National Plating, Inc.
Syracuse, New York

Voluntary Cleanup Program Investigation Work Plan

Former National Plating Facility
1501 Brewerton Road
Syracuse, New York
VCP ID: V00264-7

ENSR Corporation
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Document Number 10160-003-WP

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1.0 INTRODUCTION

The Volunteers have entered into a Voluntary Cleanup Agreement to investigate the property located at 1501 Brewerton Road in Syracuse, New York, which was formerly home to a metal plating facility.

This Work Plan has been developed to address concerns raised by the NYSDEC and meet three main goals:

- Identify contamination source areas;
- Delineate the areal and vertical extent and nature of impacts to the site; and
- Produce data of sufficient quality and quantity to support the development of a remedial work plan, should remediation be necessary.

The sampling activities described within this Work Plan will serve to characterize conditions at the site.

1.1 Site Background

The site was in use from the early 1950s to 2002 as a metal plating facility, which specialized in decorative and industrial metal finishing. National Plating was operated by its original owners until 1987, when the business and property were purchased the Volunteers, respectively. Between 1987 and 1989, various plant renovations were conducted, including upgrading the wastewater treatment system and installing monitoring systems. In 1999, the Volunteers sold the business. The plating operations were discontinued in 2002. The property is owned by D.J.H. Realty.

The building is currently being leased to Solvents and Petroleum Services, Inc. and is used for storage of cleaning supplies (i.e., hangers, laundry detergent, etc.).

1.2 Site Setting

The site is located in Syracuse, New York, approximately three miles northeast of Onondaga Lake (Figure 1-1).

Elevation at the site ranges from approximately 374 to 380 feet above mean sea level. The site slopes generally from the north-northeast to the south.

The property is bounded to the north by light industry, to the south by the former Town of Salina Landfill (a sub-site of the Onondaga Lake NPL site) and Ley Creek, to the west by the former Town of Salina Landfill, and to the east by Brewerton Road and residences. The northern boundary of the Ley Creek sewer right-of-way extends east-west across the site.

Geology

The site is located in a glacial terrain, characterized by flat-lying plains consisting of lacustrine fine sand and silt deposits; other glacial features evident in the region are moraines, drumlins, U-shaped valleys and meltwater channels. The meltwater channels consist of sands and gravels, which originally served to transmit large volumes of water at high velocities away from the glacier. In the Syracuse region, these channels form important water bearing and transmitting units that lie in an irregularly branching, net-like pattern throughout the area.

Bedrock in the Syracuse area includes Lower to Middle Paleozoic-age sedimentary rocks predominated by carbonates (dolostone and limestone) and shale, and containing some sandstone, siltstone, and evaporites. The bedrock beneath the site is the Silurian Vernon Shale, which exhibits low permeability but possesses secondary porosity due to fractures.

Hydrogeology

Investigations at the Town of Salina Landfill indicate that groundwater in the vicinity of the site is at an elevation of approximately 368 feet (approximately six feet below grade) and generally flows in a south-southwesterly direction towards Ley Creek.

No groundwater supply or monitoring wells are located on the site. The site is serviced by public water.

Surface Water Hydrology

Ley Creek is located approximately 350 feet south of the site and flows in a southwesterly direction. Groundwater generally flows in a south-southwesterly direction toward Ley Creek. Beartrap Creek lies approximately one mile west of the site. The confluence of Beartrap Creek and Ley Creek is downstream of the site. Surface water runoff is assumed to drain into either Ley Creek or municipal street sewers. Ley Creek is a tributary of Onondaga Lake, which lies approximately three miles southwest of the site.

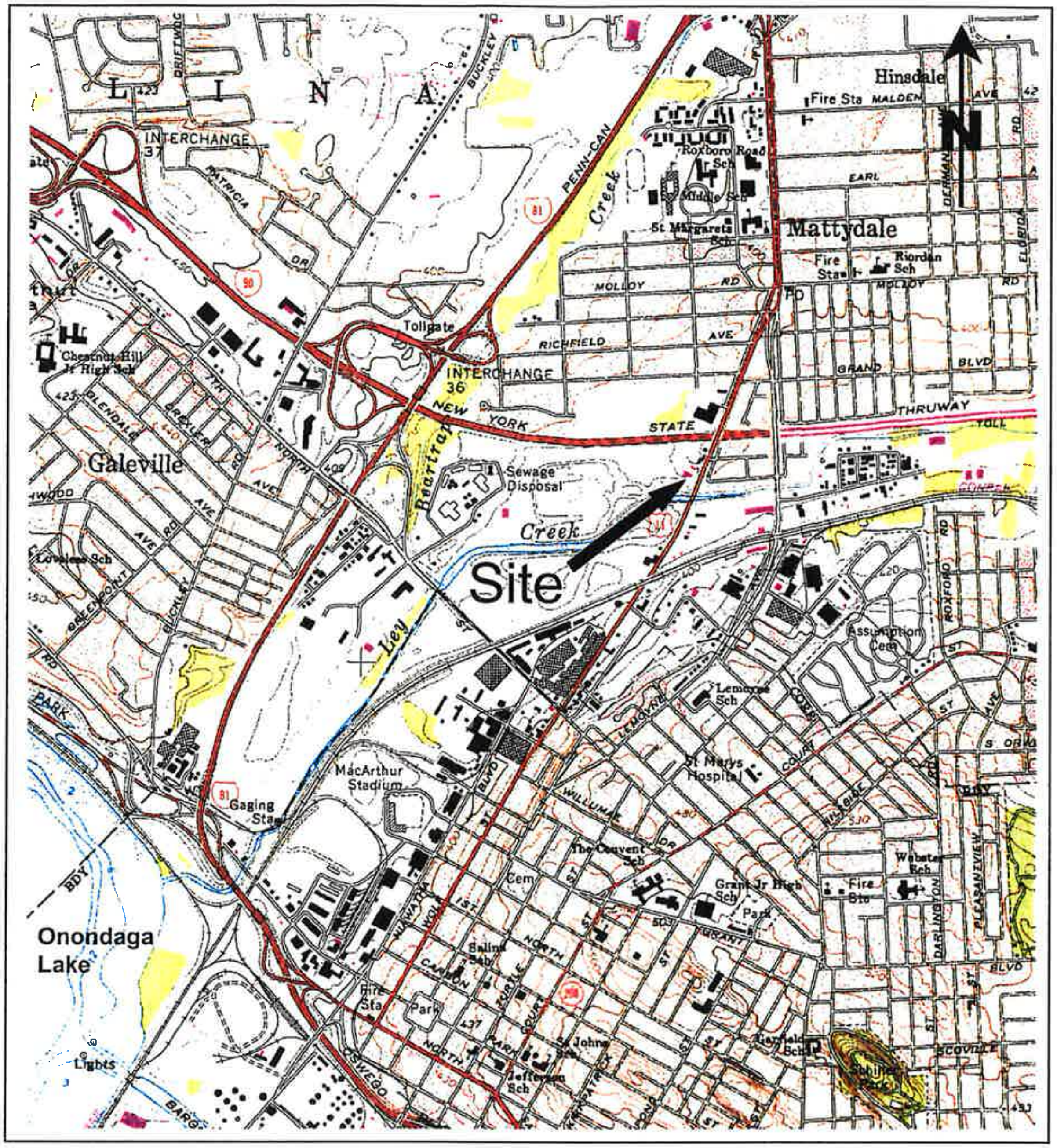
The segment of Ley Creek adjacent to the landfill is a Class B stream, a protected water under New York state regulations. Downstream of the site, Ley Creek is a Class C stream from the location of the former Ley Creek sewage treatment plant outfall near the mouth of Beartrap Creek to Onondaga Lake.

A drainage swale along the eastern access drive collects drainage from the front parking area and the adjacent property for conveyance to Ley Creek. There are no catch basins or storm water detention/retention facilities on site.

Wetlands

No State or National Wetland Inventory mapped wetlands are present on the site. The Town of Salina Landfill, adjacent to the site, was formerly a wetland area.

A regulated NYS wetland area is located approximately 3,500 feet northwest of the site along Beartrap Creek. Another regulated NYS wetland is located approximately one mile southwest of the site near the mouth of Ley Creek. Two federal wetlands are present approximately one-quarter mile from the site. One of the wetlands is located approximately 1,000 feet northwest of the site on the north side of the NYS Thruway and is designated as Palustrine, Scrub/Shrub/Palustrine Emergent. The other wetland is about 1,000 feet southwest of the site, on the south side of Ley Creek and is designated as Palustrine, Scrub/Shrub.



SCALE
1:24,000

0 1000 2000 3000 4000 5000 FEET

0 .5 1.0 KILOMETERS

0 .5 1.0 MILES

MAP REFERENCE
United States Geological Survey
7.5 minute Series Topographic Map
Quadrangle: Syracuse, NY
Date: 1994 (check)

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SITE LOCATION

FORMER NATIONAL PLATING FACILITY
SYRACUSE, NEW YORK

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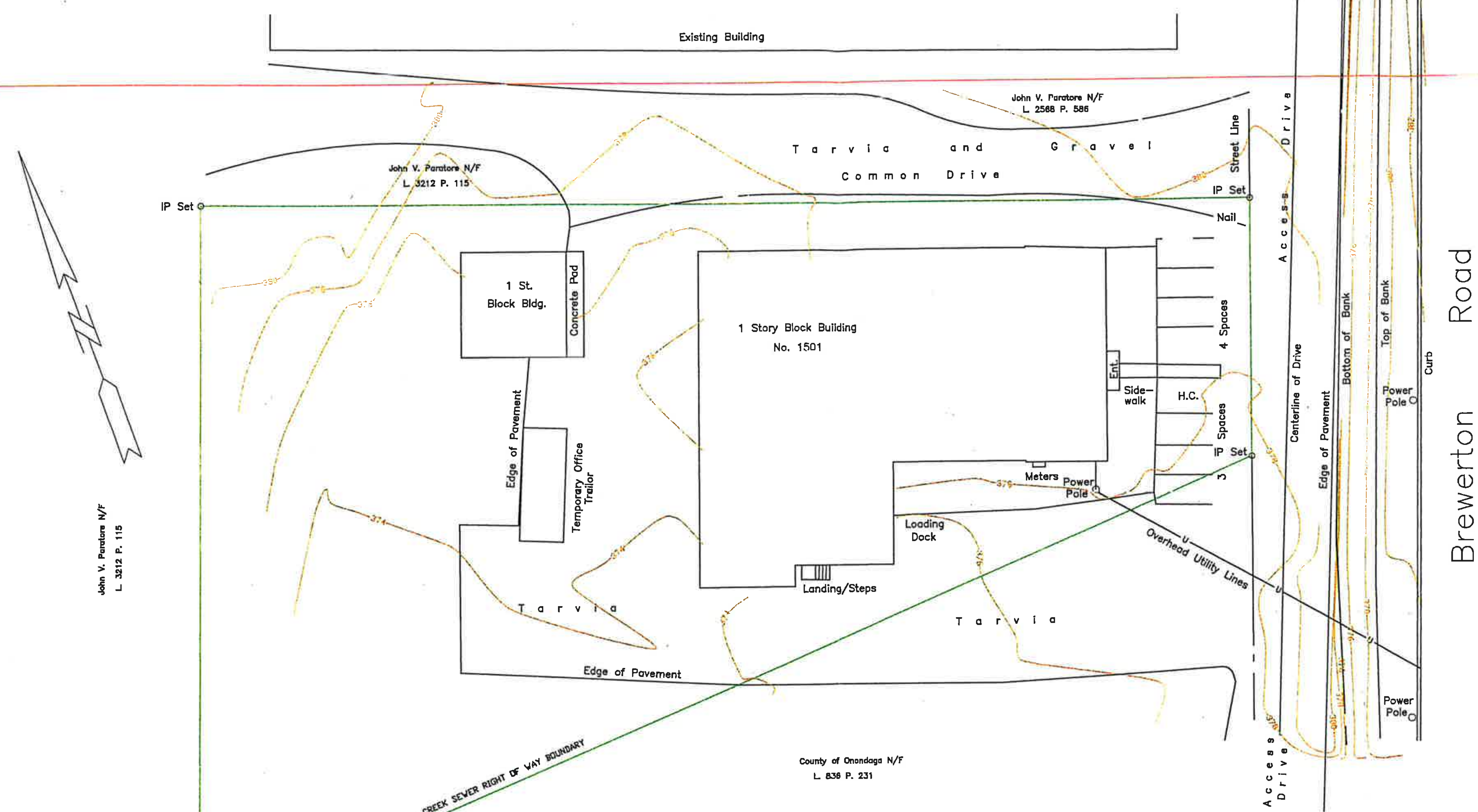

Pt. of F.L. 18, Town of Salina, Onondaga County, New York

Scale – 1" = 30'

Date – June 18, 2001
Rev'd 8/9/01 – Adjoiners Only
Rev'd 8/13/03

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J017502 SF–Same L.21 BK.178 – F:\Projects\J017502\Base Plan\Revised Final Plan

FILENAME: LANSTAND\0120\REPORTS\WORK PLAN\10160003-WP.DWG

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SITE LAYOUT

FORMER NATIONAL PLATING FACILITY
1501 BREWERTON ROAD
SYRACUSE, NEW YORK

SCALE: 1" = 30'
DATE: 8/22/03
PROJECT NUMBER: 10160-003

FIGURE NUMBER: 1-2

SHEET NUMBER: X

2.0 PROCESS/WASTE INFORMATION

2.1 Historical Processes

Metal plating processes which historically occurred at the facility are described as decorative and industrial metal finishing, including electroplating, electroless plating, buffing, and polishing of various metals.

Plating activities involve applying inorganic coatings onto surfaces to provide corrosion resistance, hardness, wear resistance, anti-frictional characteristics, electrical or thermal conductivity, or decoration. Electroplating is achieved by passing an electrical current through a solution containing dissolved metal ions and the metal object to be plated. Cyanide, usually in the form of sodium or potassium cyanide, is frequently used as a complexing agent for many plating metals. Electroless plating is the chemical deposition of a metal coating onto an object, by immersion of the object in a plating solution.

The sequence of unit operations in a plating operation typically involves various cleaning and stripping steps, plating steps, and rinsing between and after each of these operations. The most commonly electroplated metals and alloys include brass (copper-zinc), cadmium, chromium, copper, gold, nickel, silver, tin, and zinc. Each of these metals and alloys has been at the facility; however, cyanide-cadmium and cyanide-zinc plating operations were discontinued in late April 1984. In some cases, parts may be plated with more than one metal (e.g., copper, then nickel, and then chrome). The facility also conducted electroless nickel plating operations. The solutions used for cleaning, stripping, and rinsing depend on which metal is being plated. Acidic and alkaline solutions were used at the facility for cleaning and stripping of the parts prior to plating.

The plating areas at the facility contained approximately 60 chemical and rinse baths as well as drying racks, a wastewater treatment system, and general and process-related ventilation systems. The plating areas were situated on raised concrete pads.

Figure 2-1 shows the approximate layout and tank inventory of the chemical and rinse baths in the plating area, circa 1990s. As the operations at the facility changed over time, the contents of particular tanks may also have changed. Appendix A-1 includes a summary of tank sizes, gallon capacities, and contents from the late 1990s. A chemical inventory for the facility circa 1998 is provided in Appendix A-2.

2.2 Chemical Storage and Use

Chemical storage was located within the interior of the main building (boiler room and storage areas), as well as in a detached garage. No exterior chemical storage is known to have existed. Materials were stored in their original packaging (55-gallon drums or smaller containers) on shelves and pallets.

Based on facility records and an interview with the former facility manager, organic solutions were not used at the facility. Cleaning of parts was done by acid- or base-washing prior to plating. A chemical inventory list for year-end 1998 is provided in Appendix A-2.

2.3 Waste Disposal Practices

National Plating operated as a small quantity generator (SQG) of hazardous waste (United States Environmental Protection Agency [US EPA] Facility ID No. NYD002226918). Site records indicate that manifests for disposal of hazardous solid wastes exist back to 1987. No records of hazardous waste transport or disposal prior to 1987 are known to exist. Waste disposal practices prior to 1987 are not known.

After the installation of the wastewater treatment system, sludge from the plating tanks was rinsed through the wastewater system. Wastes generated from the use of the sludge filter press were containerized in 55-gallon drums (approximately 1 drum per month) for transport off-site as D006 (metal hydroxide sludge) wastes. The wastewater treatment sludge contained cadmium, chromium, copper, lead, silver, nickel, zinc, and cyanide. Transport of the waste was historically handled by several different contractors, including Allegheny Environmental Services, Dart Trucking, and SCA Chemical Services. Disposal historically occurred at several facilities, including CyanoKEM (Michigan) and Model City (New York). More recently, the waste was incinerated at Marine Shale Processors (Louisiana).

2.3.1 Wastewater

Process wastewater generated in the operations area was conveyed through six 1.5-inch PVC pipelines to a centrally located sump pit. The sump is approximately six feet deep. A metal grate and screen over the sump prevented solids from entering the sump. Process wastewater was reportedly discharged to the sump since at least 1970. Until the installation of the wastewater treatment system, discharges from the sump were conveyed to the municipal sewer system, and ultimately the Syracuse METRO sewage treatment plant, without treatment. A wastewater treatment system was installed in approximately 1984. Reportedly, a polypropylene pit liner was installed at the same time as the wastewater treatment system. After the installation of the treatment system and sump liner, wastewater in the sump was pumped to the on-site treatment system prior to discharge to the municipal sewer. The discharge was historically regulated in accordance with a municipal industrial wastewater discharge permit under federal effluent guidelines and standards specified for the metal finishing and electroplating industry.

Wastewater was generated from the water baths used to rinse parts after they were removed from the plating baths. Two types of water baths were used at the facility, moving baths and non-moving baths. Water in the moving baths was replenished as the wastewater was piped to the collection pit for processing through the wastewater treatment system. Water from the non-moving baths was replaced as needed, when the wastewater was either added back into the plating bath or batch treated through the wastewater treatment system. Waste solutions from the process baths and spent acid were also periodically batch treated through the on-site treatment system.

The treatment process included the collection of wastewater, raising the pH to 9, adding an organic polymer, and filtering the system to remove the precipitated solids prior to discharge to the public sewer system. A paper filtration system was used to remove the precipitated solids from approximately 1984 to 1987. The paper filtration system was replaced by a 30-gpm clarifier and a 2.5 cubic foot filter press. A 175-gallon cone bottom effluent polish tank was added to the treatment system (after the clarifier) in 1988. Figure 2-2 shows a schematic of the wastewater treatment system.

As part of the self-monitoring required by the permit for wastewater discharge, the wastewater was sampled annually for cadmium, chromium, copper, cyanide, lead, mercury, nickel, oil and grease, volatile organic compounds, silver, and zinc.

2.3.2 Other

Approximately two 55-gallon drums per year of baghouse wastes from the polishing room ventilation system were disposed in the general office trash dumpster which was located along the western edge of the pavement behind the facility.

Trash from the dumpster, as well as cardboard recyclables in a second dumpster were removed weekly and managed with other municipal wastes and recyclables.

Site documents indicate the presence of two floor drains, one each in the storage and polishing rooms. Drainage into these drains would reportedly be conveyed and discharged through the exterior of the building. Boiler blowdown was also historically conveyed and discharged to the exterior of the building along the western perimeter.

Used plating tanks were reportedly stored along the western edge of the pavement in an approximately 30-foot by 30-foot area. These tanks were acquired in the late 1970s and were stored in the area for approximately one to two years.

2.4 Site Environmental History

2.4.1 Prior Investigations

1987 Soil Investigation

A limited soil investigation was conducted in 1987. The results are provided in Table 2-1. Soil samples were reportedly collected from the west edge of the pavement at the property, as well as along the west, north, and south property boundaries, as shown on Figure 2-3. The samples were collected from ground surface to a depth of two- or three-inches below grade, except for the northern boundary sample, which was limited to immediate surficial materials.

The samples were analyzed for specific metals (cadmium, cyanide, chromium, nickel, and zinc); one sample was submitted for PCB analysis. Cyanide was detected in three of the four samples, while chromium, nickel, cadmium, and zinc were detected in all four samples. PCBs were not detected in the sample submitted for analysis.

1997 Site Summary Report, TAMS Consulting

In the late 1990s, information pertaining to the site was reviewed by TAMS Consulting on behalf of the NYSDEC under the State Superfund Contract. In a report dated August 29, 2003, TAMS concluded that:

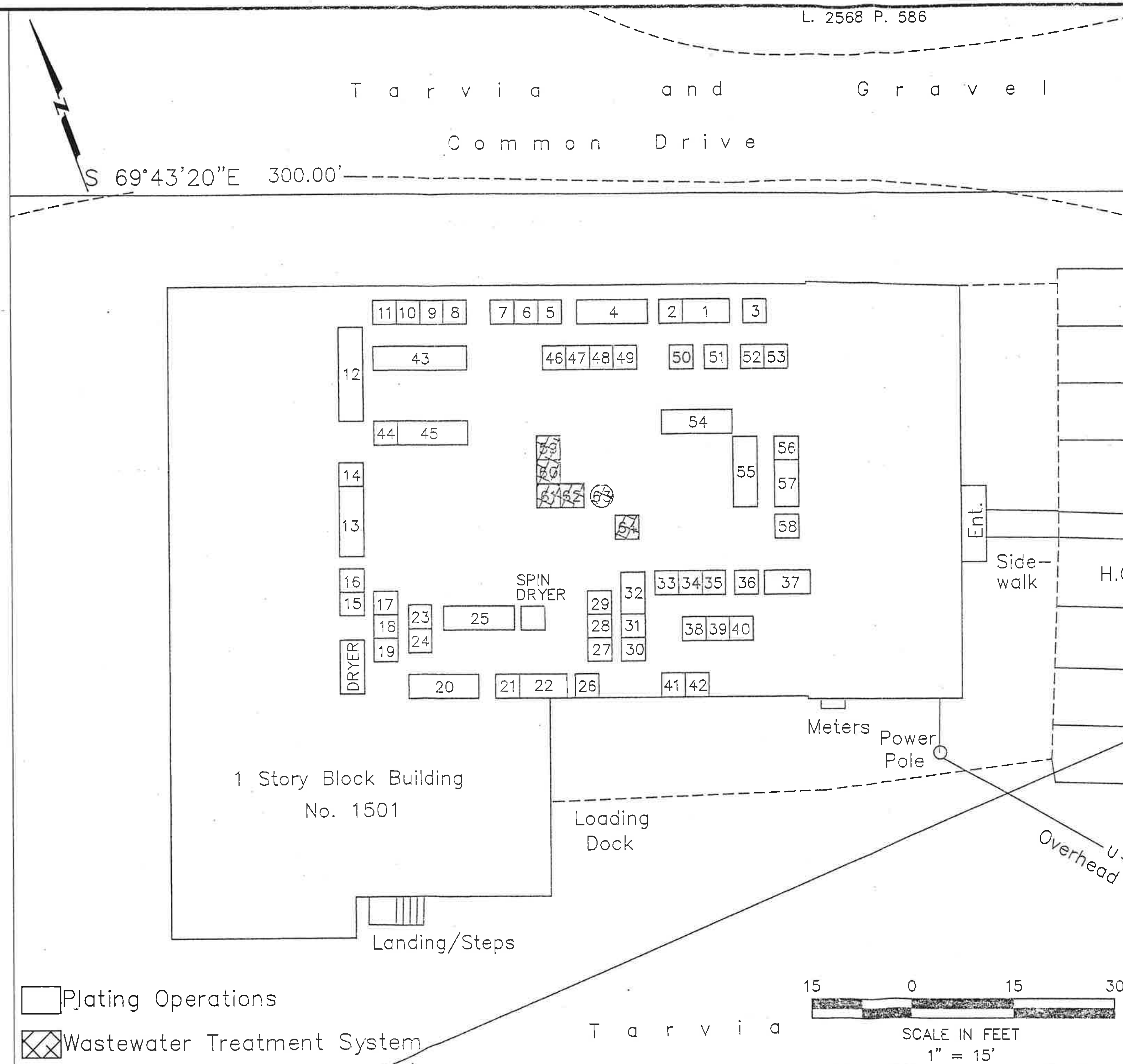
- Based on available data collected as part of the Town of Salina Landfill Site Assessment, contamination of soil and groundwater in the vicinity of National Plating is likely associated with the landfill and not National Plating operations or spills.
- Limited soil data collected from the edges of the National Plating property indicate that historic operations or possible spills of hazardous substances at the site could have impacted on-site soils.

Table 2-1
1987 Soil Sampling Results
Former National Plating Facility
Syracuse, New York

Sample Location	Cyanide	Chromium	Nickel	Cadmium	Zinc	PCBs
West Edge of Pavement	440	710	4,800	1,400	3,800	-
West Boundary	36	110	360	96	360	< 0.50
South Boundary	< 0.50	73	270	54	880	-
North Boundary	11	110	600	160	1,600	-
RSCO	*NA*	*10 or SB*	*13 or SB*	*1.0 or SB*	*20 or SB*	*1.0 (Surface)*

Note: All results are in ppm. 10000/40 6800/NS 13000/130 60/7.5 10000/2480 10/1
SB- Site Background
RSCO- Recommended Soil Cleanup Objective values from NYSDEC Technical and Administrative Guidance Memorandum #4046- Determination of Soil Cleanup Objectives and Cleanup Levels, Jan. 1994

Tank ID	Contents	Capacity
	Plating Operations	
1	Potassium Cyanide Silver	395 gal
2	Dead Rinse-Cyanide	93.5 gal
3	Acid Gold	17 gal
4	Chrome Tank	446 gal
5	Dead Rinse	71 gal
6	Chromium Kill R.	71 gal
7	Chromium Kill R.	71 gal
8	Cyanide Brass	217 gal
9	Dead Rinse-Cyanide	53 gal
10	C-12 Activator	53 gal
11	Sulfuric Strip	53 gal
12	Watts Nickel	308 gal
13	Cyanide Copper	327 gal
14	Dead Rinse-Cyanide	50 gal
15	Tin	130 gal
16	W. Nickel	130 gal
17	Hot Water	104 gal
18	Rinse	50 gal
19	Rinse	50 gal
20	Alkaline Zinc	390 gal
21	Rinse	93 gal
22	Alkaline Zinc	375 gal
23	Yellow Chromate Zinc	57 gal
24	Clear Chromate Zinc	57 gal
25	Steel Cleaner	754 gal
26	Black Oxide	300 gal
27	Rinse	35 gal
28	Hot Water	35 gal
29	Oil	35 gal
30	50% Nitric Acid	90 gal
31	Biflouride & Nitric Acid	90 gal
32	Rinse	146 gal
33	Etch Aluminum	113 gal
34	Rinse	120 gal
35	Aluminum Cleaner	113 gal
36	Gold Dye	75 gal
37	Nickel Seal Anodize	125 gal
38	B.K. Dye	226 gal
39	Rinse	56 gal
40	Rinse	56 gal
41	Rinse	56 gal
42	Sulfuric Anodize (16%)	432 gal
43	Nickel	800 gal
44	Electroless Nickel	93 gal
45	Steel Cleaner	375 gal
46	Rinse	50 gal
47	1% Sulfuric Acid	50 gal
48	Soak Cleaner	90 gal
49	Hot Water Rinse	90 gal
50	Nickel Strip	90 gal
51	Zinc Phosphate	115 gal
52	Aluminum Cleaner	90 gal
53	Rinse	90 gal
54	Rinse	200 gal
55	Aluminum Cleaner	130 gal
56	Dead Rinse	90 gal
57	Yellow Irridite	125 gal
58	Hot Water	90 gal
	Wastewater Treatment System	
59	Filter Press	2.5 cuft
60	Clarifier	30 GPM
61	pH Adjust	100 gal
62	pH Adjust	100 gal
63	Effluent Polisher Tank	175 gal
64	Pit to drain pipe discharge	



REVISIONS

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PLATING AREA LAYOUT
FORMER NATIONAL PLATING FACILITY
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SYRACUSE, NEW YORK

SCALE: 1" = 15' | DATE: 10/03 | PROJECT NUMBER: 10160-003-200

FIGURE NUMBER: 2-1

SHEET NUMBER: 1

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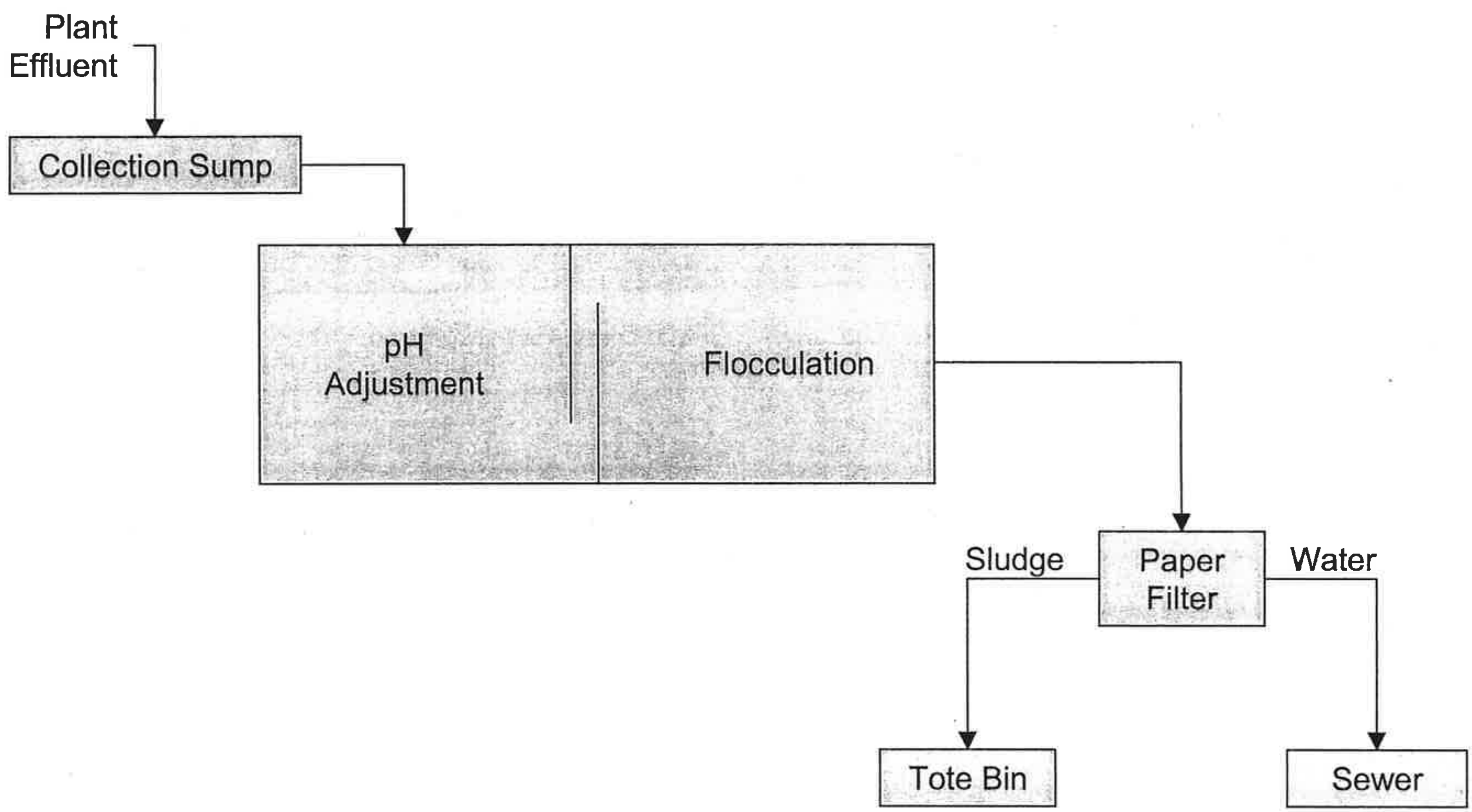

NOTES:
Process flow from "Nickel-Zinc Removal Process Schematic"
(Great Lakes Environmental; February 1985)

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WW TREATMENT SYSTEM - 1985

FORMER NATIONAL PLATING FACILITY
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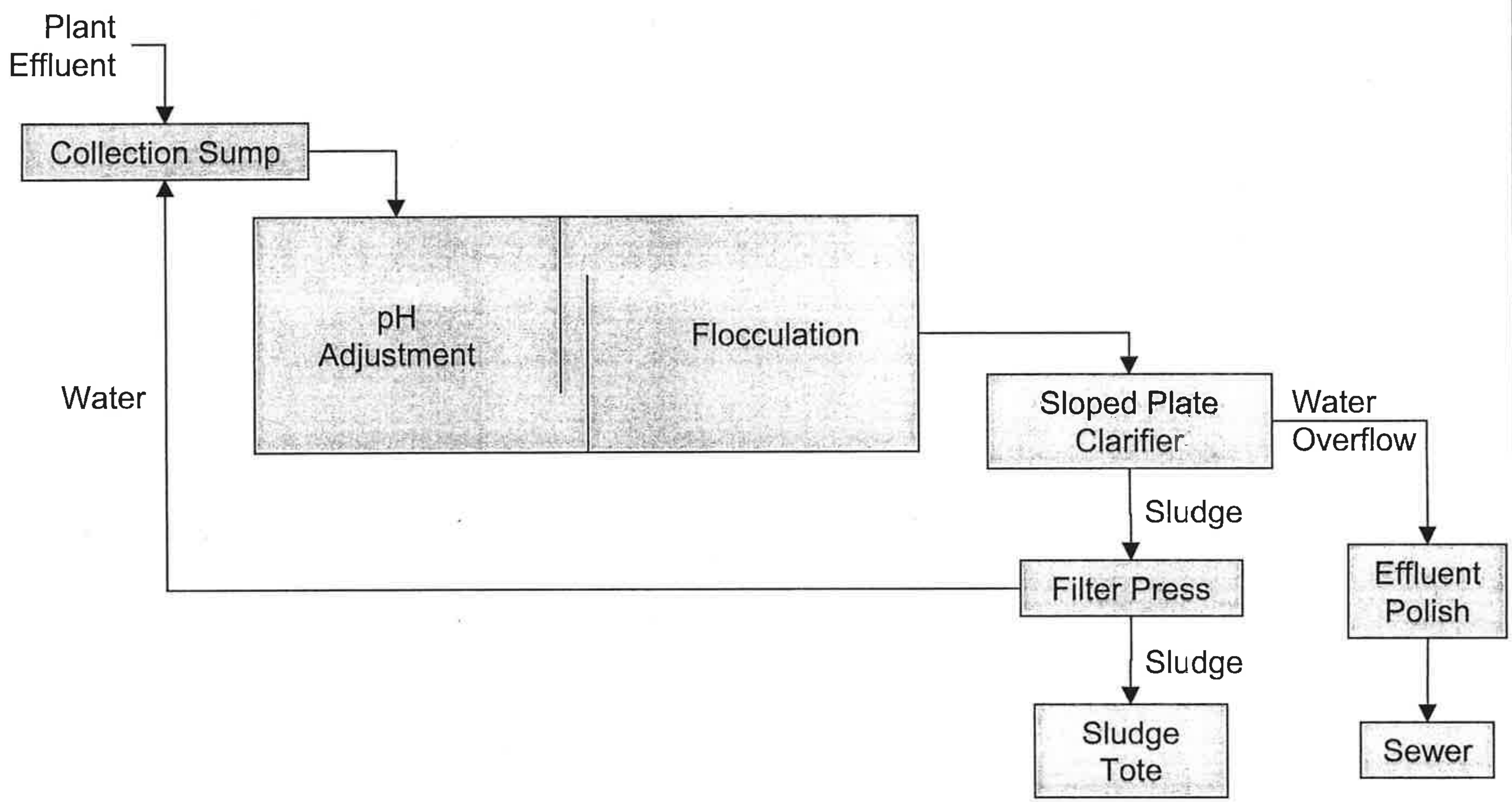
DRAWN BY:	DATE:	PROJECT NUMBER:	FIGURE NUMBER:
KAG	10/07/03	10160-003	2-2a



NOTES:
Process flow from "Operations and Maintenance Manual"
(Great Lakes Environmental; December 1988)

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WW TREATMENT SYSTEM - 1988

FORMER NATIONAL PLATING FACILITY
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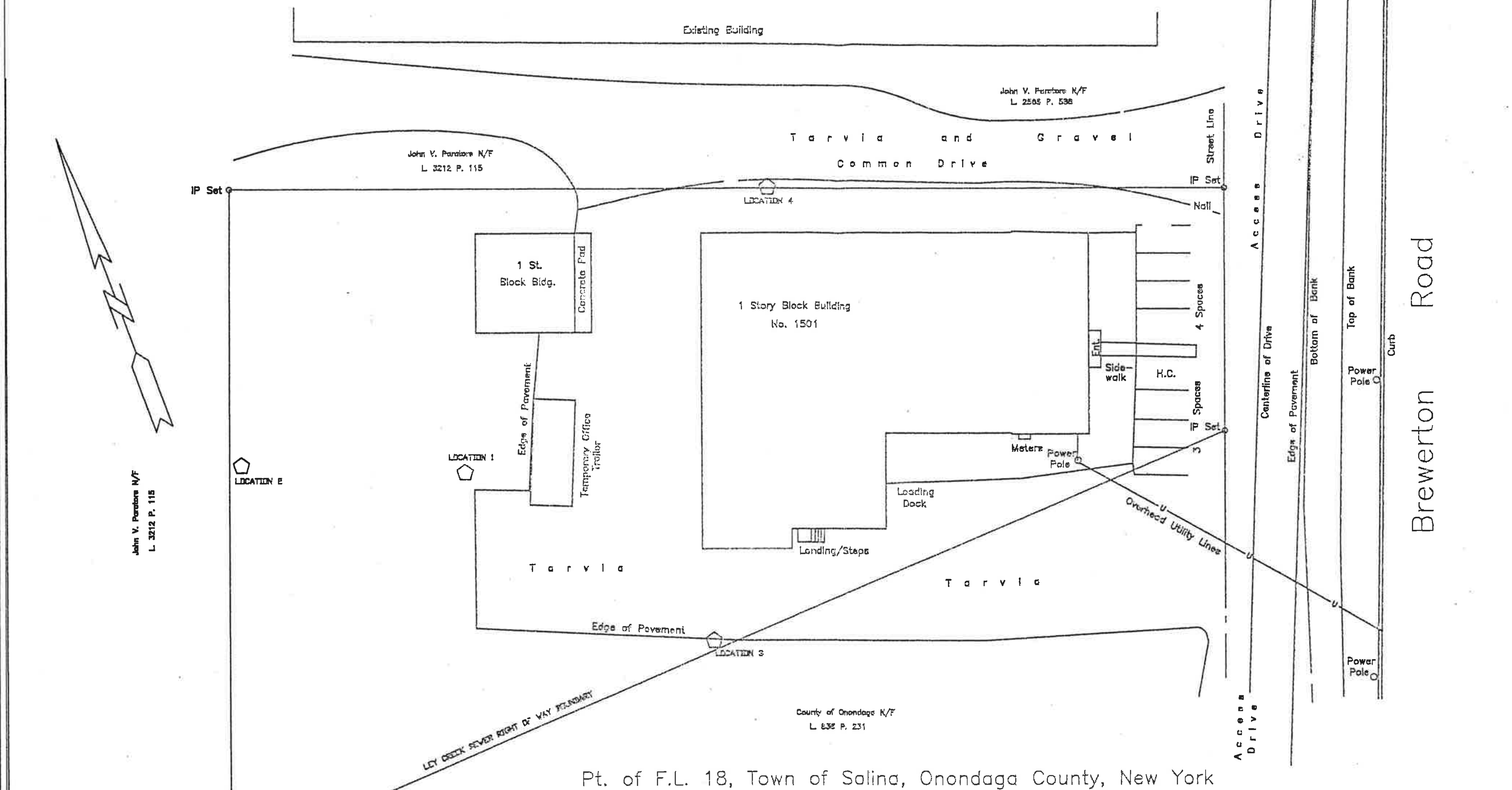
DRAWN BY:	DATE:	PROJECT NUMBER:	FIGURE NUMBER:
KAG	10/22/03	10160-003	2-2b



Scale – 1" = 30'

Date – June 18, 2001
Rev'd 8/9/01 – Adjoiners Only
Rev'd 6/13/03

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⬠ HISTORICAL SAMPLE LOCATIONS (APPROXIMATE)

FILENAME: LANSTAND\0120\REPORTS\WORK PLAN\10160003-WP.DWG

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HISTORICAL SAMPLE LOCATIONS

FORMER NATIONAL PLATING FACILITY
1501 BREWERTON ROAD
SYRACUSE, NEW YORK

SCALE:	DATE:	PROJECT NUMBER:
1" = 30'	8/22/03	10160-003

FIGURE NUMBER: 2-3

SHEET NUMBER: X

3.0 FIELD ACTIVITIES PLAN

Several areas of the site have been identified for investigation. This section summarizes the rationale for investigating each of the selected areas and identifies the sampling techniques and analytical requirements for the investigation. All field activities will be completed in accordance with the site-specific health and safety plan (Appendix B) and community air monitoring plan (Appendix C).

3.1 Investigation Areas

Based on historical information and a site visit, there are two areas where the investigation will be focused:

- Concrete Sump Pit
- Western Edge of Pavement

In addition, three monitoring wells will be installed at the site, one upgradient and two downgradient of the facility. Figure 3-1 shows the proposed locations and types of samples to complete the investigation of these areas. Final sampling locations may be adjusted in the field based on access and utility clearance.

Based on a review of the chemicals that were historically used at the facility, samples will be analyzed for target analyte list (TAL) metals, cyanide, pH (soil only), and hexavalent chromium (water only). Due to concerns raised by the New York State Department of Health (NYSDOH), volatile organic compounds (VOCs) will also be analyzed from two soil samples and two monitoring wells.

3.1.1 Concrete Sump Pit

Process waste waters generated in the operations area were conveyed through six 1½ -inch PVC pipes to a centrally located concrete sump pit which is approximately six feet deep. Process wastewater had been discharged to the sump since at least 1970. Until the late 1980s, the sump was unlined and discharges from the sump were conveyed to the County sanitary sewer without treatment.

There are two floor drains in the building, one in the former storage room and one in the former polishing room. In the past, other floor drains associated with various stages of operations were present. These drains were all directed towards the concrete sump. All these drains have been plugged. ENSR considers that any potential impacts from these drains will be identified by the sump investigation activities.

A polypropylene liner and wastewater treatment system were installed in 1984. Wastewater treatment consisted of batch treatment (precipitation) and pH adjustment of rinse waters prior to discharge to the municipal sanitary sewer system.

To investigate potential impacts from the concrete sump pit, the pit will be dewatered and inspected. Once the sample has been dewatered, a soil boring will be advanced through the pit base. Based on visual evidence and PID screening results, a soil sample will be collected and submitted for analysis for VOCs, TAL metals, cyanide and pH. If groundwater is encountered in the boring, a sample will be collected to be analyzed for TAL metals, cyanide and hexavalent chromium. If groundwater sample turbidity is greater than 50 NTUs, a filtered sample will also be collected for analysis of TAL metals and cyanide, and hexavalent chromium.

3.1.2 Western Edge of Pavement

There were four potential sources of impacts to soils along the western edge of the pavement.

- Materials utilized in the plating process and kept in the storage room did not have secondary containment. A chemical inventory list and a summary of process tanks are included as Appendix A-2. The floor drains discharged to the western exterior perimeter of the building.
- Baghouse wastes (approximately two 55-gallon drums per year) from the polishing room ventilation system were disposed in the general office trash dumpster located along the western edge of the pavement.
- Used plating tanks were reportedly stored along the western edge of the pavement in an approximately 30-foot by 30-foot area. These tanks were acquired in the late 1970s and were stored in the area for approximately one to two years.
- Blowdown from boiler discharge is assumed to migrate with over-land flow to the western edge of the asphalt.

To investigate potential impacts from these potential sources of impacts on the western edge of the pavement, five surface soil samples will be collected from the surface to a depth of 2-inches below ground surface. These samples will be analyzed for TAL metals, cyanide, pH, and VOCs (one sample only). At each soil boring location, five deeper soil samples will be collected between depths of 2 feet to 3 feet. These samples will be submitted to the laboratory and held pending evaluation of laboratory results for the shallow samples.

3.1.3 Upgradient and Downgradient Groundwater

To evaluate upgradient and downgradient groundwater quality, three monitoring wells will be installed. One well will be installed in the assumed upgradient direction and two wells will be installed in the assumed downgradient direction. The second downgradient monitoring well will be installed hydraulically downgradient of the sump, in an effort to evaluate potential downgradient impacts. The groundwater samples will be analyzed for TAL metals, cyanide, hexavalent chromium, and VOCs in two of the three wells (one upgradient and one downgradient).

The monitoring wells will be constructed of 2-inch PVC solid risers and 2-inch slotted PVC screen, ten feet in length. Each monitoring well will be installed at the water table. The wells will be constructed such that approximately two-thirds of the screen is located beneath the water table and one-third is located above the water table. The monitoring wells will be developed prior to sampling to reduce turbidity within the well and improve the hydraulic connection between the well and the surrounding formation.

The groundwater samples will be analyzed for TAL metals, cyanide, and hexavalent chromium. If the groundwater sample has turbidity greater than 50 NTUs, a filtered sample will also be collected for analysis of TAL metals and cyanide, and hexavalent chromium. In one downgradient and one upgradient well, a VOC sample will also be collected.

3.2 Field Sampling Techniques

The following media will be sampled and analyzed as part of the site investigation:

- Surface soil
- Subsurface soil
- Groundwater

The media will be sampled and analyzed and then a corrective action plan will be developed for areas with elevated analytical detection limits, if necessary. The estimated number of samples to be collected at each of the areas is identified in Table 3-1.

Quality Assurance/Quality Control (QA/QC) samples will be collected to ensure the data are accurate and meet the data quality objectives. Equipment rinsate blank, field blank, trip blank, method blank, and matrix spike samples will be collected and analyzed to assess the accuracy of the data resulting from the field sampling and analytical programs. The number and type of QA/QC samples to be collected for each media of interest are summarized in Table 3-2. ENSR's Standard Operating Procedures for various sampling methods and decontamination have been included as Appendix D.

3.2.1 Soil Investigation

Surface and subsurface soil samples will be collected using a hollow stem auger (HSA) drill rig or Geoprobe™. Each method is described below.

3.2.1.1 Soil Sampling Procedures

At each location, discrete soil samples will be collected from a depth of 0- to 2-inches below grade, with vegetation removed. Several discrete samples may be required to obtain the sample volume necessary; these samples will be collected from within a one-square foot area. The discrete samples will be composited prior to filling the sample jars. Surface soil samples will not be collected from areas covered by impermeable surfaces (e.g., building, pavement, etc.). Soil samples will also be collected at depths between 2 feet – 3 feet bgs. These samples will be submitted for laboratory analyses but held pending analytical results of the shallow samples.

ENSR standard operating procedure (SOP) 7160 - Subsurface Soil Sampling by Geoprobe™ (Appendix D-1) details the methods for obtaining surface and subsurface soil samples for chemical and physical analyses. Surface and subsurface soil samples will be collected using a hydraulically powered percussion/probing machine and the Macro-core soil sampler. The sampler is driven into the ground to within the targeted sample depth. The soil sampler is extracted from the ground to obtain the sample.

A cellulose acetate butyrate clear plastic liner is used inside the sampler to collect the soil. The liner is extracted and cut open. Once the soil has been logged, a sample can be collected from the liner.

An alternative sampling methodology using split spoons may be used to collect soil samples. ENSR SOP 7115 - Subsurface Soil Sampling by Split Spoon (Appendix D-2) describes the methods for obtaining soil samples for analyses using a hollow-stem auger drill rig equipped with split spoon sampling apparatus.

Cuttings from the subsurface soil sampling program will be inspected for signs of contamination. Samples will be classified using the ASTM-D2488-84 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Field observations will be recorded in a field logbook.

3.2.2 Groundwater Investigation

Monitoring wells will be constructed of 2-inch PVC solid risers and 2-inch slotted PVC screen, ten feet in length. Each monitoring well will be installed at the water table. The wells will be constructed such that approximately 2/3 of the screen is located beneath the water table and 1/3 is located above the water table. The monitoring wells will be installed according to ENSR SOP 7220 - Monitoring Well Construction and Installation (Appendix D-3).

Monitoring wells will be developed prior to sampling to reduce turbidity within the well and improve the hydraulic connection between the well and the surrounding formation. ENSR SOP 7221 - Monitoring Well Development (Appendix D-4) details various methods for monitoring well development. The monitoring wells will be allowed to set for a minimum of 48-hours prior to development.

ENSR SOP 7130 - Groundwater Sample Collection from Monitoring Wells (Appendix D-5) details various methods for sampling groundwater. Prior to the initiation of groundwater sampling activities, static water levels will be measured at each of the monitoring wells to evaluate groundwater flow direction. The monitoring wells will be purged and sampled using low-flow methodologies, as presented in Appendix D-6. Use of low-flow methodologies will reduce sample turbidity and ensure a groundwater sample that is representative of the water in the formation.

3.2.3 Field Logbooks / Documentation

Bound field logbooks will be used to record field activities. Entries will be described in as much detail as practical so that activities can be reconstructed for a particular situation. The following information should be recorded in the field logbook:

- Weather observations
- All field measurements and samples collected
- Equipment used to take measurements along with the date of calibration
- Date and time of sample collection
- Sample description, volume, type of preservative, and number of containers
- Equipment decontamination procedures
- Time of arrival at the Site and the time of departure from the Site

3.2.4 Chain-of-Custody Procedures

Properly completed chain-of-custody (COC) forms will accompany the samples. When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the COC form.

Samples will be packaged properly for shipment and dispatched to the laboratory for analysis with a separate signed COC record enclosed in each shipping container. Shipping containers will be secured with packaging tape and sealed with signed custody seals.

Samples will be shipped from the field to the laboratory using a reputable courier or will be driven to the laboratory. To ensure that holding time requirements are met, the selected courier will provide dependable overnight delivery. Samples not shipped overnight, but otherwise properly preserved, will be valid for the maximum holding time period.

All shipments will be accompanied by the COC record identifying the contents. The back copy will be detached and kept as part of the field records. The original COC record and remaining copies will accompany the shipment.

3.2.5 Equipment Decontamination

Procedures for equipment decontamination are described in ENSR SOP 7600 (Decontamination of Equipment) (Appendix D-7). Equipment decontamination will be completed following standard procedures at each sampling location and following sample collection. In addition, general equipment conditions will be checked at the end of the day. Decontaminated equipment will be stored when not in use within a secure area.

3.2.6 Field Equipment Calibration

Instruments used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Each instrument used in the field will be examined daily by the Field Team Leader or his/her designee to verify that it is operating properly. Field instruments for the field activities will include dust monitors; CO meters may be used if drilling in the building is done with a gasoline- or propane-fueled rig.

The frequency of calibration for all instruments will be daily before initial use. Calibration procedures will be documented in the field records. Documentation will include the date and time of calibration, the identity of the person performing the calibration, the reference standard used, the readings taken, and any corrective action taken.

3.3 Laboratory Analysis

Soil samples will be analyzed for TAL metals, cyanide, VOCs (two samples only), and pH. Groundwater samples will be analyzed for TAL metals, cyanide, hexavalent chromium, and VOCs (two samples only). These parameters were selected based on a review of the chemicals historically used at the facility. The analytical methods for the various media sampled are shown in Table 3-3;

preservative and holding time requirements are shown in Table 3-4. The method detection limits are provided in Appendix E.

Laboratory analysis will be conducted by a NYSDOH ELAP-certified laboratory. Results will be reported in a NYSDEC ASP Category B deliverable package. Data will be evaluated according to the Division of Environmental Remediation (DER) Data Usability Summary Report (DUSR) guidelines.

Table 3-1
Sample Rationale
Former National Plating Facility
Syracuse, New York

Location ID	Site Location	Purpose	Soil Analyses	Groundwater Analyses
MW-1	Upgradient	Groundwater flow; quality	--	VOCs, TAL Metals + Cyanide Hexavalent Chromium
MW-2	Downgradient	Groundwater flow; quality	--	VOCs, TAL Metals + Cyanide Hexavalent Chromium
MW-3	Downgradient	Groundwater flow; quality	--	TAL Metals + Cyanide Hexavalent Chromium
TW-1	Adjacent to Sump	Groundwater quality, subsurface soil quality [(a)]	VOCs, TAL Metals + Cyanide pH	TAL Metals + Cyanide Hexavalent Chromium
SS-1	Adjacent to Building Entrance	Background soil quality	TAL Metals + Cyanide pH	-
SS-2	Western pavement edge	Soil quality	VOCs, TAL Metals + Cyanide pH	-
SS-3	Western pavement edge	Soil quality	TAL Metals + Cyanide pH	-
SS-4	Western pavement edge	Soil quality	TAL Metals + Cyanide pH	-
SS-5	Western pavement edge	Soil quality	TAL Metals + Cyanide pH	-

(a) Subsurface soil sample will only be collected if unsaturated soils are encountered beneath the sump pit.

Table 3-2
Summary of Sampling and Analysis Program
Former National Plating Facility
Syracuse, New York

Sample Matrix	Laboratory Analyses	Number of Investigative Samples	Number of Field QC Samples		MS/MSD[c] Samples	Number of LD[d] Samples	Total Samples
			Duplicates [a]	Blanks[b]			
Soil	VOCs	2	1	1	1	1	6
	Metals[e]	5	1	1	1	1	9
	Cyanide	5	1	1	1	1	9
	pH	5	1	1	1	1	9
Groundwater	VOCs	2	1	1	1	1	6
	Metals[e]	4	1	1	1	1	8
	Cyanide	4	1	1	1	1	8
	Hexavalent Chromium	4	1	1	1	1	8

Notes:

(a) Field duplicate samples will be collected at a frequency of 1 duplicate per 20 environmental samples.

(b) Field blanks will be collected at a frequency of 1 per 10 environmental samples.

(c) MS/MSD - Matrix Spikes and Matrix Spike Duplicates will be collected for inorganic analysis at a frequency of 1 MS per 20 environmental samples.

(d) LD - Laboratory Duplicates will be collected for inorganic analysis at a frequency of 1 LD per 20 environmental samples.

(e) Metals - Target Analyte List Metals (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Th, Va, and Zn).

Table 3-3
Analytical Methods for Solid and Liquid Samples
Former National Plating Facility
Syracuse, New York

Parameter	Analytical Methods		Reference[(a)]
	Solid	Liquid	
VOCs	8260	8260	SW-846
TAL Metals	6010a/6020	6010a/6020	SW-846
Hg	7471	7471	SW-846
pH	9045C	N/A	SW-846
Cyanide	9010B	9010B	SW-846
Hexavalent Chromium	N/A	3060A	SW-846
Detection Limits are provided in Appendix E.			

Notes:

(a) USEPA, Test Methods for Evaluating Solid Wastes. Physical/Chemical Methods, SW846, Third Edition including 1992, 1993, 1994, 1995 and 1996 updates.

Table 3-4a
Containers, Preservation, and Holding Times for Solid Samples
Former National Plating Facility
Syracuse, New York

Parameter	Container	Preservation	Holding Time[a]
VOCs	1 - 4 oz. wide mouth glass jar with teflon-lined cap	Cool, 4°C	14 days
Metals TAL + cyanide	1 - 8 oz. glass jar with teflon-lined cap	Cool, 4°C	6 months to analyze 28 days for Hg
pH	1 - 4 oz. glass bottle	Cool, 4°C	48 hours

Notes:
(a) Holding time is the maximum time that a sample may be held prior to analysis and still be considered valid. Holding times are calculated from the date of collection.

Table 3-4b
Containers, Preservation, and Holding Times for Water Samples
Former National Plating Facility
Syracuse, New York

Parameter	Container	Preservation	Holding Time[(a)]
VOCs	2 - 40 mL glass VOA vials with teflon-lined caps	HCl, Cool, 4°C	14 days with pH $\leq$2
TAL Metals	1 - 8 oz. Plastic/250 mL bottle with teflon-lined cap	HNO3, Cool, 4°C	6 months to analyze 28 days for Hg
Cyanide	125 mL glass bottle	NaOH, Cool, 4°C	12 days
Hexavalent Chromium	1 - 1 liter plastic or glass bottle	Cool, 4°C	24 hours

Notes:

(a) Holding time is the maximum time that a sample may be held prior to analysis and still be considered valid. Holding times are calculated from the date of collection.

4.0 FINAL REPORT

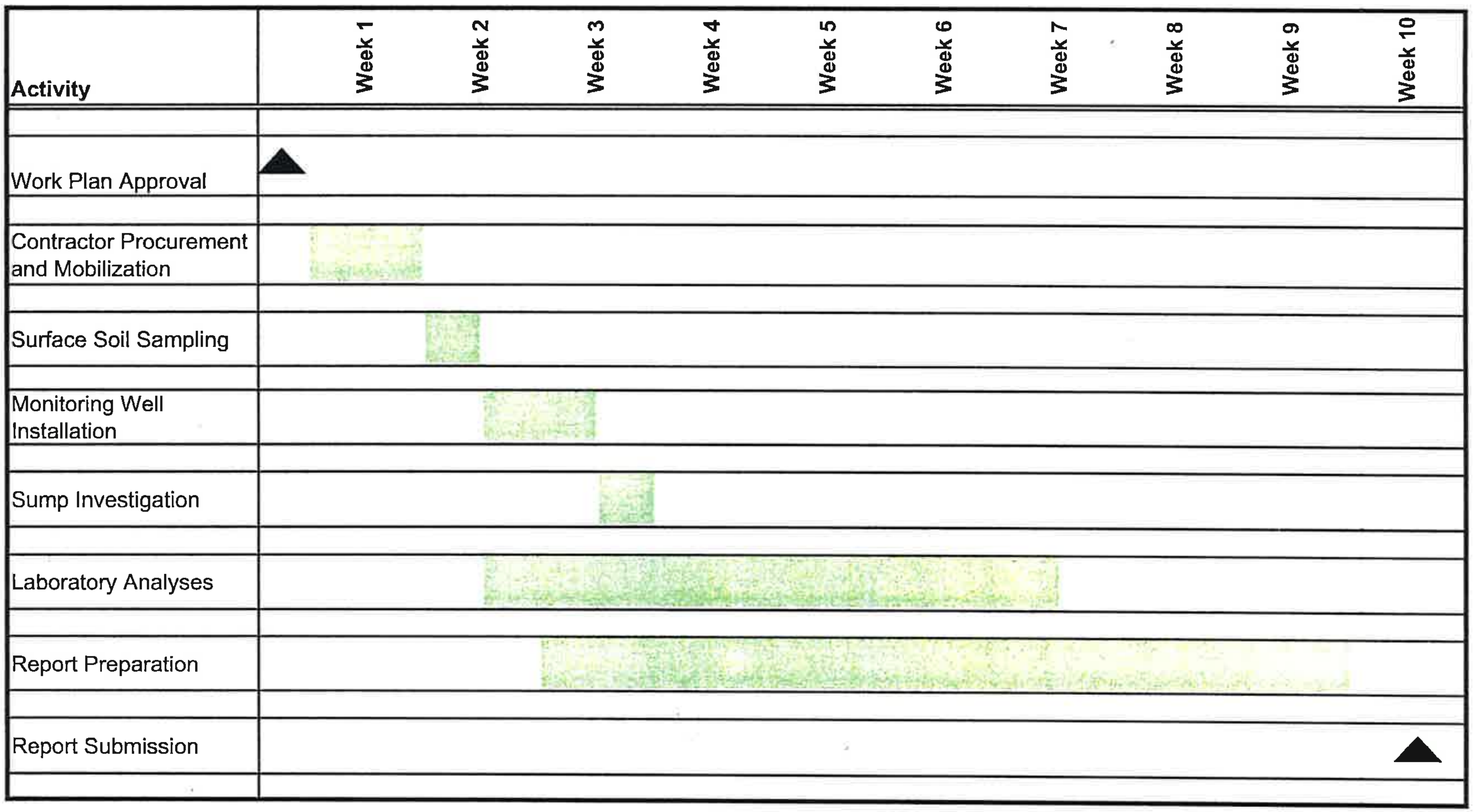
After completion of field investigation activities, a final investigation report will be prepared and submitted to NYSDEC. This report will provide a description of the site and present a summary of the work done, the analytical results, interpretations of the data, and overall conclusions regarding the nature and extent of contamination at the site.

Included in the final report will be a qualitative health exposure assessment. This assessment will characterize the exposure setting, identify exposure pathways, and evaluate contaminant fate and transport.

5.0 SCHEDULE

A preliminary project schedule has been included as Figure 5-1.

Figure 5-1
Tentative Investigation Schedule
Former National Plating Facility
Syracuse, New York



APPENDICES

APPENDIX A:

HISTORICAL DOCUMENTATION

ENSR INTERNATIONAL

A-1: Summary of Process Tanks

Tank Sizes and Gallon Capacity

P. Cyn. Silver	95 X 31 X 31	395 Gallons
Rinse Tank	30 X 30 X 24	93.5
Chrome Tank	95 X 35 X 31	446
S. Chrome Tank	29 X 19 X 30	71.5
Chrome Destructor	30 X 20 X 29	75.3
Rinse Tank	30 X 20 X29	75.3
Cyanide Brass tank	54 X 30 X 31	217.4
Woods Nickel Activator	30 X 20 X 30	77.9
C-12	30 X 20 X 25	64.9
Nickel Strip	30 X 20 X 31	80.5
nickel tank	30 X 95 X 25	308.4
copper cyanide	84 X 30 X 30	327.3
lg. nickel tank	141 X 46 X 23	645.8
cleaner	95 X 24 X 28	276.4
electroless nickel	24 X 29 X 33	99.4
rinse water tank	18 X 60 X 29	135.6
Hot water rinse tank	35.5 X 30 X 28	129.1
Brass Cleaner	36 X 30 X 28	130.9
1% Sulfuric acid	30 X 19.5 X 28	70.9
rinse water tank	30 X 19.5 X 28	70.9
Barrel tin tank	44 X 36 X 19	130.3
barrel nickel tank	44 X 36 X 20	137.1
rinse tank	43 X 29 X 15.5	83.7
zinc chromate dip	24 X 18 X 27	50.5
zinc bright dip	24 X 18 X 27	50.5
Hot water tank	48 X 18 X 28	104.7
Rinse water tank	24 X 18 X 28	52.3
Rinse water tank	24 X 18 X 28	52.3
Alkaline zinc tank	107.5 X 30 X 28	390.9
Alkaline steel cleaner	110 X 48 X 33	754.3
Sodium Stannate tin	95 X 30 X 29	375.8
rinse water tank	24 X 30 X 30	93.5
oil tank	24 X 24 X 17	42.4
rinse tank	24 X 24 X 19	47.4
rinse tank	24 X 24 X 21	52.4
dulite tank	43 X 37 X 29	199.7
nickel strip (steel)	24 X 96 X 11	109.7
30% Hydrochloric Acid	36 X 24 X 24	89.8
rinse tank	36 X 24 X 28	104.7
phosphate tank	48 X 30.5 X 24	150.1
blue,red & gold anodized tank	20 X 30 X 29	75.3
caustic Alum. etch	30 X 30 X 29	113.0
rinse water	30 X 30 X 31	120.8
Alum. soak cleaner	30 X 30 X 29	113.0
rinse water	30 X 92 X 30	358.4
Ammonium Biflouride	24 X 30 X 29	90.4
50% nitric acid	24 X 30 X 29	90.4
yellow irridite	24 X 47 X 30	146.5
rinse water	24 X 24 X 30	74.8
black anodize	60 X 30 X 29	226.0
rinse water	24 X 30 X 29	90.4
hot water rinse tank	24 X 30 X 30	93.5
16% Sulfuric anodize	36 X 84 X 33	432

TO: Steve Eckler

FROM:
National Plating, Inc.
1501 Brewerton Road
Syracuse, NY 13208-1403

ENSR INTERNATIONAL

A-2: 1998 Year-End Chemical Inventory List

NATIONAL PLATING, INC.
INVENTORY 12/31/98

ITEM	AMOUNT	PRICE/EA	TOTAL PRICE
COPPER ANODE BALLS	200.00	1.84	368.00
ENPLATE NI-418B	10.00	41.53	415.30
MB 438B	4.00	21.23	84.92
ENBONOL C-115	4.00	20.64	82.56
ENTHOBRITE 916A	2.00	18.55	37.10
ENTHOBRITE 916B	2.20	12.65	27.83
ENTEK WAX 18	3.50	18.59	65.07
ENTHOX 550 BRITE ZINC	30.00	2.06	61.80
ENTHONE EN. 418B	40.00	41.53	1661.20
ENTEK WAX #19	3.00	19.81	59.43
ENTEK EX-LAQ	7.00	20.22	141.54
ENPREP 14	105#	0.92	96.60
ENTHOBRITE AL990	5.00	14.31	71.55
ENPLATE NI-418A	10.00	21.54	215.40
ENPLATE NI-418C	12.00	41.53	498.36
ENTHOX AL-990	5.00	14.38	71.90
ENSTRIP NI 429R	5.00	14.57	72.85
ENPLATE MB-435 (OXIDIZER)	3.00	25.00	75.00
ENSTRIP 165S	25.00	3.23	80.75
ENTHOX 980 LIQUID	9.00	10.01	90.09
ENPREP 808E	800.00	0.88	704.00
ENTHOBRITE NCZ LIQUID	10.00	6.71	67.10
ENPLATE MB 438A	2.00	10.75	21.50
ENPLATE MB 438B	2.00	21.23	42.46
NCZ 916C	7.00	7.41	51.87
NCZ 916B	10.00	12.65	126.50
ALUMON D LIQUID	2.00	12.28	24.56
NICKEL SULPHATE SOL. 55.5#	5.00	11.50	57.50
LIQUID NICKEL SULPHATE	3.00	11.77	35.31
LIQUID NI. CHLORIDE	2.00	12.50	25.00
418 C E NICKEL	1.00	41.53	41.53
DV-CHROME (IRRIDITE)	35.00	5.94	207.90
SODIUM DICHROMATE	25.00	1.32	33.00
FUME LID (SUPRESSANT)	1.00	12.50	12.50
LEA RONAL SILVER GLO TY	1.00	17.40	17.40
SILVER GLO 3KBP	1.00	23.50	23.50
ALDET BRASS SOAK CLEANER	50.00	2.00	100.00
TOTAL - PAGE 1			5500.88

NATIONAL PLATING, INC.
INVENTORY 12/31/97

ITEM	AMOUNT	PRICE/EA	TOTAL PRICE
DWS 1807			
POL-E-Z- 692	1	15.00	15.00
NCZ 916-B	1	12.65	12.65
QTRAL	17	2.94	49.98
CW-7 WETTING AGENT	2.5	10.00	25.00
Q LEVEL BRIGHTNER	2	12.50	25.00
HYDROGEN PEROXIDE 3.5%	2.5	6.50	16.25
NAOH	550	0.48	264.00
CR03	100	2.00	200.00
TOTAL PAGE 3			607.88
TOTAL PAGES 1,2,3			11408.94

APPENDIX B

Site Specific Health and Safety Plan

HEALTH AND SAFETY PLAN

Focused Site Investigation
Former National Plating Co. Inc. Site
1501 Brewerton Road
Syracuse, New York

Approved by: ______________________________ Date: ________________
ENSR Regional Health and Safety Manager

Approved by: ______________________________ Date: ________________
ENSR Project Manager

CONTENTS

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1.0 INTRODUCTION

1.1 HASP Applicability

This site-specific Health and Safety Plan (HASP) has been developed by ENSR Corporation (ENSR). It establishes the health and safety procedures to minimize any potential risk to ENSR and contractor personnel implementing the focused site investigation at the Former National Plating Co. Inc. facility located in Syracuse, New York. ENSR is performing this work on behalf of Hancock & Estabrook.

The provisions of this plan apply to all ENSR personnel and ENSR subcontractor personnel who may potentially be exposed to safety and/or health hazards related to activities described in Section 3.0 of this document.

This HASP has been written to comply with the requirements of the Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120). All activities covered by this HASP must be conducted in complete compliance with this HASP and with all applicable federal, state, and local health and safety regulations. Personnel covered by this HASP who cannot or will not comply will be excluded from site activities.

This plan will be distributed to each employee involved with the investigations being conducted at the former manufacturing facility. Each employee must sign a copy of the attached health and safety plan receipt and acceptance form (see Attachment A).

This HASP only pertains to the tasks that are listed in Section 3.0. A task specific HASP or addenda to this HASP will be developed at a later date for any other subsequent investigative/remedial activities at the facility.

1.2 Organization/Responsibilities

The implementation of health and safety at this project location will be the shared responsibility of the ENSR Project Manager (PM), the ENSR Regional Health and Safety Manager (RHSM), the ENSR Project Site Safety Officer (SSO) and all other ENSR and contractor personnel.

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The implementation of health and safety at this project location will be the shared responsibility of the ENSR Project Manager (PM), the ENSR Regional Health and Safety Manager (RHSM), the ENSR Project Site Safety Officer (SSO) and all other ENSR and contractor personnel.

1.2.1 ENSR Project Manager

The ENSR PM (Karl Reimer) is the individual who has the primary responsibility for ensuring the overall health and safety of this project. As such, the PM is responsible for ensuring that the requirements of this HASP are implemented. Some of the PM's specific responsibilities include:

- Assuring that all personnel to whom this HASP applies have received a copy of it;
- Providing the RHSM with updated information regarding environmental conditions at the site and the scope of site work;
- Providing adequate authority and resources to the on-site SSO to allow for the successful implementation of all necessary safety procedures;
- Supporting the decisions made by the SSO and RHSM;
- Maintaining regular communications with the SSO and, if necessary, the RHSM; and,
- Coordinating the activities of all subcontractors and ensuring that they are aware of the pertinent health and safety requirements for this project.

1.2.2 ENSR Regional Health and Safety Manager

The ENSR RHSM (Kathleen Harvey) is the individual responsible for the preparation, interpretation and modification of this HASP. Modifications to this HASP which may result in less stringent precautions cannot be undertaken by the PM or the SSO without the approval of the RHSM. Specific duties of the RHSM include:

- Writing, approving and amending the HASP for this project;
- Advising the PM and SSO on matters relating to health and safety for this program;
- Recommending appropriate personal protective equipment (PPE) and air monitoring instrumentation to protect personnel from potential site hazards;
- Conducting accident investigations in conjunction with the SSO; and,
- Maintaining regular contact with the PM and SSO to evaluate site conditions and new information which might require modifications to the HASP.

1.2.3 ENSR Site Safety Officer

All ENSR field technicians are responsible for implementing the safety requirements specified in this HASP. However, one field technician will serve as the SSO. The SSO will be appointed by the PM and will be on-site during all activities covered by this HASP. The SSO is responsible for enforcing the requirements of this HASP once work begins. The SSO has the authority to immediately correct all situations where noncompliance with this HASP is noted and to stop work in cases where an immediate danger is perceived. Some of the SSO's specific responsibilities include:

- Assuring that all personnel to whom this HASP applies have submitted a completed copy of the HASP receipt and acceptance form;
- Assuring that all personnel to whom this HASP applies have attended a pre-entry briefing prior to entering an exclusion zone;
- Maintaining a high level of health and safety consciousness among employees at the work site;
- Procuring and distributing the PPE needed by ENSR employees for this project;
- Verifying that all PPE and health and safety equipment used by ENSR is in good working order;
- Setting up and maintaining the work zones and assuring proper decontamination of all site personnel and equipment;
- Notifying the PM and RHSM of all noncompliance situations and stopping work in the event that an immediate danger situation is perceived;
- Monitoring and controlling the safety performance of all personnel within the established work areas to ensure that required safety and health procedures are being followed;
- Conducting accident/incident investigations and preparing accident/incident investigation reports;
- Conducting the pre-entry briefing as required by Section 10.3 of the HASP; and,
- Initiating emergency response procedures in accordance with Section 11.0 of this HASP.

1.2.4 ENSR Field Personnel and Covered Contractor Personnel

All ENSR field personnel and contractor personnel covered by this HASP are responsible for following the health and safety procedures specified in this HASP and for performing their work in a safe and responsible manner. Some of the specific responsibilities of the field personnel are as follows:

- Reading the HASP in its entirety prior to the start of on-site work;
- Submitting a completed HASP Acceptance Form and documentation of medical surveillance and training to the ENSR PM prior to the start of work;
- Attending the required pre-entry briefing prior to beginning on-site work;
- Bringing forth any questions or concerns regarding the content of the HASP to the PM or the SSO prior to the start of work;
- Reporting all accidents, injuries and illnesses, regardless of their severity, to the ENSR SSO; and,
- Complying with the requirements of this HASP and the requests of the SSO.

1.2.5 Contractors

In addition to other requirements referenced in this HASP, all contractors are required to:

- Provide appropriate PPE for their employees;
- Ensure, via daily inspections, that their equipment is maintained in good working condition;
- Operate their equipment in a safe manner; and
- Appoint an on-site safety coordinator to interface with the ENSR SSO.

1.3 Modification of the HASP

The procedures in this HASP have been developed based on a site visit and a review of historical information regarding site operations and previous investigations. Should additional information become available regarding potential on-site hazards, it may be necessary to modify this HASP. All proposed modifications to this HASP must be reviewed and approved by the ENSR RHSM before such modifications are implemented.

Any significant modifications must be incorporated into the written document as addenda and the HASP must be reissued. The ENSR PM will ensure that all personnel covered by this HASP receive copies of all issued addenda. Sign-off forms will accompany each addendum and must be signed by all personnel covered by the addendum. Sign-off forms will be submitted to the ENSR PM. The HASP addenda should be distributed during the daily safety meeting so that they can be reviewed and discussed. Attendance forms will be collected during the meeting.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Description

The Former National Plating Co. Inc. facility is located at 1501 Brewerton Road in Syracuse, New York.

The site was in use from the early 1950s to 2002 as a metal plating facility, which specialized in decorative and industrial metal finishing. Previous sampling performed by O'Brien & Gere (1987) detected elevated levels of cadmium, chromium, cyanide, nickel and zinc in surficial soil samples collected at the site. The concentrations of these inorganic constituents exceed current soil cleanup criteria, and suggest the potential for the plating operations to have impacted the condition of the property.

2.2 Areas to be Investigated

The volunteers have entered into the New York State Voluntary Cleanup Program (VCP). Based on a review of historical information and a site visit, there are two general areas of the site where investigations will be focused, including:

- Concrete Sump Pit
- Western Edge of Pavement

In addition, monitoring wells will be installed at the site, one upgradient and two downgradient of the facility.

2.2.1 Concrete Sump Pit

Process waste waters generated in the operations area were conveyed through six 1½ -inch PVC pipes to a centrally located concrete sump pit which is approximately six feet deep. Process wastewater had been discharged to the sump since at least 1970. Until the late 1980s, the sump was unlined and discharges from the sump were conveyed to the County sanitary sewer without treatment.

A polypropylene liner and wastewater treatment system were installed in 1984. Wastewater treatment consisted of batch treatment (precipitation) and pH adjustment of rinse waters prior to discharge to the municipal sanitary sewer system.

2.2.2 Western Edge of Pavement

There were four potential sources of impacts to soils along the western edge of the pavement.

- There are two floor drains in the building, one in the former storage room and one in the former polishing room. Materials utilized in the plating process and kept in the storage room did not have secondary containment. The floor drains discharged to the western exterior perimeter of the building.
- Baghouse wastes (approximately two 55-gallon drums per year) from the polishing room ventilation system were disposed in the general office trash dumpster located along the western edge of the pavement.
- Used plating tanks were reportedly stored along the western edge of the pavement in an approximately 30-foot by 30-foot area. These tanks were acquired in the late 1970's and were stored in the area for approximately one to two years.
- Blowdown from boiler discharge is assumed to migrate with over land flow to the western edge of the asphalt.

3.0 SCOPE OF WORK

3.1 Project Overview

The purpose of the proposed focused site investigation is to characterize conditions at the site.

3.2 Field Investigations

Specific field tasks being implemented to meet the project objective include the following:

- Advance a soil boring through the sump pit using a direct-push drill rig and collect a soil sample and groundwater sample, if encountered, for subsequent laboratory analyses.
- Install groundwater monitoring wells downgradient and upgradient of the facility, using hollow-stem auger drilling techniques;
- Develop each well prior to sampling;
- Measure static water levels in each well prior to sampling;
- Collect groundwater samples from each well, using low-flow sampling techniques, for subsequent laboratory analyses; and,
- Collect surface and subsurface soil samples (0-2 inches below grade and 2 feet – 3 feet below grade) from the four potential sources of impacts on the western edge of the pavement using either a Geoprobe™ or hollow stem auger and splitspoon method for sampling for subsequent laboratory analyses.

4.0 CHEMICAL HAZARD ASSESSMENT AND CONTROLS

4.1 Chemical Hazards

The site has been used for metal plating operations since approximately 1950. Metal plating processes which historically occurred at the facility are described as decorative and industrial metal finishing, including electroplating, electroless plating, buffing, and polishing of various metals. Detailed information pertaining to the specific processes used at the site is not currently available. However, processes used during metal fabrication can include metal shaping, surface preparation, surface finishing and cleaning. Surface preparation can include solvent degreasing and emulsion, alkaline and acid cleaning. Surface finishing can include anodizing, chemical conversion coating, electroplating, plating and painting.

Limited sampling performed by O'Brien & Gere (1987) detected elevated levels of cadmium, chromium, cyanide, nickel and zinc in surficial soil samples collected at the site. The concentrations of these inorganic constituents exceed current soil cleanup criteria, and suggest the potential for the plating operations to have impacted the condition of the property.

Based on the areas where sampling is proposed, the primary constituents of concern include metals and cyanide. Soils and groundwater may also have altered pH due to the use of both acidic and alkaline solutions during metal preparation and finishing as well as wastewater pre-treatment.

4.1.1 Metals

A variety of metals have been previously detected in surface soils collected by O'Brien & Gere including cadmium, chromium, nickel and zinc.

4.1.1.1 Cadmium

Cadmium can cause local skin and eye irritation. The early symptoms of overexposure, via inhalation of fumes or dusts, may include mild irritation of the upper respiratory tract, a sensation of constriction of the throat, a metallic taste and/or a cough. A period of 1-10 hours may precede the onset of rapidly progressing shortness of breath, chest pain and flu-like symptoms. Repeated overexposure to cadmium may result in kidney dysfunction/damage and an increased risk of cancer of the lung and prostate. The OSHA Permissible Exposure Limit (PEL) for cadmium is 5 ug/m3, as an 8-hour time-weighted average (TWA).

4.1.1.2 Chromium

Hexavalent chromium compounds, upon contact with the skin can cause ulceration and possibly an allergic reaction. Inhalation of hexavalent chromium dusts is irritating and corrosive to the mucous membranes of the upper respiratory tract. Chrome ulcers and chrome dermatitis are common occupational health effects from prolonged and repeated exposure to hexavalent chromium compounds. Acute exposures to hexavalent chromium dusts may cause coughing or wheezing, pain on deep inspiration, tearing, inflammation of the conjunctiva, nasal itch and soreness or ulceration of the nasal septum. Repeated and chronic overexposures to certain forms of hexavalent chromium have been found to cause increased respiratory cancer among workers. Trivalent chromium compounds (chromic oxide) are generally considered to be of lower toxicity, although dermatitis may occur as a result of direct handling. The OSHA PEL for hexavalent chromium compounds is 0.1 mg/m3, as an 8-hr TWA.

4.1.1.3 Nickel

Skin sensitization is the most frequently seen toxic reaction to nickel and nickel compounds. This often results in chronic eczema known as "nickel itch". Nickel and its compounds are also irritants to the conjunctiva of the eye and mucous membrane of the upper respiratory tract. Studies have shown that chronic overexposures to the dusts of nickel and nickel salts can produce cancers of the lung and nasal passages. The OSHA PEL is 1 mg/m3, as an 8-hr TWA
{PRIVATE }

4.1.1.4 Zinc

Zinc metal is not considered to be hazardous. It is zinc oxide, which is considered hazardous if inhaled but this not a contaminant of concern for this program.

4.1.2 Cyanide

During electroplating, cyanide salts are used. Typical salts include potassium and sodium cyanide. Cyanide salts are granular solids that exhibit a faint almond-like odor. The primary toxic effect associated with overexposure to cyanide salts is their ability to combine in the tissues with enzymes associated with cellular oxidation. It renders oxygen unavailable to the tissues. The presence of cherry-red venous blood in cases of cyanide poisoning is due to the inability of the tissues to remove oxygen from the blood (i.e, cyanosis). The OSHA PEL for cyanide salts is 5 mg/m3, as an 8-hr TWA.

4.1.3 High or Low pH

Soils and/or groundwater may be acidic or alkaline due to the use of both types of materials, typically in liquid baths, during the metal preparation and finishing processes, as well as waste water pre-treatment. pH altered materials can cause irritation of the skin, especially if the skin is moist as well as irritation of the eyes, nose, throat and respiratory tract if the vapors or dusts of such materials are inhaled.

4.1.4 Exhaust Gases during Interior Drilling

The sump is located within the building. As such, the build up of exhaust gases from gasoline-powered internal combustion engines is a concern during the installation of the soil boring in this interior location. Carbon monoxide is the most toxic of the exhaust gases. Carbon monoxide is an asphyxiant in that it prevents hemoglobin from binding with oxygen. Symptoms of acute carbon monoxide poisoning include intense headache, dizziness, nausea, and collapse. Initially the victim is pale; later the skin and mucous membranes may turn cherry-red in color. The OSHA PEL for carbon monoxide is 35 ppm, as an 8-hour TWA with a ceiling value of 200 ppm. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends a threshold limit value (TLV) of 25 ppm, as an 8-hr TWA.

{PRIVATE }

4.2 Chemical Exposure Potential

The contaminants of concern are not volatile in nature. Therefore, it is the potential for inhaling dusts that is a concern. However, the use of direct-push technology to collect subsurface soil samples and the use of hand tools to collect surface soil samples will greatly minimize the potential for the generation of dusts. Dusts may be generated during conventional auger drilling. However, the most likely route of potential exposure to the contaminants of concern will be via direct dermal contact with environmental media during sampling activities. There is also the potential for employees to transport contaminated dusts home on their shoes or clothing if contamination is surficial in nature.

4.2.1 Chemical Exposure Control

The following chemical exposure control measures will be implemented during the proposed investigations:

- To avoid direct dermal contact with potentially contaminated media, as well as the potential for contamination transport, protective clothing, as described in Section 7.1, will be required during the investigative program.
- To determine if sustained dust levels exceed the established action level during well installation, a portable dust monitor will be used, as defined in Section 6.0. To reduce the potential for dust generation during the installation of the monitoring wells, a light mist of water can be applied over the boreholes during drilling.
- If the above mentioned measures are unsuccessful in controlling the dust, work will be suspended until additional controls can be implemented, including the use of respiratory protection.
- If possible, electrical coring devices and an electric-rig will be used to advance the soil boring near the concrete sump. If this piece of equipment is not available and a drilling rig with an internal combustion engine is used, a carbon monoxide meter must be used to

monitor the build up of exhaust gas in the building. The unit will be set to alarm at 25 ppm. If the alarm sounds, work will cease and all employees will leave the building. Even if the building is well-ventilated and the exhaust gas is ducted to the outside, a CO meter is still required.

- Although highly unlikely, exposure to all of the contaminants of concern may occur via ingestion (hand-to-mouth transfer). The decontamination procedures described in Section 9.0 address personal hygiene issues that will limit the potential for contaminant ingestion.
- To prevent deposition of potentially contaminated dust on stored material within the building, plastic sheeting will be used to cover the material. The sheeting will be removed and disposed of as PPE at the completion of the investigation.

5.0 PHYSICAL HAZARDS AND CONTROLS

5.1 Working Inside the Facility

The facility is currently used for the storage of cleaning supplies (mainly soap, hangers, spot remover, etc.). None of these materials are stored in drums. Further, employees only go to the facility as needed; no employees work at the facility on a full time basis. So it is unlikely that the proposed interior drilling will pose a problem to the current site occupants. However, ENSR has arranged to have the current occupant clear an area, if necessary, around the sump so that we have clear and unrestricted access to the sump during the proposed drilling.

5.2 Utility Hazards

5.2.1 Underground Utility Hazards

New York law requires that, at least 48 hours prior to initiation of any subsurface work, a utility clearance be performed at the site. The drilling contractor will contact DIG SAFELY NEW YORK (1-800-962-7962) to request a mark-out of underground utilities in the proposed boring/monitoring well locations. Work will not begin until the required utility clearances have been performed. {PRIVATE }Public utility clearance organizations typically do not mark-out underground utility lines that are located on private property. As such, the contractor must exercise due diligence and try to identify the location of any private utilities on the property being investigated. The contractor can fulfill this requirement in several ways, including:

- obtaining as-built drawings for the areas being investigated from the property owner;
- visually reviewing each proposed drilling location with the property owner or knowledgeable site representative;
- performing a geophysical survey to locate utilities or hiring a private line locating firm to determine the location of utility lines that are present at the property;
- identifying a no- drill zone; or
- hand digging in the proposed drilling locations if insufficient data is available to accurately determine the location of the utility lines.

5.2.2 Overhead Utilities

Be particularly aware of overhead power lines in the work area. Any vehicle or mechanical equipment capable of having parts of its structure elevated (drill rig, crane etc.) near energized overhead lines shall be operated so that a clearance of at least 10 feet is maintained. If the voltage is higher than 50kV, the clearance shall be increased 4 inches for every 10kV over that voltage.

5.3 Drilling Hazards

5.3.1 Auger Drilling

Use of a drill rig to install monitoring wells will require all personnel in the vicinity of the operating rig to wear steel-toed boots, hardhats, hearing protection and safety eyewear. Personnel shall not remain in the vicinity of operating equipment unless it is required for their work responsibilities. Additionally, the following safety requirements must be adhered to:

- All drill rigs and other machinery with exposed moving parts must be equipped with an operational emergency stop device. Drillers and geologists must be aware of the location of this device. This device must be tested prior to job initiation and periodically thereafter. The driller and helper shall not simultaneously handle augers unless there is a standby person to activate the emergency stop.

- The driller must never leave the controls while the tools are rotating unless all personnel are kept clear of rotating equipment.

- A long-handled shovel or equivalent must be used to clear drill cuttings away from the hole and from rotating tools. Hands and/or feet are not to be used for this purpose.

- A remote sampling device must be used to sample drill cuttings if the tools are rotating or if the tools are readily capable of rotating. Samplers must not reach into or near the rotating equipment. If personnel must work near any tools which could rotate, the driller must shut down the rig prior to initiating such work.

- Drillers, helpers and geologists must secure all loose clothing when in the vicinity of drilling operations.

- Only equipment that has been approved by the manufacturer may be used in conjunction with site equipment and specifically to attach sections of drilling tools together. Pins that protrude excessively from augers shall not be allowed

- No person shall climb the drill mast while tools are rotating.

- No person shall climb the drill mast without the use of ANSI-approved fall protection (approved belts, lanyards and a fall protection slide rail) or portable ladder which meets the requirements of OSHA standards.

5.3.2 Geoprobe Drilling

Use of the Geoprobe System to advance a soil boring near the sump will require all personnel in the vicinity of the operating unit to wear steel-toed boots, hardhats, hearing protection and safety eyewear. Personnel shall not remain in the vicinity of operating equipment unless it is required for their work responsibilities. Additionally, the following safety requirements must be adhered to:

- A remote vehicle ignition is located on the control panel of the Geoprobe unit. This allows the operator to start and stop the vehicle engine from the rear. This device must be tested prior to job initiation and periodically thereafter. All employees should be aware of how to access and operate the rear ignition.

- The driller must never leave the controls while the probe is being driven.

- Drillers, helpers and geologists must secure all loose clothing when in the vicinity of drilling operations.

- The Geoprobe vehicle shall not be moved any distance with the probe in the extended position. Check for clearance at roof or the vehicle before folding the Geoprobe out of the carrier vehicle.

- Be sure the parking brake is set before probing.

- Never allow the derrick foot to be lifted more than 6" off of the ground surface.

- Deactivate hydraulics when adding or removing probe rods, anvils or any tool in the hammer.

- Verify that all threaded parts are completely threaded together before probing.

5.4 Cuts and Lacerations

Employees are at an increased risk of cutting themselves with the knives used to cut tubing that is used for groundwater sampling. Similarly, the acetate soil liners used for geoprobe soil sampling must also be cut open to collect the sample. If a tube cutter is not used for cutting tubing or the acetate sleeve and a knife or blade must be used, follow the safety precautions listed below:{PRIVATE }

- Keep your free hand out of the way and secure your work if cutting through thick material

- Use only sharp blades; dull blades require more force which results in less knife control
- Pull the knife toward you; pulling motions are easier to manage
- Don't put your knife in your pocket
- Use a self-retracting blade or a linoleum knife
- Wear leather or Kevlar™ gloves when using knives or blades.

5.5 Noise Exposure

The use of the drilling rig will generate noise levels that will require the use of hearing protection in the immediate vicinity. Appropriate earmuffs or earplugs (i.e., with an NRR greater than 25 dB) should be worn to prevent overexposure. The general rule of thumb is that if you have to raise your voice to be understood by someone who is standing 3 to 5 feet away from you, the noise levels are likely to be above 85 dB and therefore require the use of hearing protection.

5.6 Back Safety

Using the proper techniques to lift and move heavy pieces of equipment is important to reduce the potential for back injury. The following precautions should be implemented when lifting or moving heavy objects:

- Use mechanical devices to move objects that are too heavy to be moved manually
- If mechanical devices are not available, ask another person to assist you.
- Bend at the knees, not the waist. Let your legs do the lifting.
- Do not twist while lifting
- Bring the load as close to you as possible before lifting
- Be sure the path you are taking while carrying a heavy object is free of obstructions and slip, trip and fall hazards.

5.7 Electrical Safety

If using portable tools that are electrically powered, follow the safety precautions listed below:{PRIVATE }

- Check to see that electrical outlets used to supply power during field operations is of the three wire grounding type.
- Extension cords used for field operations should be of the three wire grounding type and designed for hard or extra-hard usage. This type of cord uses insulated wires within an inner insulated sleeve and will be marked S, ST, STO, SJ, SJO or SJTO.
- NEVER remove the ground plug blade to accommodate ungrounded outlets.
- Do not use extension cords as a substitute for fixed or permanent wiring. Do not run extension cords through openings in walls, ceilings or floors.
- Protect the cord from becoming damaged if the cord is run through doorways, windows or across pinch points.
- Examine extension and equipment cords and plugs prior to each use. Damaged cords with frayed insulation or exposed wiring and damaged plugs with missing ground blades MUST BE REMOVED from service immediately.
- All portable or temporary wiring which is used outdoors or in other potentially wet or damp locations must be connected to a circuit that is protected by a ground fault circuit interrupter (GFCI). GFCI's are available as permanently installed outlets, as plug-in adapters and as extension cord outlet boxes. DO NOT CONTINUE TO USE A PIECE OF EQUIPMENT OR EXTENSION CORD THAT CAUSES A GFCI TO TRIP.
- When working in flammable atmospheres, be sure that the electrical equipment being used is approved for use in Class I, Division I atmospheres.
- Do not touch a victim who is still in contact with current. Separate the victim from the source using a dry, nonmetallic item such as a broomstick or cardboard box. Be sure your hands are dry and you are standing on a dry surface. Turn off the main electrical power switch and then begin rescue efforts.

5.8 Thermal Stress

5.8.1 Heat Stress

Types of Heat Stress

Heat related problems include **heat rash, fainting, heat cramps, heat exhaustion and heat stroke**. **Heat rash** can occur when sweat isn't allowed to evaporate, leaving the skin wet most of the time and making it subject to irritation. **Fainting** may occur when blood pools to lower parts of the body and as a result, does not return to the heart to be pumped to the brain. Heat related fainting often occurs during activities that require standing erect and immobile in the heat for long periods of time. **Heat cramps** are painful spasms of the muscles due to excessive salt loss associated with profuse sweating. **Heat exhaustion** results from the loss of large amounts of fluid and excessive loss of salt from profuse sweating. The skin will be clammy and moist and the affected individual may exhibit giddiness, nausea and headache.

Heat stroke occurs when the body's temperature regulatory system has failed. The skin is hot, dry, red and spotted. The affected person may be mentally confused and delirious. Convulsions could occur. EARLY RECOGNITION AND TREATMENT OF HEAT STROKE ARE THE ONLY MEANS OF PREVENTING BRAIN DAMAGE OR DEATH. A person exhibiting signs of heat stroke should be removed from the work area to a shaded area. The person should be soaked with water to promote evaporation. Fan the person's body to increase cooling.

Early Symptoms of Heat-Related Health Problems:

- decline in task performance
- incoordination
- decline in alertness
- unsteady walk
- excessive fatigue
- reduced vigilance
- muscle cramps
- dizziness

Susceptibility to Heat Stress Increases due to:

- lack of physical fitness
- lack of acclimation
- increased age
- dehydration
- obesity
- drug or alcohol use
- sunburn
- infection

People unaccustomed to heat are particularly susceptible to heat fatigue. First timers in PPE need to gradually adjust to the heat.

The Effect of Personal Protective Equipment

Sweating normally cools the body as moisture is removed from the skin by evaporation. However, the wearing of certain personal protective equipment (PPE), particularly chemical protective coveralls (e.g., Tyvek), reduces the body's ability to evaporate sweat and thereby regulate heat buildup. The body's efforts to maintain an acceptable temperature can therefore become significantly impaired by the wearing of PPE.

Measures to Avoid Heat Stress:

The following guidelines should be adhered to when working in hot environments:

- Establish work-rest cycles (short and frequent are more beneficial than long and seldom).
- Identify a shaded, cool rest area.
- Rotate personnel, alternative job functions.
- Water intake should be equal to the sweat produced. Most workers exposed to hot conditions drink less fluids than needed because of an insufficient thirst. DO NOT DEPEND ON THIRST TO SIGNAL WHEN AND HOW MUCH TO DRINK. For an 8-hour workday, 50 ounces of fluids should be drunk.
- Eat lightly salted foods or drink salted drinks such as Gatorade to replace lost salt.
- Save most strenuous tasks for non-peak heat hours such as the early morning or at night.
- Avoid alcohol during prolonged periods of heat. Alcohol will cause additional dehydration.
- Avoid double shifts and/or overtime.

The implementation and enforcement of the above mentioned measures will be the joint responsibility of the project manager, on-site field coordinator, and health and safety officer. Potable water and fruit juices should be made available each day for the field team.

Heat Stress Monitoring Techniques

Site personnel should regularly monitor their heart rate as an indicator of heat strain by the following method: Check radial pulse rates by using fore-and middle fingers and applying light pressure to the pulse in the wrist for one minute at the beginning of each rest cycle. If the pulse rate exceeds 110 beat/minute, shorten the next work cycle by one-third and keep the rest period the same. If, after the next rest period, the pulse rate still exceeds 110 beats/minute, shorten the work cycle by one-third.

5.8.2 Cold Stress

Types of Cold Stress

Cold injury is classified as either localized, as in frostbite, frostnip or chilblain; or generalized, as in hypothermia. The main factors contributing to cold injury are exposure to humidity and high winds, contact with wetness and inadequate clothing.

The likelihood of developing frostbite occurs when the face or extremities are exposed to a cold wind in addition to cold temperatures. The freezing point of the skin is about 30° F. The fluids around the cells of the body tissue freeze, causing the skin to turn white. This freezing is due to exposure to extremely low temperatures. As wind velocity increases, heat loss is greater and frostbite will occur more rapidly.

Symptoms of Cold Stress

The first symptom of frostbite is usually an uncomfortable sensation of coldness, followed by numbness. There may be a tingling, stinging or aching feeling in the effected area. The most vulnerable parts of the body are the nose, cheeks, ears, fingers and toes.

Symptoms of hypothermia, a condition of abnormally low body temperature, include uncontrollable shivering and sensations of cold. The heartbeat slows and may become irregular, the pulse weakens and the blood pressure changes. Pain in the extremities and severe shivering can be the first warning of dangerous exposure to cold.

Maximum severe shivering develops when the body temperature has fallen to 95° F. This must be taken as a sign of danger and exposure to cold must be immediately terminated. Productive physical and mental work is limited when severe shivering occurs.

Methods to Prevent Cold Stress

When the ambient temperature, or a wind chill equivalent, falls to below 40° F (American Conference of Governmental Industrial Hygienists recommendation), site personnel who must remain outdoors should wear insulated coveralls, insulated boot liners, hard hat helmet liners and insulated hand protection. Wool mittens are more efficient insulators than gloves. Keeping the head covered is very important, since 40% of body heat can be lost when the head is exposed. If it is not necessary to wear a hard hat, a wool knit cap provides the best head protection. A face mask may also be worn.

Persons should dress in several layers rather than one single heavy outer garment. The outer piece of clothing should ideally be wind and water proof. Clothing made of thin cotton fabric or synthetic fabrics such as polypropylene is ideal since it helps to evaporate sweat. Polypropylene is best at wicking away moisture while still retaining its insulating properties. Loosely fitting clothing also aids in sweat evaporation. Denim is not a good protective fabric. It is loosely woven which allows moisture to penetrate. Socks with a high wool content are best. If two pairs of socks are worn, the inner sock should be smaller and made of cotton, polypropylene or a similiar type of synthetic material that wicks away moisture. If clothing becomes wet, it should be taken off immediately and a dry set of clothing put on.

If wind conditions become severe, it may become necessary to shield the work area temporarily. The SSO and the PM will determine if this type of action is necessary. Heated break trailers or a designated area that is heated should be available if work is performed continuously in the cold at temperatures, or equivalent wind chill temperatures, of 20° F.

Dehydration occurs in the cold environment and may increase the susceptibility of the worker to cold injury due to significant change in blood flow to the extremities. Drink plenty of fluids, but limit the intake of caffeine.

6.0 AIR MONITORING

6.1 Direct Reading Instruments

The contaminants of concern are non-volatile. Therefore, it is the potential for inhaling dusts during the implementation of this field program that is a concern to the field team. However, the use of direct-push technology to collect subsurface soil samples and the use of hand tools to collect surface soil samples will greatly minimize the potential for the generation of dusts. Therefore, monitoring for dusts will be limited to those activities that may generate dust, which for this program involves the installation of monitoring wells using conventional auger drilling.

Instrument 1: Dust Monitor - MIE pDR 2000 or equivalent

A dust monitor, such as a MIE pDR 2000 or equivalent, will be used to measure the total dust concentration generated during the installation of groundwater monitoring wells. The monitor will be used to measure dust concentrations generated in the immediate work areas. The action level* for total dust in the worker's breathing zone is 0.36 mg/m3. This level is based upon the presence of cadmium at concentrations up to 1,400 mg/kg (west edge of pavement), its PEL of 5 µg/m3 and an applied safety factor of 10 due to cadmium's carcinogenicity.

$$\text{Action Level} = \frac{(1E^{+6})(\text{exposure limit mg/m3})}{(\text{concentration mg/kg})(\text{safety factor } 10)}$$

Engineering controls, such as the application of a fine mist of water over the boreholes, will be implemented if total dust concentrations exceed the action level. If engineering controls are unsuccessful in keeping the dust concentration below the action level, respiratory protection will be donned.

Instrument 2 - Carbon Monoxide Meter

If electric sampling equipment is not available and traditional drilling techniques (internal combustion engine) are used to advance the boring within the building, a carbon monoxide meter must be used to monitor the build up of exhaust gas in the building. The unit will be set to alarm at 25 ppm. If the alarm sounds, work will cease and all employees will leave the building until the levels of CO have been removed. If levels continue to exceed 25 ppm, mechanical ventilation will be required to remove the vapors from the work area as the use of air-purifying respiratory protection is not applicable. Even if the building is well-ventilated and the exhaust gas is ducted to the outside, a CO meter is still required.

6.2 Personal Air Sampling

OSHA does not require the collection of personal air sampling during the proposed activities. As such, this type of monitoring will not be conducted by ENSR during any of the proposed tasks.

6.3 Instrument Calibration and Recordkeeping

The dust monitor will be sent for calibration several weeks before the commencement of investigation activities at the site. In accordance with the manufacturer's instructions, a zero value update will be performed every 8 hours if the unit is operated in high particle concentration (>5 mg/m^3) environments. At aerosol concentrations below 1 mg/m^3, this update will be performed on a weekly basis. If at any time the zero value exceeds 2.5 mg/m^3, the sensor will be cleaned. If the zero value still exceeds 1.0 mg/m^3, the unit will be sent out for factory calibration (manufacturers suggested maintenance). A new unit will be made immediately available.

A log of total dust readings will be recorded at least once every 30 minutes and kept in the field notebook. Daily calibration information will also be recorded in the field notebook unless separate equipment calibration logs are maintained on site.

ENSR will request that the rental agency calibrate the carbon monoxide meter the day before the unit is to be used. The calibration record will be kept in the project files.

6.4 Community Air Monitoring Program (CAMP)

As required by the New York State Department of Health, a CAMP has been prepared for the instrusive activities being performed during this investigation and more specifically, for the installation of the groundwater monitoring wells. Due to the limited nature of the dust-producing work being performed, ENSR proposes the following work area perimeter monitoring. As indicated above, the presence of total dust will be monitored at the immediate work area. If sustained readings for total dust are detected in the breathing zone at the NYSDOH action limit of 100 ug/m3, initial perimeter air monitoring will be conducted. This monitoring will be conducted in a "step out" radial pattern of 5-foot intervals up to approximately 10 to 20 feet downwind of the work area. If elevated readings (i.e. total dust readings exceeding 100 ug/m3) are detected at downwind locations, the engineering controls being used to control dust will be increased. Work will not proceed until the increased controls are implemented and total dust levels at the perimeter locations are below the action levels.

A record of all perimeter air monitoring readings, including the time recorded, location, and reading, as well as a description of activities that resulted in elevated readings and response actions taken, will be maintained.

7.0 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) will be worn during sampling activities to prevent on-site personnel from being injured by the safety hazards posed by the site and/or the activities being performed. The following table describes the PPE and chemical protective clothing to be worn for general site activities and for certain specific tasks.

7.1 Chemical Protective Clothing

To put checkmarks in the any of the table's boxes, highlight one of the checkmark that is already located in the table and select Edit and Copy. Place your cursor in the appropriate box and select Edit and Paste. Additional check marks can be inserted by placing the cursor in the appropriate and simply hitting "Ctrl-V". Don't worry, the blue text that is underlined in dots will not print.

PPE Item	Task 1	Task 2	Task 3	Task 4
Hard Hat		✓	✓	
Steel Toed Safety Shoes	✓	✓	✓	✓
Safety Glasses with Sideshields	✓	✓	✓	✓
Tyvek coveralls	*			
Kevlar or Leather gloves		*		*
Disposable Best N-Dex Nitrile gloves	✓	✓	✓	✓
Hearing Protection		✓	✓	

Task 1 –Surface Soil Sampling
* if employees kneel on impacted surface soils to collect samples

Task 2 - Geoprobe Sampling
* -when cutting acetate soil liners

Task 3 - Well Installation

Task 4 - Water Level Measurements/Groundwater Sampling
* -when cutting tubing for sampling

7.2 Respiratory Protection

A dust monitor will be used to measure the total dust concentration generated during the installation of groundwater monitoring wells. If the action limit of 0.36 mg/m3 is sustained for 15-minutes within employee breathing zones, engineering controls, such as the application of a fine mist of water over the boreholes, will be implemented. If engineering controls are unsuccessful in keeping the dust concentration below the action level, respiratory protection will be donned.

Level C Respiratory Protection - Half-mask air-purifying respirator with P-100 filters

Employees who are expected to don respiratory protection must have successfully passed a fit-test within the past year for the brand and model respirator they plan to wear for this program.

If electric sampling equipment is not available and traditional drilling techniques (internal combustion engine) are used to advance the boring within the building, a carbon monoxide meter must be used to monitor the build up of exhaust gas in the building. The unit will be set to alarm at 25 ppm. If the alarm sounds, work will cease and all employees will leave the building until the levels of CO have been removed. If levels continue to exceed 25 ppm, mechanical ventilation will be required to remove the vapors from the work area as the use of air-purifying respiratory protection is not applicable.

7.3 Other Protective Equipment

The following additional safety items should be available at the site:

- Portable, hand-held eyewash bottles
- First aid kit
- Type 10A:40B:C fire extinguisher (on drill rig is sufficient)
- Portable phones

8.0 SITE CONTROL

8.1 Work Zones

To prevent both exposure of unprotected personnel and migration of contamination due to tracking by personnel or equipment, work areas and personal protective equipment requirements will be clearly identified. ENSR designates work areas or zones as suggested in the "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," NIOSH/OSHA/USCG/EPA, November, 1985. They recommend the areas surrounding each of the work areas to be divided into three zones:

- Exclusion or "hot" Zone
- Contamination Reduction Zone (CRZ)
- Support Zone

8.1.1 Exclusion Zone

The facility is essentially non-operational. Therefore, establishing formal exclusion zones during the proposed soil boring/well installation program is not required. However, all personnel entering the active work area must be trained in accordance with the requirements defined in Section 10.2 of this HASP and must wear the prescribed level of personal protective equipment.

8.1.2 Contamination Reduction Zone

The decontamination zone will be established adjacent to the work zone. Personnel will remove contaminated gloves and other disposable items in this area and place them in a plastic bag until they can be properly disposed of.

8.1.3 Support Zone

At this site the support zone will include the area outside of the work area.

8.2 Safety Practices

The following measures are designed to augment the specific health and safety guidelines provided in this plan.

- The "buddy system" will be used at all times by all field personnel. No one is to perform field work alone. Standby team member must be intimately familiar with the procedures for initiating an emergency response.
- Eating, drinking, chewing gum or tobacco, smoking or any practice that increases the probability of hand-to-mouth transfer and ingestion of materials is prohibited in the immediate work area and the decontamination zone.
- Smoking is prohibited in all work areas. Matches and lighters are not allowed in these areas.

- Hands and face must be thoroughly washed upon leaving the work area and before eating, drinking or any other activities.
- Beards or other facial hair that interfere with respirator fit are prohibited.
- The use of alcohol or illicit drugs is prohibited during the conduct of field operations.
- All equipment must be decontaminated or properly discarded before leaving the site in accordance with the project work plan.

9.0 DECONTAMINATION

9.1 Personal Decontamination

Proper decontamination is required of all personnel before leaving the site. Decontamination will occur within the contamination reduction zone. Disposable PPE will be removed in the decontamination zone and placed in garbage bags and disposed of as general refuse.

Regardless of the type of decontamination system required, a container of potable water and liquid soap should be made available so employees can wash their hands before leaving the site for lunch or for the day.

10.0 MEDICAL MONITORING AND TRAINING REQUIREMENTS

10.1 Medical Monitoring

All personnel performing activities covered by this HASP must be active participants in a medical monitoring program that complies with 29 CFR 1910.120(f). Each individual must have completed an annual surveillance examination and/or an initial baseline examination within the last year prior to performing any work on the site covered by this HASP.

10.2 Health and Safety Training

10.2.1 HAZWOPER

All personnel performing activities covered by this HASP must have completed the appropriate training requirements specified in 29 CFR 1910.120(e). Each individual must have completed an annual 8-hour refresher-training course and/or initial 40-hour training course within the last year prior to performing any work on the sites covered by this HASP.

10.2.2 Pre-Entry Briefing

The SSO will conduct a pre-entry briefing before site activities begin. HASP receipt and acceptance sheets will be collected at this meeting. Short safety refresher meetings will be conducted, as needed, throughout the duration of the project. Attendance of the pre-entry meeting is mandatory and will be documented by the ENSR SSO. An attendance form is presented in Attachment B.

11.0 EMERGENCY RESPONSE

OSHA defines emergency response as any "response effort by employees from outside the immediate release area or by other designated responders (i.e., mutual-aid groups, local fire departments, etc.) to an occurrence which results, or is likely to result in an uncontrolled release of a hazardous substance." According to ENSR policy, ENSR personnel shall not participate in any emergency response where there are potential safety or health hazards (i.e., fire, explosion, or chemical exposure). ENSR response actions will be limited to evacuation and medical/first aid as described within this section below. As such this section is written to comply with the requirements of 29 CFR 1910.38 (a).

The basic elements of an emergency evacuation plan include:

- employee training,
- alarm systems,
- escape routes,
- escape procedures,
- critical operations or equipment,
- rescue and medical duty assignments,
- designation of responsible parties,
- emergency reporting procedures and
- methods to account for all employees after evacuation.

11.1 Employee Training

Employees must be instructed in the site-specific aspects of emergency evacuation. This information will be communicated to the field team during the pre-entry briefing. On-site refresher or update training is required anytime escape routes or procedures are modified or personnel assignments are changed.

11.2 Alarm Systems/Emergency Signals

An emergency communication system must be in effect at all sites. The most simple and effective emergency communication system in many situations will be direct verbal communications. Each site must be assessed at the time of initial site activity and periodically as the work progresses. Verbal communications must be supplemented anytime voices can not be clearly perceived above ambient noise levels (i.e., noise from heavy equipment; drilling rigs, backhoes, etc.) and anytime a clear line-of-sight can not be easily maintained amongst all ENSR personnel because of distance, terrain or other obstructions.

Verbal communications will be adequate to warn employees of hazards associated with the immediate work area. The facility is non-operational so ENSR will not have access to telephone facilities. Therefore, cellular phones will be brought to the site to facilitate contact with local emergency responders.

11.3 Escape Routes and Procedures

The escape routes from the work area will be via internal facility roads to Brewerton Road. The escape routes and assembly areas will be reviewed during the pre-entry briefing. All personnel on site are responsible for knowing the escape route from the site and where to assemble after evacuation.

11.4 Rescue and Medical Duty Assignments

The phone numbers of the police and fire departments, ambulance service, local hospital, and ENSR representatives are provided in the emergency reference sheet. This sheet will be posted in the site vehicle.

In the event an injury or illness requires more than first aid treatment, the SSO will accompany the injured person to the medical facility and will remain with the person until release or admittance is determined. The escort will relay all appropriate medical information to the on-site project manager and the RHSM.

If the injured employee can be moved from the accident area, he or she will be brought to the CRZ where their PPE will be removed. If the person is suffering from a back or neck injury the person will not be moved and the requirements for decontamination do not apply. The SSO must familiarize the responding emergency personnel about the nature of the site and the injury. If the responder feels that the PPE can be cut away from the injured person's body, this will be done on-site. If this not feasible, decontamination will be performed after the injured person has been stabilized.

11.5 Designation of Responsible Parties

The SSO is responsible for initiating emergency response. In the event the SSO can not fulfill this duty, the alternate SSO will take charge.

11.6 Employee Accounting Method

The SSO is responsible for identifying all ENSR personnel on-site at all times. On small, short duration jobs this can be done informally as long as accurate accounting is possible.

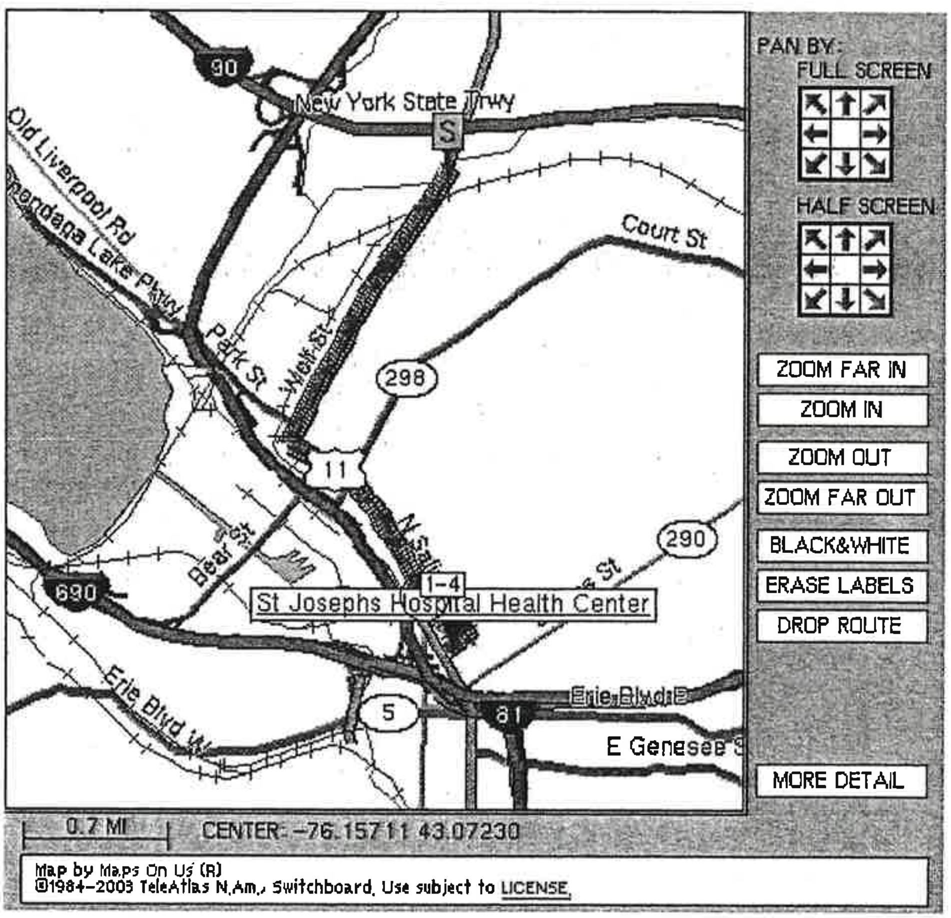
11.7 Accident Reporting and Investigation

Any incident (other than minor first aid treatment) resulting in injury, illness or property damage requires an accident investigation and report. The investigation should be conducted as soon as emergency conditions are under control. The purpose of the investigation is not to attribute blame but to determine the pertinent facts so that repeat or similar occurrences can be avoided. An ENSR accident investigation form is presented in Attachment C of this HASP. The injured ENSR employee's supervisor and the RHSM should be notified immediately of the injury.

If a subcontractor employee is injured, they are required to notify the ENSR SSO. Once the incident is under control, the subcontractor will submit a copy of their company's accident investigation report to the ENSR SSO.

EMERGENCY REFERENCES

Ambulance:	9-1-1
Fire:	9-1-1
Police:	9-1-1
Medical Services:	315-448-5111
	St. Josephs Hospital Health Center 301 Prospect Ave Syracuse, NY
Directions to Hospital:	From Brewerton Road, head south on US 11. Go 2.6 miles and continue onto Prospect Ave. Go 0.2 miles and turn left onto E. Laurel St. Go less than 0.1 miles and turn right onto N. Townsend Ave. Go 0.1 mile and turn right onto Union. Go 0.1 mile to hospital.



Dont' forget to add the basic directions to the hospital prior to issuing the HASP. Don't use "To be Determined Upon Arrival at the Site". Don't worry, this won't print.

ENSR Project Representatives:

ENSR/WESTFORD, MA	978-589-3000
-Kathleen Harvey (RHSM)	x 3325
ENSR/SYRACUSE, NY	315-432-0506
-Karl Reimer (PM)	x233

Attachment A

Health and Safety Plan Receipt and Acceptance Form

Health and Safety Plan Receipt and Acceptance Form

Focused Site Investigation
Former National Plating Co. Inc. Site
1501 Brewerton Road
Syracuse, New York

I have received a copy of the Health and Safety Plan prepared for the above-referenced site and activities. I have read and understood its contents and I agree that I will abide by its requirements.

Name (Print) ____

Signature ____________________________________ Date: __________________

Representing (Print) ____
Company Name

Attachment B

Health and Safety Plan Pre-Entry Briefing Attendance Form

Focused Site Investigation
Former National Plating Co. Inc. Site
1501 Brewerton Road
Syracuse, New York

Briefing Conducted By: ______________________________

Date Performed: ____________________

Printed Name	Signature	Representing

APPENDIX C

Community Air Monitoring Plan

COMMUNITY AIR MONITORING PLAN

A Community Air Monitoring Plan (CAMP) is intended to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. If the action levels provided below are exceeded, additional requirements including increased monitoring, corrective actions to abate emissions, and/or work shutdown may be required. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

Reliance on the CAMP should not preclude simple, common-sense measures to keep dust and odors at a minimum around the work areas.

Particulate Monitoring

The presence of total dust will be monitored at the immediate work area. If sustained readings for total dust are detected in the breathing zone at the NYSDOH action limit of 100 ug/m^3, initial perimeter air monitoring will be conducted. This monitoring will be conducted in a "step out" radial pattern of 5-foot intervals up to approximately 10 to 20 feet downwind of the work area. If elevated readings (i.e. total dust readings exceeding 100 ug/m^3) are detected at downwind locations, the engineering controls being used to control dust will be increased. Work will not proceed until the increased controls are implemented and total dust levels at the perimeter locations are below the action levels.

A record of all perimeter air monitoring readings, including the time recorded, location, and reading, as well as a description of activities that resulted in elevated readings and response actions taken, will be maintained.

AIR MONITORING RESPONSE AND ACTIONS

Former National Plating Facility
Syracuse, New York

Constituent Monitored	Response Level (above background)	Action
Community Air Monitoring		
Particulates **(15-minute average)**	100 ug/m^3 or airborne dust observed leaving work area	• Dust suppresion techniques must be employed. • Work may continue as long as downwind PM-10 particulate levels do not exceed 150 ug/m^3 above the upwind level and no visible dust is migrating from the work area.
	150 ug/m^3	• Work must be stopped and a re-evaluation of activities initiated. • Work can resume provided that dust suppresion measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 ug/m3 of the upwind level and in preventing visible dust migration.
Air Monitoring for Indoor Drilling Activities		
Carbon Monoxide	25 ppm	• Work activities must be halted and all employees will leave the work area and/or building. • Work can resume provided that mechanical ventilation reduces the carbon monoxide concentration below 25 ppm.

Notes:

Action levels from NYSDOH Generic Community Air Monitoring Plan (NYSDOH, June 2000).
Action levels are not intended for use in determining worker respiratory protection. Worker respiratory protection is evaluated in the Health and Safety Plan (provided in Attachment B).

APPENDIX D

ENSR Standard Operating Procedures

D-1: SOP 7110 – Surface Soil Sampling

ENSR.

SOP NUMBER: 7110

Surface Soil Sampling

Date:	2^{nd} Qtr. 1994
Revision Number:	1
Author:	Charlie Martin
Discipline:	Geosciences

1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This standard operating procedure (SOP) describes the methods used for obtaining surface soil samples for physical and/or chemical analysis. For purposes of this SOP, surface soil (including shallow subsurface soil) is loosely defined as soil that is present within 5 feet of the ground surface and can be sampled with the use of readily available and easy-to-operate sampling equipment. Various types of sampling equipment are used in the collection of surface soil samples and include spoons or scoops, trowels, shovels, and hand or bucket augers.

The purpose of this SOP is to provide a specific method and/or procedure to be used in the collection of surface soil samples which, if followed properly, will promote consistency in sampling and provide a basis for sample representativeness.

This SOP is generally applicable to surface and shallow depth soils which are unconsolidated and are of low to moderate density. Higher density or compacted soils may require use of drill rigs or other powered equipment to effectively obtain representative samples.

It should be noted that other specific state and/or federal agency standard operating procedures may be in existence in certain areas which may require deviation from this sampling procedure. The applicability of other agency operating procedures, which may differ from ENSR's SOP, needs to be determined prior to start of the sampling program. Deviations from this SOP to accommodate other regulatory requirements should be reviewed in advance of the field program, should be explained in the project work plan, and must be documented in the field project notebook when they occur.

1.2 General Principles

Surface soil sampling generally involves use of hand-operated equipment to obtain representative soil samples from the ground surface and to shallow depths below the ground surface. If soil conditions are appropriate, surface soil sampling, following the procedures described in this SOP, can provide representative soil samples in an efficient manner.

1.3 Quality Assurance Planning Considerations

Project personnel should follow specific quality assurance guidelines for sampling as outlined in the site-specific QAPP and/or Sampling Plan. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements typically suggest the collection of a sufficient quantity of field duplicate, field blank, and equipment blank samples.

1.4 Health and Safety Considerations

Surface soil sampling may involve chemical exposure hazards associated with the type of contaminants present in surface soil. When surface soil sampling is performed, adequate Health and Safety measures must be taken to protect sampling personnel. These measures must be addressed in the project Health and Safety Plan (HASP). This plan must be approved by the project Health and Safety Officer before work commences, must be distributed to all personnel performing sampling, and must be adhered to as field activities are performed.

2.0 RESPONSIBILITIES

2.1 Sampling Personnel

It will be the responsibility of the sampling personnel to conduct surface soil sampling in a manner consistent with this SOP. The above individual will be responsible for the proper use and maintenance of all types of equipment used for obtaining surface soil samples, and the collection, labeling, handling and storage of all samples until further chain-of-custody procedures are undertaken.

2.2 Sampling Coordinator

Large sampling programs may require additional support personnel such as a sampling coordinator. The sampling coordinator is responsible for providing management support such as maintaining an orderly sampling process, providing instructions to sampling personnel regarding sampling locations, and fulfilling sample documentation requirements, thereby allowing sampling personnel to collect samples in an efficient manner.

2.3 Project Manager

It is the responsibility of the project manager to ensure that the sampling activity is properly staffed, planned, and executed.

3.0 REQUIRED MATERIALS

3.1 Spoons or Scoops

Spoons or scoops should preferably be constructed of stainless steel as this material is abrasion resistant, can be easily decontaminated, and can be used to manually extract low to moderate density soil samples directly from the ground surface. Other spoon/scoop construction materials such as high-density polyethylene and teflon may be suitable in some applications but are difficult to use in higher density soils.

3.2 Trowel

Stainless steel construction is preferred. The blade of a trowel is generally flat or slightly curved and is 5 to 6 inches in length. Some trowels are available with depth calibrations marked on the blade.

3.3 Shovel

Shovels may be long or short-handled and are most often used for preparation of the sample collection area, i.e., for removal of surface debris or penetration of a high density/compacted surface prior to collection of the sample with another more appropriate device. Shovels may be used for the collection of samples that require large volumes of material for analysis (i.e., for bench-scale treatability studies). Shovels can also be used for scraping of test pit sidewalls in preparation for sidewall sampling using another device.

3.4 Hand Auger

This tool, commonly referred to as a soil auger, consists of a short spiral-bladed metal rod (solid-stem auger) attached to a handle. Clockwise rotation of the handle provides the cutting motion for the auger. Most of the loose soil is discharged upwards as the auger moves downwards. However, if the soil is cohesive some of it will stick to the auger flight providing a collectable sample at a measurable depth. Samples of surface soil can also be collected using a tube sampler which is attached to the end of the auger rods and advanced into the soil to extract a sample.

3.5 Bucket Auger

This device consists of a short length of hollow tube with cutting teeth at the bottom. As the handle is rotated, the sample is brought into and retained within the tube. When the auger is removed from the ground surface, the sample is retrieved from the tube with a spoon, or, if loosely consolidated, is poured directly into a collection pan or into the sample containers. Typically constructed of stainless steel, bucket augers are commonly available in diameters varying from two to four inches.

3.6 Collection Pan

A soil collection pan is often used as an intermediate sample container between removal of the sample from the ground and final bottling of the sample. Soil collection pans should preferably be constructed of stainless steel, although common household steel cooking pans may be used if the pan is lined with aluminum foil during sample collection.

3.7 Supporting Materials

- Teaspoon or spatula
- Aluminum foil
- Sample kit (i.e., bottles, labels, custody records, cooler, etc.)
- Sample logs/boring logs
- Decontamination materials
- Six-foot folding rule or tape measure for depth measurement
- Personal protective equipment (as required by the HASP)
- Field project notebook/pen

4.0 METHOD

4.1 General Procedures

Site-specific soil characteristics such as soil density and moisture will generally dictate the preferred type of sampling equipment for use at a particular site. Similarly, other project-specific requirements such as sampling depth and requested type of analysis such as physical testing (e.g., grain-size distribution) and/or chemical analysis will dictate the use of a preferred type of sampling equipment. Analytical testing requirements will indicate sample volume requirements that also will influence the selection of the appropriate type of sampling tool. The project sampling plan should define the specific requirements for collection of surface soil samples at a particular site. Should site-specific characteristics remain unidentified prior to start of the sampling program, sampling personnel should be equipped with a variety of sampling equipment to address the most likely sampling situations to be encountered.

As indicated, sample volume and sampling depth requirements should be defined in the sampling plan. This information should define the size of the hole which will be created during collection of the sample. For instance, if only a 500-ml sample will be required for analysis from a depth interval of 0 to 6 inches, an approximate 2 to 3-inch diameter hole will be needed. The indicated types of sampling equipment will generally make a minimum diameter hole of approximately 3 inches, therefore, an excess volume of soil may be generated during collection of a small volume soil sample. For samples requiring a large volume of soil, multiple holes and soil compositing may be necessary. Collection of the requisite volume of soil to meet sample volume requirements without underestimating the sample volume is the overall objective and is a technique which improves with experience.

It should be noted that some sampling programs may require the use of a sampling grid for the purpose of obtaining a statistically representative number of soil samples. This SOP does not provide information relative to construction of a sampling grid. This information may be found in other documents.

4.2 Equipment Decontamination

Regardless of the specific type of equipment used, each piece of equipment needs to be decontaminated prior to its initial use and following collection of each individual soil sample. Site-specific requirements for equipment decontamination should be outlined within the project sampling plan. Equipment decontamination procedures are specified within ENSR SOP 7600 - Decontamination of Equipment.

4.3 Collection of Samples for Volatile Organics Analysis

Collection of surface soil samples for volatile organics analysis (VOA) is different than collection of soil samples for other routine physical or chemical testing primarily because of the concern for potential loss of volatiles during the normal sample collection procedure. To limit the potential for loss of volatiles, the soil sample must be obtained as quickly and as directly as possible. This generally means that if a VOA sample is to be collected as part of a multiple analyte sample, the VOA sample portion should be obtained first. The VOA sample should also be obtained from a discrete portion of the entire collected sample and not from a sample which has been composited or homogenized from the entire sample interval. In general, it is best to collect the VOA sample by transferring the sample directly from the sampling tool into the sample bottles. Intermediate sample containers such as collection pans should not be used during collection of VOA samples.

4.4 Standard Procedures

4.4.1 Surface Preparation

At some sampling locations, the ground surface may require preparation in advance of sampling. Surface preparation can include removal of surface debris which blocks access to the actual soil surface or loosening of dense surface soils such as those encountered in heavy traffic areas, or frozen soils. If sampling equipment is used for both removal of surface debris and for collection of the soil sample, the equipment should be decontaminated prior to sample collection to reduce the potential for sample interferences between the surface debris and the underlying soil.

4.4.2 Shovel Sampling Procedure

A detailed operating procedure for proper use of a shovel for soil sampling is unnecessary. Specific requirements for sample quantity and sampling depth should be outlined within the project sampling plan.

Decontaminate the shovel in accordance with established procedures prior to use.

Once the soil sample is obtained and placed into the appropriate sample container(s) the hole from which the sample was retrieved should be filled with surrounding soils to eliminate a potential surface hazard.

4.4.3 Spoon, Scoop, and Trowel Sampling Procedure

Spoons, scoops, and trowels are of similarly designed construction and can therefore be operated in accordance with the following procedure.

Select the sampling location and prepare the surface by removal of surface debris if present. If the sample depth interval is at some depth below the ground surface, the surface soil material should also be removed as part of the surface preparation step. Surface preparation should be completed using other appropriately decontaminated sampling equipment.

Decontaminate the sampling tool in accordance with established procedures prior to use.

The soil sample should be obtained by inserting the sampling tool into the ground and rotating the tool so that a representative "column" of soil is removed from the ground.

The immediate objective is to collect the VOA sample fraction first if this is required. If the VOA sample is to be collected from the upper sampling interval, then the first scoop of soil should be used to directly fill the sample containers. If a specific depth below the ground surface has been targeted for the VOA sample, the overlying soils should be removed and discarded or placed into a soil collection pan as part of the remaining composite sample.

Regardless of whether or not a VOA sample is required, one or more cores or scoops of soil may be needed until the desired sampling depth is achieved. Removal of a representative column of soil in cohesionless soils may be difficult to achieve, however. If more soil is needed to meet sample volume requirements, additional soil cores may be collected from an immediately adjacent location.

Except for VOA samples, as each portion of the sample is removed from the ground, it should be placed into an intermediate sample container (collection pan) until the entire sample interval of soil is removed.

Once the sample interval has been collected, the soil sample should be thoroughly homogenized within the collection pan prior to bottling. Sample homogenizing is accomplished by manually mixing the entire soil sample in the collection pan with the sampling tool or with a clean teaspoon or spatula until a uniform mixture is achieved.

The appropriate sample containers should be filled with soil from the collection pan. The sampling tool may be used to fill the sample bottles. If packing of the samples into the bottles is necessary, a clean stainless steel teaspoon or spatula may be used. Use of fingers/hands to fill or pack sample containers should be avoided (this also includes VOA samples).

Once each sample container is filled, the rim and threads of the sample container will be cleaned of gross soil by wiping with a paper towel, then capped and labeled. Do not submerge the sample containers in water to clean them. Once labeled the sample containers should be placed into a cooler for protection. Sample chain-of-custody and other documentation requirements should be completed at this time.

The sampling tool and other sampling equipment should be decontaminated prior to reuse. All investigation-derived waste should be properly contained before leaving the area.

The sample hole should be backfilled to eliminate any surface hazard. The project sampling plan may indicate the requirements for backfilling of the sample hole.

4.4.4 Hand Auger Sampling

Select the sampling location and prepare the surface by removal of surface debris if present.

Decontaminate the sampling tool in accordance with established procedures prior to use.

A hand auger, or soil auger, can be used to extract shallow soil samples up to three (3) feet below the surface. Representative samples can be collected directly from the auger flight as it is withdrawn from the ground, or from the tube sampler attachment which can be advanced into the soil after augering to the desired depth.

When using the hand auger, the hole should be augered to the required depth by manually pushing and turning the auger. As the auger is turned, soils will be discharged to the ground surface, although some soil will be retained on the auger flight. Augering should be continued until the desired depth is achieved. If a composite or homogenized soil sample is the objective, those soils which have been discharged to the ground surface as well as those soils which cling to the auger flight should be homogenized within a soil collection pan prior to bottling. If a VOA sample is required, this fraction of the soil sample should be collected as soon as possible without compositing. It should be noted that soil augers cause considerable disturbance of the soil, therefore, some consideration should be given toward collection of VOA sample fractions using some other method (spoons, trowels, bucket augers may cause less disturbance).

Except for VOA sample fractions, the remainder of the soil sample should be thoroughly homogenized in the soil collection pan prior to bottling.

The appropriate sample containers should be filled with soil from the collection pan. A clean spoon or spatula may be needed to fill the sample bottles as necessary.

Once each sample container is filled, the rim and threads of the sample container will be cleaned of gross soil by wiping with a paper towel, then capped and labeled. Do not submerge the sample containers in water to clean them. Once labeled the sample containers should be placed into a cooler for protection. Sample chain-of-custody and other documentation requirements should be completed at this time.

All used sampling equipment should be decontaminated prior to reuse and investigation-derived waste should be properly contained before leaving the area.

The sample hole should be backfilled to eliminate any surface hazard. The project sampling plan may indicate the requirements for backfilling of the sample hole.

4.4.5 Bucket Auger Sampling

A bucket auger may be used to collect soil samples from depths ranging from one (1) to approximately five (5) feet. In some instances, soil samples may be collected from greater depths, but often with considerable more difficulty. Bucket augers allow for discrete depth interval sampling as the soil is retained within the hollow tube of the auger when it is extracted from the ground. It should be noted that if depth-discrete sampling is the objective, more than one auger may be necessary, with one auger used to provide access to the required sampling depth and the other (clean) auger used for sample collection.

Select the sampling location and prepare the surface by removal of surface debris, if present.

Decontaminate the sampling tool in accordance with established procedures prior to use.

When using the bucket auger, the auger should be pushed downward and rotated until the bucket becomes filled with soil. Usually a 6 to 12-inch core of soil is obtained each time the auger is inserted. Once filled, the auger should be removed from the ground and emptied into the soil collection pan. If a VOA sample is required, the sample should be taken directly from the auger using a teaspoon or spatula and/or directly filling the sample container from the auger. The augering process should be repeated until the desired sample interval has been augered and placed into the collection pan.

If the desired sample interval is located at a specific depth below the ground surface, the unwanted interval can be removed with one auger and the soil discarded. Sample collection can then proceed in normal fashion using a clean auger or following decontamination of the original auger.

Except for VOA sample fractions, the remainder of the soil sample should be thoroughly homogenized in the soil collection pan prior to bottling.

The appropriate sample containers should be filled with soil from the collection pan. Once each sample container is filled, the rim and threads of the sample container will be cleaned of gross soil by wiping with a paper towel, then capped and labeled. Do not submerge the sample containers in water to clean them. Once labeled the sample containers should be placed into a cooler for protection. Sample chain-of-custody and other documentation requirements should be completed at this time.

All used sampling equipment should be decontaminated prior to reuse and investigation-derived waste should be properly contained before leaving the area.

The sample hole should be backfilled to eliminate any surface hazard. The project sampling plan may indicate the requirements for backfilling of the sample hole.

5.0 QUALITY CONTROL

Quality control requirements for sample collection are dependent on project-specific sampling objectives. The Quality Assurance Project Plan (QAPP) will provide requirements for sample preservation and holding times, container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

6.0 DOCUMENTATION

Various forms are required to ensure that adequate documentation is made of the sample collection activities. These forms include:

- Field log books
- Sample collection records
- Chain-of-custody forms
- Shipping labels

The field book will be maintained as an overall log of all samples collected throughout the study. Sample collection records are generated for each sample collected and include specific information about the sample (Figure 1). Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes. Shipping labels are required if sample coolers are to be transported to the laboratory by a third party (courier service). Original and/or copies of these documents will be retained in the appropriate project files.

7.0 TRAINING/QUALIFICATIONS

Surface soil sampling is a relatively simple procedure requiring minimal training and a relatively small amount of equipment. It is, however, recommended that initial attempts be supervised by more experienced personnel. Sampling personnel should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

8.0 REFERENCES

Not applicable.

FIGURE 1 Surface Soil Sample Log

ENSR

SURFACE SOIL SAMPLE LOG

Project Number:__________ Project Location:__________

Sample Point No.:__________

Date:__________ Time:

Sample Point Description/Designation:__________

____

____

____

SAMPLE COLLECTION

Equipment Used:__________

No. of Samples Collected: Container Size: __________

Sample Number	Depth	Type of Material	Analyses Requested

Comments:

Lab Designation__________

Shipping ID Number:__________

Collector's Name__________

D-2: SOP 7115 – Subsurface Soil Sampling by Split Spoon

ENSR

SOP NUMBER: 7115

Subsurface Soil Sampling by Split Spoon

Date:	3rd Qtr. 1994
Revision Number:	3
Author:	Charles Martin
Discipline:	Geosciencies

1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) describes the methods used in obtaining subsurface soil samples for physical and/or chemical analysis. Subsurface soil samples are obtained in conjunction with soil boring programs and provide information as to the physical and/or chemical makeup of the subsurface environment.

The purpose of this SOP is to provide a description of a specific method or procedure to be used in the collection of subsurface soil samples. Subsurface soil is defined as unconsolidated material which may consist of one or a mixture of the following materials: sand, gravel, silt, clay, peat (or other organic soils), and fill material. Subsurface soil sampling, conducted in accordance with this SOP will promote consistency in sampling and provide a basis for sample representativeness.

This SOP covers subsurface soil sampling by split-spoon only, as this is the means most often used for obtained samples of unconsolidated deposits. Other types of equipment are available for use in subsurface soil sampling, including thin-wall tube samplers (Shelby tubes), piston samplers, and continuous core barrel samplers. Information on the use of these other sampling devices may be found in several available drilling handbooks and respective state and/or federal agency technical guidance documents. The American Society for Testing and Materials (ASTM) also provides procedures for use of split-spoon and other sampling devices.

Deviations from this SOP to accommodate other regulatory requirements should be reviewed in advance of the field program, should be explained in the project work plan, and must be documented in the field project notebook when they occur.

1.2 General Principles

Split-spoon subsurface soil sampling generally requires use of a drilling rig and typically the hollow-stem auger or other common drilling method to generate a borehole in which to use the split-spoon sampler. The split-spoon sampler is inserted through the augers (or other type of drill casing) then is driven into the subsurface soil with a weighted hammer. The sampler is then retrieved and opened to reveal the recovered soil sample. Soil samples may be collected at a continuous interval or at pre-selected vertically spaced intervals within the borehole.

1.3 Quality Assurance Planning Considerations

Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific Quality Assurance Project Plan (QAPP). Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements outlined in the QAPP typically suggest the collection of a sufficient quantity of field duplicate, field blank, and other samples.

1.4 Health and Safety Considerations

Subsurface soil sampling may involve chemical hazards associated with the types of contaminants potentially encountered and will always involve potential physical hazards associated with use of drilling equipment. When sampling is performed in materials which may contain hazardous constituents, or when the quality assurance objectives of the project require the use of hazardous solvents, adequate Health and Safety measures must be taken to protect sampling personnel. These measures must be addressed in the project Health and Safety Plan (HASP). This plan must be approved by the project Health and Safety Officer before work commences, must be distributed to all personnel performing sampling, and must be adhered to as field activities are performed.

2.0 RESPONSIBILITIES

2.1 Drilling Subcontractor

It will be the responsibility of the drilling subcontractor to provide the necessary materials for obtaining subsurface soil samples. This generally includes one or more split-spoon samplers in good operating condition and sample containers used for stratigraphic characterization samples (sample containers for environmental samples should be provided by the designated analytical laboratory). It is the drilling subcontractor's responsibility to provide and maintain their own boring logs if desired. Equipment decontamination materials should also be supplied by the subcontractor and should meet project specifications.

2.2 Project Geologist/Sampling Engineer

It will be the responsibility of the project geologist/sampling engineer to conduct subsurface soil sampling in a manner which is consistent with this SOP. The project geologist/sampling engineer will observe all activities pertaining to subsurface soil sampling to ensure that the SOP is followed, and to record all pertinent data onto a boring log. It is also the project geologist/sampling engineer's responsibility to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. The project geologist/sampling engineer is also responsible for the collection of representative environmental or stratigraphic characterization samples once the sampling device has been retrieved and opened. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain-of-custody procedures are implemented.

3.0 REQUIRED MATERIALS

In addition to those materials provided by the subcontractor, the project geologist/sampling engineer will require:

- Project Sampling Plan, QAPP, and HASP
- Boring logs
- Teaspoon or spatula (stainless steel is recommended)
- Sample kit (bottles, labels, custody records and tape, cooler)
- Sample collection pen
- Folding rule or tape measure
- Equipment decontamination materials
- Health and safety equipment (as required by HASP)
- Field project notebook/pen

4.0 METHOD

4.1 General Method Description

Split-spoon sampling devices are typically constructed of steel and are most commonly available in lengths of 18 and 24 inches and diameters of 1.5 to 3 inches. The split-spoon consists of a tubular body with two halves that split apart lengthwise, a drive head on the upper end with a ball-check valve for venting, and a hardened steel cutting shoe at the bottom. The soil sample enters the split-spoon through the cutting shoe as the device is driven into the ground. A replaceable plastic or metal basket is often inserted into the shoe to assist with retaining samples. Once the sampler is retrieved, the drive head and cutting shoes are removed and the split-spoon halves are then separated, revealing the sample.

Sample depth intervals are usually defined on a project-specific basis with these requirements specified in the project sampling plan. Sampling intervals typically range from one (1) sample per five (5) feet of drilling to continuous sampling where the entire drilled interval is sampled.

Subsurface soil sampling is usually accomplished as part of a drilling program where a soil boring is advanced with drilling equipment to the designated depth prior to collection of a representative sample. The general procedures outlined briefly in the following section provide requirements for advancing drill casing/augers in preparation for sampling.

4.2 General Procedures - Borehole Preparation

4.2.1 Advancing Casing/Augers

Soil borings that are completed for soil sampling purposes are typically advanced using hollow-stem augers and sometimes drive-and-wash or other casing methods. The casing/augers must be of sufficient diameter to allow for soil sampling at a minimum. The casing/augers will be advanced according to project requirements to the required depth for sampling. If hollow-stem augers are used, a temporary plug shall be used in the lead auger to prevent the auger from becoming filled with drill cuttings while drilling is in progress.

4.2.2 Obstructions

For those borings which encounter obstructions, the casing/augers will be advanced past or through the obstruction if possible. Caution should be exercised when obstructions are encountered and an effort made to identify the obstruction before drilling is continued. If the obstruction is not easily drilled through or removed, the boring should be relocated to an adjacent location.

4.2.3 Use of Added Water

The use of added or recirculated water during drilling is permitted when necessary. Use of extraneous water should be minimized or avoided if possible as it may impact sample quality. Water usage should be documented in the field notebook. Sampling and analysis of added or recirculated water may be required for quality assurance purposes (refer to QAPP). If a well is installed within the completed borehole, removal of the added water may be required.

4.3 Sampling Procedure

4.3.1 Equipment Decontamination

Each split-spoon must be decontaminated prior to its initial use and following collection of each soil sample. Site-specific requirements for equipment decontamination should be outlined within the Project Sampling Plan. Equipment decontamination procedures are also outlined within SOP 7600 - Decontamination of Equipment.

4.3.2 Standard Penetration Test

The drilling subcontractor will lower the split-spoon into the borehole. Samples are generally obtained using the Standard Penetration Test (SPT) in accordance with ASTM standards (ASTM D 1586-84). Following this method, the sampler will be driven using the 140-pound hammer with a vertical free drop of 30 inches using two turns of the rope on the cathead. The number of hammer blows required for every 6 inches of penetration will be recorded on the boring log. Blowcount information is used as an indicator of soil density for geotechnical as well as stratigraphic logging purposes. Once the split-spoon has been driven to its fullest extent, or to refusal, it will be removed from the borehole.

4.3.3 Sample Recovery

The split-spoon will be immediately opened upon removal from the casing/auger. The open sampler shall then be screened for volatile organics with a photoionization device (PID) if required by the Project Sampling Plan. If the Sampling Plan also requires individual soil sample headspace screening for volatile organic compounds, then a small portion of the split-spoon sample shall be removed and properly contained for that purpose.

Sample recovery will be determined by the project geologist/sampling engineer who will examine the soil core once the sampler is opened. The length of sample shall then be measured with a folding rule or tape measure. Any portion of the split-spoon contents which are not considered part of the true sample (i.e., heaved soils) will be discarded. If the sample recovery is considered inadequate for sample characterization or analytical testing purposes, another sample should be collected from the next vertical interval if possible before drilling is reinitiated.

Adequate sample recovery for stratigraphic logging purposes and/or headspace organic vapor testing purposes should be approximately 6 inches. Adequate sample recovery for analytical testing purposes should be a minimum of 12 inches and is somewhat dependent on the type of analytical testing required. In some cases, continuous sampling over a short interval, and compositing of the sample, may be required to satisfy analytical testing requirements. Larger diameter samplers may be used if large volumes of soil are required for analytical testing.

4.3.4 Sample Containment - General

Once retrieved, the sample will be removed from the split-spoon with a teaspoon or spatula and placed into the appropriate sample container. The sample will be split if necessary to meet sampling program requirements. Sample splitting may be necessary to provide individual samples for headspace testing, visual characterization, physical testing, analytical testing, or simply for archiving purposes. In general, most sampling programs are structured around environmental characterization needs; therefore, sample portions required for analytical testing should be collected first. The Project Sampling Plan and QAPP provides specific sample container requirements for each type of sample and should be referred to for guidance.

Once filled, the sample containers should be properly capped, cleaned, and labeled, and chain-of-custody and sample preservation procedures initiated. Sampling equipment should then be properly decontaminated.

4.3.5 Sample Containment - Volatile Organic Analyses

Collection of subsurface soil samples for volatile organic analysis (VOA) is slightly more complex than collection of samples for other routine chemical or physical testing primarily because of the concern for the potential loss of volatiles during the sample collection procedure. To limit the potential for loss of volatiles, the soil sample needs to be obtained as quickly and as directly as possible from the split-spoon. This generally means that the VOA sample is to be collected and placed into the appropriate sample container first. The VOA sample should also be obtained from a discrete portion of the entire sample interval and not composited or homogenized. The remainder of the recovered sample can then be composited, homogenized or split to meet the other testing requirements. The boring log and/or sample logbook should be filled out to indicate actual sample collection depths for both VOA samples and other portions of the sample which may have been composited over a larger vertical interval.

5.0 QUALITY CONTROL

Quality control requirements are dependent on project-specific sampling objectives. The QAPP will provide requirements for sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

6.0 DOCUMENTATION

Various forms are required to ensure that adequate documentation is made of sample collection activities. These forms include:

- Boring logs
- Field log books
- Sample collection records
- Chain-of-custody records
- Shipping labels

Boring logs (Figure 1) will provide visual and descriptive information for each sample collected and are often the most critical form of documentation generated during a sampling program. The field log book is kept as a general log of activities. Chain-of-custody forms are transmitted with the samples to the laboratory for sample tracking purposes. Shipping labels are required if sample coolers are to be transported to the laboratory by a third party (courier service). Original copies of these records should be maintained in the appropriate project files.

7.0 REFERENCES

ASTM D 1586-84

ENSR

Figure 1

Sheet 1 of

BORING LOG

Project No. ______ Date – Start ______ Finish ______ Boring ______

Project Name ______ Drilling Co. ______

Location ______ Drilling Method ______

Total Depth ______ Inspector ______ Reviewer ______

Remarks ______

Depth Feet	Sample				Graphic Log	Lithologic Description	Equipment Installed
	Type & No.	Blows per 6 in.	Depth Range	Rec.			

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D-3: SOP 7220 – Monitoring Well Construction and Installation

SOP NUMBER: 7220

Monitoring Well Construction and Installation

Date:	3rd Qtr., 1995
Revision Number:	4
Author:	Charles Martin
Discipline:	Geosciences

1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This SOP provides guidance for installing groundwater monitoring wells. Monitoring wells are installed to monitor the depth to groundwater, to measure aquifer properties, and to obtain samples of groundwater for chemical analysis.

This SOP is applicable to installation of single monitoring wells within a borehole. The construction and installation of nested, multilevel or other special well designs is not covered within this SOP as these type of wells are not frequently constructed. This SOP applies to both overburden and bedrock monitoring wells.

Some states and EPA Regions have promulgated comprehensive guidelines for monitoring well construction and for subsurface investigation procedures. Deviations from this SOP to accommodate other regulatory requirements should be reviewed in advance of the field program, should be explained in the project work plan, and must be documented in the field project notebook when they occur.

1.2 General Principles

Monitoring well construction and installation generally involves drilling a borehole using conventional drilling equipment, installing commercially available well construction and filter/sealing materials, and development of the well prior to sampling. This SOP covers well construction and installation methods only. Borehole drilling and well development methods are covered under SOP-7115 (Subsurface Soil Sampling) and SOP-7221 (Monitoring Well Development), respectively.

1.3 Quality Assurance Planning Considerations

Field personnel should follow specific quality assurance guidelines as outlined in the site-specific QAPP.

The following aspects of monitoring well design and installation procedures depend on project-specific objectives which should be addressed in the QAPP and in the project work plan:

- Borehole drilling method and diameter,
- Type of construction materials for well screen, riser, filter pack and seals,
- Diameter of well materials,
- Length of well screen,
- Location, thickness, and composition of annular seals, and
- Well completion and surface protection requirements.

1.4 Health and Safety Considerations

Monitoring well installation may involve chemical hazards associated with materials in the soil or groundwater being investigated; and always involves physical hazards associated with drilling equipment and well construction methods. When wells are to be installed in locations where the aquifer and/or overlying materials may contain chemical hazards, a Health and Safety Plan (HASP) must be prepared and approved by the Health and Safety Officer before field work commences. This plan must be distributed to all field personnel and must be adhered to as field activities are performed.

2.0 RESPONSIBILITIES

2.1 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary equipment for well construction and installation. Well construction materials should be consistent with project requirements.

2.2 Surveying Subcontractor

It is the responsibility of the surveying subcontractor to provide one or more of the following well measurements as specified in the project work plan: ground surface elevation, horizontal well coordinates, top of well casing elevation (i.e., top-of-casing, or measuring point elevation), and/or top of protective casing elevation.

2.3 Project Geologist/Engineer

It is the responsibility of the Project Geologist/Engineer to directly oversee the construction and installation of the monitoring well by the drilling subcontractor to ensure that the well-installation specifications defined in the project work plan are adhered to, and that all pertinent data are recorded on the appropriate forms.

2.4 Project Manager

It is the responsibility of the Project Manager to ensure that each project involving monitoring well installation is properly planned and executed.

3.0 REQUIRED MATERIAL

3.1 Well Construction Materials

Well construction materials are usually provided by the drilling subcontractor and most often consist of commercially available flush-threaded well screen and riser pipe constructed of PVC or stainless steel with a minimum 2-inch inside diameter. The length of the screen and the size of the screen slots should be specified in the project work plan.

3.2 Well Completion Materials

Well completion materials include silica sand, bentonite, cement, protective casings and locks. Completion materials are generally provided by the drilling subcontractor.

3.3 Other required materials include the following:

- Potable water supply
- Fiberglass or steel measuring tape
- Water level indicator
- Well construction diagrams (Figure 1)
- Waterproof marker or paint (to label wells)
- Health and Safety supplies

- Equipment decontamination materials

- Field project notebook/pen

4.0 METHOD

4.1 General Preparation

4.1.1 Borehole Preparation

Standard drilling methods should be used to achieve the desired drilling/well installation depths specified in the project work plan. Soil sampling, if conducted, should be conducted in accordance with ENSR SOP-7115 (Subsurface Soil Sampling).

The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals. Bedrock wells may require reaming after coring in order to provide a large enough borehole diameter for well installation.

Rotary drilling methods requiring bentonite-based drilling fluids, if selected, should be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, potentially reducing the permeability of the material adjacent to the well screen.

If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site. In addition, an attempt should be made to recover the quantity of fluid or water that was introduced, either by flushing the borehole prior to well installation and/or by overpumping the well during development.

4.1.2 Well Material Decontamination

Although new well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, it is sometimes necessary to decontaminate the materials prior to their use. Well materials should be inspected by the project geologist/engineer upon delivery to check cleanliness. If the well materials appear dirty, or if local or regional regulatory guidance requires decontamination, then well material decontamination should be performed by the drilling subcontractor in accordance with ENSR SOP-7600 (Decontamination of Equipment).

4.2 Well Construction Procedure

4.2.1 Depth Measurement

Once the target drilling depth has been reached, the drilling subcontractor will measure the total open depth of the borehole with a weighted, calibrated tape measure. Adjustments of borehole depth can be made at this time by drilling further or installing a small amount of sand filter material to achieve the desired depth. If drilling fluids were used during the drilling process, the borehole should be flushed at this time using potable water. The water table depth may also be checked with a water level indicator if this measurement cannot be obtained with the calibrated tape.

4.2.2 Centralizers

In order to install a well which is centered within the borehole, it is recommended that centralizers be used. Centralizers are especially helpful for deep well installations where it may be difficult to position the well by hand. Centralizers may not be necessary on shallow water table well installations where the well completion depth is within 25 feet of the ground surface.

4.2.3 Well Construction

The well screen and riser pipe generally are assembled by hand as they are lowered into the borehole. Before the well screen is inserted into the borehole, the full length of the slotted portion of the well screen as well as the unslotted portion of the bottom of the screen should be measured with the measuring tape. These measurements should be recorded on the well construction diagram.

After the above measurement has been taken, the drilling subcontractor may begin assembling the well. As the assembled well is lowered, care should be taken to ensure that it is centered in the hole if centralizers are not used. The well should be temporarily capped before filter sand and other annular materials are installed.

4.2.4 Filter Sand Installation

The drilling subcontractor should fill the annular space surrounding the screened section of the monitoring well to at least 1 foot above the top of the screen with an appropriately graded, clean sand or fine gravel. In general, the filter pack should not extend more than 3 feet above the top of the screen to limit the thickness of the monitoring zone. If coarse filter materials are used, an additional 1-foot thick layer of fine sand should be placed immediately above the filter pack to prevent the infiltration of sealing components (bentonite or grout) into the filter pack. As the filter pack is placed, a weighted tape should be lowered in the annular space to verify the depth to the top of the layer. Depending upon depth, some time may be required for these materials to settle. If necessary, to eliminate possible bridging or creation of voids, placement of the sand pack may require the use of a tremie pipe. Tremie pipe sandpack installations are generally suggested for deep water table wells and for wells which are screened some distance beneath the water table.

4.2.5 Bentonite Seal Installation

A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed by the drilling subcontractor immediately above the well screen filter pack in all monitoring wells. The purpose of the seal is to provide a barrier to vertical flow of water in the annular space between the borehole and the well casing. Bentonite is used because it swells significantly upon contact with water. Pellets generally can be installed in shallow boreholes by pouring them very slowly from the surface. If they are poured too quickly, they may bridge at some shallow, undesired depth. As an option, powdered bentonite may be mixed with water into a very thick slurry and a tremie pipe used to inject the seal to the desired depth.

4.2.6 Annular Grout Seal Installation

This grout seal should consist of a bentonite/cement mix with a ratio of bentonite to cement of between 1:5 and 1:20. The grout ratio should be chosen based on site conditions with a higher percentage of bentonite generally used for formations with higher porosity. A mud balance should be used if a specific mud density is required at a particular site. Grout slurry should be pumped into the annular space using a side-discharging tremie pipe located about 2 feet above the sand pack. Side discharge will help preserve the integrity of the sand pack.

In situations where the monitoring well screen straddles the water table, the seal will be in the unsaturated zone and pure bentonites (pellets or powder) will not work effectively as seals without hydration. Dry bentonite may be used if sufficient time to hydrate the seal is allowed. Seal hydration requires the periodic addition of clean water. Optionally, seals in this situation may be a cement/bentonite mixture containing up to 10 percent bentonite by weight. This type of mixture shall be tremied to the desired depth in the borehole.

The borehole annulus will be grouted with seal materials to within 3 feet of the ground surface. Drill cuttings, even those known not to be contaminated, will not be used as backfill material.

4.2.7 Well Completion

The drilling subcontractor will cut the top of the well to the desired height and install a vented (if possible), locking cap. The upper portion of the well casing can optionally be drilled to allow venting. Well casings are usually cut to be a certain height above ground surface (typically 2.5 to 3 feet) or are cut to be flush with the ground surface.

4.2.8 Protective Casing/Concrete Pad Installation

The drilling subcontractor will install a steel guard pipe on the well as a protective casing. The borehole around the guard pipe will be dug out to an approximate 2 to 3-foot radius to a minimum depth of 1 foot at the center and 6 inches at the edges. After installing the protective casing, the excavation will be filled with a concrete/sand mix. The surface of the concrete pad will be sloped so that drainage occurs away from the well. Flush-mount protective casings may not require an extensive concrete pad and should be completed such that they are slightly mounded above the surrounding surface to prevent surface water from running over or ponding on top of the casing. It should be noted, however, that in areas subject to snowfall, flush-mount casings may have to be installed so that they are entirely flush with the ground surface as they may be damaged by snow plows.

Above-ground protective casings should also be vented or should have non-air tight caps. Road box installations should not be vented. Installation of additional guard pipes may be necessary around above-ground well completions in traffic areas. Protective casings should be lockable to prevent unauthorized access.

4.2.9 Well Numbering

The project geologist/engineer will number each well casing with an indelible marker or paint to identify the well. This is particularly important with nested or paired wells to distinguish between shallow and deep wells. The well should be labeled on both the outside of the protective casing and inside beneath the protective casing lid.

4.2.10 Measuring Point Identification

The project geologist/engineer will mark the measuring point from which water level measurements will be made at a specific location along the upper edge of the well casing. PVC wells can easily be notched with a pocket knife or saw. Stainless steel wells (or PVC wells) can be marked with a waterproof marker on the outside of the well casing with an arrow pointing to the measuring point location. The measuring point is the point which will require surveying during the well elevation survey task.

4.2.11 Well Measurements

Upon completion, the following well measurements should be taken by the project geologist/engineer and recorded on the well construction diagram (Figure 1):

- Depth to static water level if water level has stabilized,
- Total length of well measured from top-of-well casing,
- Height of well casing above ground surface,
- Height of protective casing above ground surface,
- Depth of bottom of protective casing below ground surface (may be estimated).

Well screen filter pack, bentonite seal and annular seal thicknesses and depths should also be recorded on the well construction diagram.

4.2.12 Disposal of Drilling Wastes

Drill cuttings and other investigation-derived wastes such as drilling mud or well development/purge water must be properly contained and disposed of. Site-specific requirements for collection and removal of these waste materials should be outlined within the project work plan. Containment of these materials should be performed by the drilling subcontractor.

4.2.13 Well Development

At some point after installation of a well and prior to use of the well for water-level measurements or collection of water quality samples, development of the well shall be undertaken in accordance with ENSR SOP-7221 (Monitoring Well Development). Well development may be performed by the drilling subcontractor if contracted to do so, or by the project geologist/engineer or other project staff.

4.2.14 Well Elevation Survey

At the completion of the well installation program, all monitoring wells are usually surveyed to provide, at a minimum, the top-of-casing measuring point elevation for water level monitoring purposes. Other surveyed points which may be required by the project work plan include: ground surface elevation, top of protective casing elevation, and well coordinate position. Well elevation surveys are usually conducted by a surveying subcontractor.

5.0 QUALITY CONTROL

Certain quality control measures should be taken to ensure proper well completion.

5.1 The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, if necessary, before any well construction materials are placed.

5.2 Water level and non-aqueous phase liquid (NAPL) presence will be checked during well installation to ensure that the positions of well screen, sand pack, and seal, relative to water level, conform to project requirements.

5.3 The depth to the top of each layer of packing (i.e., sand, bentonite, grout, etc.) will be verified and adjusted if necessary to conform to project requirements before the next layer is placed.

5.4 If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids may be required for analysis of chemical constituents of interest at the site.

6.0 DOCUMENTATION

All well construction data will be recorded on the Monitoring Well Construction Detail form (Figure 1). All wells will be referenced onto the appropriate site map. A field notebook and/or boring log will be used as additional means of recording data. In no case will the notebook or boring log take the place of the well construction diagram.

7.0 TRAINING/QUALIFICATIONS

Well construction and installation requires a moderate degree of training and experience as numerous drilling situations may occur which will require field decisions to be made. It is recommended that inexperienced personnel be supervised for several well installations before working on their own. Experienced drillers are also of great assistance with problem resolution in the field. Field personnel should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present.

8.0 REFERENCES

1. Standard References for Monitoring Wells, Massachusetts Department of Environmental Protection, WSC-310-91, 1991.

APPENDIX: DEFINITIONS

Annulus: The measured width between the borehole wall and the outside of the well screen or riser pipe.

Bentonite Seal: A granular, chip, or pellet-size bentonite material that is often used to provide an annular seal above the well screen filter pack. This seal is typically installed dry followed by in-place hydration with or without the addition of water. Hydrated bentonite is sometimes used as a grout seal.

Bottom Cap/Plug: Threaded or slip-on cap placed at the bottom of the well prior to installation. Often serves as a sump for accumulation of silt which settles within the well. The measured length from the lowermost well screen slot to the bottom of the bottom cap is known as the sump or tail pipe portion of the well.

Centralizers: Stainless steel expansion clamps which, when fitted to well screens or riser pipe, expand to contact the borehole walls positioning the well centrally within the open borehole. Centralizers assist with even positioning and distribution of filter pack and sealant materials and assist with maintaining well plumbness.

Expansion Cap/Well Cap: Cap used to cover the opening at the top of the well riser pipe. Expansion caps are equipped with a rubber gasket and threaded wing nut which, when turned, provides a watertight seal. Expansion caps may also be locked, and generally are recommended for use with flush-constructed wells where road box protective casings are also used. Other well caps may include slip-on or threaded caps made of the same material as the well casing.

Filter Pack: A well-graded, clean sand or gravel placed around the well screen to act as a filter in preventing the entry of very fine soil particles into the well.

Grout Seal: A cement/bentonite mixture used to seal a borehole that has been drilled to a depth greater than the final well installation depth or to seal the remaining borehole annulus once the well has been installed. Occasionally, pure cement or pure bentonite is used as a grout seal.

Measuring Point: A selected point at the top of the well casing (riser pipe) used for obtaining periodic water-level measurements. The measuring point should consist of either a notch or indelibly marked point on the upper surface of the casing. Typically, the highest point on the casing (if not level) is used as the measuring point. The measuring point is also the point that is surveyed when well elevation data is obtained.

Protective Casing: A locking metal casing, placed around that portion of the well riser pipe that extends above the ground surface. The protective casing is generally cemented in place when the concrete pad is constructed around the well.

Riser Pipe: The section of unperforated well casing material used to connect the well screen with the ground surface. Frequently, it is made of the same material and has the same diameter as the well screen. Riser pipe is typically available pre-cleaned and pre-threaded for immediate use.

Road Box: A protective casing that is flush-mounted with the ground around a well installation. Road boxes are used in areas where the monitoring well cannot extend above the ground surface for traffic or security reasons. Road boxes usually require a special key to open.

Tremie Pipe: A small diameter pipe which fits in the open borehole annulus and is used to inject filter sands or hydrated seal materials under pressure.

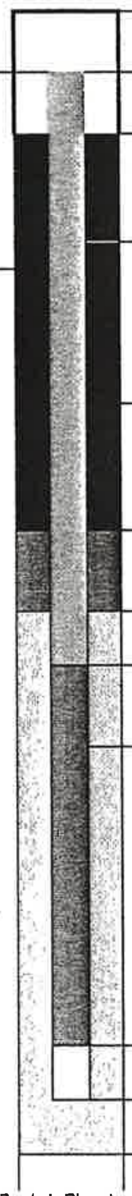
Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. Typically a well screen is purchased pre-slotted, pre-cleaned, and pre-threaded for immediate use.

Vent Hole: Small diameter hole drilled in the upper portion of the well riser pipe which provides atmospheric venting of the well. Allows for constant equilibration of the water level with changing atmospheric conditions. In flood-prone areas, or with flush-mount wells, vent holes should not be used.

Figure 1 Monitoring Well Construction Detail

ENSR	*Client:*	WELL ID:
	Project Number:	
	Site Location:	*Date installed:*
	Well Location: *Coords:*	*Inspector:*
	Method:	*Contractor:*

MONITORING WELL CONSTRUCTION DETAIL



	Depth from G.S. (feet)	Elevation(feet) Datum ______
Top of Steel Guard Pipe	______	______
Top of Riser Pipe	______	______
Ground Surface (G.S.)	0.0	______
Top of Bentonite	______	______
Top of Sand	______	______
Top of Screen	______	______
▼ Stabilized Water Level	______	______
Bottom of Screen	______	______
Bottom of Tail Pipe:	______	______
Bottom of Borehole	______	______

Measuring Point for Surveying & Water Levels

Cement, Bentonite, Bentonite Slurry Grout, or Native Materials

______ % Cement

______ % Bentonite

______ % Native Materials

Riser Pipe:

- Length ______
- Inside Diameter (ID) ______
- Type of Material ______

Bottom of Steel Guard Pipe

Bentonite Seal Thickness ______

Screen:

- Length ______
- Inside Diameter (ID) ______
- Slot Size ______
- Type of Material ______

Type/Size of sand ______

Sand Pack Thickness ______

Bottom of Tail Pipe: Length ______

Borehole Diameter ______

Approved:

______ Signature

______ Date

Describe Measuring Point:

______

D-4: SOP 7221 – Monitoring Well Development

ENSR

SOP NUMBER: 7221

Monitoring Well Development	
Date:	4^{th} Qtr., 1994
Revision Number:	2
Author:	Charles Martin
Discipline:	Geosciences

1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This SOP describes the methods used for developing newly installed monitoring wells and/or existing wells which may require redevelopment/rehabilitation. This SOP is applicable to monitoring wells and/or small diameter recovery wells and piezometers.

Monitoring well development and/or redevelopment is necessary for several reasons:

- To improve/restore hydraulic conductivity of the surrounding formations as they have likely been disturbed during the drilling process, or may have become partially plugged with silt,
- To remove drilling fluids (water, mud), when used, from the borehole and surrounding formations, and
- To remove residual fines from well filter materials and reduce turbidity of groundwater, therefore, reducing the chance of chemical alteration of groundwater samples caused by suspended sediments.

Respective state or federal agency (regional offices) regulations may require specific types of equipment for use or variations in the indicated method of well development. Deviations from this SOP to accommodate other regulatory requirements should be reviewed in advance of the field program, should be explained in the project work plan, and must be documented in the field project notebook when they occur.

1.2 General Principles

Well development generally involves withdrawal of an un-specified volume of water from a well using a pump, surge block or other suitable method such that, when completed effectively, the well is in good or restored hydraulic connection with the surrounding water bearing unit and is suitable for obtaining representative groundwater samples or for other testing purposes.

1.3 Quality Assurance Planning Considerations

Field project personnel should follow specific quality assurance guidelines as outlined in the site-specific Quality Assurance Project Plan (QAPP) and/or Sampling Plan. The plan should indicate the preferred method of well development at a particular site based on project objectives, aquifer conditions, and agency requirements. Specific well performance criteria such as low turbidity values to be achieved following well development should also be specified as well as any requirements for collection/containerization and disposal of well development water.

1.4 Health and Safety Considerations

Monitoring well development may involve chemical hazards associated with materials in the soil or aquifer being characterized and may involve physical hazards associated with use of well development equipment. When wells are to be installed and developed on hazardous waste investigation sites, a Health and Safety Plan must be prepared and approved by the Health and Safety Officer before field work commences. This plan must be approved by the project Health and Safety Officer before work commences, must be distributed to all field project personnel, and must be adhered to as field activities are performed.

2.0 RESPONSIBILITIES

2.1 Project Geologist/Engineer

Development or oversight of development of new monitoring wells is the responsibility of the project geologist/engineer involved in the original installation of the well. Records of well development methods and results will be retained in the project file.

2.2 Project Manager

The project manager is responsible for ensuring that the appropriate method of well development has been chosen which best meets project objectives, site hydrogeologic conditions, and/or relevant regulatory requirements.

3.0 REQUIRED MATERIALS

Well development can be performed using a variety of methods and equipment. The specific method chosen for development of any given well is governed by the purpose of the well, well diameter and materials, depth, accessibility, geologic conditions, static water level in the well, and type of contaminants present, if any.

The following list of equipment, each with their own particular application, may be used to develop and/or purge monitoring wells.

3.1 Bailer Purging

A bailer is used to purge silt-laden water from wells after using other devices such as a surge block. In some situations, the bailer can be used to develop a well by bailing and surging, often accompanied with pumping. A bailer should be used for purging in situations where the depth to static water is greater than 25 feet and/or where insufficient hydraulic head is available for use of other development methods.

3.2 Surge Block Development

Surge blocks are commercially available for use with Waterra™-type pumping systems or may be manufactured using a rubber or teflon "plunger" attached to a rod or pipe of sufficient length to reach the bottom of the well. Well drillers usually can provide surge blocks if requested. A recommended design is shown in Figure 1.

3.3 Pump Development

A pump is often necessary to remove large quantities of silt-laden ground water from a well after using the surge block. In some situations, the pump alone can be used to develop the well and remove the fines by overpumping. Since the purpose of well development is to remove suspended solids from a well and surrounding filter pack, the pump must be capable of moving some solids without damage. The preferred pump is a submersible pump which can be used in both shallow and deep ground water situations. A centrifugal pump may be used in shallow wells but will work only where the depth to static ground water is less than approximately 25 feet. Pumping may not be successful in low-yielding aquifer materials or in wells with insufficient hydraulic head.

3.4 Other Required Materials:

- Well development records (Figure 2)
- Health and Safety equipment
- Equipment decontamination materials

- Water quality instrumentation: nephelometer, pH, temperature, specific conductance meters, as required

- Field project notebook/pen

4.0 METHOD

4.1 General Preparation

4.1.1 Well Records Review: Well completion diagrams should be reviewed to determine well construction characteristics. Formation characteristics should also be determined from review of available boring logs.

4.1.2 Site Preparation: Well development, similar to groundwater sampling, should be conducted in as clean an environment as possible. This usually requires, at a minimum, placing sheet plastic on the ground to provide a clean working area for development equipment.

4.1.3 IDW Containment: Provisions should be in place for collection and management of investigation-derived wastes (IDW), specifically well development water and miscellaneous expendable materials generated during the development process. The collection of IDW in drums or tanks may be required depending on project-specific requirements. The QAPP should specify the requirements for IDW containment.

4.1.4 Water Level/Well Depth Measurement: The water level and well depth should be measured with a water level indicator and written on the well development record. This information is used to calculate the volume of standing water (i.e., the well volume) within the well.

4.1.5 Equipment Decontamination: All down-well equipment should be decontaminated prior to use in accordance with ENSR SOP-7600 (Decontamination of Equipment).

4.1.6 Removal of Drilling Fluids: Drilling fluids such as mud or water, if used during the drilling and well installation process, should be removed during the well development procedure. It is recommended that a minimum of 1.5 times the volume of added fluid be removed from the well during development. Drilling muds should initially have been flushed from the drilling casing during the well installation procedure with water added during the flushing process. If the quantity of added fluid is not known or could not be reasonably estimated, removal of a minimum of 10 well volumes of water is recommended during the development procedure.

4.2 Development Procedures

4.2.1 Development Method Selection

The construction details of each well shall be used to define the most suitable method of well development. Some consideration should be given to the potential degree of contamination in each well as this will impact IDW containment requirements.

The criteria for selecting a well development method include well diameter, total well depth, static water depth, screen length, the likelihood and level of contamination, and characteristics of the geologic formation adjacent to the screened interval.

The limitations, if any, of a specific procedure are discussed within each of the following procedures.

4.2.2 General Water Quality Measurements

Measure and record water temperature, pH, specific conductance, and turbidity periodically during development using the available water quality instruments. These measurements will aid in determining whether well development is proceeding efficiently, will assist in identifying when well development is complete, will determine whether the development process is effective or not with any given well and, potentially, may identify well construction irregularities (i.e., grout in well, poor well screen slot-size selection). Water quality parameters should be checked a minimum of 3 to 5 times during the development process.

4.2.3 Bailer Procedure

- As stated previously, bailers shall preferably not be used for well development but may be used in combination with a surge block to remove silt-laden water from the well.

- When using a bailer to purge well water; select the appropriate bailer, then tie a length of bailer cord onto the end of it.

- Lower the bailer into the screened interval of the monitoring well. Silt, if present, will generally accumulate within the lower portions of the well screen.

- The bailer may be raised and lowered repeatedly in the screened interval to further simulate the action of a surge block and pull silt through the well screen.

- Remove the bailer from the well and empty it into the appropriate storage container.

- Continue surging/bailing the well until sediment-free water is obtained. If moderate to heavy siltation is still present, the surge block procedure should be repeated and followed again with bailing.

- Check water quality parameters periodically.

4.2.4 Surge Block Procedure

- A surge block effectively develops most monitoring wells. This device first forces water within the well through the well screen and out into the formation, and then pulls water back through the screen into the well along with fine soil particles. Surge blocks may be manufactured to meet the design criteria shown in the example (Figure 1) or may be purchased as an adaptor to fit commercially available well purging systems such as the Waterra system.

- Insert the surge block into the well and lower it slowly to the level of static water. Start the surge action slowly and gently above the well screen using the water column to transmit the surge action to the screened interval. A slow initial surging, using plunger strokes of approximately 3 feet, will allow material which is blocking the screen to separate and become suspended.

- After 5 to 10 plunger strokes, remove the surge block and purge the well using a pump or bailer. The returned water should be heavily laden with suspended silt and clay particles. Discharge the purged water into the appropriate storage container.

- Repeat the process. As development continues, slowly increase the depth of surging to the bottom of the well screen. For monitoring wells with long screens (greater than 10 feet) surging should be undertaken along the entire screen length in short intervals (2 to 3 feet) at a time. Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material.

- Check water quality parameters periodically.

4.2.5 Pump Procedure

- Well development using only a pump is most effective in monitoring wells that will yield water continuously. Theoretically, pumping will increase the hydraulic gradient and velocity of groundwater near the well by drawing the water level down. The increased velocity will move residual fine soil particles into the well and clear the well screen of this material. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge.

- When using a submersible pump or surface pump, set the intake of the pump or intake line in the center of the screened interval of the monitoring well.

- Pump a minimum of three well volumes of water from the well and raise and lower the pump line through the screened interval to remove any silt/laden water.

- Continue pumping water from the well until sediment-free water is obtained. This method may be combined with the manual surge block method if well yield is not rapid enough to extract silt from the surrounding formations.

- Check water quality parameters periodically.

4.2.6 Compressed Gas Procedure

- Although the equipment used to develop a well using this method is more difficult to obtain and use, well development using compressed gas is considered to be a very effective method. This method is also not limited by well depth, well diameter, or depth to static water. Caution must be exercised, however, in highly permeable formations not to inject gas into the formation. Drilling subcontractors will often provide the necessary materials as well as perform this method , if requested. When using a compressor, an oil-less compressor should be used, or an oil trap/filter should be placed on the air discharge line which enters the well.

- Lower the gas line into the well, setting it near the bottom of the screened interval. Install the discharge control equipment (i.e., tee fitting) at the well head.

- Set the gas flow rate to allow continuous discharge of water from the well.

- At intervals during gas-lifting, especially when the discharge begins to contain less suspended material , shut off the air flow and allow the water in the well to backflush through the screened interval to disturb any bridging that may have occurred. Re-establish the gas flow when the water level in the well has returned to the pre-development level.

- Continue gas-lifting and/or jetting until the discharged water is free from suspended material.

- Check water quality parameters periodically.

5.0 QUALITY CONTROL

A well has been successfully developed when one or more of the following criteria are met:

- The sediment load in the well has been eliminated or greatly reduced. Regulatory requirements may be in place which state that water turbidity values ranging from 5 to 50 NTU must be achieved at the end of the development procedure. Use of a nephelometer is required during the well development procedure to measure water turbidity if meeting a specific turbidity value is required by the regulations. Attaining low turbidity values in fine-grained formations may be difficult to achieve.

- Permeability tests conducted in accordance with ENSR SOP-7720 (Hydraulic Conductivity Testing) yield repeatable hydraulic conductivity values.

6.0 DOCUMENTATION

The Monitoring Well Development Record (Figure 2) will be completed by the geologist or hydrogeologist conducting the development. In addition, a field project notebook should be maintained detailing any problems or unusual conditions which may have occurred during the development process.

7.0 TRAINING/QUALIFICATIONS

Well development procedures vary in complexity. It is recommended that initial development attempts be supervised by more experienced personnel. Field personnel should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present.

8.0 REFERENCES

Standard References for Monitoring Wells, Massachusetts Department of Environmental Protection, WSC-310-91, 1991.

APPENDIX: DEFINITIONS

Bridging: A condition within the filter pack outside the well screen whereby the smaller particles are wedged together in a manner that causes blockage of pore spaces.

Hydraulic Conductivity: a characteristic property of aquifer materials which describes the permeability of the material with respect to flow of water.

Hydraulic Connection: A properly installed and developed monitoring well should have good hydraulic connection with the aquifer. The well screen and filter material should not provide any restriction to the flow of water from the aquifer into the well.

Permeability Test: Used to determine the hydraulic conductivity of the aquifer formation near a well screen. Generally conducted by displacing the water level in a well and monitoring the rate of recovery of the water level as it returns to equilibrium. Various methods of analysis are available to calculate the hydraulic conductivity from these data.

Static Water Level: The water level in a well that represents an equilibrium or stabilized condition, usually with respect to atmospheric conditions in the case of monitoring wells.

Well Surging: That process of moving water in and out of a well screen to remove fine sand, silt and clay size particles from the adjacent formation.

Well Purging: The process of removing standing water from a well to allow surrounding formation water to enter the well.

Well Screen: That portion of the well casing material that is perforated in some manner so as to provide a hydraulic connection to the aquifer. The perforated, or slotted, portion of a well is also known as the screened interval.

Figure 1
Recommended Surge Block Design

SURGE BLOCK DESIGN
(Not to Scale)

Steel washers should be 1/2" to 3/4" smaller in diameter than the well ID. Gasket can be rubber or leather and should be the same diameter or 1/8" smaller than the well ID to compensate for swelling of the leather/ Rod can be steel, fiberglass, or plastic but must be strong and lightweight.

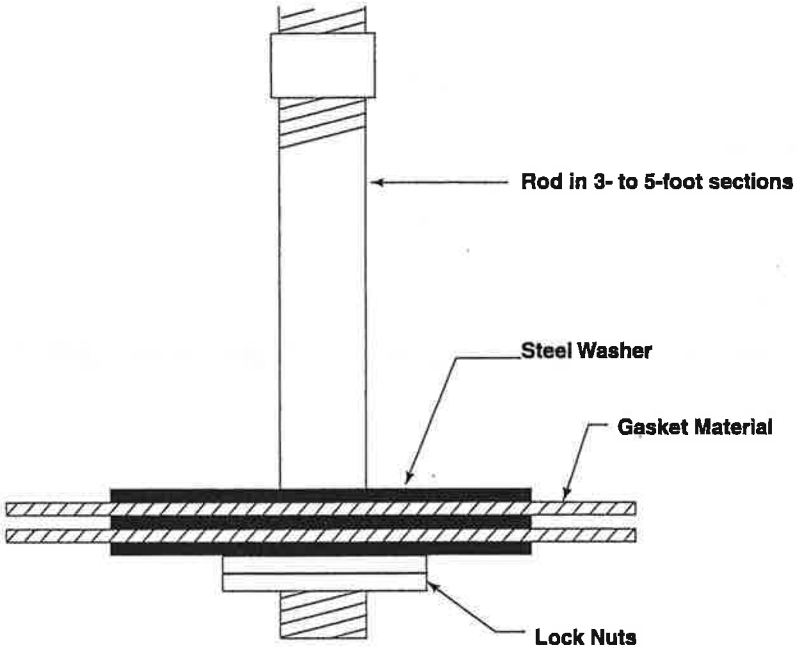


Figure 2
Well Development Record

ENSR

MONITORING WELL DEVELOPMENT RECORD

DATE: ______________________ WELL I.D.: ______________________

PROJECT NAME: ______________________ LOCATION: ______________________

PROJECT NUMBER: ______________________ DEVELOPER: ______________________

☐ ORIGINAL DEVELOPMENT ☐ REDEVELOPMENT ORIGINAL DEVELOPMENT DATE: ______________________

WELL DATA	
Well Diameter: ________	Geology at Screened Interval:
Total Well Depth: ________	Likely Contaminants:
Depth to Top of Screen: ________	
Depth to Bottom of Screen: ________	Purge Water & Sediment Disposal Method:
Depth to Static Water Level: ________	

DEVELOPMENT METHOD	PURGE METHOD	PERMEABILITY TEST RESULTS

ACCEPTANCE CRITERIA

Signature: ______________________ Date: ____________

ENSR INTERNATIONAL

D-5: SOP 7130 – Groundwater Sample Collection from Monitoring Wells

SOP NUMBER: 7130

Groundwater Sample Collection from Monitoring Wells

Date:	November, 1999
Revision Number:	2
Author:	Charles Martin
Discipline:	Geosciences

1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This standard operating procedure (SOP) is concerned with the collection of valid and representative samples of groundwater from monitoring wells. The scope of this document is limited to field operations and protocols applicable during groundwater sample collection.

This SOP is written in a broad-based manner and considers the application of a variety of sampling equipment in the collection of representative groundwater samples. Respective state and/or federal agency regulations may require specific types of equipment to be used when applying this SOP to a particular project. The project manager should review the applicable regulatory requirements, if any, prior to the start of the field sampling program. Deviations from this SOP to accommodate regulatory requirements should be reviewed in advance of the field program and documented in the project work plan.

1.2 Quality Assurance Planning Considerations

Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific QAPP. Proper quality assurance requirements should be provided which will allow for collection of representative samples from representative sampling points. Quality assurance requirements typically suggest the collection of a sufficient quantity of quality control (QC) samples such as field duplicate, equipment and/or field blanks and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements should be outlined in the QAPP. Additional information regarding quality assurance sample collection relevant to groundwater sampling is contained in Section 5.0 of this SOP.

1.3 Health and Safety Considerations

Groundwater sampling may involve chemical hazards associated with the materials being sampled. Adequate health and safety measures must be taken to protect project sampling personnel from potential chemical exposures or other hazards.

These measures must be addressed in the project Health and Safety Plan (HASP). This plan must be approved by the project Health and Safety Officer before work commences, must be distributed to all personnel performing sampling, and must be adhered to as field activities are performed.

2.0 RESPONSIBILITIES

2.1 Project Manager

The project manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and the project-specific work plan.

2.2 Sampling Technician

It is the responsibility of the sampling technician to be familiar with the sampling procedures outlined within this SOP and with specific sampling, quality assurance, and health and safety requirements outlined within project-specific work plans (Sampling Plan, HASP, QAPP). The sampling technician is responsible for collection of groundwater samples and for proper documentation of sampling activities as samples are being collected.

3.0 REQUIRED MATERIALS

Groundwater sampling objectives may vary significantly between projects. Project objectives should be defined within the project-specific work plans. The list of required materials below identifies the types of equipment which may be used for a range of groundwater sampling applications. From this list, a project-specific equipment list should be selected based upon project objectives and other factors such as the depth to groundwater, well construction, required purge volumes, and analytical parameters, among others. The various types of sampling equipment which may be used include:

<u>Well Purging Equipment</u>

- Bailers
- Bladder pumps
- Submersible pumps
- Peristaltic pumps
- Centrifugal Pumps
- Waterra™ pumps

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Field Instruments

- Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, dissolved oxygen (DO) oxidation reduction potential (ORP), and/or turbidity
- Water level measuring device
- Interface probe or product detection paste

Sampling Equipment

- Reusable or disposable bailers
- Peristaltic pump
- Bladder pump

Sample Preparation Equipment

- Filtration equipment
- Intermediate containers
- Sample kit (i.e., bottles, labels, preservatives, custody records, cooler)

General Equipment

- Project-specific sampling plans (SAP, QAPP, HASP)
- Sample collection records
- Field notebook/pen
- Waterproof marker pens
- Deionized water dispenser bottler
- Sample cup
- Buckets
- Coolers, or sample shuttles
- Instrument calibration solutions
- Power source (generator of 12V marine battery)
- Equipment decontamination supplies (refer to SOP 7600)
- Health and safety supplies
- First-Aid kit
- Tool box

Expendable Materials

- Deionized water supply

- Disposable bailer string (nylon or polypropylene)
- 0.45 micron filters
- Paper towels
- Plastic sheeting
- Ice/blue ice for sample preservation
- Disposable latex powder-free glove liners
- Disposable nitrile gloves
- Plastic trash bags
- Ziplock® bags

This equipment list was developed to aid in field organization and should be used in preparation for each sampling event. Depending on the site-specific sampling plan, additional material and equipment may be necessary and should be determined before the scheduled sampling event. Similarly, not all of the items shown in this list may be necessary for any one sampling event.

Additional SOPs are also available which provide procedures for different aspects of groundwater sampling. These SOPs include:

- ENSR SOP 7121, Field and Laboratory Measurement of pH
- ENSR SOP 7122, Field and Laboratory Measurement of Dissolved Oxygen
- ENSR SOP 7123, Field and Laboratory Measurement of Temperature
- ENSR SOP 7124, Field and Laboratory Measurement of Specific Conductance
- ENSR SOP 7125, Field and Laboratory Measurement of Turbidity
- ENSR SOP 7131, Field Filtration of Water Samples for Inorganics
- ENSR SOP 7510, Packaging and Shipment of Samples
- ENSR SOP 7600, Decontamination of Equipment

4.0 METHOD

4.1 Instrument Calibration

Field instruments will be calibrated according to the requirements of the project-specific plan and water quality SOPs (see Section 3.0).

4.2 Sampling Preparation

Before opening the well, a clean working surface shall be set up around the well head using a plastic sheet with slit cut in the middle. Prior to opening the well, the required health and safety gear (as specified in the HASP) shall be donned. This, at a minimum, usually means wearing gloves to limit the potential for exposure to contaminants as well as reduce the potential for handling-induced contamination of sampling equipment.

4.3 Well Security and Condition

At each monitoring well location, observe the conditions of the well and surrounding area. The following information shall be noted on the Groundwater Sample Collection Record (Attachment 1 or 2) or in the field notebook:

- Condition of the wells identification marker
- Condition of the well lock and associated locking cap
- Integrity of the well - protective outer casing, obstructions or kinks in the well casing, presence of water in the annular space, and the top of the interior casing
- Condition of the general area surrounding the well

4.4 Measuring Point Determination

Before collecting a water level measurement, check for an existing measuring point (notch, or other visible mark) established either at the time of well installation or by the latest survey. Generally, the measuring point is referenced from the top of the well casing (TOC), not the protective casing. If no measuring point exists, a measuring point should be established, clearly marked, and identified on the Groundwater Sample Collection Record or the field logbook. The same measuring point should be used for subsequent sampling events.

4.5 Free Product Determination

Wells that may potentially contain free product should be assessed for product with an interface probe or product detection paste. Interface probes generally operate on the same principle as a water level tape although they are designed to register water and product levels usually with different audible tones. Product paste generally is used in combination with some type of measuring tape which is lowered into the well with a coating of paste applied to it. Wells containing free product are generally not used for groundwater sampling, since the concentration of contaminants present in the free product can adversely effect the quality of the water sample, lending to a non-representative water sample.

4.6 Water Level Measurement

To obtain a water level measurement, lower the probe of a water level measuring device into the well until the audible sound of the unit is detected or the light on an electronic sounder illuminates. At this time the precise measurement should be determined (to nearest 0.01 feet) by repeatedly raising and lowering the tape to converge on the exact measurement. Obtain the reading of the TOC measuring point. The water level measurement should be entered on the Groundwater Sample Collection Record or in the field records.

The measurement device shall be decontaminated immediately after use with a non-phosphatic detergent and rinsed with distilled water. Generally, only that portion of the tape which enters the water table should be cleaned. It is important that the measuring tape is never placed directly on the ground surface or allowed to become kinked. Measuring devices, including interface probes, which come into contact with free product will likely require more thorough decontamination (see SOP 7600).

4.7 Purge Volume Calculation

Wells designated for sampling require purging to remove stagnant water in the well. A single casing volume of groundwater will be calculated after measuring the length of the water column and checking the well casing diameter. The Groundwater Sample Collection Record provides information used to compute the casing volume, which includes: a diagram, a numerical conversion table, and the standard calculation. The volume of standing water in the well (ie., one purge volume) should be entered on the Groundwater Sample Collection Record.

4.8 Well Purging Methods and Procedures

4.8.1 Objectives

Prior to sample collection, purging must be performed for all groundwater monitoring wells to remove stagnant water from within the casing and gravel pack and to ensure that a representative groundwater sample is obtained.

There are three general types of non-dedicated equipment used for well purging and include: bailers, surface pumps and down-well pumps. The purge method and equipment selected should be specified in the project-specific work plans.

NOTE: This SOP only describes the most common equipment and methods used for purging. Other purging equipment, as well as dedicated equipment, can be used provided that the method employed does not have an adverse affect on the overall quality of the groundwater.

Regardless of the purge method, purge water temperature, pH, and specific conductance will be monitored at predetermined purge volumes and recorded on the Groundwater Sample Collection Record. Additional water quality parameters may be required by the project-specific sampling plan. In general, purging will be considered complete following the withdrawal of at least 3 to 5 well volumes of groundwater <u>and</u> when all field parameters have stabilized to within 10% of their preceding measurements.

Purging a well to dryness may occur under some low-yield conditions. When the well recovers, a cascading effect may occur within the screened zone which can volatilize some organic compounds. This may be considered inappropriate by regulatory agencies when volatile organic compounds (VOC) are the target analyte of interest. Purging a well to dryness, then sampling after it has recovered may be acceptable for other target analytes, however. Under low yield conditions, low-flow sampling pumps such as bladder pumps may be required for VOC sample collection.

4.8.2 Bailing

<u>General</u>

Bailing is often the most convenient method for well purging especially if only a small volume of purge water is required during the purge routine. Bailers are constructed using a variety of materials including PVC, polyethylene, stainless steel, and Teflon®. Teflon® bailers are generally most "inert" and are available in reusable and disposable form. Disposable polyethylene bailers are relatively inert and inexpensive. Reusable stainless steel and PVC bailers must be decontaminated between uses. Most commercially available bailers are constructed to fit into a 2-inch diameter well, although other bailer diameters are available.

Waterra™ foot valves are essentially bailer check valves which manually thread onto the bottom of standard pump tubing (polyethylene, teflon). The foot valves are commercially available in a variety of diameters in stainless steel, Teflon®, and high-density plastic (Delrin). The foot valves operate by manually or mechanically raising and lowering the valve assembly within the water column which raises the water level within the discharge tube. Flow rates usually in the vicinity of 1 gallon per minute can be achieved with these devices.

Measurements of the pumping rate, temperature, pH, and specific conductance (and/or other parameters as required) should be made after each purge volume is removed and documented on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been withdrawn and the field parameters have stabilized to within 10% of their preceding measurement. Project-specific sampling objectives may require that the sample be collected with a bailer.

Bailing presents two potential problems with well purging. First, increased suspended solids may be present in samples as a result of the turbulence caused by raising and lowering the bailer through the water column. High solids concentrations may affect sample representativeness. Second, bailing may be less feasible for deep wells or wells which require a large volume of water to be removed during purging because of the time involved with continuous insertion and removal/emptying of the bailer.

Bailing Procedure

Obtain a clean bailer and a spool of clean polypropylene or nylon bailer cord. Uncover the top end of the bailer and tie a bowline knot, or equivalent, through the bailer loop. Test the knot and the bailer itself to ensure that all knots and parts are secure prior to inserting the bailer into the well.

Remove the protective wrapping from the bailer, and lower the bailer to the bottom of the monitoring well and cut the cord at a proper length. Bailer rope should never touch the ground surface at any time during the purge routine. Tie a hand loop at the end of the bailer cord.

Raise the bailer by grasping a section of cord using each hand alternatively in a "rocking" action. This method requires that the sampler's hands be kept approximately 2-3 feet apart and that the bailer rope is alternately looped onto or off each hand as the bailer is raised and lowered.

Grab the bailer with one hand as it emerges from the well. Pour the bailed groundwater from the bailer into a graduated bucket to measure the purged water volume. Repeat this procedure until one complete purge volume of water is removed from the well.

At the end of one complete well purge volume, place a small of purged water into a sample cup. Measure temperature, pH and specific conductance (and for other assigned parameters) and record the results on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been withdrawn and the specific field parameters have stabilized to within 10% of their preceding measurement.

4.8.3 Surface Pumps

General

Well purging using pumps located at the ground surface can be performed with peristaltic or centrifugal pumps if the water level in the well is within approximately 20 feet of the top of the well.

Peristaltic pumps provide a low rate of flow typically in the range of 0.02-0.2 gallons/minute (75-750 ml/min). For this reason, peristaltic pumps are not particularly effective for well purging. Peristaltic pumps are suitable for purging situations where disturbance of the water column must be kept minimal for particularly sensitive analyses.

Centrifugal pumps are designed to provide a high rate of pumping, in the range of 5 to 40 gallons/minute (gpm), depending on pump capacity. Discharge rates can also be regulated somewhat, provided the pump has an adjustable throttle. These pumps also require polyethylene or teflon-lined polyethylene tubing as suction line. The pump may also require priming to initiate flow.

Peristaltic Pump Procedure

Attach a new suction and discharge line to the peristaltic pump. Silicon tubing must be used through the pump head and must meet the pump head specifications. A second type of tubing may be attached to the silicon tubing for use as the suction and discharge lines. The secondary tubing material, usually consisting of polyethylene or teflon-lined polyethylene, should be compatible with the target analytes. The suction line must be long enough to extend to the static groundwater surface and reach further should drawdown occur during pumping.

Measure the length of the suction line and lower it down the monitoring well until the end is in the upper foot or more of the water column. Start the pump and direct the discharge into a graduated bucket. Adjust the pumping rate with the speed control knob so that a smooth flowing discharge is attained.

Measure the pumping rate in gallons per minute by recording the time required to fill a calibrated bucket. The pumping shall be monitored to assure continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts.

Measurements of temperature, pH and specific conductance (and/or other assigned parameters) should be made after each well purge volume and documented on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been removed and the specific field parameters have stabilized to within 10% of their preceding measurement. Project-specific sampling objectives may require that the sample be collected with a bailer.

Centrifugal Pump Procedure

Attach a new suction and discharge line to the centrifugal pump. Start the pump and record the stabilized rate of discharge. As with other well purging systems, measurement of temperature, pH, and specific conductance (or other parameters as required) will be made after each well purge volume has been removed. These measurements shall be recorded on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been removed and the field parameters have stabilized to within 10% of their preceding measurement. Project-specific sampling objectives may require that the sample be collected with a bailer.

4.8.4 Down-Well Pumps

General

Groundwater withdrawal using non-dedicated down-well pumps may be performed with a submersible pump or a bladder pump.

Electric submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than 20 feet and where the depth or diameter of the well requires that a large purge volume be removed before sample collection.

Commonly available submersible pumps include the Johnson-Keck pump model SP-82, the Grunfos Ready-Flow 2 pump, and disposable marine galley pumps, all of which are suited for operation in 2-inch or larger internal diameter wells.

Recently, the use of bladder pumps (positive gas-displacement pumps) has been promoted by the EPA for use in well purging and sampling primarily because the pumps can be operated at low flow rates (less than 1 liter per minute). Bladder pumps generally reduce the potential turbidity of the sample and theoretically reduce the potential for loss of VOC constituents, ultimately providing a more representative groundwater sample. Use of bladder pumps may require additional time for purging and sampling because of the low flow rate. Please note, however, that when using bladder pumps, it may not be necessary to purge an entire well volume of water prior to each check of the water quality parameters. Well purging is accomplished at such a low rate that, theoretically, the influent flow into the pump represents groundwater flow through the well screen, thereby eliminating the requirement for purging several entire well volumes of water before sample collection.

Bladder pumps usually consist of a stainless steel pump housing with an internal teflon or polyethylene bladder. Discharge tubing is generally made from teflon, polyethylene, or teflon-lined polyethylene. The pump is operated by lowering it into the water column within the well screen, then pulsing air into the bladder with an air compressor and pump controller unit. Pumps and controllers are often not interchangeable between manufacturers, therefore, it is usually necessary to have both items provided by the same manufacturer. Pump bladders are generally field-serviceable and replaceable.

A check of well condition may be required prior to inserting any down-well pump if the well has not been sampled for some time or if groundwater quality conditions are not known. The well condition check should include a check of casing plumbness as a bent well casing could cause a pump to get stuck. Casing plumbness can be checked by lowering a clean cylindrical tube with the approximate pump dimensions into the well. If the well casing is not plumb then an alternative purging method should be used.

The well inspection should also include a check of air quality or headspace conditions within the well for potentially explosive gasses and a check for free product which could foul the pump. Well casing headspace conditions can be monitored with a photoionization detector (PID) and/or an explosimeter for the presence of potentially explosive gasses. If potentially hazardous conditions exist, then an alternative purging method should be used. In general, it is rare for explosive conditions to be present.

The presence of free product should be determined before inserting the submersible pump into the well because free product may contaminate the pump's internal mechanisms making it extremely difficult to decontaminate.

An interface probe should be used to check for free product. Refer to Section 4.5 of this SOP for additional information on free product determination.

Electric Submersible Pump Procedure

Once the above well conditions have been assessed, and assuming its safe to proceed, slowly lower the submersible pump with attached discharge line into the monitoring well taking notice of any roughness or restriction within the well riser pipe. The pump should be placed in the uppermost section of the static water column of the monitoring well. The power cord should be attached to the discharge line with an inert material (i.e., zip-ties) to prevent the power cord from getting stuck between the pump, discharge line, and the well casing. Secure the discharge line and power cord to the well casing, using tape or a clamp, taking care not to crimp or cut either the discharge line or power cord.

Connect the power cord to the power source (i.e., rechargeable battery pack, auto battery, or generator) and turn the pump on. Voltage and amperage meter readings on the pump controller (if provided) should be monitored closely during purging. The operations manual for the specific pump used should be reviewed regarding changes in voltage/amperage and the potential impacts on pump integrity. Pumping should be discontinued if warning conditions occur and/or if the well is pumped to where drawdown falls below the pump's intake level.

If drawdown continues to the extent that the well is pumped dry, the pump should be shut off and the well allowed to recharge. This on/off cycle may be necessary in order to purge the well properly.

Measurements of the pumping rate, temperature, pH, and specific conductance (and/or other required parameters) should be made after each purge volume is removed and documented on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required purge volume has been withdrawn and the field parameters have stabilized to within 10% of their preceding measurement. Project-specific sampling objectives may require that the sample be collected with a bailer.

Bladder Pump Procedure

To operate the bladder pump system, the pump and discharge line should be lowered into the well close to the bottom of the well screen, then secured to the well casing with a clamp. The air compressor should then be turned on to activate pumping. The pump controller is used to vary the discharge rate to the required flow.

Measurements of the pumping rate, temperature, pH, and specific conductance (and/or other required parameters) should be made at periodic intervals while water is removed and documented on the Groundwater Sample Collection Record or in the field logbook. Samples may be collected after the required field parameters have stabilized to within 10% of their preceding measurement. Generally, because of the low flow rate, samples are usually obtained from the bladder pump discharge line.

4.9 Sample Collection Methods and Procedures

4.9.1 Objectives

Groundwater samples can be collected using similar methods employed for purging, provided these methods do not adversely affect the quality of the groundwater. These methods include bailing, surface pumping and down-well pumping.

In most cases during sampling, groundwater will be transferred to the appropriate containers directly for the discharge source. During transfer, discharge tubing and other equipment shall not contact the inside of the sample containers. In addition, a clean pair of nitrile or latex gloves will be worn during sample collection and handling.

As a general rule of thumb, samples should be collected in order of decreasing volatilization of the target parameters. The preferred order of sample collection is as follows: volatile organic compounds, extractable organic compounds (e.g., semivolatile organic compounds, PCBs, pesticides), metals, and general water chemistry (ions and turbidity).

4.9.2 Bailers

The methods and procedures described in Section 4.9.2 also apply to collecting groundwater samples with a bailer. If a bailer was used to purge the well, the same bailer may be used for sampling. If other well purging equipment was used, a decontaminated or new disposable bailer should be used for sampling.

When volatile organic compounds are the target sampling parameter, a bottom discharge tip should be used during sample transfer. A discharge tip restricts the outflow of the sample from the bailer and diminishes the potential for volatilization. Reusable bailers may require a special screw-on tip fitted with a bottom discharge top. Disposable bottom discharge tips are usually supplied with disposable bailers.

Bailer cord shall be discarded after sampling is completed. Disposable bailers should only be used in one well. Reusable bailers should be appropriately decontaminated between uses.

4.9.3 Surface Pumps

The methods and procedures described in Section 4.9.3 for peristaltic and centrifugal pumps also apply to groundwater sample collection.

Peristaltic Pumps

Peristaltic pumps equipped with the appropriate type tubing will be used to collect groundwater from wells in which the water resides at a depth less than 20 feet. Sample bottles shall be filled directly from the pump's discharge line and care shall be taken to keep the discharge tube from contacting the sample container.

Groundwater samples requiring filtration prior to placement in sample containers can be placed in intermediate containers for subsequent filtration, or may be filtered directly with in-line disposable 0.45-micron filters, as described in SOP 7131.

After sampling is complete, all used tubing and filters shall be disposed of appropriately.

Centrifugal Pumps

Centrifugal pumps are generally not recommended for use in sample collection, especially when volatile organic compounds are the target analyte of interest. Samples for other analytes, however, may be obtained with use of an in-line sample trap. It is suggested that if samples cannot be obtained before going through the pump, that samples be obtained by using a bailer once purging is complete and pumping has ceased. Collecting samples from the pump discharge is not recommended.

After sampling is complete, all suction line tubing should be disposed of properly.

4.9.4 Down-Well Pumps

Electric Submersible Pump

Using the pump methods described in Section 4.9.4, groundwater samples can be collected directly from the pump discharge line, provided the discharge line is composed of inert material. Sample bottles will be filled directly from the discharge line of the pump. This method is generally not recommended for collection of volatile organic samples.

After sampling is complete, the pump, discharge line and power cord shall be decontaminated according to the procedures contained in SOP 7600 and/or disposed of as required by the project-specific work plan.

Bladder Pumps

Groundwater samples, including those collected for VOC analysis, may be collected directly from the pump discharge tubing under active pumping conditions. Sample bottles will be filled directly from the discharge line of the pump.

After sampling is complete, the pump, discharge line and power cord shall be decontaminated according to the procedures outlined in SOP 7600 and/or disposed of as required by the project-specific work plan.

4.10 Sample Filtration

The filtration of groundwater samples will be performed in accordance with SOP 7131. Groundwater samples collected for total dissolved metals analyses will be filtered prior to being placed in sample containers and properly preserved. Groundwater filtration will be performed using a peristaltic pump and a 0.45-micron in-line water filter. Disposable filters are commonly available in 0.45-micron size. Low-capacity or high-capacity cartridges are available and may be selectively used based on sample turbidity.

The filtration of groundwater samples shall be performed either directly from the pump discharge line or from laboratory-supplied intermediate containers. In either case, well purging shall be performed first. Fresh groundwater shall then be filtered directly into sample containers.

4.11 Sample Handling

All samples collected should be packaged and handled according to SOP 7510 and the project-specific sampling plan. Preservatives should be used where analytical methods require preservation. The QAPP will indicate the type of sample preservation necessary.

5.0 QUALITY CONTROL

5.1 Field Blank/Equipment Blank Sample Collection

Field blank samples serve as a quality assurance check of equipment and field conditions at the time of sampling. Field blank samples are usually prepared by transferring analyte-free water into a clean set of sample containers, then analyzing it as a sample. Sometimes, the analyte-free water is transferred over or through the sampling device before it is placed into the sample containers. This type of field blank sample is known as an equipment blank. The QAPP contains specific information regarding the type and number of field blanks or equipment blanks required for collection.

5.2 Field Duplicate Sample Collection

Field duplicate samples are collected for the purpose of providing two sets of results for comparison. These samples are used to assess precision. Duplicate samples are usually prepared by splitting the sample into two sets of sample containers, then analyzing each set as a separate sample. The QAPP contains specific information regarding the type and number of duplicate samples for collection.

5.3 MS/MSD Sample Collection

MS/MSDs provide information about the effect of the sample matrix on digestion and measurement methodology. For samples submitted for MS/MSD analysis, triple sample volume is generally required (contact the analytical laboratory for information specific to the project analytical parameters). The QAPP contains specific information regarding the frequency of MS/MSD samples.

6.0 DOCUMENTATION

Specific information regarding sample collection should be documented in several areas: the sample chain-of-custody record, sample collection record, field notebook, and sample labels, tags. Additional information regarding each form of documentation is presented in the following paragraphs:

6.1 Sample Chain-of-Custody Record

This ENSR standard form requires input of specific information regarding each collected sample for laboratory analytical purposes. The information requested includes site name and location, project number, field notebook reference, collection date and type of analysis requested. Each sample submitted for analysis is also listed individually using its field identification number, number and type of container, and requested analyses (see SOP 7510).

6.2 Groundwater Sample Collection Record

This form (Attachment 1 or 2) requires input of specific information regarding the collection of each individual sample including sample identification, water quality parameters, collection method, and containers/preservation requirements.

6.3 Field Logbook

This logbook should be dedicated to the project and should be used by field personnel to maintain a general log of activities throughout the sampling program. This logbook should be used in support of, and in combination with, the sample collection record. Documentation within the logbook should be thorough and sufficiently detailed to present a concise, descriptive history of the sample collection process.

6.4 Sample Labels/Tags

Sample labels shall be completed at the time each sample is collected and attached to each sample container. Labels will include the information listed below.

- Client or project name/project number
- Sample number
- Sample designation
- Analysis type
- Preservative
- Sample collection date
- Sample collection time
- Sampler's name

The project-specific work plan may also require the use of sample tags which generally contain the same information as the sample labels. Sample tags, if used, should be tied to each sample bottle with wire ties.

7.0 TRAINING/QUALIFICATIONS

Groundwater sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling attempts be supervised by more experienced personnel. Sampling technicians should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials are considered to be present.

8.0 REFERENCES

EPA, Handbook for Sampling and Sample Preservation of Water and Wastewater, EPA-600/4-82-029, September 1982.

EPA, RCRA Groundwater Monitoring Technical Enforcement Guidance, November 1992.

Geotrans, Inc., RCRA Permit Writer's Manual, Groundwater Protection, prepared for the U.S. EPA, Contract No. 68-01-6464, October 1983.

Code of Federal Regulations, Chapter 40 (Section 261.4(d)).

Attachment 1 Ground Water Sample Collection Record
Attachment 2 Low Flow Ground Water Sample Collection Record

ENSR

Attachment 1
Groundwater Sample Collection Record

ENSR.

Well/Piezo ID:

Ground Water Sample Collection Record

Client: ______________________ Date: ________
Project No: ______________________ Time: Start ________ am/pm
Site Location: ______________________ Finish ________ am/pm
Weather Conds: ____________ Collector(s) ____________

WATER LEVEL DATA: (measured from Top of Casing) Well ☐ Piezometer ☐

a. Total Well Length ________ c. Casing Material ______ e. Length of Water Column ________

b. Water Table Depth ________ d. Casing Diameter ______ f. Calculated Well Volume (see back) ____

WELL PURGING DATA

a. Purge Method ______________________

b. Acceptance Criteria defined (from workplan)
- Minimum Required Purge Volume (@ ______ well volumes) ______________
- Maximum Allowable Turbidity ________ NTUs
- Stabilization of parameters ________ %

c. Field Testing Equipment Used: Make Model Serial Number

____

____

d. Field Testing Equipment Calibration Documentation Found in Field Notebook # ______ Page #______

Time	Volume Removed (gal)	T° (C/F)	pH	Spec. Cond (umhos)	Turbidity (NTUs)	DO	Color	Odor	Other

e. Acceptance criteria pass/fail	Yes	No	N/A
Has required volume been removed	☐	☐	☐
Has required turbidity been reached	☐	☐	☐
Have parameters stabilized	☐	☐	☐

If no or N/A - Explain below.

____

____

SAMPLE COLLECTION: Method: ______________________

Sample ID	Container Type	No. of Containers	Preservation	Analysis	Time

Comments ______________________

____

Signature ______________________ Date ______________________

ENSR

Attachment 2
Low Flow Ground Water Sample Collection Record

ENSR

Well ID:

Low Flow Ground Water Sample Collection Record

Client: ____________ Date: ____________ Time: Start ______ am/pm
Project No: ____________ Finish ______ am/pm
Site Location: ____________
Weather Conds: ____________ Collector(s): ____________

1. WATER LEVEL DATA: (measured from Top of Casing)

a. Total Well Length ______ c. Length of Water Column ______ (a-b) Casing Diameter/Material

b. Water Table Depth ______ d. Calculated System Volume (see back) ______ ____________

2. WELL PURGE DATA

a. Purge Method: ____________

b. Acceptance Criteria defined (see workplan)

- Temperature	3%	-D.O.	10%
- pH	± 1.0 unit	- ORP	± 10mV
- Sp. Cond.	3%	- Drawdown	< 0.3'

c. Field Testing Equipment used: Make Model Serial Number

Time (24hr)	Volume Removed (Liters)	Temp. (°C)	pH	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (feet)	Color/Odor

d. Acceptance criteria pass/fail

	Yes	No	N/A
Has required volume been removed	☐	☐	☐
Has required turbidity been reached	☐	☐	☐
Have parameters stabilized	☐	☐	☐

If no or N/A - Explain below.

(continued on back)

3. SAMPLE COLLECTION: Method: ____________

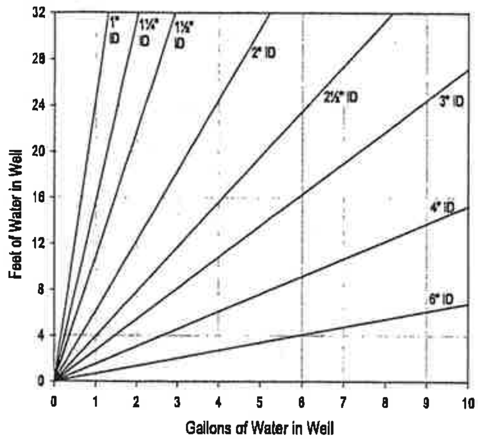
Sample ID	Container Type	No. of Containers	Preservation	Analysis Req.	Time

Comments ____________

Signature ____________ Date ____________

R

Purge Volume Calculation



Volume / Linear Ft. of Pipe		
ID (in)	Gallon	Liter
0.25	0.0025	0.0097
0.375	0.0057	0.0217
0.5	0.0102	0.0386
0.75	0.0229	0.0869
1	0.0408	0.1544
1.25	0.0637	0.2413
1.5	0.0918	0.3475
2	0.1632	0.6178
2.5	0.2550	0.9653
3	0.3672	1.3900
4	0.6528	2.4711
6	1.4688	5.5600

(continued from front)

Time (24 hr)	Volume Removed (Liters)	Temp (°C)	pH	Spec. Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	Flow Rate (ml/min)	Drawdown (ft)	Color/Odor

D-6: USEPA Low Stress Groundwater Sampling

United States Environmental Protection Agency
Office of Research and Development
Office of Solid Waste and Emergency Response
EPA/540/S-95/504
April 1996

EPA Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

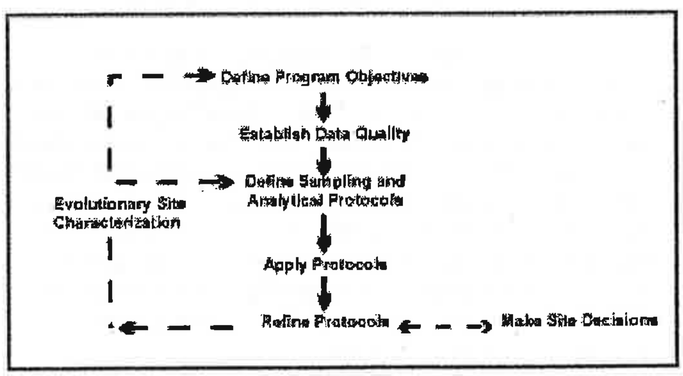

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:
- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action.*

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g. , pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:
- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. *Low-Permeability Formations (<0.1 L/min recharge)*

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. *Fractured Rock*

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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Figure 2. **Ground Water Sampling Log**

Project ______________ **Site** ______________ **Well No.** ____________ **Date** ____________________

Well Depth ___________ **Screen Length** _________ **Well Diameter** ________ **Casing Type** ___________

Sampling Device ______________ **Tubing type** ____________________ **Water Level** _________________

Measuring Point __________________ **Other Infor** ____

____

Sampling Personnel ____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc			Notes

Type of Samples Collected

____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi\ r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project ______________ **Site** ______________ **Well No.** ____________ **Date** ________________

Well Depth ____________ **Screen Length** __________ **Well Diameter** _________ **Casing Type** ___________

Sampling Device ______________ **Tubing type** ____________________ **Water Level** _______________

Measuring Point __________________ **Other Infor** ____

____

Sampling Personnel ____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

D-7: SOP 7600 – Decontamination of Equipment

ENSR

SOP NUMBER: 7600

Decontamination of Field Equipment		
	Date:	4th Qtr. 1994
	Revision Number:	4
	Author:	Charles Martin
	Discipline:	Geosciences

1.0 PURPOSE AND APPLICABILITY

1.1 Purpose and Applicability

This SOP describes the methods to be used for the decontamination of field equipment used in the collection of environmental samples. The list of field equipment may include a variety of items used in the collection of soil and/or water samples, such as split-spoon samplers, trowels, scoops, spoons, bailers and pumps. Heavy equipment such as drill rigs and backhoes also require decontamination, usually in a specially constructed temporary decontamination area.

Decontamination is performed as a quality assurance measure and a safety precaution. Improperly decontaminated sampling equipment can lead to misinterpretation of environmental data due to interference caused by cross-contamination. Decontamination protects field personnel from potential exposure to hazardous materials. Decontamination also protects the community by preventing transportation of contaminants from a site.

This SOP emphasizes decontamination procedures to be used for decontamination of reusable field equipment. Occasionally, dedicated field equipment such as well construction materials (well screen and riser pipe) or disposable field equipment (bailers or other general sampling implements) may also require decontamination prior to use. The project-specific work plan should indicate the specific decontamination requirements for a particular project.

Respective state or federal agency (regional offices) regulations may require specific types of equipment or procedures for use in decontamination of field equipment. The project manager should review the applicable regulatory requirements, if any, prior to the start of the field investigation program.

1.2 General Principles

Decontamination is accomplished by manually scrubbing, washing, or spraying equipment with detergent solutions, tap water, distilled/deionized water, steam and/or high pressure water, or solvents. The decontamination method and agents are generally determined on a project-specific basis and must be stated in the Quality Assurance Project Plan (QAPP).

Generally, decontamination of equipment is accomplished at each sampling site between collection points. Waste decontamination materials such as spent liquids and solids will be collected and managed as investigation-derived waste for later disposal. All decontamination materials, including wastes, should be stored in a central location so as to maintain control over the quantity of materials used or produced throughout the investigation program.

1.3 Quality Assurance Planning Considerations

1.3.1 General Considerations

Sampling personnel should follow specific quality assurance guidelines as outlined in the site-specific QAPP. The QAPP guidelines typically require collection of equipment blank samples in order to determine the effectiveness of the decontamination procedure.

The decontamination method, solvent, frequency, location on site and the method of containment and disposal of decontamination wash solids and solutions are dependent on site logistics, site-specific chemistry, and nature of the contaminated media to be studied and the objectives of the study. Each topic must be considered and addressed during development of a decontamination strategy and should be outlined in the Quality Assurance Project Plan (QAPP).

1.3.2 Solvent Selection

There are several factors which need to be considered when deciding upon a decontamination solvent. The solvent should not be an analyte of interest. The sampling equipment must be resistant to the solvent. The solvent must be evaporative or water soluble or preferably both. The applicable regulatory agency may have specific requirements regarding decontamination solvents. The QAPP should specify the type of solvent to be used for a particular project.

The analytical objectives of the study must also be considered when deciding upon a decontamination solvent. Pesticide-grade methanol is the solvent of choice for general organic analyses. It is relatively safe and effective. Hexane, acetone, and isopropanol are sometimes used as well. A 10% nitric acid in deionized water solution is the solvent of choice for general metals analyses. Nitric acid can be used only on Teflon, plastics and glass. If used on metal equipment, nitric acid will eventually corrode the metal and lead to the introduction of metals to the collected samples. Dilute hydrochloric acid is usually preferred over nitric acid when cleaning metal sampling equipment.

Equipment decontamination should be performed a safe distance away from the sampling area so as not to interfere with sampling activities but close enough to the sampling area to maintain an efficient working environment. If heavy equipment such as drill rigs or backhoes are to be decontaminated, then a central decontamination station should be constructed with access to a power source and water supply.

1.4 Health and Safety Considerations

Decontamination procedures may involve chemical exposure hazards associated with the type of contaminants encountered or solvents employed and may involve physical hazards associated with decontamination equipment. When decontamination is performed on equipment which has been in contact with hazardous materials or when the quality assurance objectives of the project require decontamination with chemical solvents, the measures necessary to protect personnel must be addressed in the project Health and Safety Plan (HASP). This plan must be approved by the project Health and Safety Officer before work commences, must be distributed to all personnel performing equipment decontamination, and must be adhered to as field activities are performed.

2.0 RESPONSIBILITIES

2.1 Sampling Technician

It is the responsibility of the sampling technician to be familiar with the decontamination procedures outlined within this SOP and with specific quality assurance, and health and safety requirements outlined within project-specific work plans (HASP, QAPP). The sampling technician is responsible for decontamination of field equipment and for proper documentation of decontamination activities. The sampling technician is also responsible for ensuring that decontamination procedures are followed by subcontractors when heavy equipment requires decontamination.

2.2 Field Project Manager

The field project manager is responsible for ensuring that the required decontamination procedures are followed at all times. The project manager is also responsible for ensuring that subcontractors construct and operate their decontamination facilities according to project specifications. The project manager is responsible for collection and control of IDW in accordance with project specifications.

3.0 REQUIRED MATERIALS

- Decontamination agents (per work plan requirements):
    - LIQUI-NOX, ALCONOX, or other phosphate-free biodegradable detergent,
    - Tap water,
    - Distilled/deionized water,
    - Nitric acid and/or hydrochloric acid,
    - Methanol and/or hexane, acetone, isopropanol.
- Health and Safety equipment
- Chemical-free paper towels
- Waste storage containers: drums, 5-gallon pails w/covers, plastic bags
- Cleaning containers: plastic buckets or tubs, galvanized steel pans, pump cleaning cylinder
- Cleaning brushes
- Pressure sprayers
- Squeeze bottles
- Plastic sheeting
- Aluminum foil
- Field project notebook/pen

4.0 METHODS

4.1 General Preparation

4.1.1 It should be assumed that all sampling equipment, even new items, are contaminated until the proper decontamination procedures have been performed on them or unless a certificate of analysis is available which demonstrates the items cleanliness.

Field equipment that is not frequently used should be wrapped in aluminum foil, shiny side out, and stored in a designated "clean" area. Small field equipment can also be stored in plastic bags to eliminate the potential for contamination. Field equipment should be inspected and decontaminated prior to use if the equipment appears contaminated and/or has been stored for long periods of time. Unless customized procedures are stated in the QAPP for decontamination of equipment, the standard procedures specified in this SOP shall be followed.

4.1.2 Establish the decontamination station within an area that is convenient to the sampling location. If single samples will be collected from multiple locations, then a centralized decontamination station, or a portable decontamination station should be established.

4.1.3 An investigation-derived waste (IDW) containment station should be established at this time also. The project-specific work plan should specify the requirements for IDW containment. In general, decontamination solutions are discarded as IDW between sampling locations. Solid waste is disposed of as it is generated.

4.2 Decontamination for Organic Analyses

4.2.1 This procedure applies to soil sampling and groundwater sampling equipment used in the collection of environmental samples submitted for organic constituents analysis. Examples of relevant items of equipment include split-spoons, trowels, scoops/spoons, bailers, and other small items. Submersible pump decontamination procedures are outlined in Section 4.4.

4.2.2 Decontamination is to be performed before sampling events and between sampling points.

4.2.3 After a sample has been collected, remove all gross contamination from the equipment or material by brushing and then rinsing with available tap water.

This initial step may be completed using a 5-gallon pail filled with tap water. Steam or a high-pressure water rinse may also be conducted to remove solids and/or other contamination.

4.2.4 Wash the equipment with a phosphate-free detergent and tap water solution. This solution should be kept in a 5-gallon pail with its own brush.

4.2.5 Rinse with tap water or distilled/deionized water until all detergent and other residue is washed away. This step can be performed over an empty bucket using a squeeze bottle or pressure sprayer.

4.2.6 Rinse with methanol or other appropriate solvent using a squeeze bottle or pressure sprayer. Rinsate should be collected in a waste bucket.

4.2.7 Rerinse with deionized water to remove any residual solvent. Rinsate should be collected in the solvent waste bucket.

4.2.8 Allow the equipment to air-dry in a clean area or blot with chemical-free paper towels before reuse. Wrap the equipment in tin foil and/or seal it in a plastic bag if it will not be reused for a while.

4.2.9 Dispose of soiled materials and spent solutions in the designated IDW disposal containers.

4.3 Decontamination for Inorganic (Metals) Analyses

4.3.1 This procedure applies to soil sampling equipment used primarily in the collection of environmental samples submitted for inorganic constituents analysis. Examples of relevant items of equipment include split-spoons, trowels, scoops/spoons, bailers, and other small items.

4.3.2 For plastic and glass sampling equipment, follow the steps outlined in 4.2 above, however, use a 10% nitric acid solution (acid in water) in place of the solvent rinse in Section 4.2.6.

4.3.3 For metal sampling equipment, follow the steps outlined in 4.2 above, however, use a 10% hydrochloric acid solution (acid in water) in place of the solvent rinse in Section 4.2.6.

4.4 Decontamination of Submersible Pumps

4.4.1 This procedure will be used to decontaminate submersible pumps before and between ground-water sample collection points. This procedure applies to both electric submersible and bladder pumps. This procedure also applies to discharge tubing if it will be reused between sampling points.

4.4.2 Prepare the decontamination area if pump decontamination will be conducted next to the sampling point. If decontamination will occur at another location, the pump and tubing may be removed from the well and placed into a clean trash bag for transport to the decontamination area. Pump decontamination is easier with the use of 3-foot tall pump cleaning cylinders (i.e., Nalgene cylinder) for the various cleaning solutions, although the standard bucket rinse equipment may be used.

4.4.3 Once the decontamination station is established, the pump should be removed from the well and the discharge tubing and power cord coiled by hand as the equipment is removed. If any of the equipment needs to be put down temporarily, place it on a plastic sheet (around well) or in a clean trash bag. If a disposable discharge line is used it should be removed and discarded at this time.

4.4.4 As a first step in the decontamination procedure, use a pressure sprayer with tap water to rinse the exterior of the pump, discharge line, and power cord as necessary. Collect the rinsate and handle as IDW.

4.4.5 Place the pump into a pump cleaning cylinder or bucket containing a detergent solution (detergent in tap water). Holding the tubing/power cord, pump solution through the pump system. A minimum of one gallon of detergent solution should be pumped through the system. Collect the rinsate and handle as IDW.

4.4.6 Place the pump into another cylinder/bucket containing a 10% solution of solvent (methanol, or other designated solvent) in distilled/deionized water. Pump until the detergent solution is removed. Collect the rinsate and handle as IDW.

4.4.7 Place the pump into another cylinder/bucket containing distilled/deionized water. Pump a minimum of 3 to 5 pump system volumes (pump and tubing) of water through the system. Collect the rinsate and handle as IDW.

4.4.8 Remove the pump from the cylinder/bucket and if the pump is reversible, place the pump in the reverse mode to discharge all removable water from the system. If the pump is not reversible the pump and discharge line should be drained by hand as much as possible. Collect the rinsate and handle as IDW.

4.4.9 Using a pressure sprayer with distilled/deionized water, rinse the exterior of the pump, discharge line, and power cord thoroughly, shake all excess water, then place the pump system into a clean trash bag for storage. If the pump system will not be used again right away, the pump itself should also be wrapped with aluminum foil before placing it into the bag.

4.5 Decontamination of Large Equipment

4.5.1 Consult the QAPP for instruction on the location of the decontamination station and the method of containment of the wash solutions. On large projects usually a temporary decontamination facility (decontamination pad) is required which may include a membrane-lined and bermed area large enough to drive heavy equipment (drill rig, backhoe) onto with enough space to spread other equipment and to contain overspray. Usually a small sump with pump is necessary to collect and contain rinsate. A water supply and power source is also necessary to run steam cleaning and/or pressure washing equipment.

4.5.2 Upon arrival and prior to leaving a sampling site, all heavy equipment such as drill rigs, trucks, and backhoes should be thoroughly cleaned and then the parts of the equipment which come in contact or in close proximity to sampling activity should be decontaminated. This can be accomplished in two ways, steam cleaning or high pressure water wash and manual scrubbing. Following this initial cleaning, only those parts of the equipment which come in close proximity to the sampling activities (i.e., auger stems, rods, backhoe bucket) must be decontaminated in between sampling events.

Occasionally, well construction materials such as well screen and riser pipe may require decontamination before the well materials are used. These materials may be washed in the decontamination pad, preferably on a raised surface above the pad (i.e., on sawhorses), with clean plastic draped over the work surfaces. Well materials usually do not require a multistep cleaning process as they generally arrive clean from the manufacturer. Usually, a thorough steam-cleaning of the interior/exterior of the well materials will be sufficient. The QAPP should provide specific guidance regarding decontamination of well materials.

5.0 QUALITY CONTROL

5.1 Field Blank Sample Collection

General guidelines for quality control check of field equipment decontamination usually require the collection of one field blank from the decontaminated equipment per day. The QAPP should specify the type and frequency of collection of each type of quality assurance sample.

Field blanks are generally made by pouring laboratory-supplied deionized water into, over, or through the freshly decontaminated sampling equipment and then transferring this water into a sample container. Field blanks should then be labeled as a sample and submitted to the laboratory to be analyzed for the same parameters as the associated sample. Field blank sample numbers, as well as collection method, time and location should be recorded in the field notebook.

6.0 DOCUMENTATION

Specific information regarding decontamination procedures should be documented in the project-specific field notebook. Documentation within the notebook should thoroughly describe the construction of each decontamination facility and the decontamination steps implemented in order to show compliance with the project work plan. Decontamination events should be logged when they occur with the following information documented:

- Date, time and location of each decontamination event
- Equipment decontaminated
- Method
- Solvents
- Noteable circumstances
- Identification of field blanks and decontamination rinsates
- Method of blank and rinsate collection
- Date, time and location of blank and rinsate collection
- Disposition of IDW

Repetitive decontamination of small items of equipment does not need to be logged each time the item is cleaned.

7.0 TRAINING/QUALIFICATIONS

All sampling technicians performing decontamination must be properly trained in the decontamination procedures employed, the project data quality objectives, health and safety procedures and the project QA procedures. Specific training or orientation will be provided for each project to ensure that personnel understand the special circumstances and requirements of that project. Field personnel should be health and safety certified as specified by OSHA (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

8.0 REFERENCES

Not applicable.

APPENDIX E

Project Quantitation Limits

ANALYTE LIST AND PROJECT QUANTITATION LIMITS
Former National Plating Facility
Syracuse, New York

Analysis/Compound	Method	Estimated Quantitation Limits Water (ug/L)	Soil (ug/kg)	State of New York Standards Water (ug/L) [(a)]	Soil (ug/kg) [(b)]
Metals					
1 Antimony	SW6010B	0.006	5.0	0.003	
2 Arsenic	SW6010B	0.01	1	0.025	7.5
3 Barium	SW6010B	0.01	1	1	300
4 Beryllium	SW6010B	0.005	0.5	0.003	0.16
5 Cadmium	SW6010B	0.005	0.5	0.005	1
6 Chromium	SW6010B	0.01	1	0.05	10
7 Copper	SW6010B	0.03	2.5	0.2	25
8 Lead	SW6010B	0.01	0.5	0.025	400[(c)]
9 Mercury	SW7470A/7471A	0.0002	0.01	0.0007	0.1
10 Nickel	SW6010B	0.04	4	0.1	13
11 Selenium	SW6010B	0.01	1	0.01	2
12 Silver	SW6010B	0.01	1	0.05	
13 Thallium	SW7841	0.002	1	0.0005	
14 Zinc	SW6010B	0.02	2	2	20
*15 Vanadium	SW6010B	0.05	1	0.0005	150
*16 Cobalt	SW6010B	0.05	1		30
*17 Aluminum	SW6010B	0.2	20		
*18 Calcium	SW6010B	5	500		
*19 Iron	SW6010B	0.1	10	0.3	2000
*20 Magnesium	SW6010B	5	500	35	
*21 Manganese	SW6010B	0.015	1.5	0.3	
*22 Potassium	SW6010B	5	500		
*23 Sodium	SW6010B	5	500	20	
*24 Cyanide	SW9010A	0.01	0.01	200	
Chromium (Hexavalent)	SW3060A	10	N/A		

Notes:
N/A - Not Applicable
(a) - Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, NYSDEC, October 1993
(b) - Determination of Soil Cleanup Objectives and Cleanup Levels, NYSDEC, January 24, 1994
(c) - EPA Guidance on Residential Lead-Based Paint, Lead Contaminated Dust, and Lead Contaminated Soil, July 14, 1994

ANALYTE LIST AND PROJECT QUANTITATION LIMITS
Former National Plating Facility
Syracuse, New York

Analysis/Compound	Method	Estimated Quantitation Limits Water (ug/L)	Estimated Quantitation Limits Soil (ug/kg)	State of New York Standards Water (ug/L) [a]	State of New York Standards Soil (ug/kg) [b]
1,1,1-Trichloroethane	8260	1	5	5	0.8
1,1,2,2-Tetrachloroethane	8260	1	5	5	0.6
1,1,2-Trichloroethane	8260	1	5.0	1	
1,1-Dichloroethane	8260	1	5.0	5	0.2
1,1-Dichloroethene	8260	1	5.0	0.7	0.4
1,2-Dichloroethane	8260	1	5.0	0.6	0.1
1,2-Dichloropropane	8260	1	5.0	1	0.3
2-Butanone (MEK)	8260	5	25	50	0.3
2-Hexanone	8260	5	25	50	
4-Methyl-2-pentanone(MIBK)	8260	5	25	NA	1
Acetone	8260	5	25	50	0.2
Benzene	8260	1	5	1	0.06
Bromodichloromethane	8260	1	5	50	
Bromoform	8260	1	5	50	
Bromomethane	8260	1	5	5	
Carbon disulfide	8260	1	5	60	2.7
Carbon tetrachloride	8260	1	5	5	0.6
Chlorobenzene	8260	1	5	5	1.7
Chloroethane	8260	1	5	5	1.9
Chloroform	8260	1	5	7	0.3
Chloromethane	8260	1	5	5	
cis-1,2-Dichloroethene	8260	1	5	5	
cis-1,3-Dichloropropene	8260	1	5	0.4	
Dibromochloromethane	8260	1	5	50	
Ethylbenzene	8260	1	5	5	5.5
m+p-Xylene	8260	2	10	5	1.2
o-Xylene	8260	1	5	5	1.2
Methylene chloride	8260	1	5	5	0.1
Styrene	8260	1	5	5	
Tetrachloroethene	8260	1	5	5	1.4
Toluene	8260	1	5	5	1.5
trans-1,2-Dichloroethene	8260	1	5	5	
trans-1,3-Dichloropropene	8260	1	5	0.4	
Trichloroethene	8260	1	5	5	0.7
Vinyl chloride	8260	1	10	2	0.2

Notes:
N/A - Not Applicable
(a) - Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, NYSDEC, October 1993
(b) - Determination of Soil Cleanup Objectives and Cleanup Levels, NYSDEC, January 24, 1994

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