ug/l	5	0.5	0.5
2-Butanone	ug/l	50	0.3	99
4-Methyl-2-Pentanone	ug/l		0.6	52
Acetone	ug/l	50	10	10
Benzene	ug/l	1	0.3	35
Bromodichloromethane	ug/l	50	0.5	5
Bromoform	ug/l	50	0.1	2
Bromomethane	ug/l	5	0.1	2
Carbon disulfide	ug/l		0.1	30
Chlorobenzene	ug/l	5	0.6	4
Chloroform	ug/l	7	0.7	18
Chloromethane	ug/l		0.5	3
cis-1,2-Dichloroethene	ug/l	5	0.4	11,000
Dibromochloromethane	ug/l	50	0.6	9
Ethylbenzene	ug/l	5	0.1	7
Methylene chloride	ug/l		0.2	200
Tetrachloroethene	ug/l	5	0.2	21,000
Toluene	ug/l	5	0.1	10
trans-1,2-Dichloroethene	ug/l	5	0.4	26
trans-1,3-Dichloropropene	ug/l	5	0.5	0.5
Trichloroethene	ug/l	5	0.2	1,800
Trichlorofluoromethane	ug/l	5	0.2	10
Vinyl chloride	ug/l	2	0.4	2,600
Xylene (total)	ug/l	5	0.2	43

Table 3
Summary of Detected SVOCs in Groundwater Samples
Siberia Area
Watervliet Arsenal, Watervliet, New York

Compound	Units	NYSDEC Class GA Standard	Range of Detected Concentrations	
			Minimum	Maximum
1,2,4-Trichlorobenzene	ug/l	5	0.1	0.6
1,4-Dichlorobenzene	ug/l		0.2	1
2,4-Dimethylphenol	ug/l		0.2	0.8
2-Methylnaphthalene	ug/l		0.2	8
4-Chloro-3-methylphenol	ug/l		2	2
Acenaphthene	ug/l	20	0.06	5
Anthracene	ug/l	50	0.04	2
Benzo(a)anthracene	ug/l	0.002	0.07	2
Benzo(a)pyrene	ug/l	ND	0.03	0.3
Benzo(b)fluoranthene	ug/l	0.002	0.1	0.3
Benzo(g,h,i)perylene	ug/l		0.08	0.2
Benzo(k)fluoranthene	ug/l	0.002	0.09	0.3
bis(2-Ethylhexyl)phthalate	ug/l	50	0.08	210
Butylbenzylphthalate	ug/l	50	0.06	0.7
Chrysene	ug/l	0.002	0.08	3
Diethylphthalate	ug/l	50	0.06	8
Di-n-butylphthalate	ug/l	50	0.09	2
Di-n-octylphthalate	ug/l	50	0.04	0.9
Fluoranthene	ug/l	50	0.04	8
Fluorene	ug/l	50	0.5	7
Indeno(1,2,3-cd)pyrene	ug/l	0.002	0.07	0.1
Naphthalene	ug/l	10	0.05	19
N-Nitrosodiphenylamine	ug/l	50	0.3	3
Phenanthrene	ug/l	50	0.03	12
Phenol	ug/l	1	0.06	2
Pyrene	ug/l	50	0.04	25

Table 4
Summary of Detected Compounds in Soil Samples
Main Manufacturing Area
Watervliet Arsenal, Watervliet, New York

Compound	Units	Range of Detected Concentrations	
		Minimum	Maximum
Semi-Volatile Organic Compounds			
2-Methylnaphthalene	ug/kg	10	8,600
4-Chloro-3-methylphenol	ug/kg	160	260
Acenaphthene	ug/kg	4	30,000
Acenaphthylene	ug/kg	10	1,800
Anthracene	ug/kg	5	30,000
Benzo(a)anthracene	ug/kg	2	20,000
Benzo(a)pyrene	ug/kg	2	14,000
Benzo(b)fluoranthene	ug/kg	2	11,000
Benzo(g,h,i)perylene	ug/kg	7	9,900
Benzo(k)fluoranthene	ug/kg	2	12,000
bis(2-Ethylhexyl)phthalate	ug/kg	24	6,800
Butylbenzylphthalate	ug/kg	13	750
Chrysene	ug/kg	2	27,000
Di-n-butylphthalate	ug/kg	6	2,500
Di-n-octyl phthalate	ug/kg	6	97
Dibenzo(a,h)anthracene	ug/kg	10	950
Diethylphthalate	ug/kg	6	530
Fluoranthene	ug/kg	2	58,000
Fluorene	ug/kg	11	47,000
Indeno(1,2,3-cd)pyrene	ug/kg	11	7,900
Naphthalene	ug/kg	5	1,600
Phenanthrene	ug/kg	6	140,000
Pyrene	ug/kg	4	58,000
Total benzofluoranthene	ug/kg	175	3,600
Volatile Organic Compounds			
1,1,1-Trichloroethane	ug/kg	2	18
1,1-Dichloroethane	ug/kg	1	1
1,2-Dichloroethene (total)	ug/kg	4	115
2-Butanone	ug/kg	5	39
Benzene	ug/kg	0.6	3
Bromodichloromethane	ug/kg	240	240
Carbon Disulfide	ug/kg	0.6	30
Chloroform	ug/kg	2	1,800
cis-1,2-Dichloroethene	ug/kg	2	78
Ethylbenzene	ug/kg	2	3
Methylene Chloride	ug/kg	1	18
Tetrachloroethene	ug/kg	2	25
Toluene	ug/kg	1	40
Trichloroethene	ug/kg	2	430
Vinyl Acetate	ug/kg	2	2
Vinyl Chloride	ug/kg	15	15
Xylene (total)	ug/kg	3	26
Inorganic Compounds			
Arsenic	mg/kg	1.3	111
Barium	mg/kg	44.7	2910
Cadmium	mg/kg	0.38	5
Chromium	mg/kg	8.9	237
Lead	mg/kg	7.2	17800
Mercury	mg/kg	0.094	0.84
Selenium	mg/kg	0.32	10.5
Silver	mg/kg	0.21	2

Table 5
Summary of Detected SVOCs in Groundwater Samples
Main Manufacturing Area
Watervliet Arsenal, Watervliet, New York

Compound	Units	NYSDEC Class GA Standard	Range of Detected Concentrations	
			Minimum	Maximum
2 6-Dinitrotoluene	ug/l	5	55	55
2,4-Dimethylphenol	ug/l		0.2	0.2
2-Methylnaphthalene	ug/l		0.7	2
4-Chloro-3-methylphenol	ug/l		0.6	890
Acenaphthylene	ug/l		0.1	16
Anthracene	ug/l	50	0.02	300
Benzo(a)anthracene	ug/l	0.002	0.8	360
Benzo(a)pyrene	ug/l	ND	0.1	140
Benzo(b)fluoranthene	ug/l	0.002	0.09	190
Benzo(g,h,i)perylene	ug/l		32	32
Benzo(k)fluoranthene	ug/l	0.002	0.06	200
bis(2-Ethylhexyl)phthalate	ug/l	50	0.1	4,200
Butylbenzylphthalate	ug/l	50	0.08	2
Chrysene	ug/l	0.002	0.2	310
Dibenzo(a,h)anthracene	ug/l		10	10
Diethylphthalate	ug/l	50	0.05	8
Dimethyl phthalate	ug/l	50	0.8	2
Di-n-butylphthalate	ug/l	50	0.07	60
Di-n-octylphthalate	ug/l	50	0.03	240
Fluoranthene	ug/l	50	0.06	6,900
Fluorene	ug/l	50	0.09	1,600
Indeno(1,2,3-cd)pyrene	ug/l	0.002	27	86
Napthalene	ug/l	10	0.05	2
N-Nitrosodiphenylamine	ug/l	50	0.5	0.5
Pentachlorophenol	ug/l	1	3	3
Phenanthrene	ug/l	50	0.04	2,600
Phenol	ug/l	1	0.04	3
Pyrene	ug/l	50	0.04	5,300

Table 6
Summary of Detected VOCs in Groundwater Samples
Main Manufacturing Area
Watervliet Arsenal, Watervliet, New York

Compound	Units	NYSDEC Class GA Standard	Range of Detected Concentrations	
			Minimum	Maximum
1,1,1-Trichloroethane	ug/l		0.5	100
1,1,2,2-Tetrachloroethane	ug/l	5	0.4	4
1,1-Dichloroethane	ug/l	5	0.5	26
1,1-Dichloroethene	ug/l	5	0.4	9
2-Butanone (MEK)	ug/l	50	0.8	17,000
2-Chloroethylvinylether	ug/l		5	5
4-Methyl-2-Pentanone	ug/l		0.5	8
Benzene	ug/l	1	0.3	47
Bromodichloromethane	ug/l	50	2	5
Bromomethane	ug/l	5	0.5	2
Carbon disulfide	ug/l		0.3	22
Carbon Tetrachloride	ug/l	5	5	5
Chlorobenzene	ug/l	5	0.2	600
Chloroethane	ug/l	5	5	7
Chloroform	ug/l	7	0.2	630
cis-1,2-Dichloroethene	ug/l	5	0.3	12,000
Dibromochloromethane	ug/l	50	0.8	1
Ethylbenzene	ug/l	5	0.4	1
Methylene Chloride	ug/l		0.2	1,400
Tetrachloroethene	ug/l	5	0.4	110,000
Toluene	ug/l	5	0.1	2
trans-1,2-Dichloroethene	ug/l	5	0.3	80
Trichloroethene	ug/l	5	0.2	15,000
Trichlorofluoromethane	ug/l	5	2	5
Vinyl Chloride	ug/l	2	0.3	8,300
Xylene (total)	ug/l	5	0.3	2