DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

RCRA Corrective Action
Environmental Indicator (EI) RCRIS code (CA750)
Migration of Contaminated Groundwater 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.*

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 "Migration of Contaminated Groundwater Under Control" EI

A positive "Migration of Contaminated Groundwater Under Control" EI determination ("YE" status code) indicates that the migration of "contaminated" groundwater has stabilized, and that monitoring will be conducted to confirm that contaminated groundwater remains within the original "area of contaminated groundwater" (for all groundwater "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 "Migration of Contaminated Groundwater Under Control" EI pertains ONLY to the physical migration (i.e., further spread) of contaminated ground water and contaminants within groundwater (e.g., non-aqueous phase liquids or NAPLs). Achieving this EI does not substitute for achieving other stabilization or final remedy requirements and expectations associated with sources of contamination and the need to restore, wherever practicable, contaminated groundwater to be suitable for its designated current and future uses.

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).

1. Has **all** available relevant/significant information on known and reasonably suspected releases to the groundwater media, 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 #8 and enter"IN" (more information needed) status code.

2. Is **groundwater** known or reasonably suspected to be **"contaminated"**[1] above appropriately protective "levels" (i.e., applicable promulgated standards, as well as other appropriate standards, guidelines, guidance, or criteria) from releases subject to RCRA Corrective Action, anywhere at, or from, the facility?

__X__ If yes - continue after identifying key contaminants, citing appropriate "levels," and referencing supporting documentation.

_____ If no - skip to #8 and enter "YE" status code, after citing appropriate "levels," and referencing supporting documentation to demonstrate that groundwater is not "contaminated."

_____ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):

Facility Description

The Watervliet Arsenal (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. Residential and light commercial properties are located along the northern and southern site boundaries. To the west are residential properties and unused manufacturing facilities including Perfection Plating, which formerly manufactured metal plates for brake pads and is currently under remediation by the New York State Department of Environmental Conservation (NYSDEC). A site location map is attached as Figure 1. WVA is an active U.S. Army facility. Tenant activities include; Benet Laboratories, a U.S. Army Health Clinic, elements of the New York Army National Guard (NYARNG), Sunmark Federal Credit Union, Hartchrom, Extreme Moulding, Applied Nano Works, Sonic, Zander Company Elmhurst, Solid Sealing Technologies and recruiting offices for the U.S. Army, the U.S. Marine Corps and the 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

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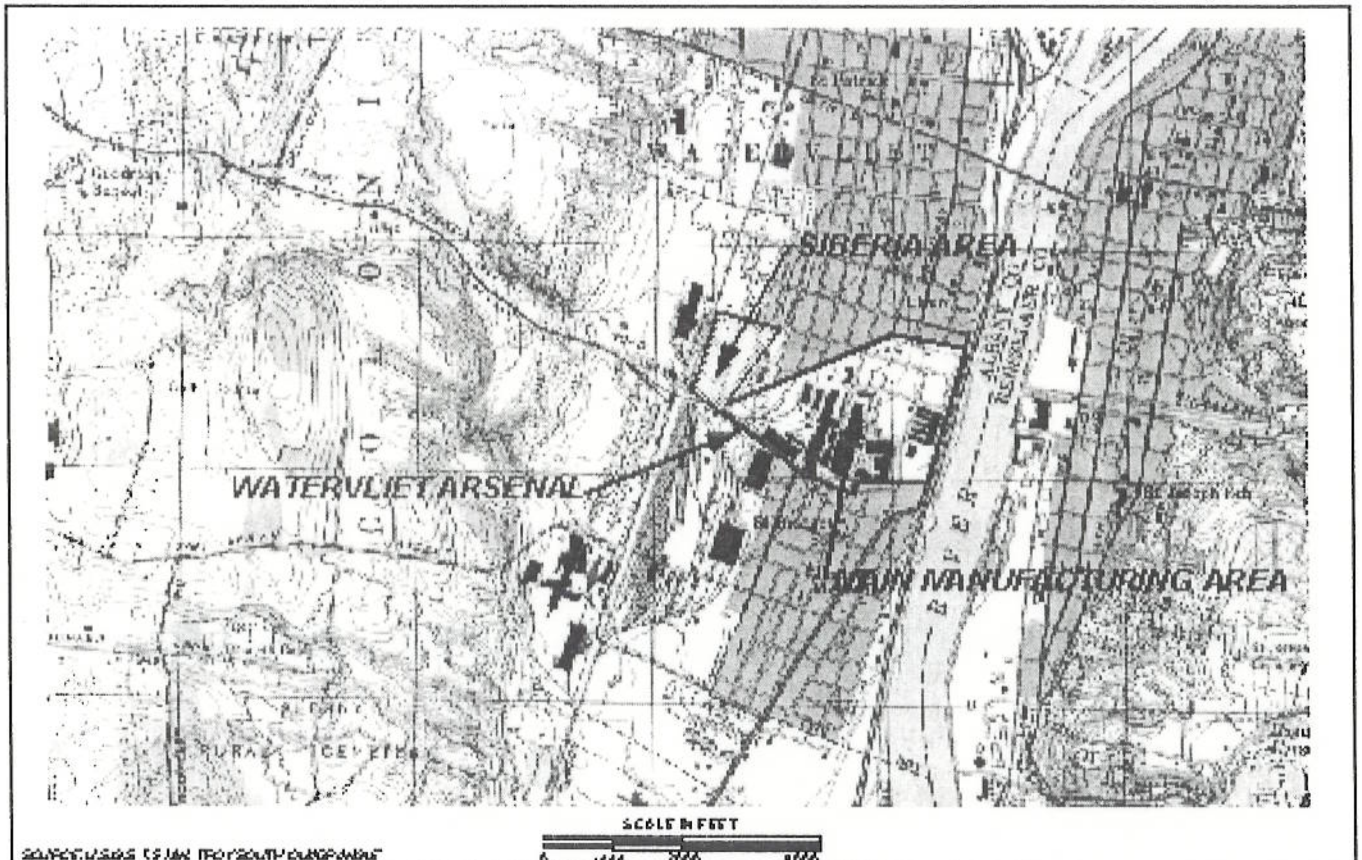
[1] "Contamination" and "contaminated" describes media containing contaminants (in any form, NAPL and/or dissolved, vapors, or solids, that are subject to RCRA) in concentrations in excess of appropriate "levels" (appropriate for the protection of the groundwater resource and its beneficial uses).

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 (MMA)

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.

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.



SITE LOCATION
WATERVLIET ARSENAL,
WATERVLIET, NEW YORK

FIGURE 1

1


LEGEND
25 BUILDING NUMBER
FIGURE 2
SIBERIA AREA
MAIN MANUFACTURING AREA
NE
NW
SE
SW
40
20
25
35
110
120
125
135
NOT TO SCALE
SITE PLAN
WATERVLIET ARSENAL
WATERVLIET, NEW YORK
US Army Corps of Engineers

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 MMA. SA 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 SA, 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. SA 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 MMA 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 MMA, 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.

SA was wetland prior to being filled during the 1940s. Today, SA is generally underlain by fill (sand, shale fragments, slag, cinders, brick, wire, wood, and concrete). During site investigations in SA, 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 MMA 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 MMA. 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 the 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 MMA is primarily controlled by both the bedrock topography and the degree of fracturing within the bedrock.

Groundwater in the SA generally flows west to the Kromma Kill and an unnamed tributary to the northwest. Groundwater level data indicate that the SA 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 (USEPA), 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 USEPA-approved work plans. At the time of writing, the Corrective Measures Study (CMS) for the SA has been completed and is under review. The CMS for the MMA 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.

Maximum contaminant concentration and other descriptive environmental data cited in this EI are levels from September of 2003.

Nature and Extent of Groundwater Contamination

Siberia Area

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. Semi-Volatile Organic Compounds (SVOCs) detected in groundwater at the SA are summarized in Table 1. Polycyclic Aromatic Hydrocarbons (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(k)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 Volatile Organic Compounds (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 2. 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 Table 3 below, VOCs were primarily detected in the shallow bedrock at monitoring well SA-MW-41.

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

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 4 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 5. 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)

Table 1
Summary of VOCs in Groundwater - Siberia Area - Watervliet Arsenal

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 2.
Summary of Detected VOCs in Groundwater Samples Siberia Area Watervliet Arsenal

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 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

Table 4
Summary of Detected SVOCs in Groundwater Samples
Main Manufacturing Area Watervliet Arsenal

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 5
Summary of Detected VOCs in Groundwater Samples
Main Manufacturing Area Watervliet Arsenal

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

3. Has the **migration** of contaminated groundwater **stabilized** (such that contaminated groundwater is expected to remain within "existing area of contaminated groundwater"[2] as defined by the monitoring locations designated at the time of this determination)?

__X__ If yes - continue, after presenting or referencing the physical evidence (e.g., groundwater sampling/measurement/migration barrier data) and rationale why contaminated groundwater is expected to remain within the (horizontal or vertical) dimensions of the "existing area of groundwater contamination"[2]).

____ If no (contaminated groundwater is observed or expected to migrate beyond the designated locations defining the "existing area of groundwater contamination"[2]) - skip to #8 and enter "NO" status code, after providing an explanation.

____ If unknown - skip to #8 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. The LTM program has shown that contaminant concentrations in the SA are stable or decreasing – indicating no ongoing sources of contamination.

Main Manufacturing Area

Groundwater

Groundwater at the MMA has historically contained concentrations of chlorinated VOCs, petroleum contaminants, and SVOCs; presumed to be associated with a former manufacturing operations.

Chlorinated VOCs are found in groundwater at concentrations greater than NYSDEC Class GA standards in:

- the Building 40 area (bedrock groundwater),
- Building 25 area (bedrock and overburden groundwater), and
- Buildings 116 and 121 (the former hazardous materials storage area).

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[2] "existing area of contaminated groundwater" is an area (with horizontal and vertical dimensions) that has been verifiably demonstrated to contain all relevant groundwater contamination for this determination, and is defined by designated (monitoring) locations proximate to the outer perimeter of "contamination" that can and will be sampled/tested in the future to physically verify that all "contaminated" groundwater remains within this area, and that the further migration of "contaminated" groundwater is not occurring. Reasonable allowances in the proximity of the monitoring locations are permissible to incorporate formal remedy decisions (i.e., including public participation) allowing a limited area for natural attenuation.

Petroleum contamination is present in the bedrock groundwater around buildings 110, 35 and 135. Groundwater elsewhere in the MMA contains visual evidence of petroleum contamination, although concentrations of regulated compounds are, for the most part, less than Class GA Standards.

SVOC concentrations in samples collected from representative MMA monitoring wells have remained stable at low concentrations throughout the long-term monitoring program.

Currently the LTM program has shown that contaminant concentrations in the MMA are stable or decreasing – indicating no ongoing sources of contamination. Specifically:

- VOCs in the groundwater in the Building 40 area are being treated as part of an ICM utilizing in-situ chemical oxidation.
- VOCs in the groundwater in the Building 25 area are being treated using enhanced bioremediation under an ICM Pilot project.
- Data collected in the site-wide, long-term monitoring program shows that the CVOC contaminant concentrations in Buildings 116 and 121 (the former hazardous materials storage area) are generally decreasing; most likely due to the ongoing natural attenuation process.
- 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.

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.
- *Long-Term Monitoring Data Summary Report, Watervliet Arsenal, Watervliet, New York, May 2004.*

4. Does "contaminated" groundwater **discharge** into **surface water** bodies?

__X__ If yes - continue after identifying potentially affected surface water bodies.

_____ If no - skip to #7 (and enter a "YE" status code in #8, if #7 = yes) after providing an explanation and/or referencing documentation supporting that groundwater "contamination" does not enter surface water bodies.

_____ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):

Data suggests that VOC contaminated groundwater, from the area of building 40, is entering the Hudson River.

5. Is the **discharge** of "contaminated" groundwater into surface water likely to be **"insignificant"** (i.e., the maximum concentration[3] of each contaminant discharging into surface water is less than 10 times their appropriate groundwater "level," and there are no other conditions (e.g., the nature, and number, of discharging contaminants, or environmental setting), which significantly increase the potential for unacceptable impacts to surface water, sediments, or eco-systems at these concentrations)?

__X__ If yes - skip to #7 (and enter "YE" status code in #8 if #7 = yes), after documenting: 1) the maximum known or reasonably suspected concentration[3] of key contaminants discharged above their groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and 2) provide a statement of professional judgement/explanation (or reference documentation) supporting that the discharge of groundwater contaminants into the surface water is not anticipated to have unacceptable impacts to the receiving surface water, sediments, or eco-system.

_____ If no - (the discharge of "contaminated" groundwater into surface water is potentially significant) - continue after documenting: 1) the maximum known or reasonably suspected concentration[3] of each contaminant discharged above its groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and 2) for any contaminants discharging into surface water in concentrations[3] greater than 100 times their appropriate groundwater "levels," the estimated total amount (mass in kg/yr) of each of these contaminants that are being discharged (loaded) into the surface water body (at the time of the determination), and identify if there is evidence that the amount of discharging contaminants is increasing.

_____ If unknown - enter "IN" status code in #8.

Rationale and Reference(s):

Contaminated groundwater from the Building 40 area has historically migrated towards, and presumably into, the Hudson River. Groundwater that has already gone past the site boundary is likely to continue to migrate towards the river. WVA has recently initiated an innovative remedial program that has been shown to remove contaminants from the groundwater before they pass the site's Eastern property line. The program is also intended to

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[3]As measured in groundwater prior to entry to the groundwater-surface water/sediment interaction (e.g., hyporheic) zone.

destroy a significant proportion of the current, VOC contamination source in the bedrock beneath and around Building 40. This program, therefore, has curtailed the migration of any additional VOC contaminated groundwater from the site into the river and promises to create conditions to make this remedial effect permanent. The program is described below.

Rock core analytical data has shown that much of the VOC mass that initially migrated preferentially along the interconnected fracture network beneath building 40 is now present as dissolved and sorbed mass in the low permeability shale bedrock. Based on groundwater and rock core data collected to date, more than 99 percent of the VOC mass may be present in the rock matrix. The only truly effective remediation technologies for the fractured bedrock aquifer are those that will treat the VOC in the groundwater and the VOC mass in the rock matrix. Failure to do so will result in a long-term diffusive transfer of VOCs from the bedrock matrix into the groundwater at concentrations that continue to exceed USEPA Maximum Contaminant Limits (MCLs) or equivalent standards.

In order to address this conundrum, Watervliet arsenal has undertaken a long-term corrective measure that will inject permanganate into the contaminated bedrock for a period of no less than five years. This long injection time is intended to use the same diffusion process to move permanganate into the bedrock matrix. Once there, it will continue to destroy much of the rock-bound contaminant load and prevent future diffusive VOC migration from the rock.

In this, Watervliet Arsenal will be using a two part program to measure success. MCLs or equivalent standards are the required final corrective action objectives. Until these levels can be met, mass-based metrics (i.e., reduction of source mass and/or reduction in flux) will be used to evaluate efficacy. One of these metrics, contaminant flux, will be measured in a series of six, multi level wells along the property line. Each well has three monitoring zone, shallow, intermediate and deep. These wells, effectively monitor the full saturated thickness down to 150 feet across the entire contaminated area. By combining measurements of flow and contaminant concentration Watervliet Arsenal will be able to calculate contaminant flux along the property line.

The ideal situation is that permanganate will be present in all of the monitoring zones, indicating that there are no VOCs left to react with the permanganate and contaminants are no longer moving across the property line. Monitoring after the most recent period of injection has demonstrated that the injected permanganate does reach these wells so that contaminants no longer migrate off of the site. This condition will last throughout the entire 5 year injection period and will remain as long as the source reduction goals have been met.

References:

- *Andrew Vitolins, Malcolm Pierny Engineers - personal converation* September 2005.
- *Corrective Measures Work Plan - Bldg. 40 Bedrock Groundwater, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York.* July 2004.

6. Can the **discharge** of "contaminated" groundwater into surface water be shown to be "**currently acceptable**" (i.e., not cause impacts to surface water, sediments or eco-systems that should not be allowed to continue until a final remedy decision can be made and implemented[4])?

_____ If yes - continue after either: 1) identifying the Final Remedy decision incorporating these conditions, or other site-specific criteria (developed for the protection of the site's surface

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[4]Note, because areas of inflowing groundwater can be critical habitats (e.g., nurseries or thermal refugia) for many species, appropriate specialist (e.g., ecologist) should be included in management decisions that could eliminate these areas by significantly altering or reversing groundwater flow pathways near surface water bodies.

water, sediments, and eco-systems), and referencing supporting documentation demonstrating that these criteria are not exceeded by the discharging groundwater; OR 2) providing or referencing an interim-assessment,[5] appropriate to the potential for impact, that shows the discharge of groundwater contaminants into the surface water is (in the opinion of a trained specialists, including ecologist) adequately protective of receiving surface water, sediments, and eco-systems, until such time when a full assessment and final remedy decision can be made. Factors which should be considered in the interim-assessment (where appropriate to help identify the impact associated with discharging groundwater) include: surface water body size, flow, use/classification/habitats and contaminant loading limits, other sources of surface water/sediment contamination, surface water and sediment sample results and comparisons to available and appropriate surface water and sediment "levels," as well as any other factors, such as effects on ecological receptors (e.g., via bio-assays/benthic surveys or site-specific ecological Risk Assessments), that the overseeing regulatory agency would deem appropriate for making the EI determination.

____ If no - (the discharge of "contaminated" groundwater can not be shown to be "**currently acceptable**") - skip to #8 and enter "NO" status code, after documenting the currently unacceptable impacts to the surface water body, sediments, and/or eco-systems.

____ If unknown - skip to 8 and enter "IN" status code.

7. Will groundwater **monitoring** / measurement data (and surface water/sediment/ecological data, as necessary) be collected in the future to verify that contaminated groundwater has remained within the horizontal (or vertical, as necessary) dimensions of the "existing area of contaminated groundwater?"

__X__ If yes - continue after providing or citing documentation for planned activities or future sampling/measurement events. Specifically identify the well/measurement locations which will be tested in the future to verify the expectation (identified in #3) that groundwater contamination will not be migrating horizontally (or vertically, as necessary) beyond the "existing area of groundwater contamination."

____ If no - enter "NO" status code in #8.

____ If unknown - enter "IN" status code in #8.

Rationale and Reference(s):

Monitoring or perimeter wells is specified in the following reference.

Corrective Measures Work Plan - Bldg. 40 Bedrock Groundwater, Main Manufacturing Area, Watervliet Arsenal, Watervliet, New York. July 2004.

Figure 3 shows the location of the monitoring wells related to the IRM. The perimeter wells are multi-port samplers set to monitor shallow, intermediate and deep groundwater zones. They are shown on the map as MW-81, MW-82R, MW-8, MW-84R, MW-85R, and MW-86R.

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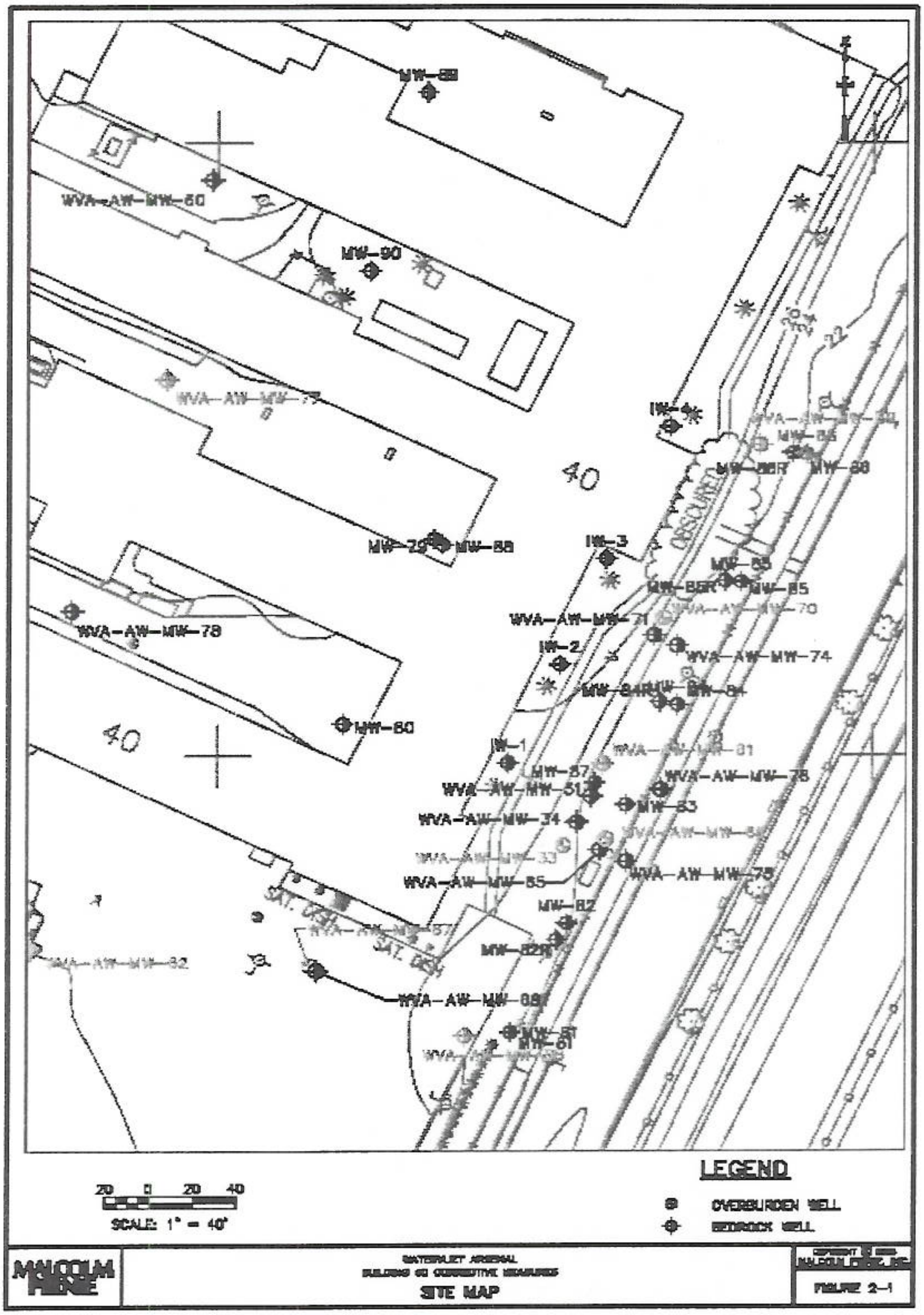
[5] The understanding of the impacts of contaminated groundwater discharges into surface water bodies is a rapidly developing field and reviewers are encouraged to look to the latest guidance for the appropriate methods and scale of demonstration to be reasonably certain that discharges are not causing currently unacceptable impacts to the surface waters, sediments or eco-systems.


WVA-AW-MW-60
MW-90
WVA-AW-MW-77
40
IW-4
MW-79
MW-88
IW-3
OBSCURED
WVA-AW-MW-71
WVA-AW-MW-74
IW-2
WVA-AW-MW-78
MW-60
40
IW-1
MW-87
WVA-AW-MW-51
WVA-AW-MW-34
MW-83
WVA-AW-MW-75
MW-82
MW-82R
LEGEND
OVERBURDEN WELL
BEDROCK WELL
20 0 20 40
SCALE: 1" = 40'
SITE MAP
FIGURE 2-1

8. Check the appropriate RCRIS status codes for the Migration of Contaminated Groundwater Under Control EI (event code CA750), and obtain Supervisor (or appropriate Manager) signature and date on the EI determination below (attach appropriate supporting documentation as well as a map of the facility).

X YE - Yes, "Migration of Contaminated Groundwater Under Control" has been verified. Based on a review of the information contained in this EI determination, it has been determined that the "Migration of Contaminated Groundwater" is "Under Control" at the Watervliet Arsenal facility, EPA ID # NY7213820940, located at Broadway, Watervliet New York. Specifically, this determination indicates that the migration of "contaminated" groundwater is under control, and that monitoring will be conducted to confirm that contaminated groundwater remains within the "existing area of contaminated groundwater" This determination will be re-evaluated when the Agency becomes aware of significant changes at the facility.

____ NO - Unacceptable migration of contaminated groundwater is observed or expected.

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

Completed by: [signature] Date: 9/28/05
Larry A. Rosenmann
Engineering Geologist II

Supervisor: Denise M. Radtke Date: 9/28/05
Denise Radtke
Chief, Engineering Geology Section

Director: [signature] Date: 9/28/05
Edwin Dassatti, P.E.
Bureau of Hazardous Waste and Radiation Management
Division of Solid & Hazardous Materials

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